Harman International

# The Subjective and Objective Evaluation of Room Correction Products

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# Overview

Motivation

Experiment

Results

Conclusions

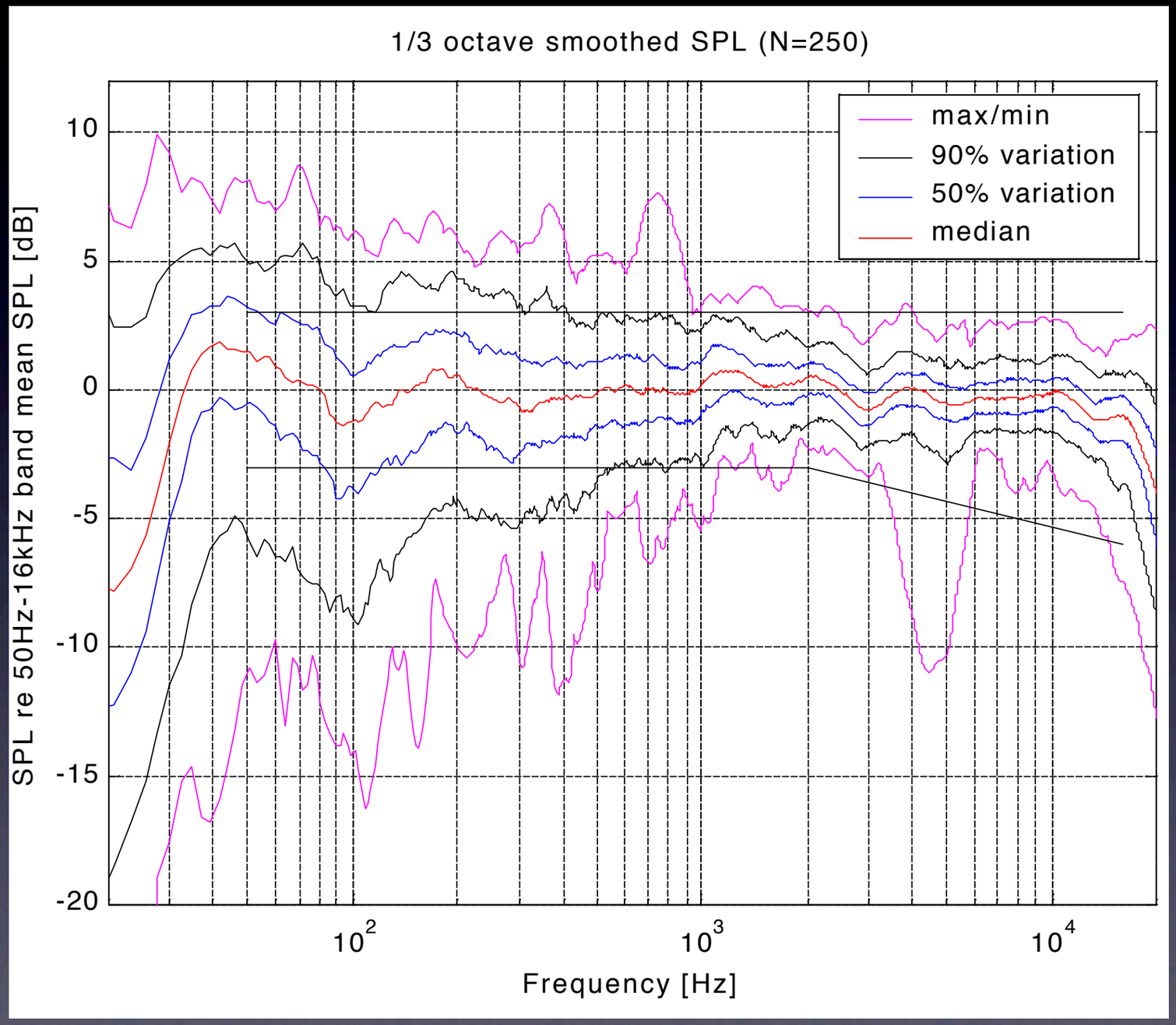
# Motivation

Acoustical interactions between loudspeakers are a significant source of variance in the playback chain

**Low frequencies** (< 500 Hz): room modes, solid angle gain/boundary effects

**Higher frequencies** (> 500 Hz); room reflections are dominant effect but room correction cannot fix this; this is mostly "loudspeaker correction" - not "room correction"

distribution of in-room responses of 372 factory calibrated 3-way Genelec loudspeakers in 164 professional control rooms




The Quality of Professional Surround Audio Reproduction, A Survey Study
Aki V. Mäkivirta and Christophe Anet. 2001

# Experiment

**Research Questions:**

1) To what extent do room correction products improve or degrade the overall quality of reproduced sound based on listener preference and spectral balance ratings?

2) Can the subjective ratings of the room correction products be explained by objective measurements such as the combined in situ loudspeaker/room frequency response?

# Independent Variables

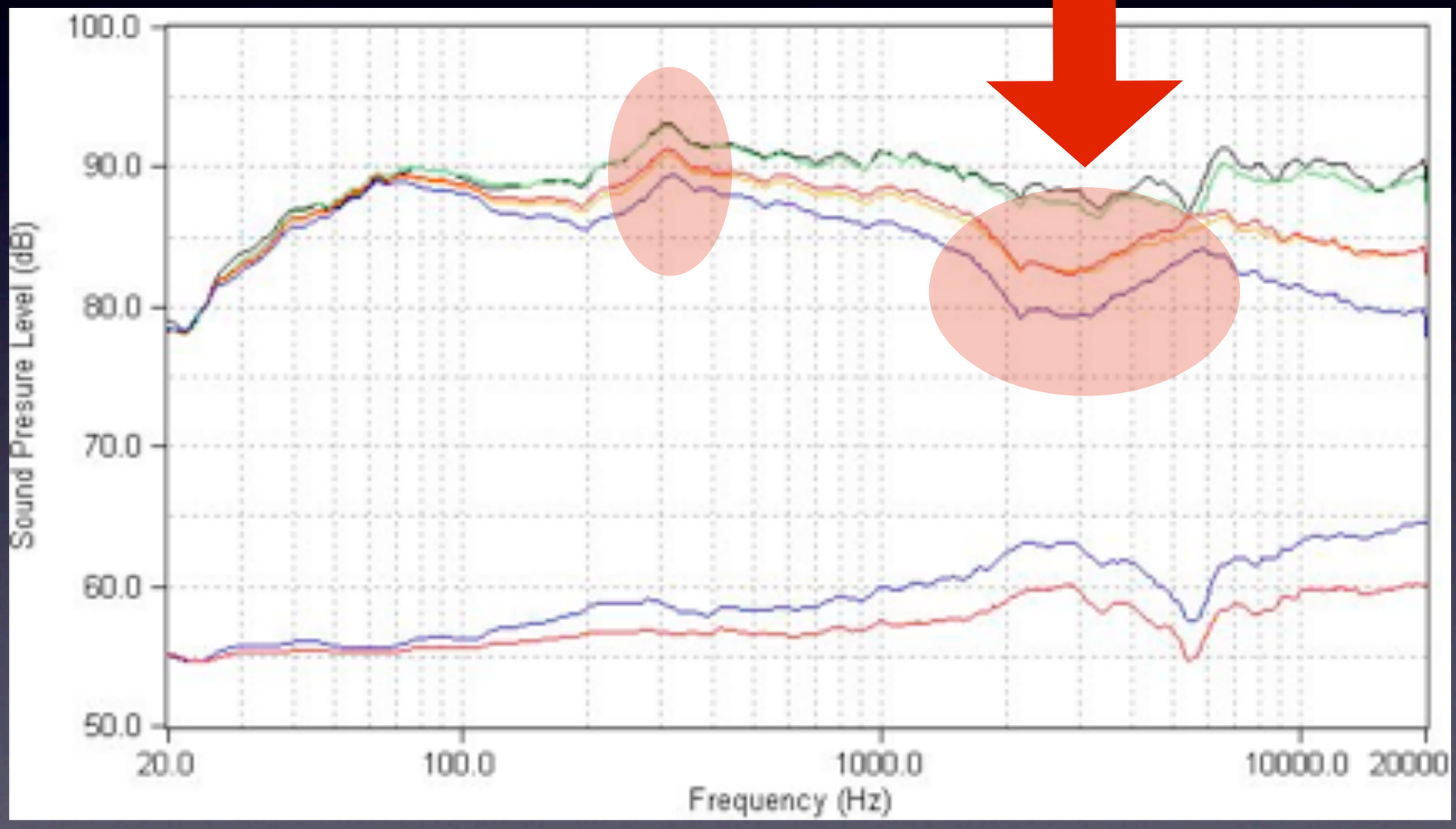
| Independent | Levels |
|---|---|
| Room Correction Products (6) | RC1<br>RC2<br>RC3<br>RC4 (No Room Correction)<br>RC5<br>RC6 |
| Programs (3) | JW - Jennifer Warnes, "Bird on a Wire"<br>TC - Tracy Chapman, "Fast Car"<br>JW - James Taylor, "That's Why I'm Here" |
| Observations (3) | O1, O2 and O3 |

