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# Get the Most from Mixing on Headphones
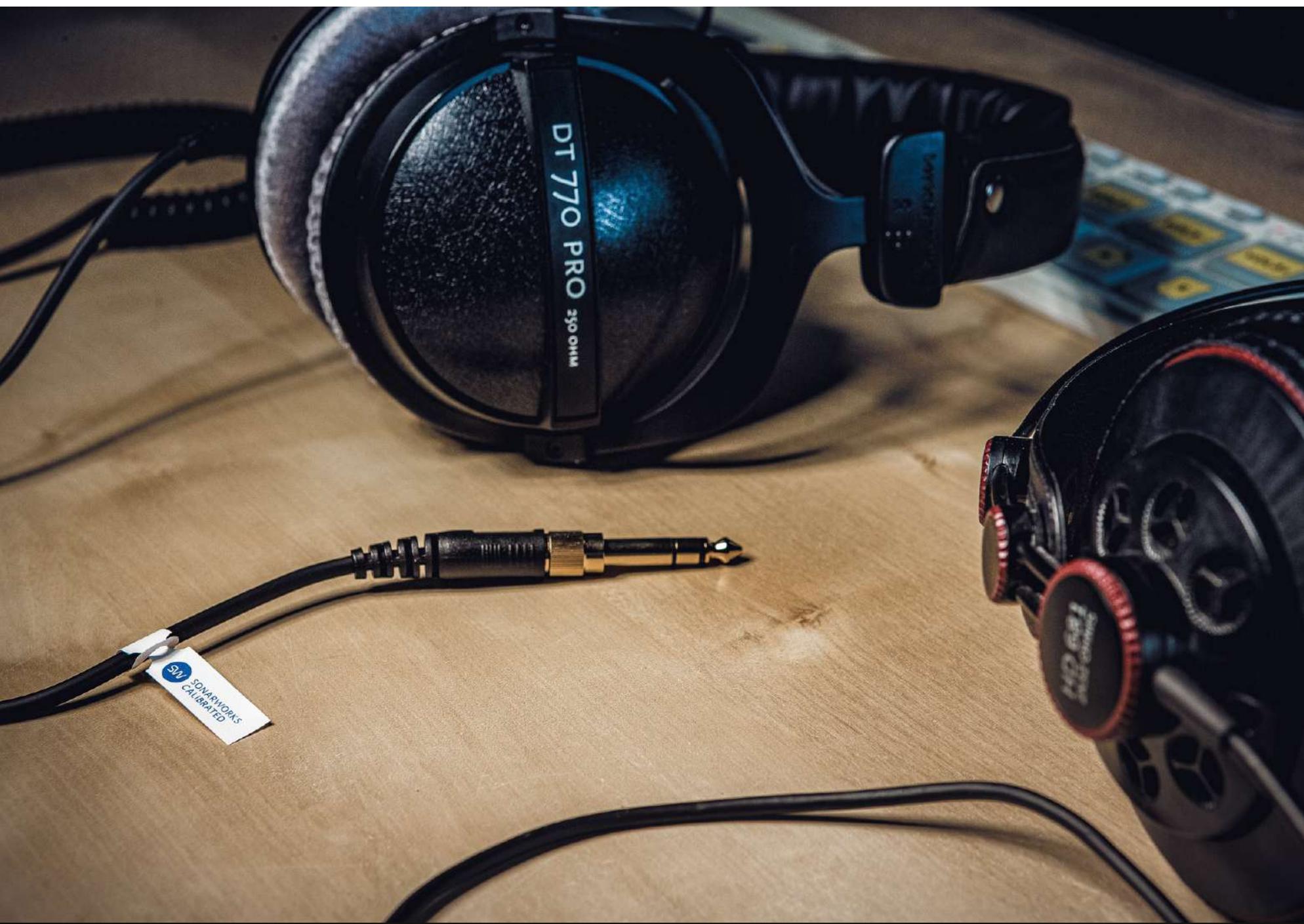
# Table of contents

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# Introduction

In 1979 Sony released the Walkman® portable cassette play and all of sudden people everywhere were walking around with headphones on, listening to music. Portable headphones were not great sounding devices and certainly wouldn't be used in a professional setting and cassettes, while portable, was not a great sounding medium. In 2001, Apple released the first iPod® mp3 player and brought decent sound, random access digital audio to the masses. Since then, headphones have been the principal way to listen to music.

Headphone use in the recording studio used to be limited to performers and an occasional reference check. In the last decade, high powered Laptops and personal computers with quality DAWs has brought headphone use into the world of music production. Audio producers and even commuters have access to affordable, high-quality headphones that can be used equally well as audio production tools or as portable phones that can be plugged into a smartphone while on the go.

In this eBook Brad Pack explores the pros and cons of mixing on headphones while David Glenn lets you in on some of his tips on how to get the most out of your headphones. We will open your eyes to some tools that can make headphone use more comfortable and Nick Messite will sum up the debate over whether speakers or headphones is the better way to work.

"I use whatever it takes to make the tracks identify what me and Guru are all about."

DJ Premier

# The Art of Mixing on Headphones

by Brad Pack

One of the most frustrating periods in your journey of becoming a professional producer or engineer is the "in-between" stage. You're not a novice anymore. You've got some experience under your belt, but you're not at the point in your career where you have a professionally-treated control room—not yet, anyway.

This is why it's so tempting to start mixing on headphones. Headphones are significantly cheaper than studio monitors and they allow you to make mix decisions without the acoustics of your room clouding your judgment. In fact, headphones offer a more consistent listening experience than some professionally treated studios, where the acoustics are limited by the often crowded environment. Additionally, headphones are affixed directly to your head, so you're free to move around without the sound changing.

Mixing on headphones, however, does come with a few drawbacks. In this article, we'll break down everything you need to know about mixing on headphones, including what to look for when purchasing a set of mixing headphones, how to overcome the limitations of mixing on headphones, and how to create mixes that translate to any system.

# Closed-Back vs Open-Back Headphones

It's important to find the right pair of headphones for mixing. Not all headphones are created equal. Conventional consumer headphones are designed to make music and movies sound exciting by hyping certain frequencies. In contrast, headphones designed for mixing should have a more flat frequency response. Not all studio headphones are created equally, either, and through thorough testing of hundreds of headphone models, Sonarworks has demonstrated that some headphones, like the Sennheiser HD650, actually produce a fairly flat and neutral frequency response, while other famous studio headphones are far from flat or neutral.

Each brand of headphones has a family sound, like the characteristic brightness of Beyerdynamic models or the subdued high-mids of the Audeze models. Personal taste should certainly play a role in choosing headphones that you can enjoy, but some models provide a measurably flatter and more neutral frequency response than others. If you have Sonarworks Reference 4 software installed, you can load up profiles of various headphones and easily compare the frequency response graphs for each model that interests you.



Reference 4 software displays the frequency response of four popular headphone modes. Beats Pro, Beyer DT770, Audio Technica M70X, and Sennheiser HD650 (shown L-R)

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When it comes to studio headphones, there are two basic types: closed-back and open-back. Closed-back headphones offer maximum isolation and are great for tracking, as they prevent the microphones from capturing bleed from a performer's headphones. However, this isolation comes at the cost of frequency response and stereo imaging. Due to their effective isolation, closed-back headphones create an exaggerated stereo spread, which can make it difficult to properly balance mixes. Some closed-back headphones also have an exaggerated low-end or "bass boost" effect, which sounds powerful, but may not be accurate.

