



Figure 9 Mean listener ratings by format (Reference value = 5.0, Confidence intervals @ 95%).



MP3 files were checked again to ensure that levels were matched, which they were to within 0.01 LUFS. Further frequency analysis showed the MP3 version exhibiting a greater reduction in higher frequencies and much more abrupt filtering after the Nyquist frequency. Although there are differences between the files, one would not expect the loss of high frequency information to contribute to the perception of improved audio quality.

Tests B and D also returned some interesting results, with the listeners responding better to the 'emulated' vinyl than the audio sampled from the genuine record. Although the mean score is slightly below that of the original un-mastered mix-down, the confidence intervals show a considerable amount of overlap, which suggest that there are some who preferred the emulated vinyl over the original stereo mix-downs (but not over the digitally re-mastered versions). This is also confirmed by the rankings, where it can be seen that the emulation performed slightly better in Test D, for the second song 'Protect and Survive'. This could possibly be a result of the song (it is a slower tempo and for want of a better word, 'heavier') being more suited to the addition of more 'overdrive'. One would however, need to undertake a more focussed study, in order to test such an assertion.

It is also interesting to compare the plots of Test A and Test C with the compact disc version performing considerably better in the latter. This is significant, as I am aware that the song used for Test C ('Protect and Survive') was originally released as a single and mastered rather aggressively (to approximately -8 LUFS). Although the loudness levels of all test files were levelled prior to upload, the original EQ, compression and limiting used would still have shaped the sound of the CD. It would appear on this occasion that contrasting digital processes have had a more positive influence on listener perceptions, than the 'round-trip' to and from vinyl.

Although we have made many assumptions (e.g. that our playback and digital audio systems were of the required quality and that our vinyl-dub plate was a close enough approximation to the behaviour of a pressed record), based purely on the evidence of the listening tests we must *reject* the hypothesis that transferring a mix to vinyl, improves perceived audio quality. To the contrary, our test data suggests that for the majority of listeners, audio quality was perceived to have been degraded, by the process of recording to and playing back from vinyl.

The results from the usability tests provide us with an interesting contrast. Only one track was chosen for inclusion in the trials ('Charm Offensive') which allowed us to cross-reference a solitary listening test. After interacting with both CD and 'vinyl', eight of the thirteen listeners perceived a difference in sound quality between the formats, five of whom favoured the sound of the 'vinyl', whilst only two favoured the CD. Recall that the vinyl used in this test was a DVS time-code disc, the audio files being played back were identical and the outputs of the CD player and computer were again, loudness-matched. Table 2 shows direct comparisons between the results given by the eleven subjects who took part in both the listening and usability tests. Viewed side-by-side, the answers suggest some clear contradictions. For example, subjects 1 and 2 preferred the 'sound of vinyl' in the



Subject	Preferred Sound in Usability Test	Listening Test Ratings	
		Vinyl	CD
1	DVS VINYL	0	5
2	DVS VINYL	0	6
3	CD	4	6
4	NO PREFERENCE	5	6
5	CD	4	5
6	DVS VINYL	2	2
7	DVS VINYL	2	4
8	NO PREFERENCE	3	5
9	DVS VINYL	0	0
10	NO PREFERENCE	3	5
11	NO PREFERENCE	2	6

Table 2 Comparison of usability lab vs. listening tests.

labs, but were completely unconvinced by the genuine vinyl excerpts, each giving a zero rating. No subject who chose vinyl in the lab, expressed the same preference during the listening tests. The qualitative interviews give us some further insight. Asked for their reason for preferring the sound of vinyl, our first subject remarked that it “didn’t sound as precise and clean, it added something that made me feel a little bit closer to the song, it made all the synthesisers sound a bit more real”. Our second respondent commented upon the tone of the record and was adamant that the DVS vinyl, “felt bassier [...] and you know, to use a cliché, sounded warmer”. Respondent eleven combined all of the above assertions, stating the following:

