The Effect of Cup Type on the Attenuation of Noise in the Beyerdynamic DT770 Headphone

August 7, 2013

L G Davison*, BSc
C Barlow, PhD, MIOA
M Ashmore, RHAD, MIOA
R Weinstein, RHAD
Southampton Solent University
Faculty of Maritime and Technology

*Point of contact: Lee.Davison@solent.ac.uk

Abstract

This short study is intended to investigate the effect of changing cup types on the Beyerdynamic DT770 headphones, and the effect this has on external noise attenuation.

1. Introduction

When conducting audiometric tests it is important to have a low level of background noise to be able to properly assess the patient. The British Society of Audiology (BSA) recommend a background noise level of 35 dBA in order to test patients to a hearing level of 0 dBHL (No hearing loss)[2]. There are many ways in which to achieve this level of background noise, including reducing noise at the source, moving to a quieter environment, or installing soundproofing or a booth. The most practical way of reducing noise however, is by the use of attenuating headphones that will "block out" prevailing noise sources.

This study is designed to investigate the attenuation properties of the Beyerdynamic DT770 cup types, to verify adequate performance with each type. This is necessary because of the nature of audiometry, many people will be using the same headphones, and therefore they must be hygienic, and easily cleaned. Previous tests have shown the Beyerdynamic DT770 headphones to be good noise attenuators, but there is no evidence yet to show that this will be the case while using different cup types on the headphones.

2. Methods

2.1. Procedure

This experiment was designed around BS EN 24869-3, with the use of an acoustic test fixture [1]. A "Random incidence sound field" of pink noise was set up, using a 5 channel speaker set in a reverberant room. This was then checked for uniformity using a sound level meter, and the test point checked at 150 mm spacing around the test point with the text fixture absent. The results are as follows:

Measurent position	Sound Pressure Level
Front	74.8
Behind	75
Right	75
Left	75
Above	77.7
Below	74.8

Table 1: Sound Pressure Level measurements 150 mm from test position (dBSPL)

The test fixture was then placed in the test position and measurements taken with no headphones, in order to establish a baseline across the spectrum of no attenuation. This test was repeated three times to control for variance in conditions.

Velour cup DT770 headphones were then

placed on the test fixture, and the same measurement taken again. This procedure was carried out for all three cup types, three times for each, with the headphones removed and replaced between measurements to control for variance in headphone placement. All measurements were taken from the left simulated ear of the acoustic test fixture.