Open-back headphones offer improved accuracy over closed-back headphones, making them ideal for mixing in studio environments. Open-back headphones, with their rear-vented speakers, can be heard clearly by those sitting nearby. While this makes them a bit impractical for recording or late-night mix sessions in your apartment, it significantly improves the frequency response, distortion, and possibly stereo imaging.

# Frequency Response

When it comes to mixing on headphones, one of the biggest drawbacks is frequency response. Due to their limited driver size and proximity to our ears, headphones simply cannot recreate the deep, rich lows or crisp, detailed highs the way that studio monitors can.

Since headphone drivers sit so close to our ears, we perceive the high frequencies to be louder than they actually are. To compensate for this, many headphone manufacturers roll-off the high-end by 3 dB or more. In order to keep size and weight down, headphones use compact divers which can not accurately produce low-frequency waveforms, which is why many manufacturers choose to artificially boost the low-end by using closed-back designs.

It can be extremely difficult to accurately judge low-end when mixing on headphones since you don't physically feel the bass emitting from the speaker in front of you. Our body responds to frequencies below about 60Hz via haptic or physical sensations in parts of our body other than our ears. It's quite common to see mixers excessively boost the lows because they can't feel the bass and also the headphones do not accurately produce low frequencies. Some headphone users are reporting good experiences using the Subpac tactile systems to enhance the feeling of bass response when using headphones.

To help make sure you're not boosting or cutting too much low-end, use a spectrum analyzer for visual feedback to confirm what you're hearing. Pay special attention to frequencies below 60Hz, as that is where most headphones begin to fall off.  For best results, take regular breaks and compare your mix with commercial reference mixes in a similar genre to your mix.

Calibration software like Sonarworks Reference 4 can also help correct the frequency response of your headphones, to provide a more accurate frequency response curve that translates well to speakers and other systems. Reference 4 software includes presets for over 300 headphone models, including popular models from AKG, Audio-Technica, Sennheiser, Sony and more.

## Stereo Imaging

Stereo imaging is another common problem with mixes done on headphones. Studio monitors are typically placed at 60-degree angles to the listening position, producing a phantom center image, where center-panned instruments sound like they're floating in front of you, between the speakers. Headphones position speakers 180 degrees to our ears, so their stereo image tends to be noticeably wider compared to studio monitors, which is why center-panned instruments sound like they're in-between your ears —

inside your head, instead of in front of it. Some newer headphones position their drivers at a 60-degree angle to the ear to simulate the positioning of loudspeakers.

Headphones also suffer from warped stereo imaging due to the lack of crossfeed, which is a term used to describe how much of the left or right channel bleeds into the opposite ear. Because your ears are on either side of your head, your left ear hears mostly the left monitor while it also hears the right speaker a little quieter, out of phase and slightly time-delayed. Crossfeed leads to a natural sense of space and three-dimensionality. On headphones, crossfeed doesn't happen—the left and right signals are completely isolated, which can be disorienting.

This makes it much more difficult to judge panning choices. Subtle panning moves are difficult to perceive, while hard-panning almost places sounds behind your ears. You may be tempted to pan sounds closer to the center when mixing on headphones to achieve a more natural sound. However, this often leads to narrow-sounding mixes, especially on speakers. On headphones, center-panned elements seem to be between your ears, instead of out in front of you, which leads to a "flat" soundstage.

Open-back headphones help introduce acoustic crossfeed for a more balanced sound. Plug-ins like CanOpener from Goodhertz and Waves Nx Virtual Mix Room simulate crossfeed and room acoustics to create a more natural listening experience. For best results, and especially when you're starting out, be sure to frequently check your mixes on a pair of studio monitors.

# Listen for Details

It's important to note that even if you rely on monitors for most of your work, it behooves you to listen carefully, at a moderate level, on a trusted pair of headphones to check your work for problems that were masked on loudspeakers. These problems include tiny clicks, pops and distortions from sloppy edits, clipped plugins, choppy automation, and digital clock problems.  You may also catch mix problems like sibilance, over-saturated processing or even just simple performance problems that could be edited better. To make a mix extra special, it's nice to find ways to add some subtle "candy" or cool effects that the listener may only notice in headphones. These special effects Easter Eggs keep each listen to a song fresh and interesting.

# Ear Fatigue

In general, mixing on headphones tends to cause ear fatigue more quickly than mixing on monitors. To make matters worse, when wearing headphones, we tend to listen to music more loudly than we should. Listening at high levels can cause headphones to sound unbalanced and can even cause permanent hearing damage.

To reduce ear fatigue, try using open-back headphones and mix at moderate levels. Be sure to check your mix at low levels and take frequent breaks when mixing to help reset your ears. Remember also, that underpowering headphones may cause extra distortion and poor response, so if you are planning on doing serious work on headphones, you may want to audition your headphones with a proper headphone amp. These needn't be expensive, as the Schiit Magni and other excellent amps beat almost any interface's built-in amp and are available for less than the price of most headphones.



Affordable and portable headphone amps from (L-R) Schiit, Audioquest and FiiO can improve the sound of your smartphone or laptop and properly drive power-hungry studio headphones

# Translation to Speakers

Due to all the factors listed above, it can be extremely difficult to achieve accurate translation when mixing on headphones. The environment we mix in is crucial to the way we hear sound. Without that physical space, it can be difficult to judge things like frequency, level balance, depth, and panning.

However, mixing on headphones also makes it possible to hear mixes in great detail—something that is not always possible through studio monitors. It can actually be easier to dial in details such as EQ and compression settings when mixing on headphones. Headphones are also great for checking for technical errors like pops, clicks and hiss. Plus, being able to carry your most trusted listening device with you anywhere you go is worth its weight in gold.

At the end of the day, the more practice you get mixing on your favorite headphones, the better your mixes will become. In the meantime, just remember to take frequent breaks, listen to reference tracks often and double-check your mixes on multiple systems. With these simple steps, you'll be well on your way to mixing professional-sounding tracks on your headphones in no time!

"I don't know how to function without music. When I'm not making it, I'm listening to it."

**Billie Eilish**

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Mixing on Headphones

# Techniques to Deliver Professional Results

by David Glenn

I used headphones exclusively for many years to mix professionally and they still play a vital role in my mixing process to this day. While nowadays I prefer to utilize multiple sets of monitors and check my mixes on several playback systems (obsessively—OCD is real), there are many scenarios, especially when traveling, where working on a trusty set of cans is the only option.

In this article, I'm going to share the techniques, tips, and tricks that I use on a daily basis to help you make your next mix with headphones your best mix yet.

## Can you really mix on headphones

Before we dive too deep into the techniques, I want to address the stigma associated with mixing on headphones. I believe this negative perception is fading due to popular mixers and content creators such as Andrew Scheps openly sharing their workflow and how they've capitalized on the benefits of mixing with cans. Not to mention that several studies have shown the vast percentage of people listening to music are in fact using headphones.

# The Goals of a Great Mix

There are many scenarios where mixing with headphones is your best option, but at the very foundation of choosing to mix with cans (or at least incorporating them into your process) is the fact that they're a great way to control your acoustic environment.

This is vital when mixing as having a trusted source on which to make decisions will allow you to make good choices when applying processing to the tracks in a song.

In order to accomplish our goals as music creators and ensure that we're releasing sonically sound art, we have to be able to hear things accurately. Or at the very least, close to accurate. A good pair of headphones is a great tool to help you achieve these goals when mixing.