*“No doubt in my mind [vinyl] sounded better.. or more preferable I should say. It seemed to be softer in the upper-mids, so less harsh, just more pleasing in that area but certainly more warmth in the bottom end. The way things sit in the mix seems to be more preferable on that kind of record.”*

When asked to indicate which format they preferred, the majority of subjects again favoured vinyl to CD. Once more, the longer answers gave listeners the opportunity to verbalise the reasons for their choices. Some of the terms used in those answers favouring vinyl were: nostalgia, novelty, comfort, satisfaction, affection, size and tactility - whilst those who preferred CD’s appeared more pragmatic, remarking upon vinyl’s unfamiliarity, size (too large), issues with handling, etc.

## 8. Summary

### 8.1 Evaluation

The DVS system generally worked very well. There were some momentary digital glitches which occurred during one or two of the trials, which were caused by the manner in which the subject cued up the tracks. I thought that these glitches had ‘given the game away’, but none of the participants passed remark. A true vinyl record would, under the same circumstances, also have skipped, the only



difference being that the audio playback responded with a digital error, rather than an analogue one. Another noticeable issue with the DVS playback, was that the un-amplified sound of the time-code could be heard coming directly from the stylus. This additional sound (similar to a sine wave tone) was also rather suspect, so I took steps to try and disguise it by carefully closing the lid of the turntable after playback had begun and encouraging the participants to put their headphones on before starting the turntable.

There was a suggestion from one of the subjects who took part in the usability test (Participant 11), that there may have been a discrepancy in loudness between the two tracks. Although the output of both the DVS and CD player were measured using loudness meters at the beginning of each test, I could not be 100% sure that the listener in question did not make an adjustment to the volume. The other issue here was that although the digital audio files used were the same, there were still two different playback systems in use - the standalone CD player and the iMac computer. Both of these systems would of course, have comprised of different audio components and having been so careful to ensure the quality and parity of audio converters when sampling the vinyl, not to apply the same level of scrutiny to the playback systems was a mistake. It is quite possible that the differing characteristics of the D/A converters would have been an influence on the perception of sound quality and those suggestions that vinyl playback was 'softer' or 'warmer', could have been valid after all.

If I was to reprise the tests, then I would make use of the second 'deck' in the DVS and a control CD (similar to a DVS vinyl disc, only with the time code burnt to CD) to trigger it. By doing this, the only audio outputs being used would have been the computer's and any disparity between playback systems would therefore be removed. Also, rather than ask each subject to play the tracks one after another, I would encourage them to switch between the DVS vinyl and CD at will.

## 8.2 Conclusion

This investigation has given a clear indication that the reasons behind the recent resurgence of the vinyl LP are numerous and rejects the hypothesis that audio quality is the sole defining factor. There does however, appear to be a clear link between subjective audio quality assessments and an individual's appreciation of other attributes of vinyl such as the artwork, sleeve notes, or even their past experiences, pre-conceptions or memories of the format. It is still clearly a subject which divides opinion and engenders passionate views on all sides but this study has shown that it is possible to delineate auditory and non-auditory influences.

The manner in which the lab tests managed to encourage some of our subjects to eulogise over the sound of vinyl, despite the fact that they were actually listening to a CD, suggests that I have (at least partially) succeeded in my aim to recreate something akin to Edison's tone tests, or at least the Memorex commercials.

Finally, it is suggested that in order to have greater confidence in this report's findings, it would be necessary to not only make the refinements mentioned in our evaluation but also to scale-up the



project, increasing the sample population of the on-line tests and also the number of subjects taking part in the lab tests.