# Room Correction Products

| | |
|---|---|
| Anthem Statement D2 Processor | $7000 |
| Audyssey Room Equalizer | $2500 |
| Harman 1 (6 seats) | NA |
| Harman 2 (optimized seat) | NA |
| Lyngdorf DPA-1 | $5500 |
| No equalization | Free |

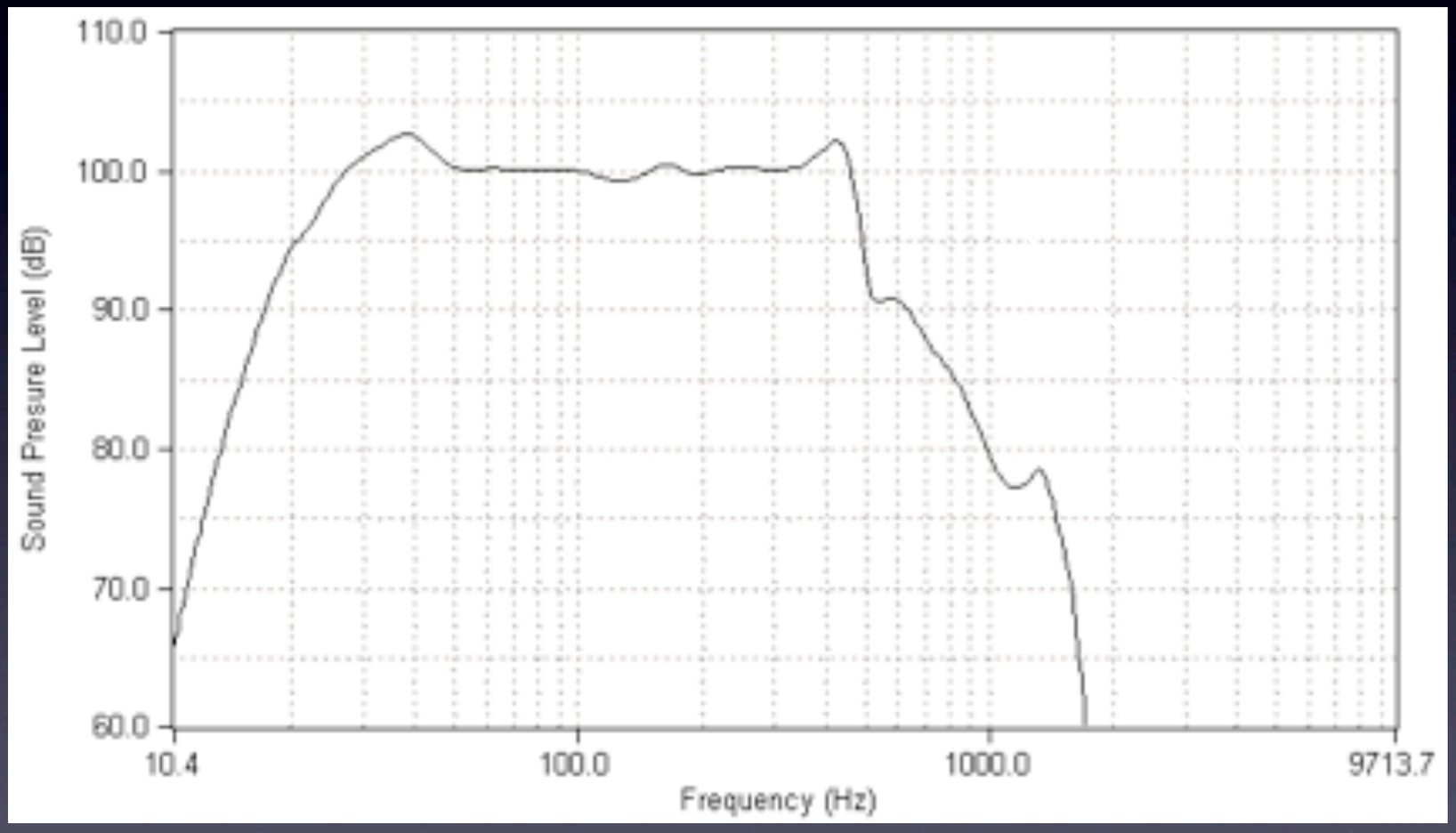

# Loudspeaker

sound power problem




B&W 802N

# Subwoofer



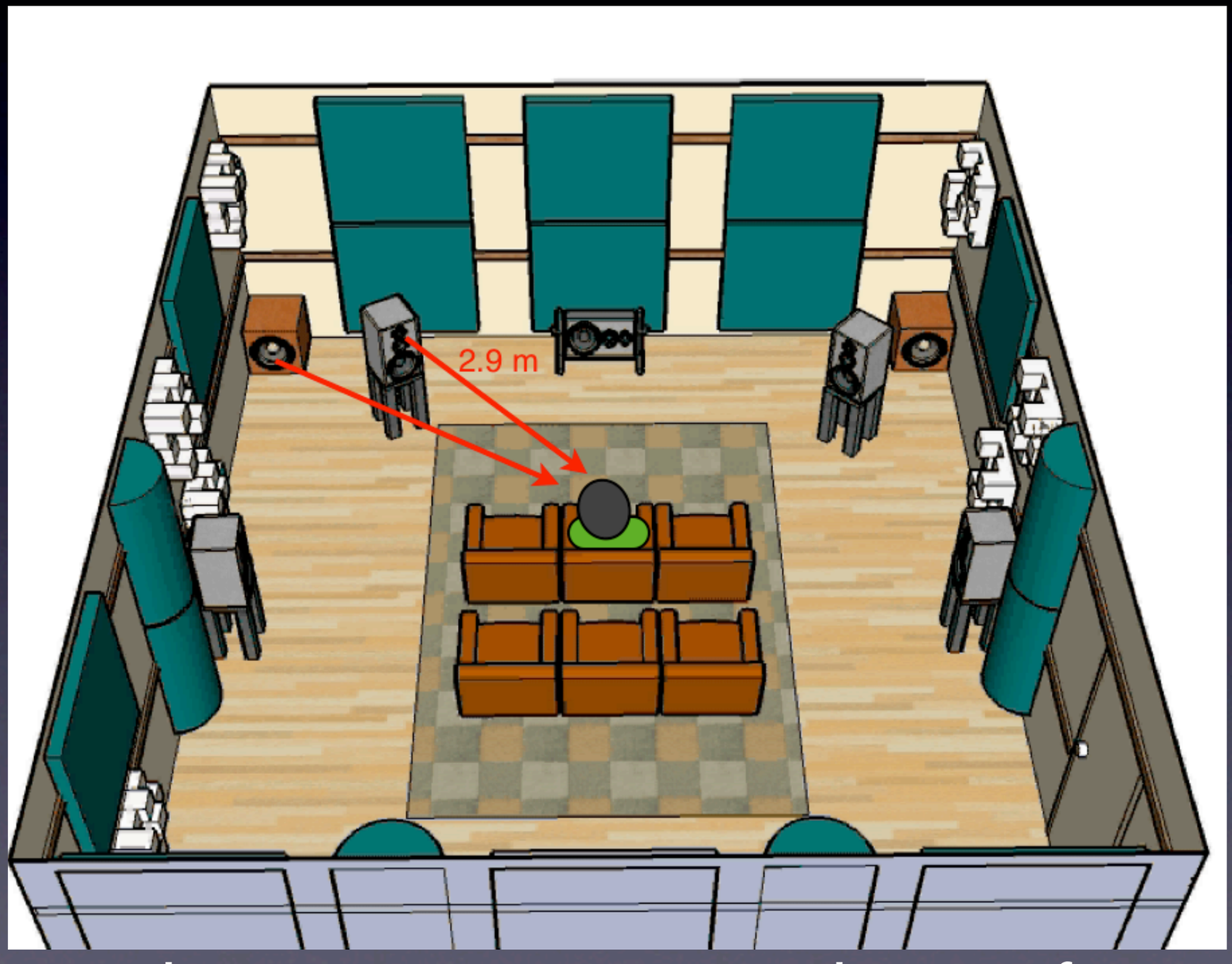

4th order LR @ 80 Hz

JBL HB5000

# Harman International Reference Listening Room

see Sean E. Olive "A New Reference Listening Room for Consumer, Professional, and Automotive Audio Research," 126th AES Convention, Munich, (May 2009)