At the core of the mixing process there are two fundamental goals:

1.  To create cohesion between the instruments in order to properly **convey the emotion of the song**.

2.  For the music to **translate well across multiple playback systems** (large stereos, clubs, earbuds, mobile devices, etc.).

We'll take a look at some of the issues that relying solely on headphones can present and then how to work around these "deficiencies." But first, a common question I see in my inbox and in YouTube comments is "What is the best type of headphones for mixing?"

# What Type of Headphones is Best for Mixing?

I want to share a brief look at the two main types of headphones: Open back and closed back.

## Closed back

Closed-back headphones are a great choice while recording because they aim to prevent sound from leaking to the outside world. This prevents any spill from hitting the microphone and allows for a clean capture of the source instrument.

## Open Back

Open-back headphones, on the other hand, will indeed spill a bit due to their acoustically transparent profile. This open-back design can help to prevent ear fatigue from setting in too quickly and is generally accepted as the default option for mixing and mastering.

I personally own a pair or two of each and will make my decision on which to use based on the environment that I'm working in. When I'm upstairs working around the kids playing or where there's noise that I don't want to disturb me from working I choose closed back. I used to fly quite a bit back when I was producing and recording more and would have to use closed-back cans while on a plane to get over the engine noise. Coffee shops? Editing? You guessed it… closed-back 'phones.

While there are pros to using closed-back cans, open back wins for me when mixing or mastering in just about every other scenario I can think of.

# Benefits and Limitations of Mixing on Headphones

Let's identify some of the benefits of mixing on headphones before listing the cons and ultimately addressing solutions to the potential problems that come with mixing on cans.

Several benefits include:

- Allow you to control your acoustic environment (sound the same no matter where you're working)
- Cheaper entry point than a good pair of studio monitors
- Isolate the sound from the outside world
- Work on the go or remotely
- Better able to hear the details
    - Setting reverb tails
    - Delays and "ear candy" effects are easier to shape and set up to taste
- Gives most people no excuse to just make music

Some limitations would be:

- Mixing the low-end without being able to physically feel the sub response of the music
- No headphone provides a flat frequency response out of the box
- Lack of inter-aural crosstalk
- Ear fatigue sets in much quicker than with monitors
- Headphones do change sound over time—mainly due to wear and tear of the earpads. Be sure to replace your earpads at least once every year. An inexpensive fix!

# My Favorite Tips, Tricks, and Techniques for Mixing on Headphones

Let's identify some of the benefits of mixing on headphones before listing the cons and ultimately addressing solutions to the potential problems that come with mixing on cans.

**Listen to a ton of music using your headphones**

I know, I know… You've heard this one before.

I get it, but honestly, it's a foundational technique to delivering quality mixes on headphones and it deserves to be mentioned first.

I do want to share a quick story that relates to learning your headphones… About 6 or 7 years ago and back when I relied heavily on my cans to get me through the mixing process, I was in the middle of a huge gospel project. I had about 3 or 4 songs where my final mixes were approved but we still had 13 or 14 more songs to mix for the album. Up until that point, I was comfortable mixing on the Beyerdynamic DT 770s. Well, as it happens in life, my 770s broke. No sound in the right ear… Toast!

Needless to say, I hopped on the phone and called every music store in town—I lived in Orlando, FL at the time and we had plenty of music stores. Nothing. I couldn't find the 770s in stock anywhere. Stressed and worried about my deadline I was talking to my good friend and fellow gear nut, Joey Fernandez, when he said "Dave, it's time to dump the 770s and move over to the Sennheiser HD 650s. I was scared. I was nervous to switch in the middle of such a big project but I trusted Joey and his ears with my life so I got on the phone and ordered a pair of the 650s right away. I picked them up… Pumped to put them to use I ripped open the box and felt the incredible comfort on my head. Okay! I can work with this…

Now, the true test… I went into my studio, plugged them in and hit play on the mix I was working through and… NO. Just. NO! I hated them… They were SO different from what I had used for years. They were nothing like I was used to and there was noooooo way I was going to finish that project using those headphones.

I called Joey. I was stressed. He encouraged me and said to give them some time. He told me to do what I knew was right and listen to a ton of music through them. I even watched a couple of movies that night using the 650s. By morning, I was a new man. I had learned what good music sounded like through these new headphones and I could get back to work.

It turned out, I loved the 650s and still rely on them today. Once I learned their strengths and weaknesses, I could begin to make better mixing decisions and flew through the rest of that project in no time. I actually ended up going back and making several huge improvements to the first few songs due to (in my opinion) the improved quality differences between my old busted cans and the new Sennheiser HD 650s.

## Step Away From The Cans

You heard me! Put them down…

Why, you ask? Because your headphones when placed out in front of you can serve as a set of small speakers. This is a great way to rest your ears and also check to see if anything in your mix is poking out. This is also a way to listen to how your mix will sound on smaller speakers in mono. While I don't personally check my mixes in mono, this is a nice little trick to give you that additional perspective. Just be careful not to crank them too hot like I did once… #ouch

## Pair Your Headphones with a Sub Pac

Remember Joey? I mentioned my friend Joey in the previous section about my Sennheiser HD 650s. Joey is a gear nut! When he speaks, I listen. I didn't use to listen quickly because he always seemed to have something new for me to check out and I'll be honest, it didn't help my marriage when my wife saw all of the shiny gear I was buying as a result of being friends with Joey.

But Joey has never let me down. His ear to help me correct weird frequencies in my mixes… his taste in music… gear… you name it! So when Joey introduced me to the SubPac I knew I had to listen. Wow! What an experience!

From the moment that I strapped the SubPac M2 tactile audio system onto my back, I fell in love with mixing in music all over again. What a tool!

If your cans don't do so well to reproduce the bottom end, check out the SubPac. If your cans do really well to reproduce the bottom end, check out the Sub Pac.

It's a must-have for me from now on and I can't ever see mixing without one.
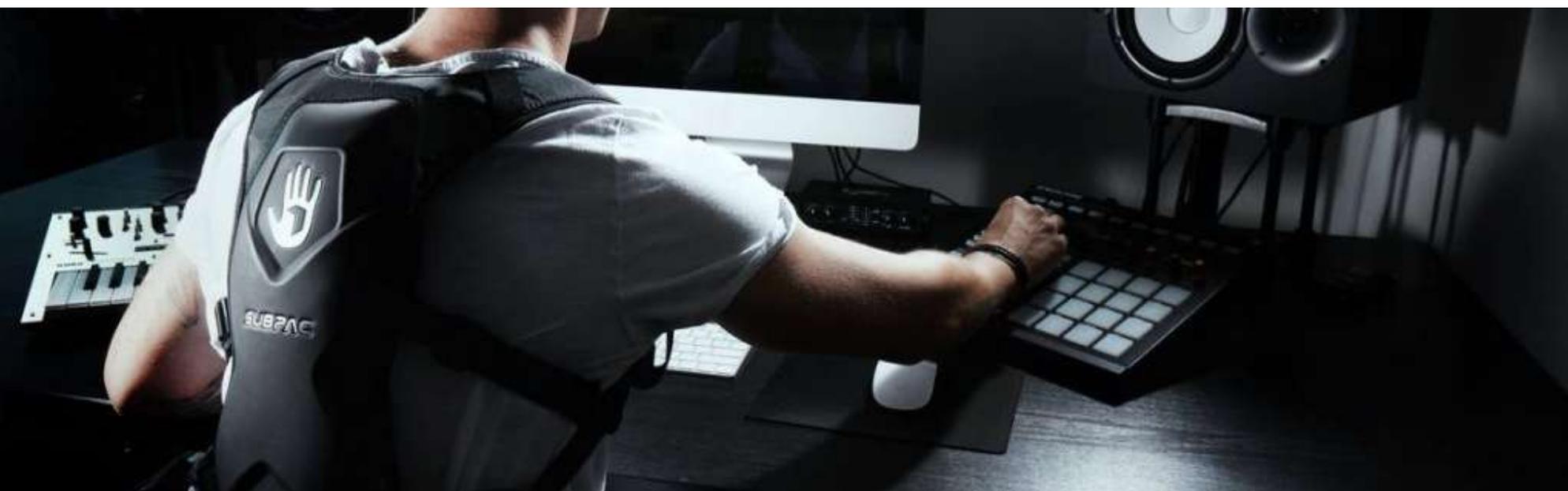


