

Evaluation of a New Active Acoustics System in Music Performance of String Quartets

Doyuen Ko and Wieslaw Woszczyk

Belmont University, Nashville, USA

McGill University, Montreal, Canada

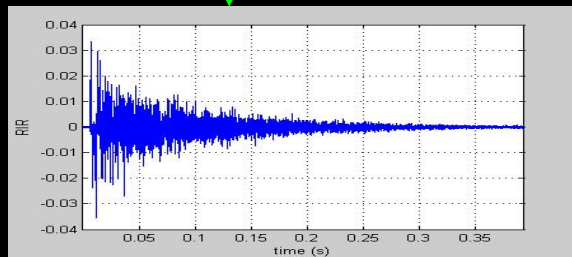
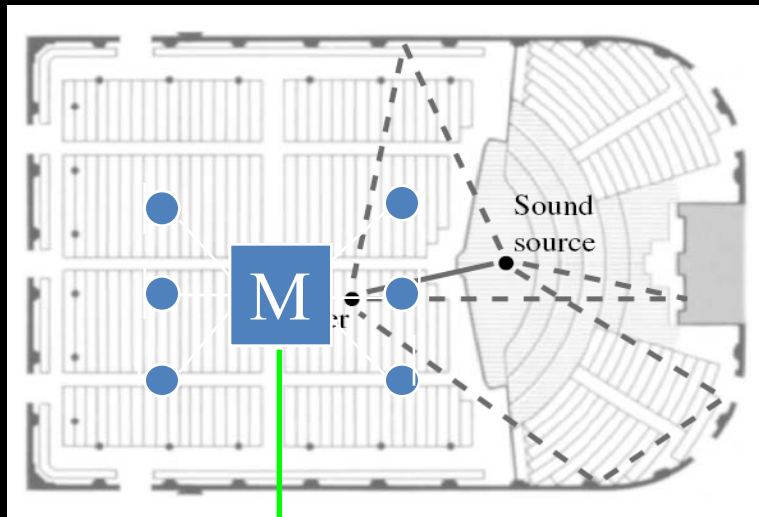


Objectives

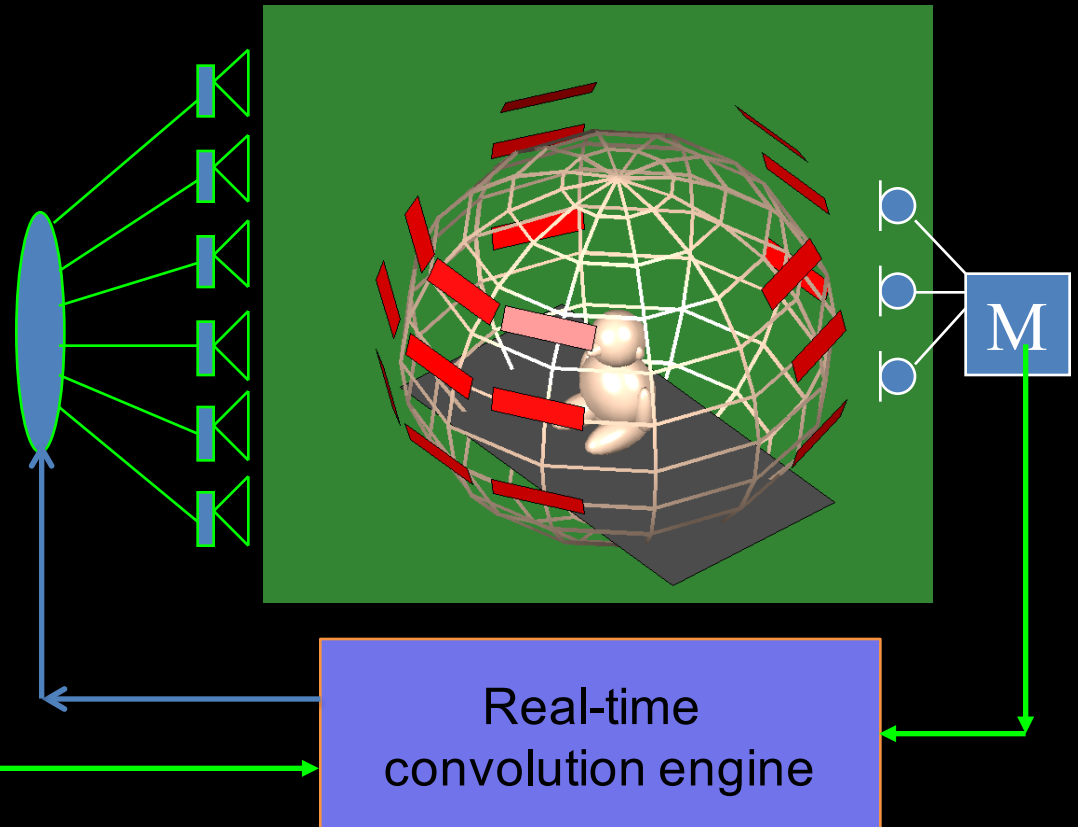
- Evaluate musicians' overall impression of a new active acoustic system
- Evaluate the effects of an active acoustic system on musicians' perception on acoustics
- Investigate the relationship between objective room acoustic parameters and musicians' preference on acoustics