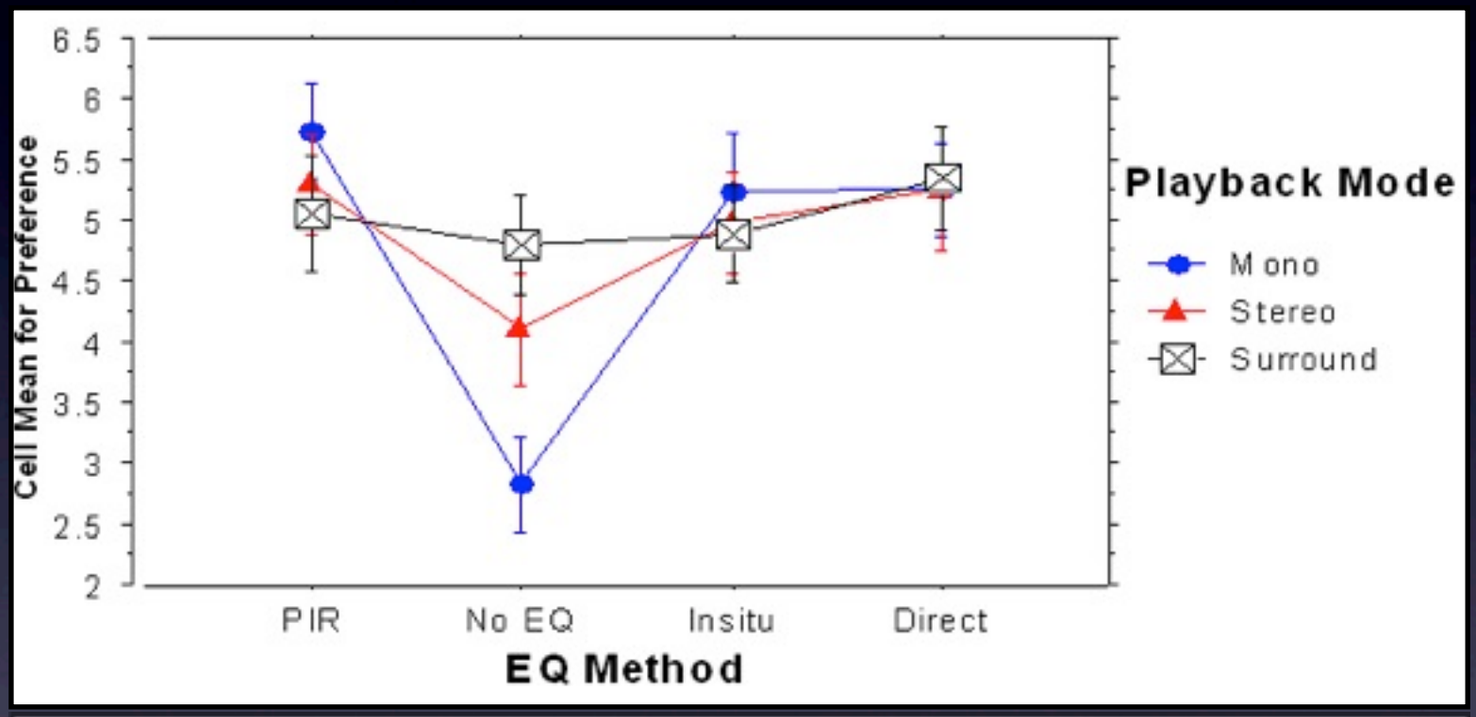
# Room/Speaker/Listener Setup



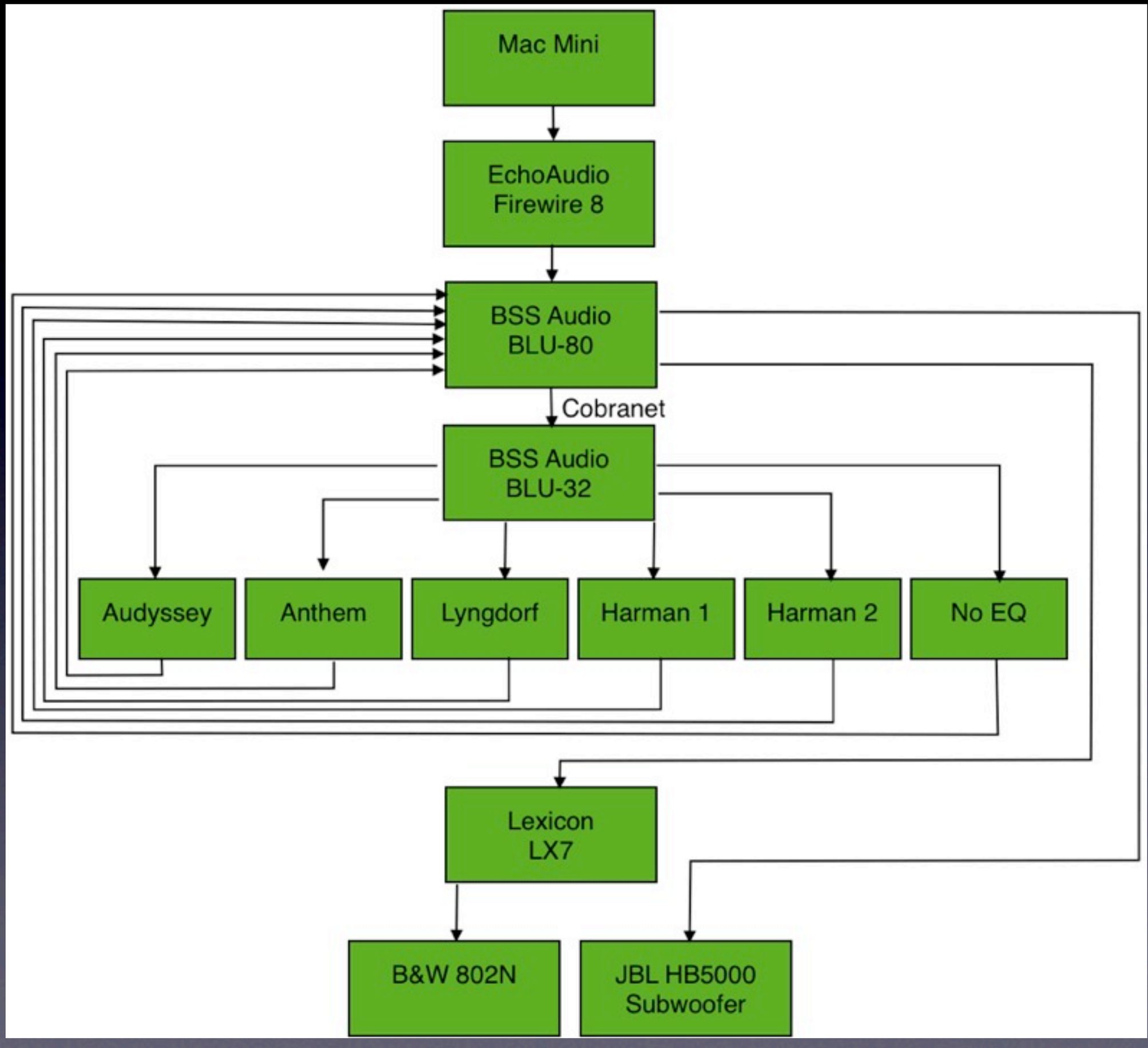

Calibrations for each room correction product performed based on manufacturer's user manual

# Why Mono Comparisons?

Listeners are more discriminating of room correction in mono than stereo or surround




Olive, Devantier & Hess," Comparison of loudspeaker-room equalization preference for multichannel, stereo, and mono reproductions: Are listeners more discriminating in mono?" AES, Convention, Munich (May 2008)