The SubPac M2x in action. Feel the bass!

## Mix at Lower Volumes

I get that you've probably heard this one as well but it's important and I had to share it. I do tend to crank the mix when I work on kick and bass, but outside of dealing with the low end, I try to be conservative with my listening level. You don't have to listen silly low but you definitely want to avoid jamming out while trying to make critical listening decisions.

## The Dave Pensado Referencing Trick

I saved the best for last as this technique is a game-changer. Actually, with no exaggeration, this is a life-changing technique. Because once I began to study industry mixes using this trick, I truly began to shape my own mixing career and the quality of my work went from zero to hero.

Inspired by an episode of Pensado's Place, I once saw Dave mention using an EQ on the stereo bus to limit the frequencies to only the subs. By placing a high-cut filter on the stereo bus, he listened to what was going on in only the bottom end. This would be similar to working in a professional, well-treated control room and turning off your mains but leaving the sub on. I saw this and my OCD went into hyperdrive. I have since not only used this technique to work the bottom end but to get a clear picture across all of the frequencies.

Here's how it works:

## Step 1. Choose Good Reference Tracks

If you don't already reference other mixes while you work, you do now. To kick things off with this technique I want you to select at least 2-3 reference mixes that are in the ballpark of the desired final result. If you're mixing for a band or artist, the references would ideally come from them and/or their producer.

This is one of the first questions I submit once a client has signed their proposal and is prepping to send me the multitracks.

Here are a couple of tips for choosing good references:

- Always level match before attempting this technique. Any referencing plugin worth its salt will have an auto-match feature. Use it.
- If you're mixing a modern song that resembles anything from the Billboard Hot 100, consider pulling in references from multiple genres. If you're mixing a hip hop track, don't be afraid to pull in some of the hot pop/country tracks or even a rock song (is rock on the hot 100 anymore?).
- Choose ONE SINGLE reference as your MAIN reference song. Ignore the last tip I gave you for this. You want your main reference song to be in a similar genre or at least represent the same sonic result that you're after AND you want your main reference to be in the same key or close to the same key as the song that you're mixing.
  - While helpful, choosing a song within the same key is not completely necessary, but it will allow you to more accurately reference things like kick drum fundamental, bass sub resonance, etc. At the very least, keep the key of the song in mind. If you start boosting sub frequencies into a kick and you don't get the same sub response as your reference track, it could simply be that the kick in the reference is tuned lower, thus the fundamental frequency will be different.

## Step 2. Set a High Cut Filter

Shown in the video below, insert an EQ as the last plugin in your mixing session (post referencing plugin). Next, instantiate a high CUT filter and take it down deep. I'm talking real deep… I start at 30Hz with a steep dB-per-octave slope value (settings shown below). Click to listen to the reference's deep sub response and then back over to your mix. BE SURE TO LEVEL MATCH! You can't forget this step as it will throw everything off if you're not just about dead on the money with level.

What to listen for:

- Is the kick pulsing in the reference track down around 30hz?
- Can you hear or feel any of the bass sustain?
- Some of each?

You'll probably have to raise the frequency of the high cut filter a tad before you hear much, but if you own a SubPac and/or utilize Sonarworks Reference Software you should feel something from either the kick or bass between 30-40Hz.

## Step 3. Raise the High Cut Filter

30hz is merely the starting point. We need to study what's going on in the low end and you'll begin to hear and feel it as you slowly raise the frequency of the high cut filter. Don't go too quickly, especially if you're new to this technique. Sometimes I'll go as little as 10Hz at a time. Start at 30Hz and move to 40Hz and on to 50, 60, etc. Compare your mix against the reference every step of the way. When does the kick begin to really come in? When does the bass start to sustain and offer power to the bottom end?

I'll go back and forth with this technique until I've learned what my mix is either lacking or contains too much of. For the low end I usually go as high as 200Hz. Once I've made my low-end adjustments I'll move on to the next step…

## Step 4. High Pass Filter with High Cut Filter

Once you're fairly happy with your low end, add a high pass (low cut) filter and move it up to around 100Hz. With the low end out of the mix, add a new high cut filter and set it around 200Hz. We're going to do the same thing but with our focus on what's going on in the 100-200Hz range. This may seem ridiculous but stay with me.

What to listen for:

- In the low mids, what do you hear?
  - Do you hear the vocal yet? Raise the high cut filter until you do. Compare to your mix. You may have too much or not enough of this frequency range in your vocal.
  - How do your instruments sound in this range compared to the reference? (Do you see why I said to pick a song similar to yours as your main reference in the introduction?) Your main reference should have similar instruments (live drums vs beat production, male vocal vs female vocal, etc.)
  - Listen for discrepancies and make adjustments to your mix as necessary

*QUICK NOTE: Don't forget to go with your taste. When using references it can be easy to try and copy the reference so much that you lose what makes you special. Your taste. I love and swear by this technique but if there is a downside to relying on it too heavily, it's the fact that we can lose sight of what WE like and change our mix to what another mixer did by default. Don't do that.

Slowly move the high cut filter up as we did when working the low end. I like to make my way up to around 1kHz and stop. Get those mids right before moving onto the next step.

## Step 5. Upper Mids and Top End

We're going to do the exact same thing as in step 4 except we're up a little higher on the frequency spectrum. Take the high pass filter up so that everything below 1kHz is out of the picture. Move your high cut filter up just above 1kHz to around 1.5kHz or even 2kHz. It's the same process as in step 4. Go back and forth between the reference track and your mix to see how your midrange stacks up. Slowly move the high cut filter up until you just delete it altogether. Make changes as necessary.

What to listen for:

- The vocal
    - Is anything masking the vocal?
    - Harsh guitars?
    - How are your vocalist's "S" sounds or sibilance in general compared to the reference?
    - Are cymbals or any high-end sounds coming across as harsh? This is a great technique to see which frequencies should be tamed on cymbals, hats, transition sounds, etc.

## EQ Match

EQ Match, as present in a handful of plugins, is the process of using a reference track to take a snapshot of the frequency response of both your mix and the reference track to then allow you to equalize your mix based on the spectrum or frequency response of the reference. Tongue twister? I promise it's not confusing once you see it in action.

My two favorite tools to utilize this technique are the FabFilter ProQ3 and the equalizer built into iZotope's Ozone Suite.



