REDUCING THE VARIABILITY OF LOUDSPEAKER PREFERENCE RATINGS THROUGH DIGITAL EQUALIZATION

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1.0 Introduction

It has long been recognized that loudspeaker location and room geometry are sources of variability in listeners' ratings of loudspeakers [2][3]. When the intent of a listening test is to compare different loudspeakers, the effects of these variables are reduced through proper experimental design. In this manner, subtle differences in sound quality can be revealed.

Unfortunately, the environments in which consumer audio products are used do not always conform with those of a controlled listening test. As a result, the sound quality delivered to the consumer may not reflect the fideltiy of the audio product.

This paper reports some key results of the recently completed Athena project, a collaboration between NRC and the Canadian Audio Research Consortium. The purpose of Athena was to investigate the interaction of loudspeakers and rooms and to develop a means to lessen the deleterious effects on subjective assessments.

2.0 Variability of Loudspeakers in Rooms

An experiment was designed to examine the variability of loudspeaker preference ratings in different positions of a variable-geometry listening room specially designed for this purpose. The experiment compared the same loudspeaker in different positions as well as different loudspeakers in the same position.

Four loudspeakers, consisting of two different pairs, were placed at four different positions throughout the room as shown in Figure 1. The anechoic frequency responses of the loudspeakers in each pair were matched to within 0.25 dB. The two loudspeakers in a matched pair, therefore, were considered identical.

Listeners sat in a low-backed swivel chair which was rotated as required, to face the activated loudspeaker. The loudspeakers' positions and identities were hidden using an acoustically transparent but visually opaque screen. Of the 13 listeners participating in the experiment, only 4 had previous experience in listening tests.

The experiment was a four-way multiple comparison test where each listener performed four simultaneous ratings. Each trial consisted of a presentation of four selections of contemporary and classical music presented in a random order. Listeners could switch between the different loudspeakers at will and were asked to give separate ratings for each musical program. At the end of each trial, the listener left the room so that the loudspeaker positions could be changed and their loudnesses balanced. Six trials were conducted.

Listeners were instructed to rate the loudspeakers using a 10-point preference scale. A preference rating of 1 indicates that the listener "really disliked" the stimulus, wheres a rating of 10 indicates that the listener "really liked" the stimulus. The listeners were also
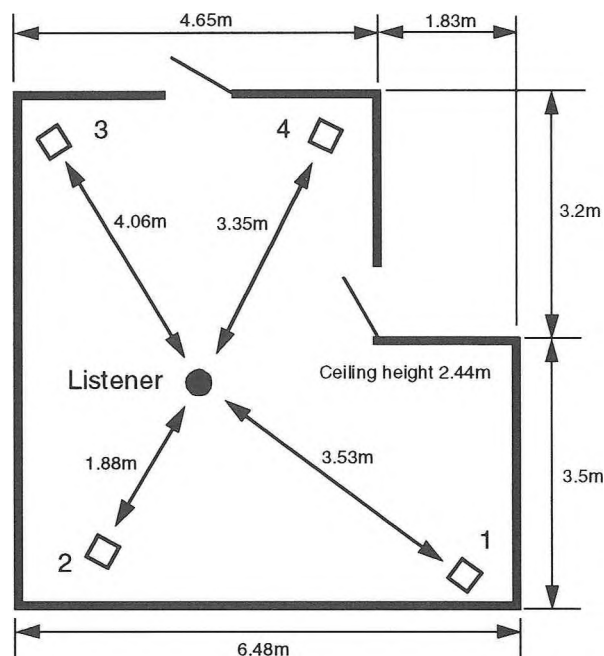

Figure 1. Layout of listening room illustrating listener and numbered loudspeaker positions.

encouraged to separate their ratings using the following guidelines:

Point Spread	Meaning
>2	strong preference
1.5 to 2	moderate preference
0.5	slight preference

Preference ratings were collected using a computer-controlled apparatus. Data were then analyzed using a repeated measures MANOVA model with SuperAnova 1.1. There are two significant findings from this analysis.

First, the most significant factor influencing listener preference ratings was loudspeaker location (p=0.0001). In fact, the listeners demonstrated a remarkable agreement in their preference for position 4 over position 1 or 2. The mean preference ratings for each location are shown in Figure 2.

The second finding is that there were no significant differences in listener preferences between loudspeakers (p=0.4269). That is, when measured in different room positions, the differences between the loudspeakers became insignificant.

3.0 Reducing Variability through Equalization

A second experiment was designed to examine the effect of a digital equalization scheme upon the variability of listener preference ratings across different room positions. The equalization is judged beneficial if it is capable of reducing this variability.

In this experiment, each member of a pair of well-matched loudspeakers were placed in two different room positions. Positions 1 and 4 were chosen because they were judged by many listeners as the most and least preferred positions, respectively.