Mac Mini
EchoAudio
Firewire 8
BSS Audio
BLU-80
Cobranet
BSS Audio
BLU-32
Audyssey
Anthem
Lyngdorf
Harman 1
Harman 2
No EQ
Lexicon
LX7
B&W 802N
JBL HB5000
Subwoofer

# Dependent Variables


Preference


Spectral Balance


Comments

# Listening Test Method

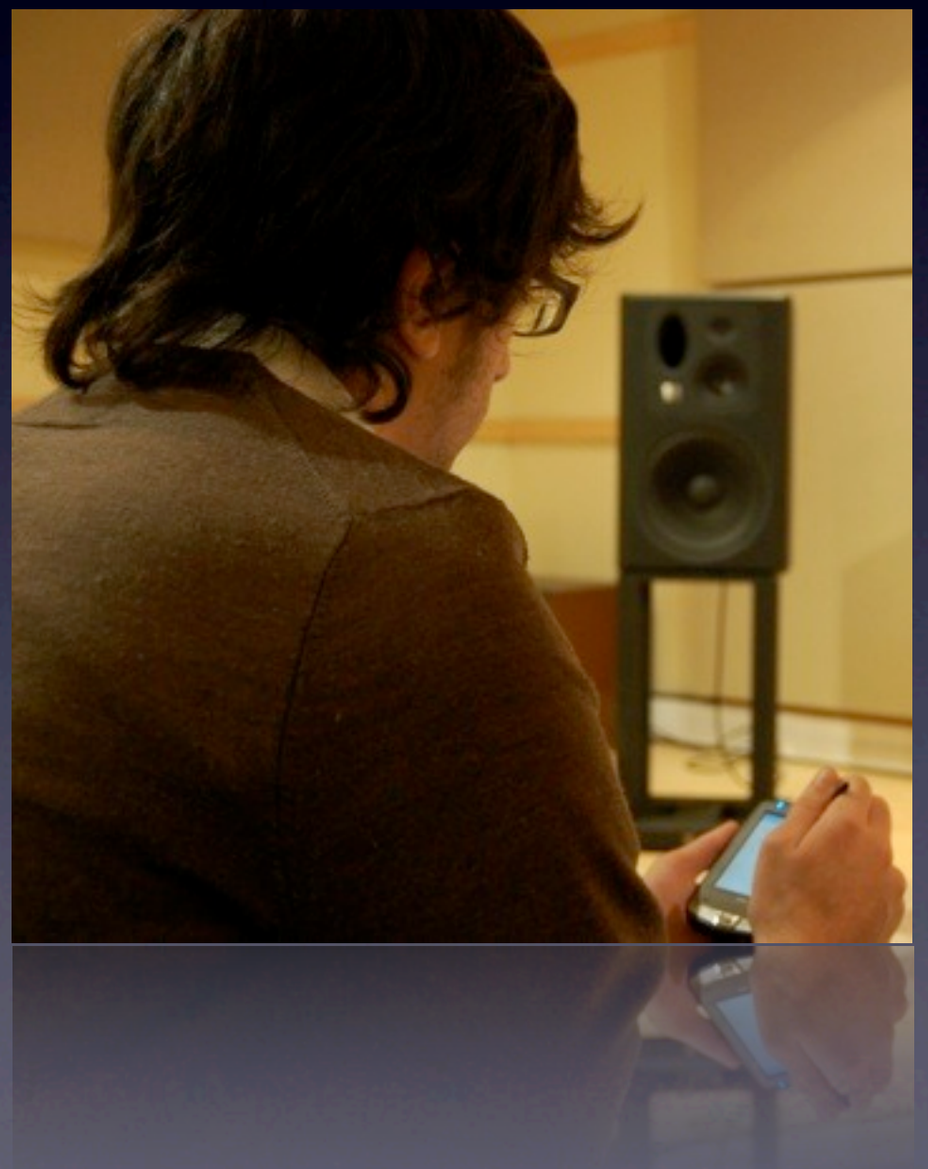
Room corrections loudness normalized within 0.1 dB according to CRC loudness meter

8 trained listeners with normal hearing

MUS~~HRA~~ (no EQ is hidden reference)