EQ Match as found in iZotope's Ozone 9 Plugin Suite

## Two Ways to Use EQ Match

1. Analyze the reference and keep the matching EQ on your stereo bus as corrective EQ

This option is sort of the thorn in my side. If I'm honest, I get lazy sometimes and keep an instance or two of matching EQ on the stereo bus. In fact, there's a song I mixed where I used 3-4 instances and it sounds awesome to my ear. That same song has over 100 million streams on YouTube alone and has been played in stadiums across the world. If it sounds good, it's good!

2.  Analyze the reference but DON'T leave the matching EQ on the stereo bus

In lieu of option #1, perform the EQ match but instead of leaving it on and relying on it for your final mix, learn from it. What does the EQ match reveal to you? Is it boosting sub frequencies? If so, go to your kick and/or bass and add or manipulate the sounds at the track level. Is the EQ match boosting 1kHz? More air on the top end? Cutting low mids? Study the frequency response presented to you in the matching EQ menu and then go back into the mix to make fine adjustments as needed. Not only will you fix your mix without being lazy but you'll begin to hear these things in future mixes and become a better mixer overall.

"Music is the shorthand of emotion."

Leo Tolstoy

## Recap

To recap, I think it's safe to say that, yes, you can create great-sounding mixes on headphones. In fact, if headphones don't already play a significant role in your mixing process, it's more than worth adding them to your monitoring rotation.

We've all heard the saying "Practice makes perfect," but being that what we do is art, I like to say practice makes you better… A lot better!

With that, I want to invite you and encourage you to complete the following labs:

1. If you haven't already, check out Sonarworks Reference 4 for your headphones

2. Take 10 mins and make a list of some of your favorite reference mixes

3. Import the references into your DAW of choice and practice the following techniques:

   a. Listening (really listen! And to lots of music across multiple genres)

   b. Critical listening with The Dave Pensado Referencing Trick (import good references that match your taste and practice this technique)

   c. EQ Match (reverse engineer)

      I. Choose a recent mix of yours to revisit

      II. Choose a good song as your MAIN reference

      III. Go through the technique as described in this article to evaluate and make changes to one of your recent mixes.

# Better Mixes on Headphones

# A Useful Plugin

by Rudi Putnins

## Boxes or Cans

Traditionally, most engineers mix on speakers and use headphones to check their mixes. The thinking behind this has always been that mixes done over speakers will translate better to headphones than vice versa, due to fundamental differences in the nature of headphone monitoring relating to stereo image perception and the headphones' tendency to more readily reveal certain details in the mix. But nowadays, given that many music lovers use headphones as their primary listening environment, mixers may have cause to rethink this conventional wisdom. This is especially true in situations where the speaker or room environment may be less than ideal acoustically such as in many small project studios or home studios. Or, when logistics make it less convenient or practical to mix over speakers—when doing so would disturb others, or when the mixer is a musician or engineer on the road with only a laptop and a pair of phones to provide a consistent mixing environment.

If a mixer does decide to switch to phones or even to just take on a particular mix project with headphones as the primary monitoring environment, one of the first things to do would be to calibrate the headphones for flat (or flatter) response, ideally matching the same similarly-calibrated response of the main speakers. But while that's an important step, there will still be fundamental differences between speaker and headphone monitoring that need to be looked at, and the mixer will need to be well aware of those differences to ensure the widest compatibility for the finished mixes.

# Inter-aural Affairs

The way stereo sound from speakers reaches our ears is inherently different to how it works in headphone monitoring. In speakers, the two actual sound sources—the left and right speakers—occupy the same physical space, so while in theory the sound from the left speaker is intended for the left ear and the sound from the right speaker is intended for the right ear, what actually happens is that both ears hear the sound from both speakers.
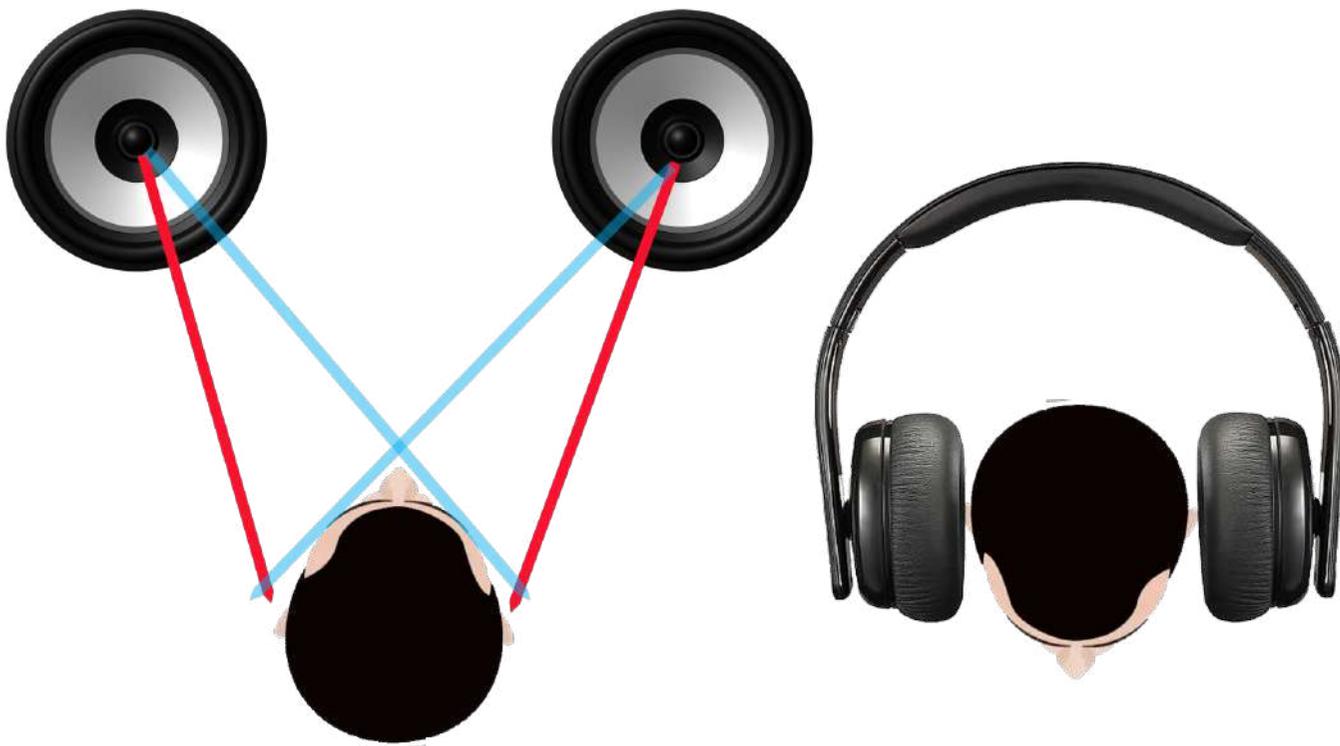


Speakers provide direct sound (red) and crosstalk (blue) while headphones provide only isolated direct sound to each ear.

The left ear receives the sound wave from the left speaker, but it also receives the wave from the right speaker. Since the right speaker's signal comes from a very slightly greater distance, the level is slightly less at the left ear than the level of the left speaker signal. And again due to that slightly greater distance, the right speaker wave is slightly delayed, arriving a little later at the left ear than the left speaker wave. The same thing occurs with the right ear and left speaker—the left speaker's wave arrives at the right ear a little later and at a slightly lower level than the right speaker's wave.