## References

- [1] IFPI (2013) Recording Industry in Numbers: The recorded music market. [Online] 8th Apr. Available from: <http://www.ifpi.org>
- [2] Nokelainen, T. & Dedehayir, O. (2012) 'Why some obsolete media stick around: the case of the LP record'. Proc. of 16th International Academic MindTrek Conference, p 105-112. New York : ACM.
- [3] Bijsterveld, K. & van Dijck, J. (2009) Sound Souvenirs: Audio Technologies, Memory and Cultural Practices, Amsterdam University Press.
- [4] Digital DJ Tips (2011) Why Record Store Day Won't Revive Vinyl [Online] DJ Culture Blog. 15th Apr. Available from: <http://www.digitaldjtips.com/2011/04/why-record-store-day-will-never-revive-vinyl/>
- [5] Milliard, A. (2000) "Edison's Tone Tests and the Ideal of Perfect Sound Reproduction" [Online] Available from : <http://www.npr.org/programs/lnfsound/talkon/millard.html#tone>
- [6] Bech, S. & Zacharov, N. (2006) Perceptual audio evaluation : theory, method and application. Chichester : John Wiley and Sons.
- [7] Miller, C. (2011) 'Forget Watson and Jeopardy – How about Thomas Edison and the Washington Avenue Armory?' [Blog] Times Union. Available from: <http://blog.timesunion.com/chuckmiller/watson-and-jeopardy-how-about-thomas-edison-and-the-washington-avenue-armory/6434/>
- [8] Milner, G. (2009) Perfecting Sound Forever. Granta Books, London.
- [9] Olive, S. (2010) "Audio Musings : Why Live Versus Recording Listening Tests Don't Work. Blog [Online] 9th July. Available from : <http://seanolive.blogspot.co.uk/2010/07/why-live-versus-recorded-listening.html>
- [10] Classic TV Ads (2011) 'Ella Fitzgerald for Memorex' [TV] Originally Broadcast Spring 1974. Available from : <http://www.youtube.com/watch?v=1-lvTF0xUxM>
- [11] Yaniger, S. "Testing One, Two, Three." Linear Audio, September 2011, 161-74.
- [12] Lipshitz, S. (1984) The Digital Challenge - More on ABX Testing. In: Boston Audio Society, 'The Speaker' (Aug-Sep 1984).
- [13] Montgomery, C. (2012) 24/192 Music Downloads ...and why they make no sense. [WWW] Xiph.org. March 25th Available from: <http://people.xiph.org/~xiphmont/demo/neil-young.html>
- [14] Nyquist, H. (1928) Certain topics in telegraph transmission theory. Trans. AIEE, Vol. 47, pp. 617–644, Apr. 1928. Reprint as classic paper in: Proc. IEEE, Vol. 90, No. 2, Feb 2002.
- [15] Robjohns, H. (2010) Analogue Warmth: The Sound Of Tubes, Tape & Transformers. Sound On Sound. [Online] Feb 2010. Available from : <http://www.soundonsound.com/sos/feb10/articles/analoguewarmth.htm>
- [16] Sound on Sound (2010) Distortion in the Studio: Dirty Sounds [Online] SOS. Apr 2010. Available from: <http://www.soundonsound.com/sos/apr10/articles/distortion.htm>
- [17] Northern Record Pressing (2013) 'Lathe Cut Records - FAQs' [Online] Available from: <http://www.nrpressing.com/?p=1235>



- [18] Dorsey, S. (2008) Mastering for Vinyl [WWW] Recording: The Magazine for the Recording Musician. Available from: <http://www.recordingmag.com/resources/resourceDetail/114.html>
- [19] Kraft, S. (2012) MushraJS [Software] Available from: <http://seebk.github.io/mushraJS/>
- [20] Zielinski, S., Hardisty, P., Hummersone, C., & Rumsey, F. (2007) Potential biases in MUSHRA listening tests. Proceedings of 123rd Audio Engineering Society Convention, Oct 2007, New York.
- [21] Mastahanksta (2013) Analogue Vinyl vs Digital Vinyl Part 2 [Online video] Available from: <http://www.youtube.com/user/djscratchdog/videos>
- [22] Sporer, T., Liebetrau, J. & Schneider, S. (2009) Statistics of MUSHRA revisited. In: Proceedings of 127th Audio Engineering Society Convention, October 2009, New York.