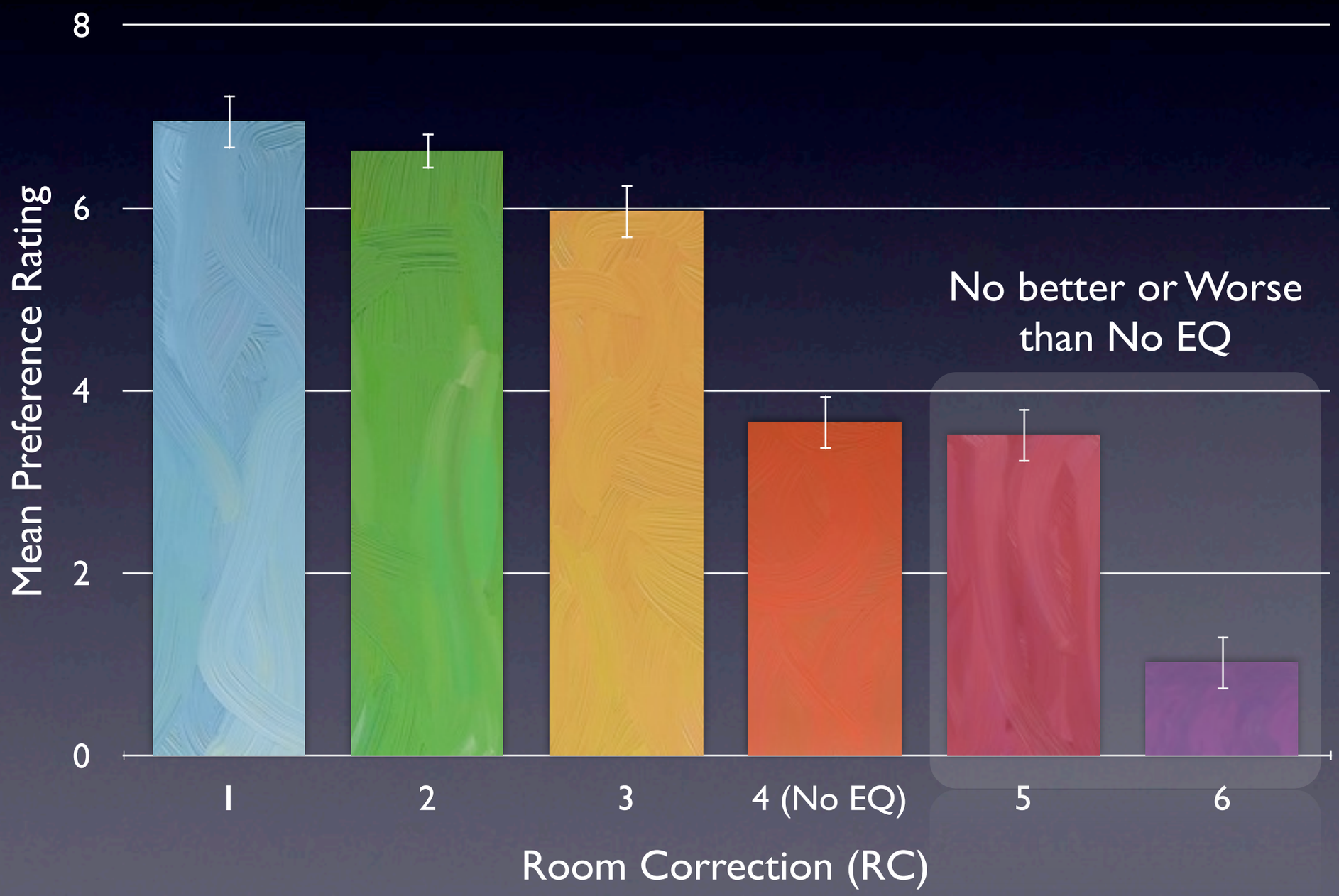
Double-blind

Room corrections and program order randomized



# Results

# Mean Preference Rating for Room Correction



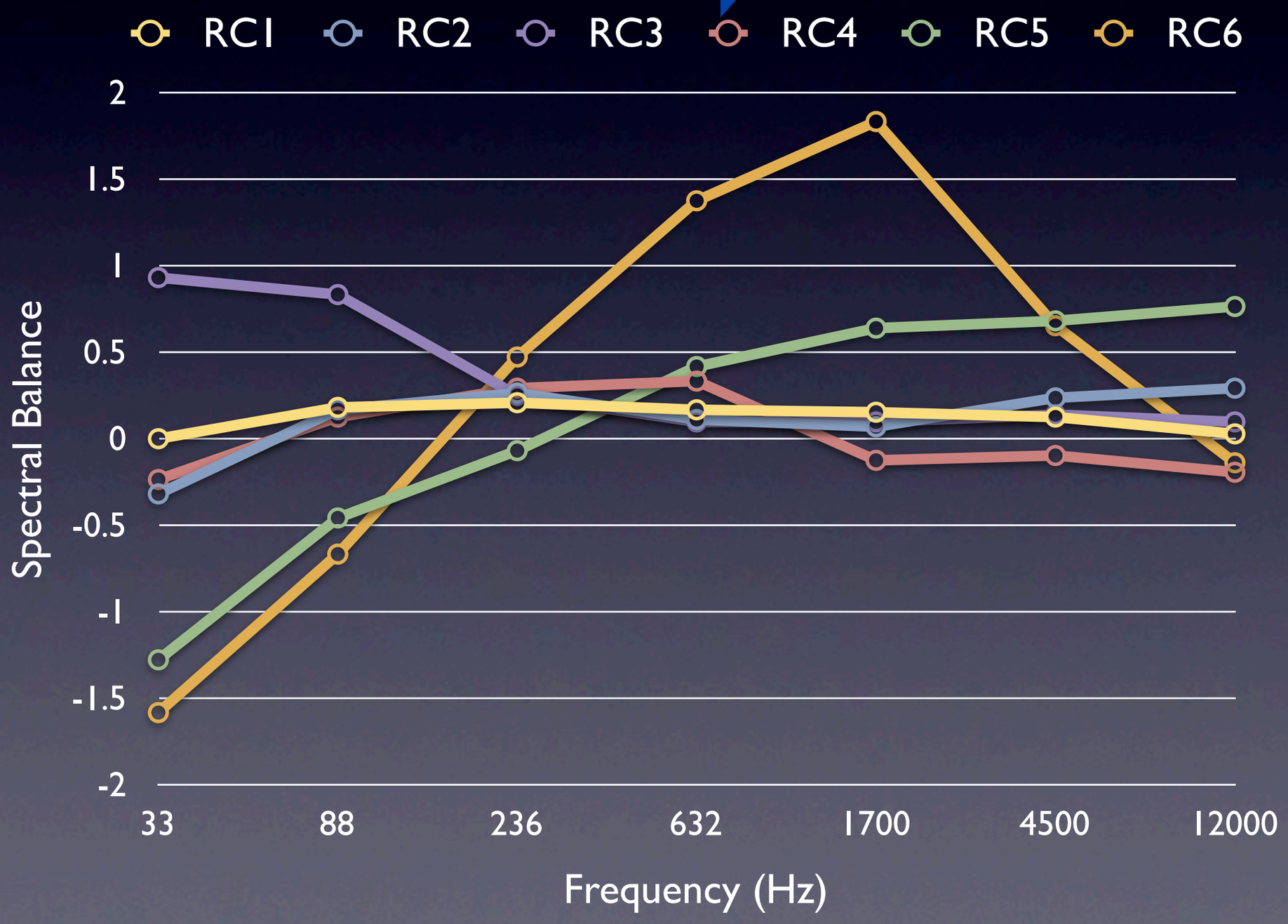
# Perceived Spectral Balance

Less Preferred

Too Much

Ideal

Too Little



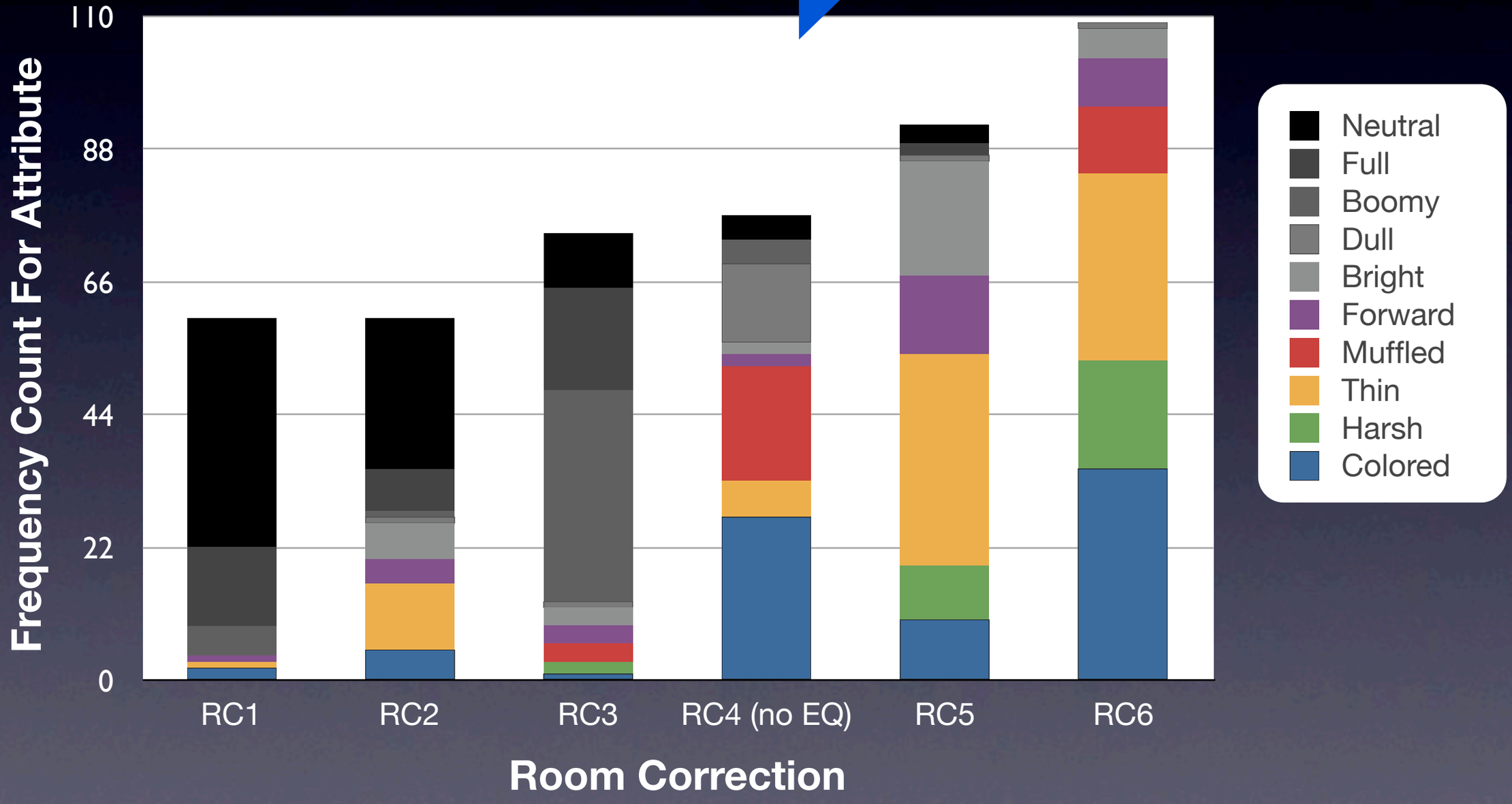
# Comments

Less Preferred

| Room Correction | Colored | Harsh | Thin | Muffled | Forward | Bright | Dull | Boomy | Full | Neutral | Preference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RC1 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 5 | 13 | 38 | 6.95 |
| RC2 | 5 | 0 | 11 | 0 | 4 | 6 | 1 | 1 | 7 | 25 | 6.63 |
| RC3 | 1 | 2 | 0 | 3 | 3 | 3 | 1 | 35 | 17 | 9 | 5.97 |
| RC4 (no EQ) | 27 | 0 | 6 | 19 | 2 | 2 | 13 | 4 | 0 | 4 | 3.66 |
| RC5 | 10 | 9 | 35 | 0 | 13 | 19 | 1 | 0 | 2 | 3 | 3.52 |
| RC6 | 35 | 18 | 31 | 11 | 8 | 5 | 1 | 0 | 0 | 0 | 1.03 |
| Correlation w. Preference | -0.9 | -0.86 | -0.75 | -0.6 | -0.59 | -0.32 | -0.24 | 0.36 | 0.79 | 1 | |