This is called Inter-Aural Crosstalk. It consists of an inter-aural level difference and an inter-aural time difference, and it determines the limitation of speakers to reproduce the stereo image. Specifically, it's the reason the stereo image in speakers is restricted to the (usually) 60° angle between the speakers, rather than spreading out to a full 180° width beyond the actual speaker locations, as a real acoustic sound field would.

And of course the additional delayed signal at each ear combines with the intended signal for that ear, creating interference effects like comb filtering.

Of course, stereo perception in speaker monitoring is more complex than just simple inter-aural crosstalk. The head itself affects the sound waves reaching the ears, with more of a masking effect on a sound from a particular source at the more distant ear. Here, the sound wave may have to travel around the head, and is subject to the damping effect of that object in its path. Even the shape of our ears themselves plays a role, with the pinna—the outer ear—focusing sound waves into the ear canal. These aspects affect not only our perception of left-right stereo width, but also height—our ability to get a sense of how high the sound source is relative to our ears.

# Inside Your Head(phones)

But for mixing concerns, the width of the stereo image—the inter-aural crosstalk—is the main thing that differentiates headphone monitoring from speaker monitoring. In the phones, there is no inter-aural crosstalk—the left and right drivers in each ear cup are right up against the corresponding ear, so the left ear does hear only the left signal, and the right ear hears only the right.

# Speaker vs Headphone Monitoring

Without the crosstalk, the stereo image is wider and any additional interference effect from the crosstalk is absent, making for a wider soundstage and clearer sound, which allows for greater perception of detail.

This extra detail is especially noticeable with certain aspects of a typical mix – the amount and depth of reverb and ambience; the audibility of the delayed signal in subtle short delay effects like doubling or chorusing, and the general audibility of subtly-mixed background parts. Sometimes a background part, for example an instrumental counterpoint that was mixed in speakers to be just barely audible, or not really perceptible on its own but adding extra thickness to the main part – will come through more clearly on headphones, which may not have been the intent.

# Back & Forth

And that gets to the question of how those basic differences can affect the ability of a mix to sound right on both speakers and headphones. Mixers have long been afraid that if they mix entirely or primarily on headphones, the extra width of the stereo image and the extra clarity and detail that can be perceived in the cans—thanks to the lack of inter-aural crosstalk—will lead them to make decisions that won't work well enough in speaker listening. They worry that panning choices based on the wider stereo image in the phones will result in a more congested sound field when sound is heard from speakers.

And they may be concerned that subtle mix balances and reverb/effect levels dialed up with the benefit of the extra clarity in the phones will result in those parts or effects not coming through clearly enough when heard on speakers, making the mix sound flatter, or be lacking in the arranging and processing details they worked so hard to come up with. On the other hand, if they mix in speakers they

may feel that all they have to do is check that certain subtle aspects of the mix don't sound too prominent in the cans. And headphones do have their disadvantages—though the sound field is wider, the centre sounds like it's in your head rather than out in front, making it potentially harder to gauge a sense of front-back depth in the mix, which can be simulated by the subtle use of delay and early-reflection reverb patterns.

# Headphone Helper

Of course, a mixer who works in phones as their primary monitoring environment can get accustomed to these differences, and he'll still be checking his mixes on speakers. But it is possible to narrow the fundamental perception difference between speakers and phones somewhat to bring the two experiences closer together, and that could potentially be a tipping point for someone thinking about shifting to mixing on phones as the main workspace.

If a little crosstalk is injected into the headphone signal, emulating the acoustic effect that occurs with speakers, that could help to somewhat minimize the differences in perception and make it more likely that subtle mix choices made in the phones will translate with greater accuracy when the mix is monitored over speakers. This may allow the mixer to take advantage of the other benefits of headphone listening such as clarity, isolation, a calibrated response free of room effects—and not have to make significant changes when the mix is eventually checked on speakers.

But you wouldn't want to just randomly bus some opposite channel crosstalk from one side to the other. Like speaker calibration, it should be done carefully, incorporating both the inter-aural level and time differences, to mimic as closely as possible the actual degree and character of the acoustic crosstalk effect.

# CanOpener

You can get that with CanOpener Studio, a plug-in from Goodhertz, makers of a collection of audio plug-ins.
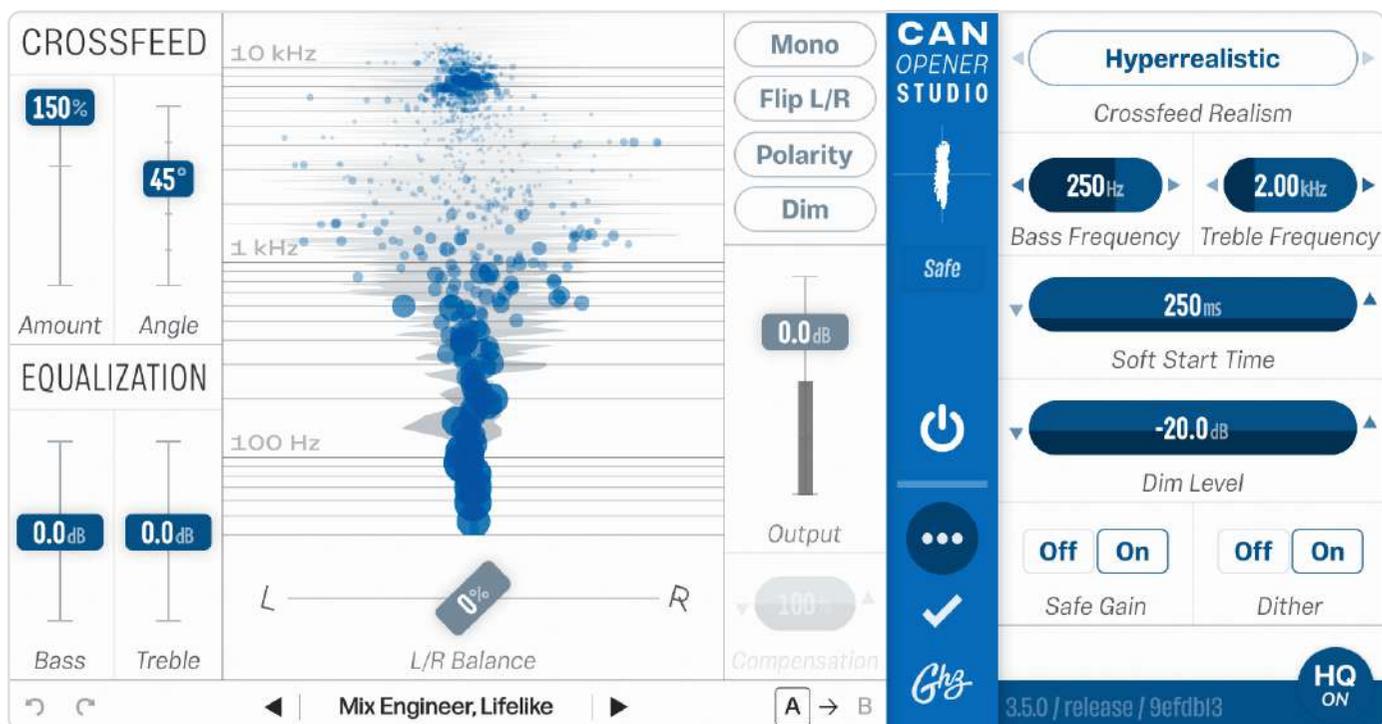


CanOpener creates inter-aural crosstalk properly, and can help bring the resulting perceptual qualities to headphone monitoring. It includes controls to set how strong the crossfeed effect will be (I prefer it at the maximum setting with the phones I work with), and a simple bass and treble EQ to counter any unwanted tonal balance changes that may result from the extra crosstalk (I turn the bass down half a dB). There are also a couple of useful graphs depicting the stereo image, but other than that the plug-in just does what it's designed to do without the need for complex measurements or major tweaking.