The experiment was a four-way multiple comparison test where each listener performed four simultaneous ratings: two positions each with and without equalization. Each trial consisted of a presentation of five selections of contemporary music presented in a random order. Listeners could switch between the four stimuli at will and were asked to give separate ratings for each musical program. The order of presentation of the stimuli were randomized for each trial. A total of three trials was conducted. Listeners were instructed to rate the loudspeakers using a 10-point preference scale as in the previous experiment. Six of the ten listeners participating in this experiment had previous listening experience at NRC.

Preference ratings were collected using a computer-controlled apparatus. Data were then analyzed using a repeated measures MANOVA model with SuperAnova 1.1.

Data analysis shows that, even with equalization, loudspeaker location remains the most significant factor influencing listener preference ratings (p=0.04). As in the previous experiment, location 4 is preferred over loctation 1.

It was encouraging to also find that, on average, the equalized stimuli were preferred over the unequalized ones, however, the effect did not reach statistical significance (p=0.1725).

A contrast between location 1 equalized and location 1 unequalized was highly significant (p=0.0053). A similar contrast for location 4 did not reach statistical significance (p=0.1693). This is illustrated in Figure 3 which shows the mean preference ratings for position 1 and 4 with and without equalization. Note that the mean ratings for
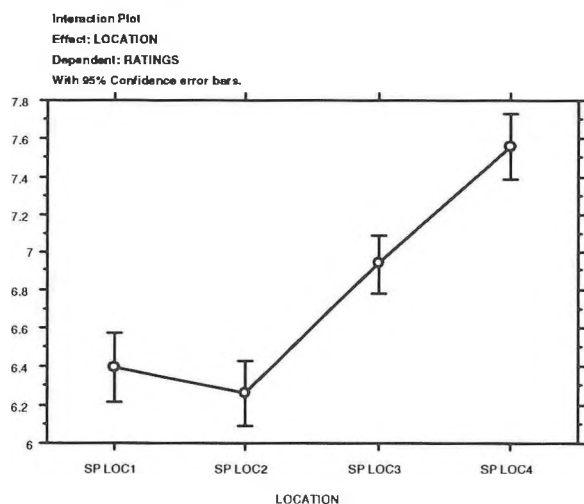
the equalized locations are close and within each others confidence interval while the unequalized means clearly differ.

4.0 Conclusions

The effect of loudspeaker placement upon listener preferecne ratings has been demonstrated. It was shown that the location of loudspeakers within a room can have a larger impact upon preference ratings than the type of loudspeaker. It was also shown that proper equalization can be used to reduce the variability of listener preference scores across different loudspeaker positions. Since the equalization scheme was implemented in realtime for these experiments, it has real potential for use as a consumer product.

5.0 Acknowledgements

6.0 References

[1]   Schuck, P.L., Olive, S.E., Sally, S.L., Bonneville, M.E., Ryan, J.G., Momtahan, K.L., Verreault, E. and Toole, F.E., "Perception of Reproduced Sound in Rooms: Some Results of the Athena Project", *12th International Conference of the A.E.S.*, June 28-30, 1993.

[2]   Toole, F.E., "Listening Tests- Turning Opinion into Fact", *J. Audio Eng. Soc.*, Vol. 30, pp. 431-445, June, 1982.

[3]   Olive, S.E., Schuck, P.L., Sally, S.L. and Bonneville, M.E., "The Effects of Loudspeaker Placement on Listeners' Preference Ratings", *93rd Convention of the A.E.S.*, October, 1992.

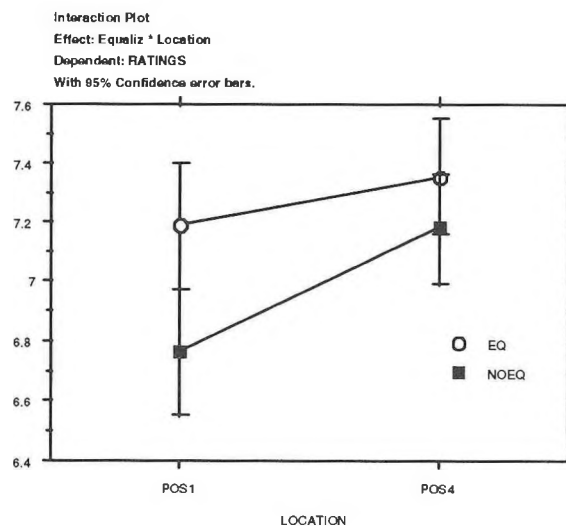Figure 2. Mean listener preference ratings for various loudspeaker locations.

Figure 3. Interaction between equalization and loudspeaker position.