

# Analyze the Performance of Headphones at Different Prices Through Survey and Frequency Response Experiment

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**Abstract:** Headphones on the market have a large price range, but is there a linear relationship between their performance and price? The article introduces an experiment to analyse the performance of headphones at different prices. Both blind listening survey and frequency response experiment were conducted to discover the relationship between headphone performance and price.

**Keywords:** Headphones, Quality of sound, Frequency response experiment.

## 1. Introduction

With the advancement of technology, the use of headphones has become more and more popular in life [1-2]. In the eyes of teenagers, music has become a relief [3]. There are many types of headphones on the current market and they have many different features. Obviously, the main function of headphones are to be used to conduct audio information. Therefore, the quality of sound that a headphone produces is the major factor in terms of evaluating the quality of the headphones.

The price of headphones ranges widely. You can get either a \$2 USD one in the dollar store or an \$8000 USD one with a well-known brand. The wide price range is a result of the differences in design, functionality, and materials used. Many people may have encountered this problem: the cheap one or the expensive one to purchase?

As a derivative of the large selection pool, all kinds of headphone evaluation articles spread out online. This inspired that the answer to the above question by evaluating headphone quality with different methods. The goal of this experiment is to conclude a relationship between headphones' price and their performances.

## 2. Methodology

Previous studies suggests that frequency response is a major factor in evaluating the performance of headphones [4-5]. The methodology of this experiment includes a frequency response experiment of different headphones and a blinding listing survey done by 15 volunteers. The experiment used four different headphones with a price range from \$2 USD to \$800 USD.

**Table 1.** Headphones Used and Prices

Headphone Brand	Actual Price (USD)
DJ Skin	\$4
Audio-Technica ATH-SJ33	\$65
B&O H6	\$400
Shure SRH1842	\$800

## 2.1. Frequency Response Experiment

Headphone spectral magnitude responses were measured on a Primo EM172 microphone equipped with two prosthetic ears. A linear sine sweep with the same amplitude covering a frequency range between 20 Hz and 20 kHz generated by MatLab was converted to electrical signals by a Focusrite sound card using the headphone output connector. The responses for both the left and right channels were measured with a sampling rate of 44100 kHz and a bit depth of 16 bits. In addition to this, a 50 Hz sine wave is used to determine headphones' bass performance.

## 2.2. Blind Listening Survey

Each volunteer would listen to the same song, and fill the questionnaire. The detailed steps of the survey were as following:

1. While listening to the song using different headphones, fill in the pros and cons of each headphone. And give a price guess for each headphone.
2. Announce the actual price of each headphone to volunteer.
3. Based on the actual price and the quality, score each headphone from 1 to 10.

## 3. Results

The Harman curve was used as the reference curve and compare if our headphones process pattern similar to the reference curve in the low, medium and high-frequency regions [6].

- 20 - 110 Hz: low frequency region ;
- 110 - 1100: mid-frequency ;
- 1100 - 20 kHz: high frequency region.

### 3.1. Frequency Response Results

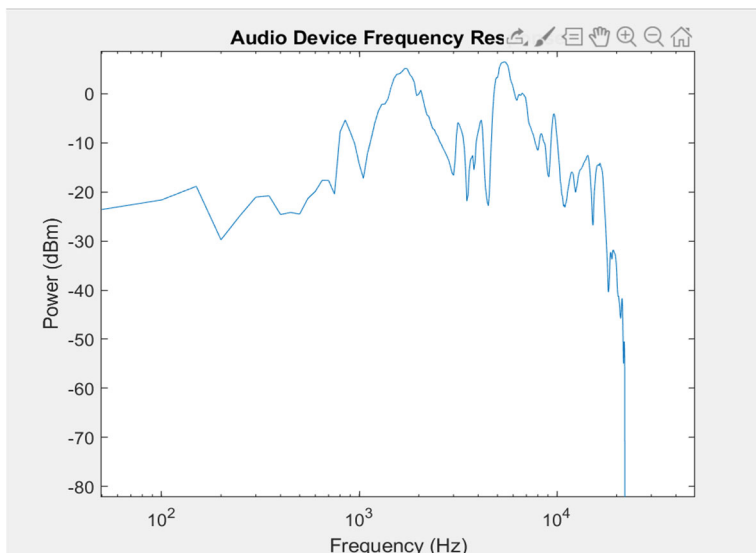
Frequency response is the measure of a headphone's ability to reproduce all frequencies equally. Theoretically, this graph should be a flat line at 0 dB. If the line is high on the left and low on the right, the headphones would be considered bass-heavy. If the line is low on the left and high on the right, the headphones would likely be "bright" sounding with an