The crossfeed effect is very subtle, as it should be! Aside from a little bass emphasis, you don't really notice it until you turn it off and then the headphone sound seems to very subtly get a little more constricted/in-the-head. It's definitely not a 3D/widening effect – remember, it's not supposed to be an effect at all!

Of course, you'll still want to check headphone mixes done on your Reference 4-calibrated, CanOpener-equipped phones, on your main speakers and other different speakers. Also, you'll want to check your mixes on headphones without the benefit of any crossfeed processing to get a good sense of what other listeners may eventually hear. But the basic mix done on the primary headphones should translate a little more successfully onto any listening setup than if it was done on uncalibrated headphones with the normal lack of crosstalk. The combination of flat frequency response and a more speaker-like perception should make the option of mixing in headphones a much more viable alternative, even for the sceptics and traditionalists among us.
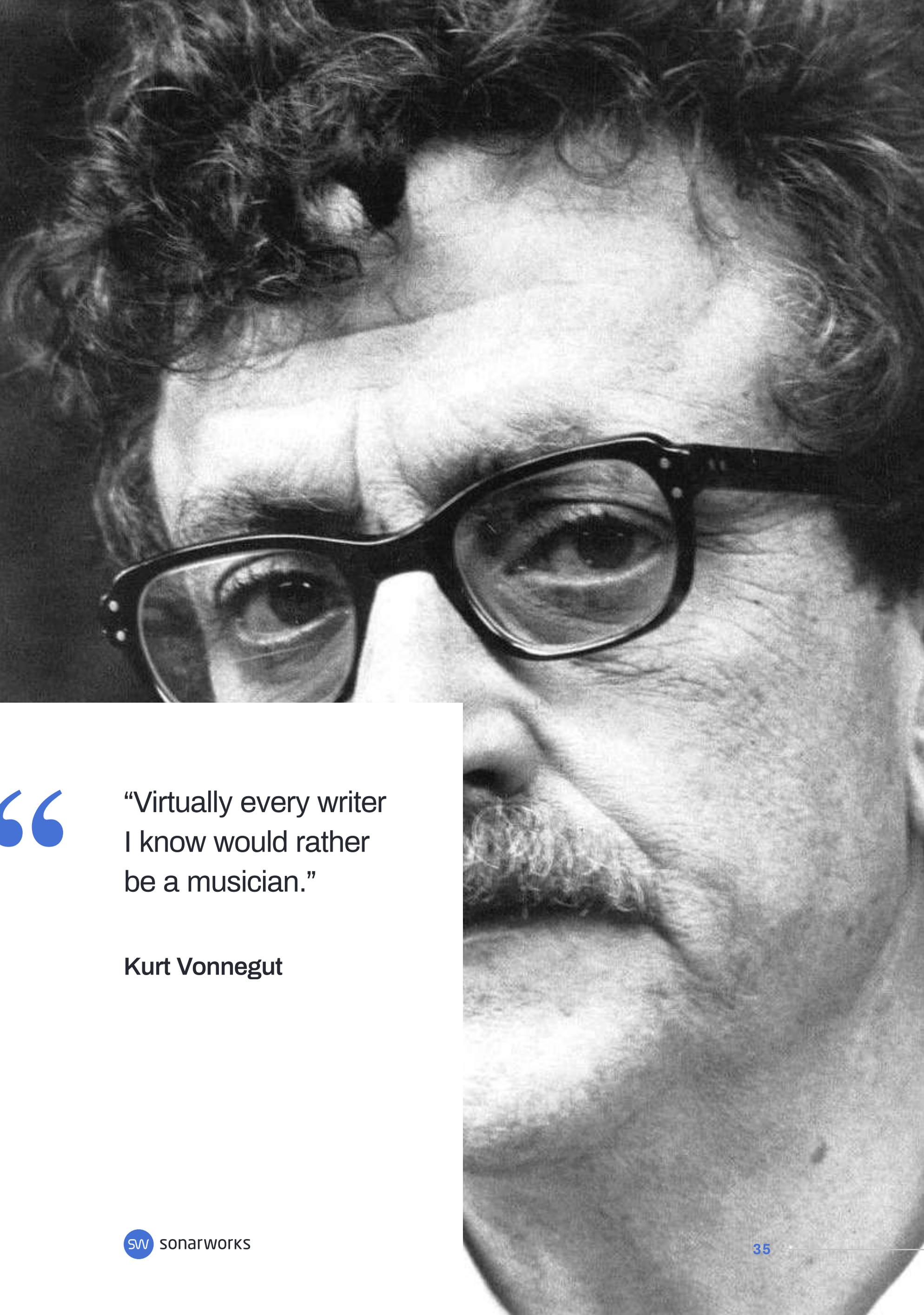
Plugins that enhance your headphone experience:

Goodhertz CanOpener Studio

Waves NX Virtual Mix Room

Waves Abbey Road Studio 3

112dB Redline Monitor

"Virtually every writer
I know would rather
be a musician."

Kurt Vonnegut

sw sonarworks

## Headphones vs. Speakers

# Which Should You Mix On?

by Nick Messite

Headphones versus loudspeakers: which is better for monitoring? At some point most beginners ponder this question—though to be fair, so do most experienced engineers. Glenn Schick, mastering engineer for J Cole, Justin Bieber, and many others, recently made the switch to exclusively mastering on headphones, while plenty of other engineers have gone the opposite route, opting for more accurate monitors as they progress from home studios to dedicated workspaces.

As for the core question of which is better–headphones or loudspeakers–the most honest answer is "It depends." Monitors exhibit qualities that make them better in some regards and worse in others, and the same is true for headphones. I'm here to help you identify the strengths and limitations of each, so read on to determine which may be best for you.

## Loudspeaker Strengths

Speakers produce sound waves by pushing air molecules throughout the physical space of your room, and therefore communicate not just the sound of music, but also physical feeling of music. Hearing a kick drum solely with your ears versus experiencing the impact of the kick in your chest are vastly different sensations. Feeling the physical power of the low-end and midrange waves can help you gauge how your mix will translate to clubs, cars, and even home hi-fi systems.

Many people find it easier to achieve proper musical balances on loudspeakers than on headphones. For instance, if you set the level of background vocals using headphones, you might notice the balance doesn't translate well in your car, or even on your studio monitors. This is due, in part, to the natural interaction between speakers and the physical listening space. As we mentioned earlier, speakers push sound waves around the room, rather than the way headphones direct sound right into your individual ears. Sound waves from speakers interact with objects in the room and undergo tiny shifts in timing and phase, providing our brain with directional and level information that feels natural and organic. Headphones, on the other hand, isolate the ears so that each ear only hears one speaker and, therefore, only one side of the stereo image. Put another way, when listening to stereo speakers, your left ear hears a bit of the right speaker, but with different reflections, timing and phase from what your right ear hears from the right speaker. Headphones, on the other hand, do not provide any right channel information to the left ear, or vice-versa. This acoustic effect of each ear hearing a bit of the opposite speaker's information is referred to as "crossfeed."