# Comments

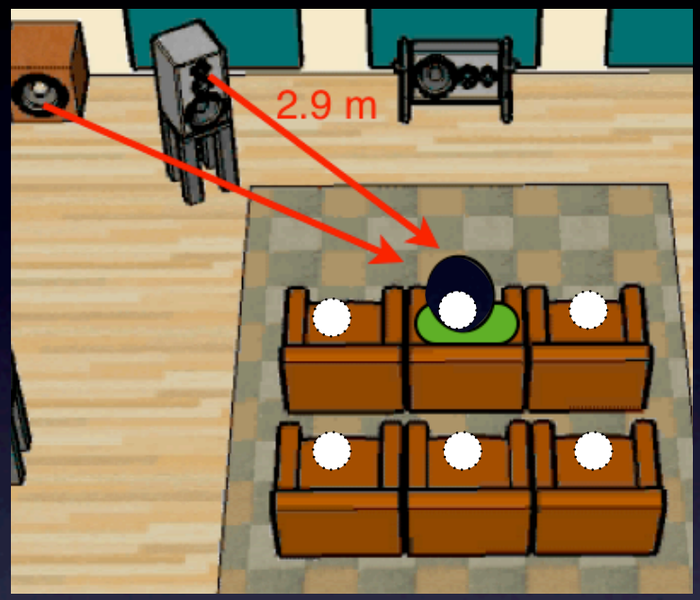
Less Preferred



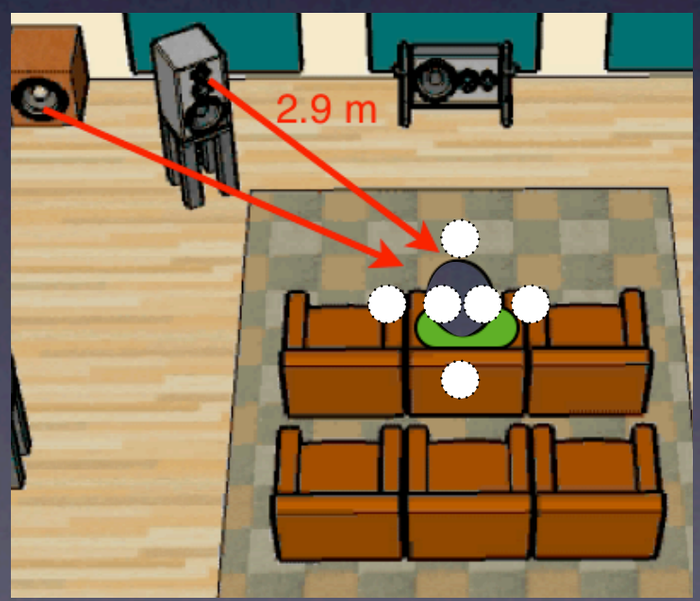
# Objective Measurements

# Objective Measurements

(1) In-room amplitude of loudspeaker spatially- averaged over 6 listening seats



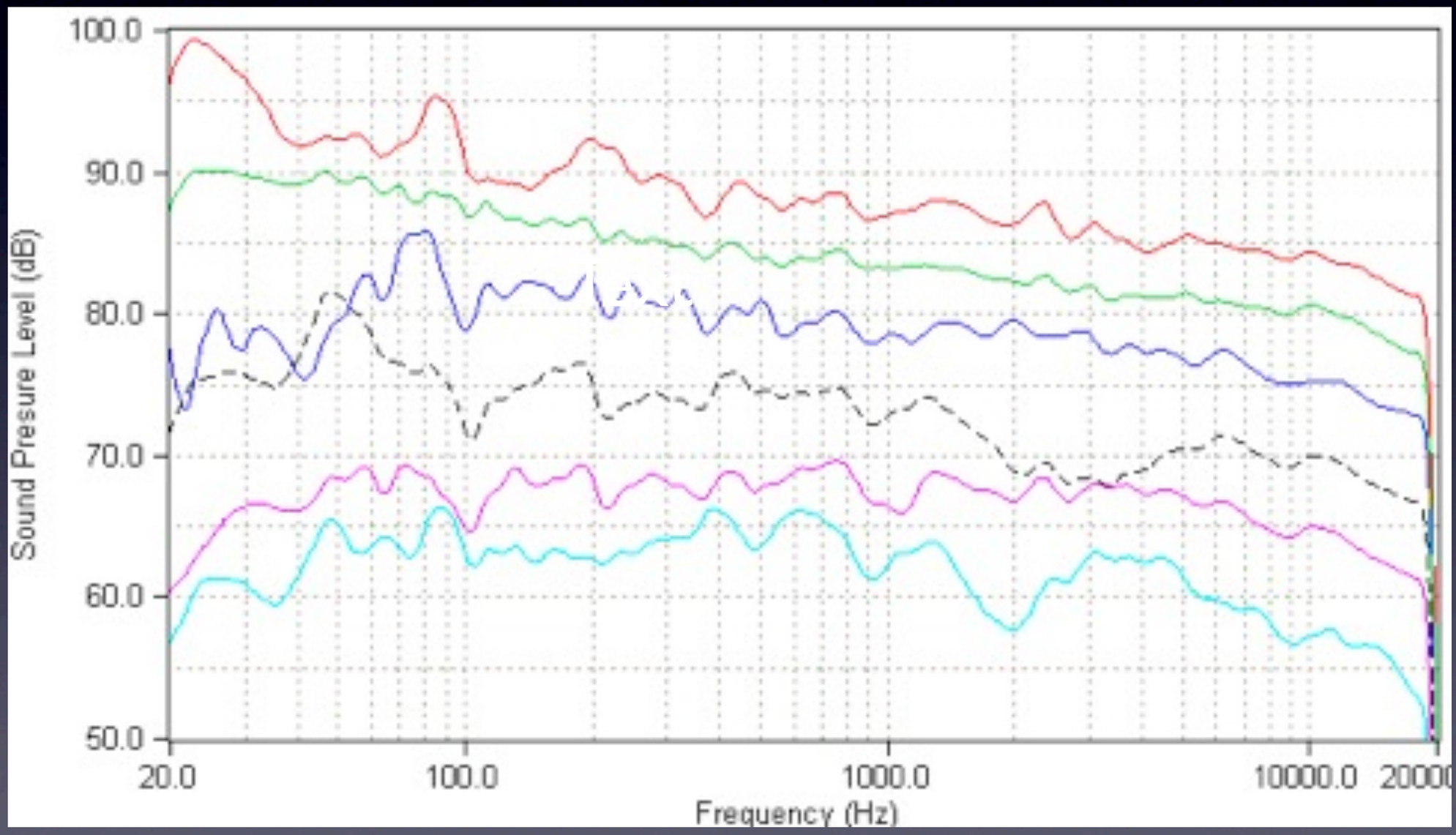

(2) In-room amplitude of loudspeaker spatially-averaged at the primary listening seat




Frequency resolution is 48 ppo; 1/6-octave smoothing

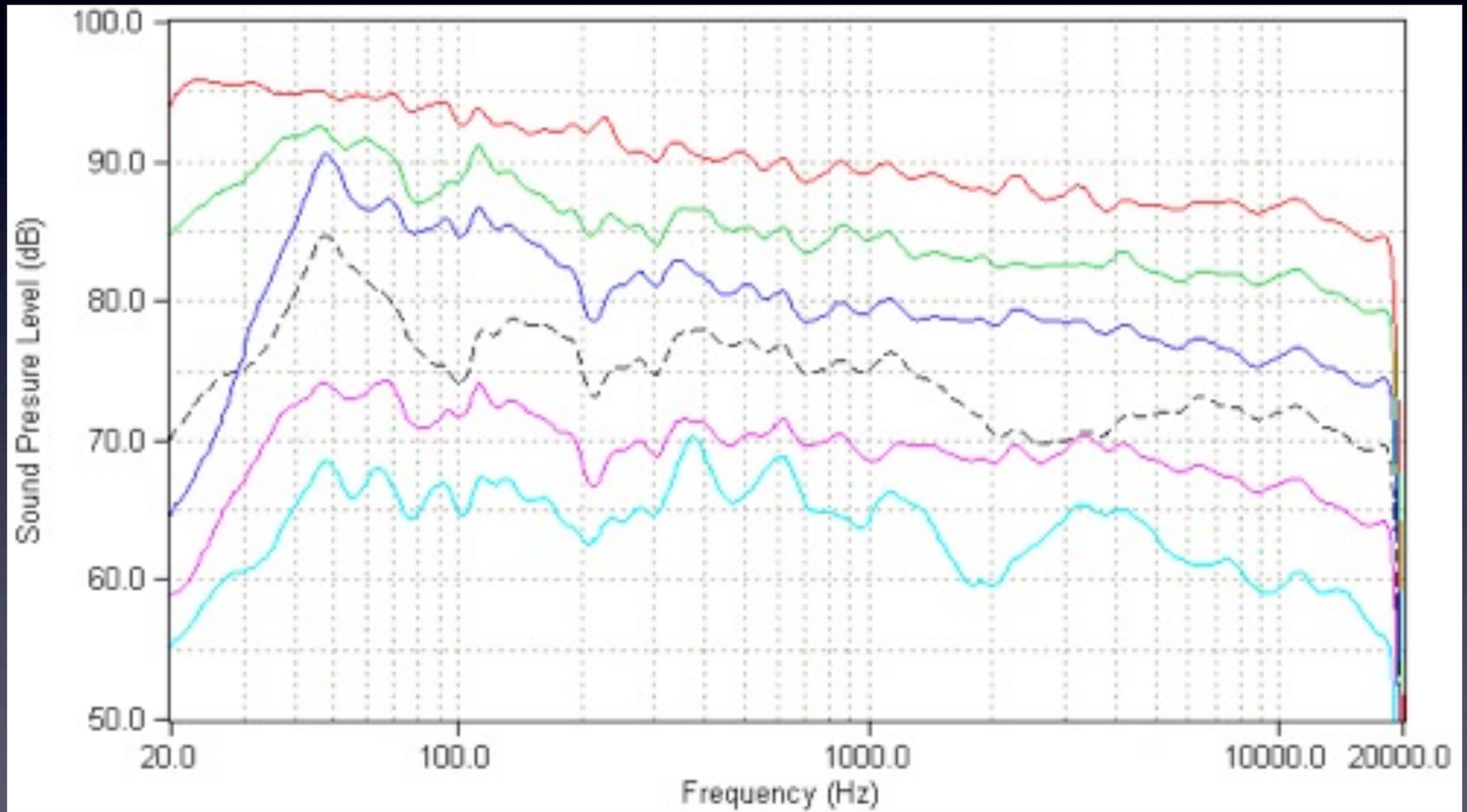
# Average Magnitude Response Over 6 Seats