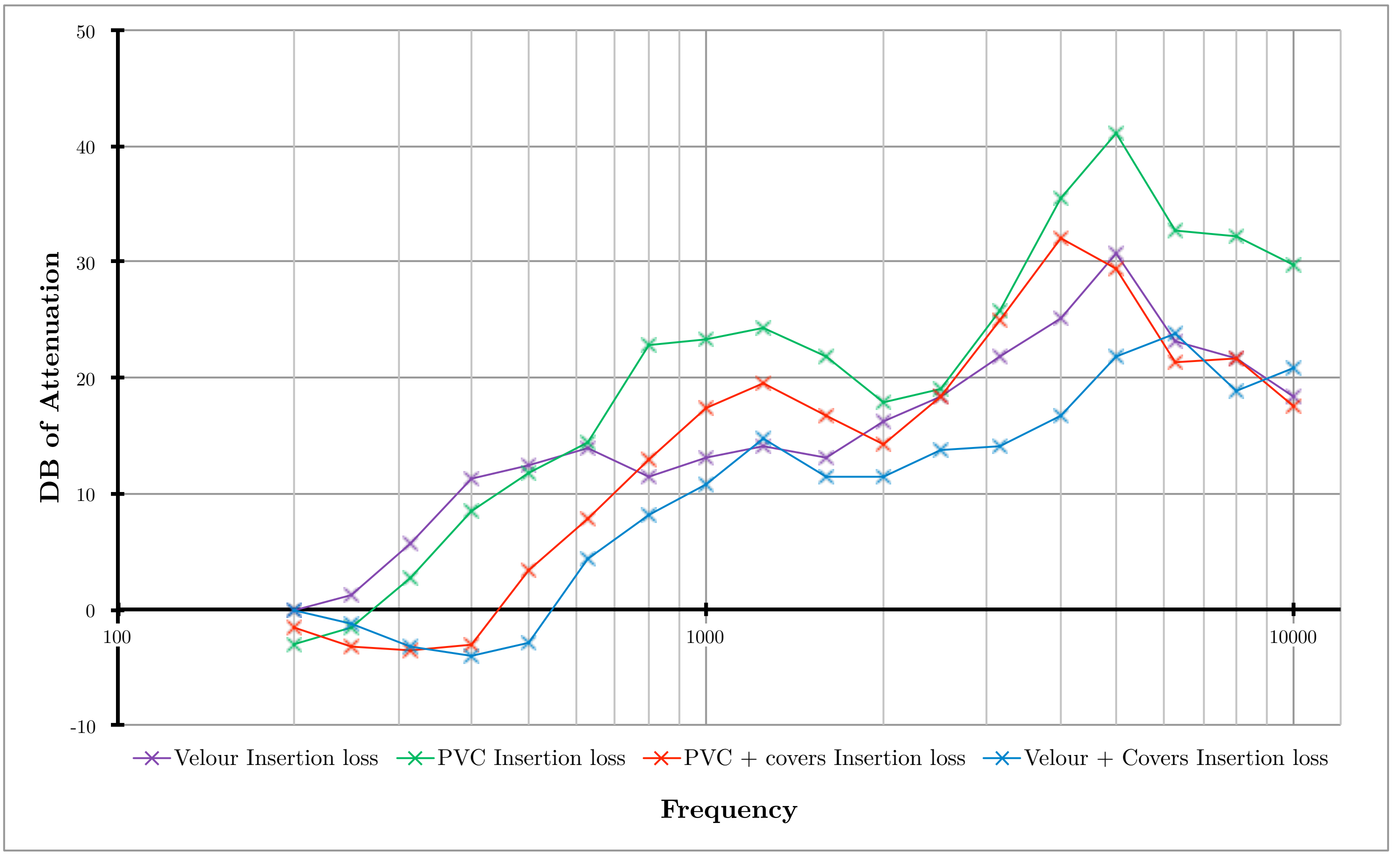
2.2. Equipment

The acoustic test fixture in this case was a Brüel & Kjær type 4100 HATS (Head And Torso Simulator), which was fed into a Brüel & Kjær type 4231 preamplifier, and then subsequently measured on an NTi XL2 3rd octave band sound level. The Brüel & Kjær type 4100 HATS is fitted with artificial simulation pinnae, and is representative of the average human head and torso. An computer running a noise sample generated in Pro Tools was used to generate the pink noise test signal.

3. Results

The full table of results can be found in the appendix.

Figure 1: Attenuation characteristics of headphone designs



4. Discussion

In light of the results, it is clear that the PVC cups offer the best level of attenuation, and are certainly recommended for this application. If the PVC cups are able to be used on their own, and cleaned between uses, then this would be the ideal combination for their use in audiometric testing.

In relation to covers, the results suggest that the covers degrade the attenuation of the cups, whenever they are fitted. If they are vital for hygiene purposes, then it is also important to note that they still will provide acceptable performance. This effect is likely due to the air gap that forms when they are used, by the tension of the cover over the cup preventing the ear pinna entering the cup fully. It is further evidenced by the negative attenuation (gain) that the results for covers show, which is caused by an air gap allowing low frequency resonance. This could be fixed by removal of the central part of the cover so that it just covers the actual cup and allows the pinna fully in to the cup and a proper seal.