Impulse response based active acoustics

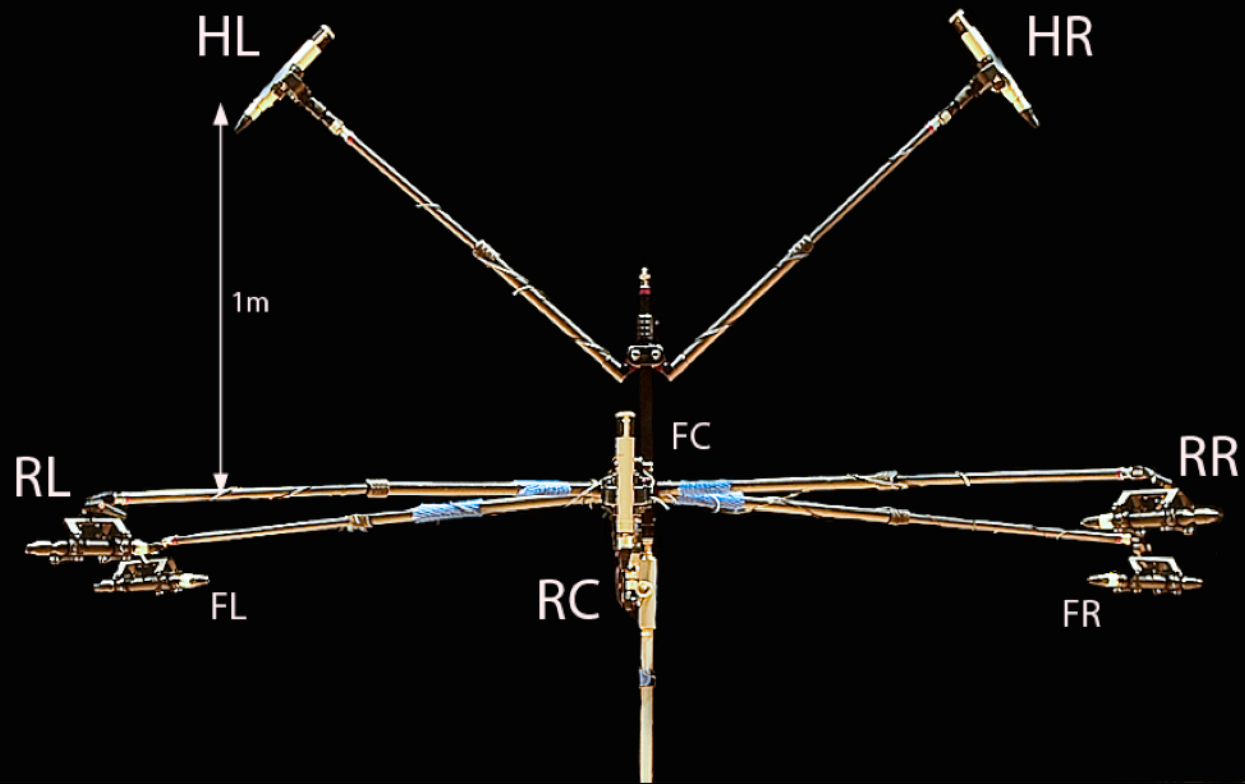
Capture



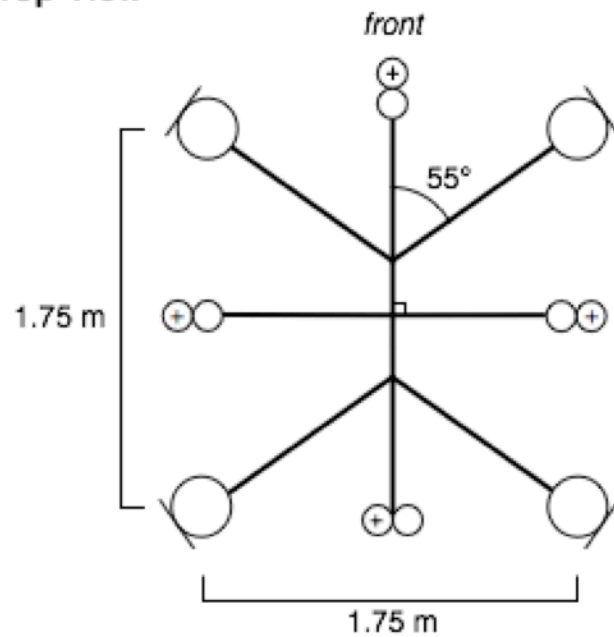
Reproduction



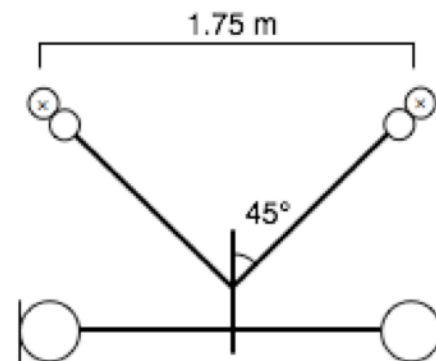


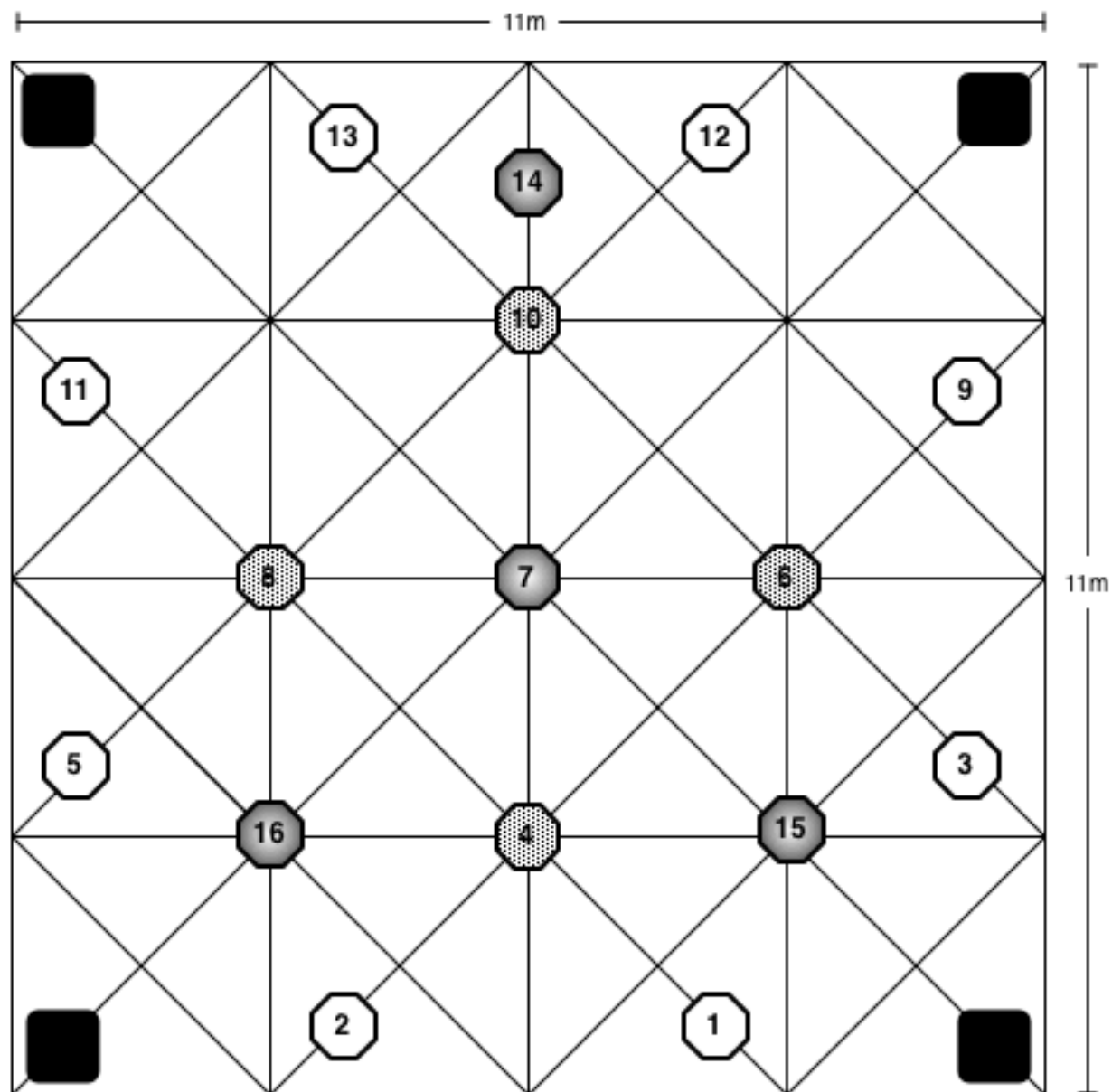


Top View



Side View





 Sub-woofer (4)
  Bottom layer (8)
  Mid layer (4)
  Top layer (4)



16 omni-directional
dodecahedral
speakers and 4 sub-
woofers
(196 drivers in total)



Previous publications

- Woszczyk, W., Ko, D., & Leonard, B. (2009). Convolution-Based Virtual Concert Hall Acoustics Using Aural Segmentation and Selection of Multichannel Impulse Responses (pp. 1–8). Presented at the Inter-Noise, Ottawa, Canada.
- Woszczyk, W., Ko, D., & Leonard, B. (2010). A Convolution-Based System for Virtual Acoustic Support of Performing Musicians. Presented at the 129th Audio Engineering Society Convention, San Francisco, USA.
- Woszczyk, W., Ko, D., & Leonard, B. (2012). Virtual Acoustics at the Service of Music Performance and Recording. *Archives of Acoustics*, 37(1), 109–113. doi:10.2478/v10168-012-0015-6

Evaluation

- 11 professional string quartets (44 musicians)
- Average 21.3 years of formal classical music training
- Played a short excerpt of their choice in each given acoustic condition
- Filled out the questionnaire after playing in each condition