*On a personal note, I find that mixing toms and hi-hat against overheads is easier in cans, but that's about where it ends. Here's why: Balancing drum mics is more like a hunting expedition for the best spatial (timing and phase) relationships, rather than a purely emotional or creative endeavor. In headphones, the isolation (lack of crossfeed) between the left and right channels seems to help me judge the phase and timing relationships between the overheads and the close-miked instruments. When it comes back to emotional and creative mixing decisions, crossfeed (from speakers) becomes my friend again.*

# Speaker Limitations

Now let's move on to the downsides of speakers. The most obvious drawback is simply a practical issue: loudspeakers are loud—you need to drive them somewhere around 80dB SPL for an accurate representation of balanced frequencies (Remember the Fletcher-Munson curves?). If you live in a thin-walled city apartment, you may not be able to run your speakers comfortably loud without annoying the neighbors. The frequency response of your speakers is also affected by the acoustics of your room. The shape of the room, the construction materials, the placement of your speakers/furniture, and the degree of room treatments—these all have an effect on how your speakers sound. Headphones, on the other hand, are immune to the room's effects.

Speaker quality and accuracy may also, unfortunately, relate to their cost. While professional headphones with a frequency response from 20Hz to 20kHz can cost under a few hundred dollars, most speakers under $1000/pair won't put out much sound below 50Hz, let alone 20 Hz. Many inexpensive speakers purport to reproduce this range, but independent analysis reveals they do not—and furthermore what they do give you below 60 or 70Hz may not be accurate enough for mixing or mastering. For both headphones and speakers, software like Sonarworks Reference 4 can help flatten most frequency response problems, but it can't account for a small speaker's inability to produce low frequencies, and it can't fix an inexpensive monitor's distortion or phase issues.

# The Strengths of Phones

For this discussion of headphones, we are considering professional headphones and not earbuds or typical consumer headphones. Cost may not be the sole indicator of professional versus consumer quality, as many consumer headphones are simply overpriced fashion accessories. Pro headphones should provide excellent sonic qualities and typically will not include features like Bluetooth or noise-cancelling circuitry. Pro headphones may include features like replaceable earpads and cables and various connector options.

Let's highlight an important advantage of headphones straightaway: you can listen to them day or night, at a reasonable volume, without bothering the neighbors. Closed-back phones are virtually silent to people around you, while open-backed headphones won't disturb anyone more than a few feet away from you.

Is there anything that makes headphones better suited than speakers for the musical tasks at hand? The answer depends on the application. Mastering engineers often put on their headphones to QC (quality control check) their final masters because phones will reveal details and forensic errors in the master—clicks, pops, and other incongruities–that may not be obvious on speakers. The clarity that comes from headphones helps put a spotlight or microscope on tiny elements of the mix. Frequent users of forensic tools like iZotope RX may find that headphones are well suited for finding and repairing clicks, pops and other artifacts.

Headphones also provide benefits to engineers working in less-than-optimal rooms. If your room has acoustic issues (see our blog posts on acoustic problems and treatments), using headphones can mitigate those problems by removing the room's influence on audio perception. Consider also that open back headphones might not help much in a noisy environment like a coffee shop, while closed back headphones may provide enough isolation that you can spend an afternoon working at the beach.

This brings us to mobile considerations: I often travel from studio to studio, and I have to work in unfamiliar surroundings and often on unfamiliar speakers. If I bring my own set of cans, I have confidence in a familiar and relatively consistent monitoring system, which is definitely a plus.

# Liabilities of Phones

Notice I wrote "relatively consistent" above; there's a lot of room for error in that qualifying adverb. If I take my headphones from a pro studio that uses a high-power headphone amp like the Little Labs Monotor to a home studio with an inexpensive interface, I'll likely notice that my headphones sound different on each system.

A couple of issues are at play here. Since headphones can be extremely revealing, they often highlight differences in frequency response, noise floor and overall accuracy of the monitoring chain. Also, each model of headphones has a different power and impedance specifications and each headphone may react to a specific headphone amp or interface in a profoundly different way. Most headphones will work fine with any decent audio interface, while some only perform their best when powered by a dedicated headphone amplifier. My Audio-Technica ATH-M50xs phones, for example, are not influenced much by most headphone amplifiers, while my Sennheiser HD 650s do sound different when powered by different interfaces or headphone amps. If you travel like I do, you may want to invest in not only a reliable pair of phones, but also a trustworthy headphone amp, like the affordable Schiit Magni.

Also, since headphones play directly into each ear, you lose the beneficial crossfeed effects mentioned earlier. This can affect your perception and mix decisions for left-to-right panning (width), as well as front-to-back depth. As a result, reverbs, delays, and even equalization that sound proper on your headphones may sound less cohesive on loudspeakers.

Indeed, a headphones-only mix could lead to improper decisions during the mixing process. When I create a mix using my Audio-Technica ATH-m50xs, I find my low-end levels often have to be tweaked later. Similarly, if I attempt a mix using only my HD 650s, I may wind up boosting the high frequencies more than necessary. These are my personal observations and experiences, which leads me to the final point regarding headphones:

Choosing headphones is inherently personal, perhaps even more so than choosing monitors. When planar magnetic headphones (like the Audeze LCD-X), became the rage, I bought a pair and found myself disappointed with the experience. I went back and forth with the manufacturer a few times, sending them in for diagnostics, talking about headphone amps and such. Finally they shrugged and said, "it's probably the shape of your head—your ear geometry." Ultimately we must consider the physical limitations of headphones. Phones just don't push air like speakers do, so you will not feel that guttural, vibrational punch that speakers provide—a punch that aids in musical translation.

# Conclusion

Since we can't clearly answer which is better, what's one to do? Use both! A combination of headphones and speakers could be your friend. Throughout your career, you'll find a process that works for you—a gameplay loop, if you will. You may build your mix on speakers, check for forensic issues on cans, and continue switching between the two while mixing. Perhaps you'll work differently, setting up the balances in cans for clarity's sake and then finishing the mix on your monitors.

It may take some trial and error, but if you devise a routine that utilizes the strengths of both, you're less prone to the weaknesses of either. And remember that Sonarworks correction software can improve both your headphones and loudspeakers––whichever platform you choose.

# Key Takeaways

- [ ] Understand the pro and cons of open-back vs closed-back headphones

- [ ] Be aware of the stereo imaging effects of listening on headphones

- [ ] Don't let ear fatigue cloud your judgement—take breaks!

- [ ] Invest in professional headphones

- [ ] Further improve your headphones with Sonarworks Reference 4 software and try out some speaker emulation software, like Canopener

- [ ] Know the limitations of feeling the bass on headphones vs. speakers

- [ ] Try to reference your headphone mixes on other playback systems

- [ ] Use reference tracks and try the Pensado trick to further refine your mixes

- [ ] Have the confidence that CAN produce great results on headphones!

# If you're looking to get the best out of your studio, then try this...

The same know-how we've used to make this e-book can be used to vastly improve your monitoring. Our Reference 4 calibration software makes your headphones and monitors coloration free, so you can hear what's really happing in your mix.

Sonarworks Reference 4 uses acoustic measurements and applies them to your headphones and monitors, so any tonal coloration is reversed. The result is a clear picture of your work, so you can focus on doing what you love!

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