5. Appendices

A. Full Table of Results

		200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000	Total
N/A	1	65.9	63.8	60.3	62.0	59.8	59.2	61.6	62.2	58.9	59.9	61.8	65.0	64.5	68.4	69.4	65.8	59.0	57.7	77.4
	2	66.1	64.1	60.5	62.2	59.8	59.0	61.3	62.2	59.4	59.8	62.0	65.0	64.4	68.4	69.3	65.5	59.0	57.9	77.6
	3	66.4	64.0	60.4	62.2	59.8	59.3	61.7	62.4	58.9	59.9	62.0	65.2	64.7	68.5	69.5	66.1	59.0	57.9	78.1
	Av	66.1	64.0	60.4	62.1	59.8	59.2	61.5	62.3	59.1	59.9	61.9	65.1	64.5	68.4	69.4	65.8	59.0	57.8	77.7
Velour	1	66.3	62.7	54.8	50.2	48.4	45.4	50.6	49.7	44.8	46.9	46.0	46.9	42.5	43.2	39.2	43.6	37.5	39.5	74.8
	2	66.2	62.8	54.5	51.0	47.1	45.2	49.8	48.9	45.0	46.6	45.6	46.7	42.9	43.5	38.5	42.2	37.3	39.4	74.4
	3	66.3	62.8	54.6	51.1	46.6	45.1	49.7	48.8	45.2	46.6	45.5	46.7	42.8	43.4	38.4	42.2	37.3	39.3	74.4
	Av	66.3	62.8	54.6	50.8	47.4	45.2	50.1	49.2	45.0	46.7	45.7	46.8	42.7	43.4	38.7	42.7	37.4	39.4	74.5
	IL	-0.1	1.2	5.8	11.3	12.4	13.9	11.5	13.1	14.1	13.2	16.2	18.3	21.8	25.1	30.7	23.1	21.6	18.4	3.2
PVC	1	69.0	65.4	57.3	52.7	47.8	43.3	38.5	39.3	34.9	38.3	44.0	46.4	39.2	33.0	28.2	33.2	26.3	27.5	76.6
	2	69.5	65.4	57.6	53.4	47.5	43.1	37.8	37.3	34.6	38.3	44.8	46.5	39.2	32.9	28.2	31.5	25.8	28.1	76.6
	3	68.9	65.7	58.0	54.6	48.5	46.8	39.6	40.0	34.9	37.5	43.2	45.2	37.8	32.8	28.7	34.3	27.8	28.5	75.9
	Av	69.1	65.5	57.6	53.6	48.0	44.8	38.7	39.0	34.8	38.0	44.0	46.1	38.8	32.9	28.4	33.1	26.7	28.1	76.4
	IL	-3.0	-1.5	2.8	8.5	11.8	14.4	22.8	23.3	24.3	21.8	17.9	19.0	25.8	35.5	41.0	32.7	32.3	29.8	1.3
PVC+C	1	67.3	66.9	64.5	66.8	58.1	52.8	49.6	46.0	40.1	43.8	48.4	47.6	40.8	37.3	42.0	46.2	38.9	41.2	76.1
	2	67.9	67.4	63.2	63.4	55.0	49.8	48.4	44.6	39.4	42.6	46.4	45.7	38.7	35.3	38.4	44.5	37.2	40.1	75.7
	3	67.7	67.2	64.0	64.5	55.2	50.6	47.5	43.9	39.1	42.9	47.8	46.4	39.1	36.5	38.8	41.6	35.3	39.3	75.7
	Av	67.6	67.2	63.9	65.1	56.3	51.3	48.6	44.9	39.6	43.1	47.6	46.6	39.6	36.4	40.1	44.5	37.4	40.3	75.8
	IL	-1.5	-3.2	-3.5	-3.0	3.5	7.9	13.0	17.3	19.5	16.7	14.3	18.4	24.9	32.0	29.3	21.3	21.6	17.6	1.9
Velour+C	1	67.5	66.9	64.1	64.9	55.4	50.8	50.4	47.7	47.8	48.4	48.1	51.0	46.9	47.4	45.6	47.3	39.3	41.9	76.4
	2	66.9	67.1	64.8	65.5	55.7	51.8	50.9	47.2	47.8	48.7	48.1	51.0	48.7	47.0	46.2	47.7	37.6	41.8	75.8
	3	67.5	67.3	64.3	64.5	55.4	50.5	51.0	47.8	47.3	48.3	48.1	50.7	47.7	45.3	44.6	45.5	37.5	40.3	76.0
	Av	67.3	67.1	64.4	65.0	55.5	51.1	50.8	47.6	47.6	48.5	48.1	50.9	47.8	46.7	45.5	46.9	38.2	41.4	76.1
	IL	-1.2	-3.1	-4.0	-2.9	4.3	8.1	10.8	14.7	11.4	11.4	13.8	14.2	16.7	21.8	23.9	18.9	20.8	16.4	1.6

Table 2: Add caption

References

[1] Acoustics. Hearing protectors. Simplified method for the measurement of insertion loss of ear-muff type protectors for quality inspection purposes, 1994.

[2] British Society of Audiology. Recommended procedure - pure-tone air-conduction and bone conduction threshold audiometry with ans without masking. *British Society of Audiology Website*, 2011.