emphasis on the highs and lean bass response.  
 Harman curve indicates that a natural-sounding headphones should have the following characteristics.  
 3 dB gain in the low-frequency region ;

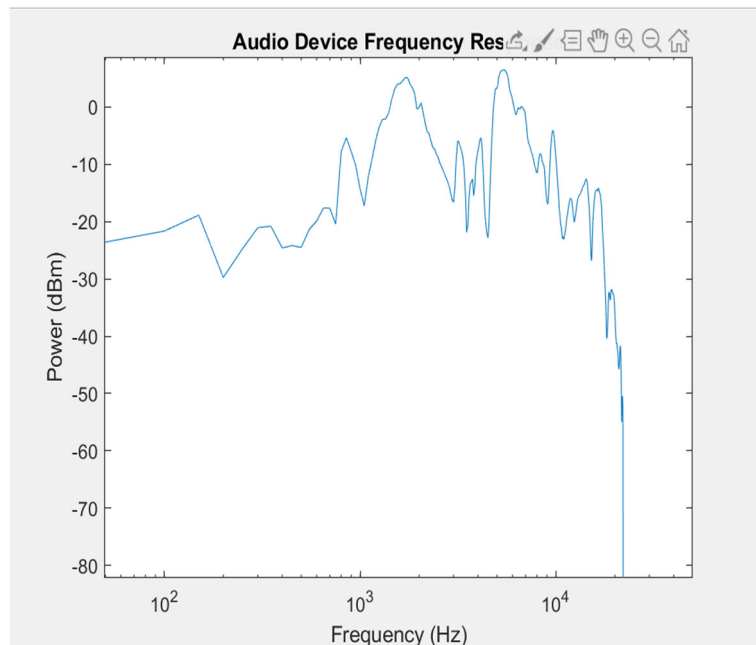
A 0 dB -3 dB linear increase in the mid-frequency region ;  
 The peak in the high-frequency region with peak amplitude around 13 dB at 1200 Hz.

**Table 2.** Results of Headphones' Response at Different Frequency Range

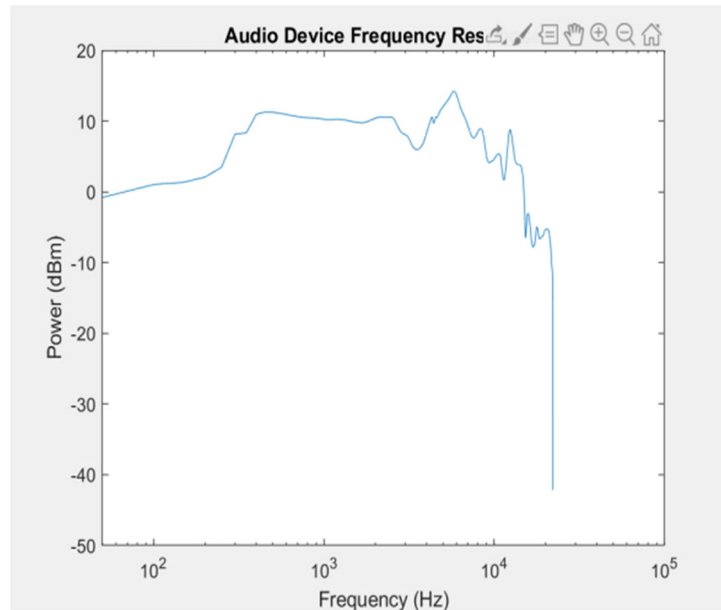
Headphone Brand	low Frequency	Mid Frequency	High Frequency
DJ Skin	Inadequate bass	Inadequate mid	Inadequate treble
Audio-Technica ATH-SJ33	Inadequate bass	Emphasized mid	Over-emphasized treble
B&O H6	Lean bass	Moderate mid	Well-tuned high frequency
Shure SRH1842	Some bass	Neutral	Slightly lack treble