Less Preferred



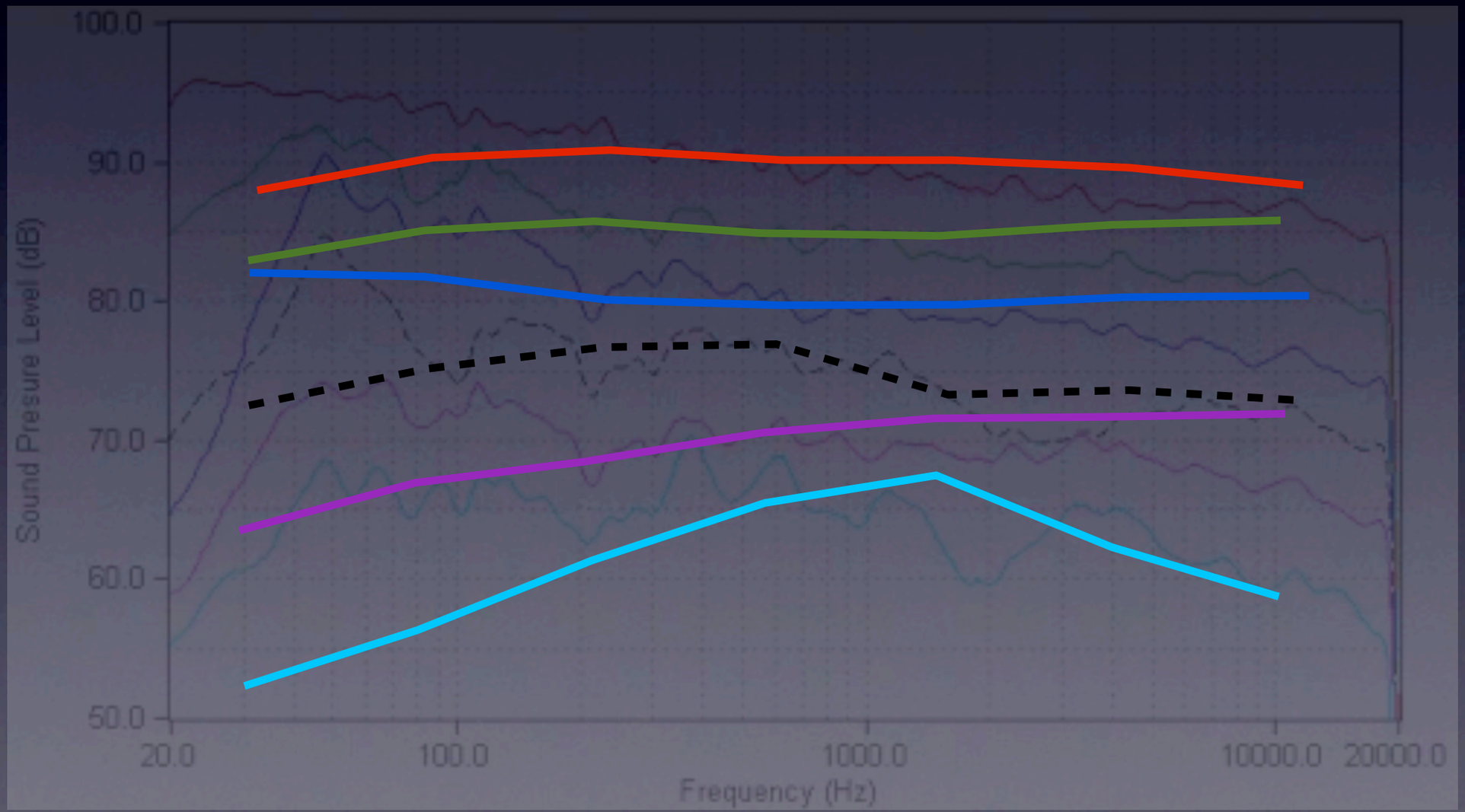
# Average Magnitude Response at Primary Listening Seat

Less Preferred



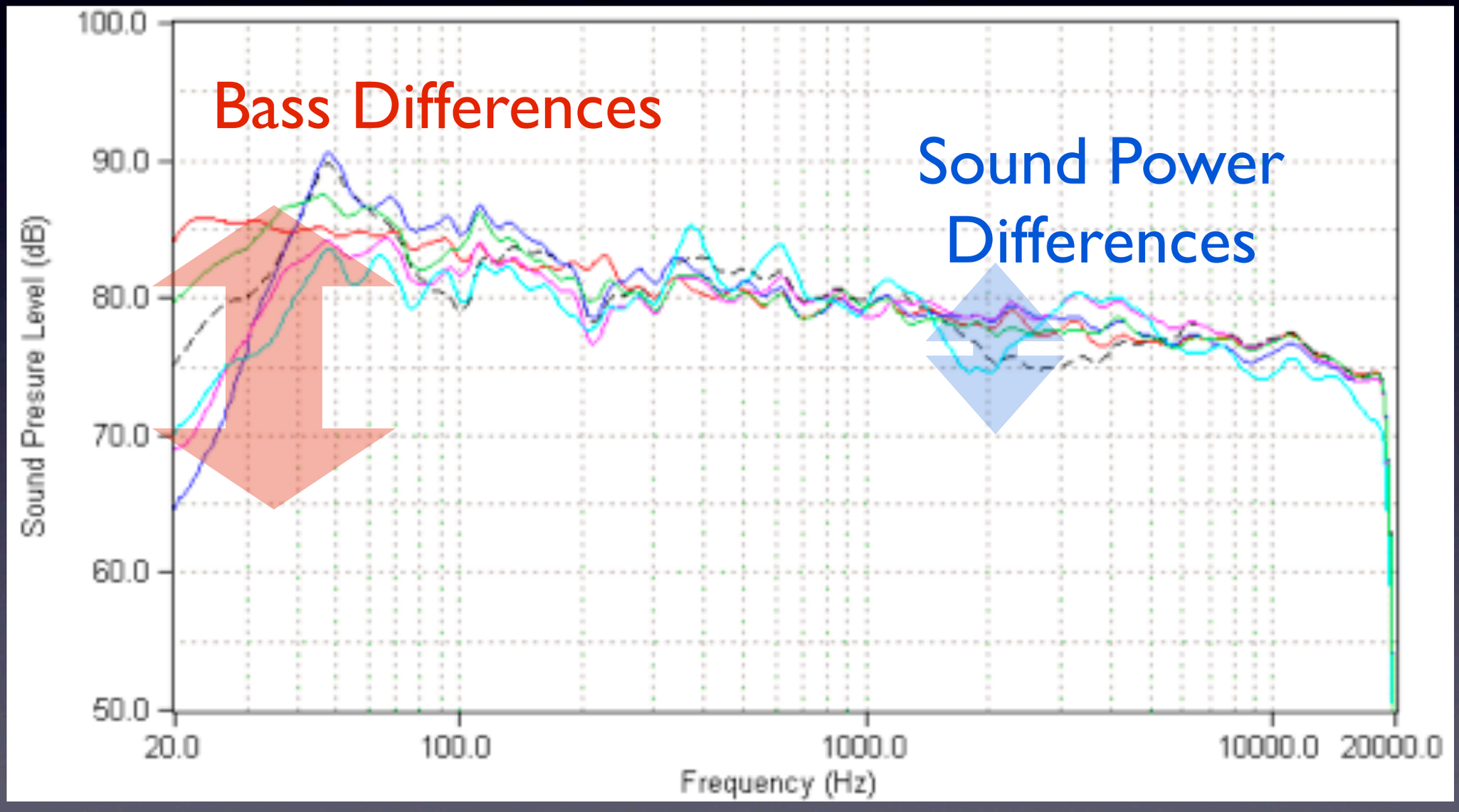
# Perceived versus Measured Spectral Balance

Less Preferred




Flat in-room response is <u>not</u> the preferred target

# Average Response at Main Seat



# Conclusions (1)

Large differences in perceived sound quality preferences among commercial room correction products

When done well, room correction can significantly improve the quality of sound production

However,  one room correction product did no better than “no correction,” and another did significantly worse

# Conclusion (2)

Preference is strongly correlated to spectral balance and comments

Less preferred products had less smooth and extended in-room frequency responses; this was associated with more negative comments related to lack of bass (thin), brightness, and coloration

# Conclusion (3)

In-room measurements spatially-averaged around the primary listening seat are good indicators of listeners' preferences, perceived spectral balance, and comments

Flat in-room response is not the optimal target response (program may be a nuisance variable)

# Thank you!

For more information contact:
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