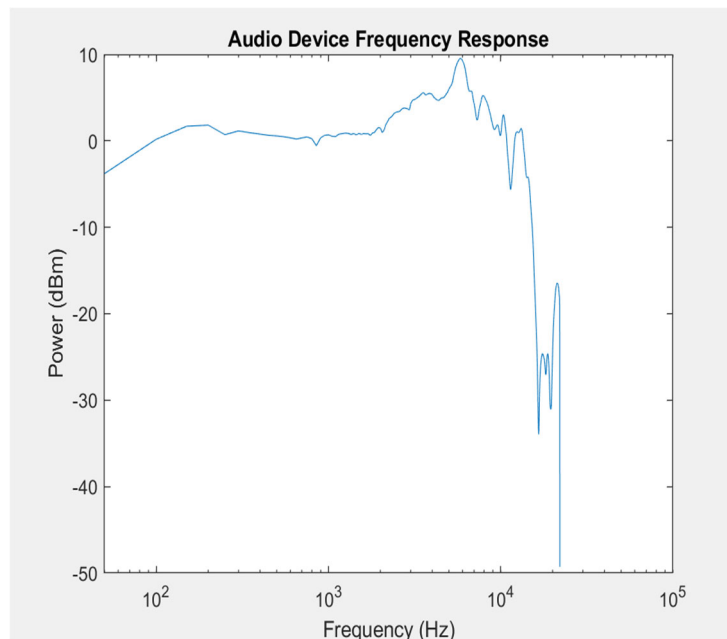
**Figure 1.** Frequency Response of DJ Skin



**Figure 2.** Frequency Response of Audio-Technica ATH-SJ33



**Figure 3.** Frequency Response of B&O H6



**Figure 4.** Frequency Response of Shure SRH1842

### 3.2. Blind Listening Survey Results

From table 3 we can see that in the gap where the price of headphones increased from \$4 to \$65, volunteers thought that the quality of the headset was significantly different and improved. However, when the price of headphones is higher

than \$400, the improvement is not obvious. Besides, as the actual prices increased, the guessed prices are significantly lower than the actual prices. Therefore, although the quality is becoming better at higher prices, volunteers thought it may not worth that much money.

**Table 3.** Results of Blind Listening Survey of Different Headphones

Headphone Brand	Actual Price (USD)	Average Price Guess (USD)	Average Score (/10)
DJ Skin	\$4	\$26.87	3.97
Audio-Technica ATH-SJ33	\$65	\$82.27	5
B&O H6	\$400	\$167.6	6.63
Shure SRH1842	\$800	\$387.6	6.57

## 4. Discussion and Limitations

This project aims to uncover the relationship between headphone price and their ability to faithfully reproducing the original recording itself. From the measurements, we arrive at the following conclusion.

The improvement is significant across all frequencies from a \$65 USD headphone to a \$400 USD headphone. The improvement is not so obvious when the price goes above \$400 USD. The headphone above \$400 generally produces good sound except the may have different emphasis in different frequency regions. And people generally can't point

out exactly what is good about them.

The human auditory system is able to detect small differences under well-controlled conditions. And once there are effects such as noise in the environment, these differences are indistinguishable [7]. Other studies have also shown no significant difference in overall sound quality ratings between luxury and budget headphones. While luxury earphones do outperform budget earphones, the performance advantage is not proportional to the price difference [8].

However, the number of test samples are very limited in this experiment due to lack of headphone resources. Also, many headphones are not repositioned to calculate the average response for the response curve. The microphone is not de-embedded within the system.

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