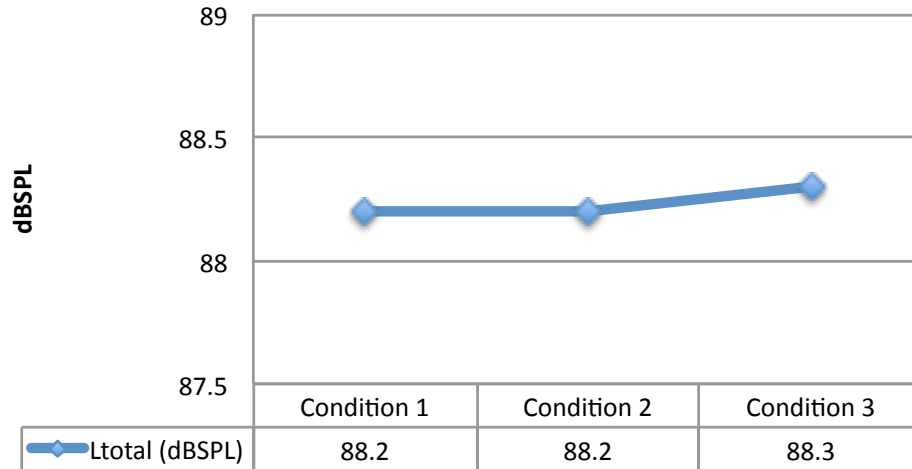


3 acoustic conditions

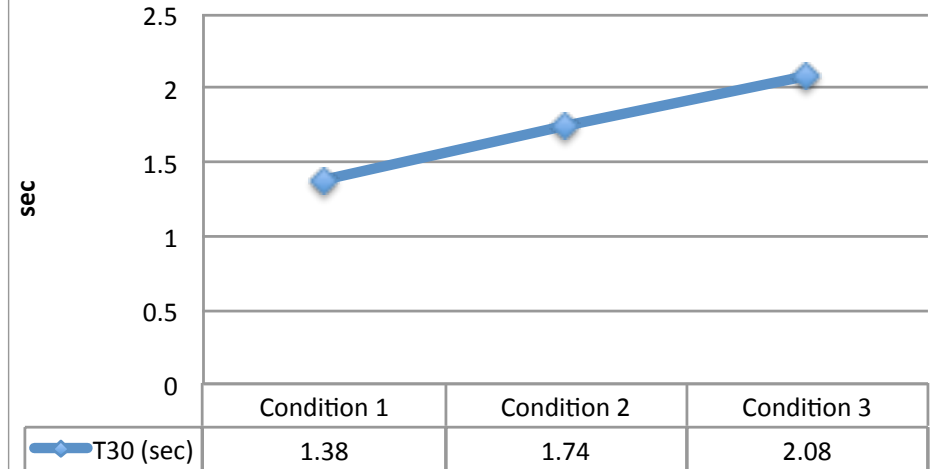
- Condition 1 – VAT system off
- Condition 2 – VAT system on (with ER, mid and late reverberation)
- Condition 3 – VAT system on with ER, mid and extended late reverberation

Objective measurements (ISO3382-1)

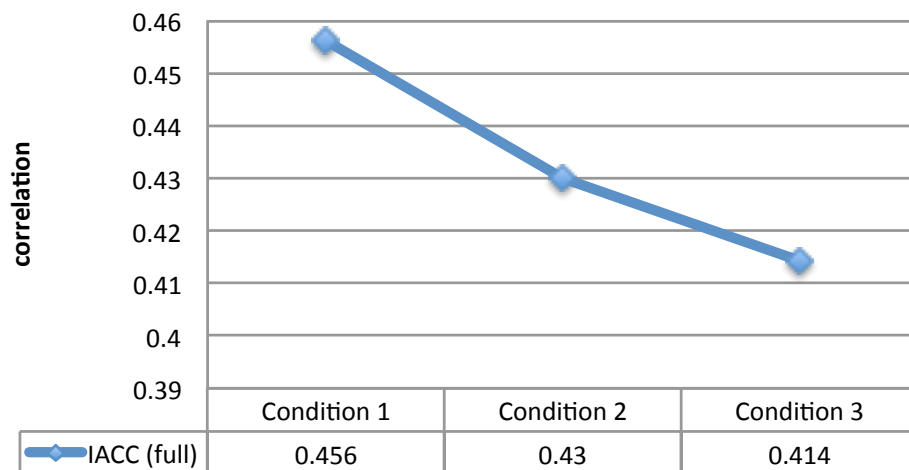
Ltotal (Level)



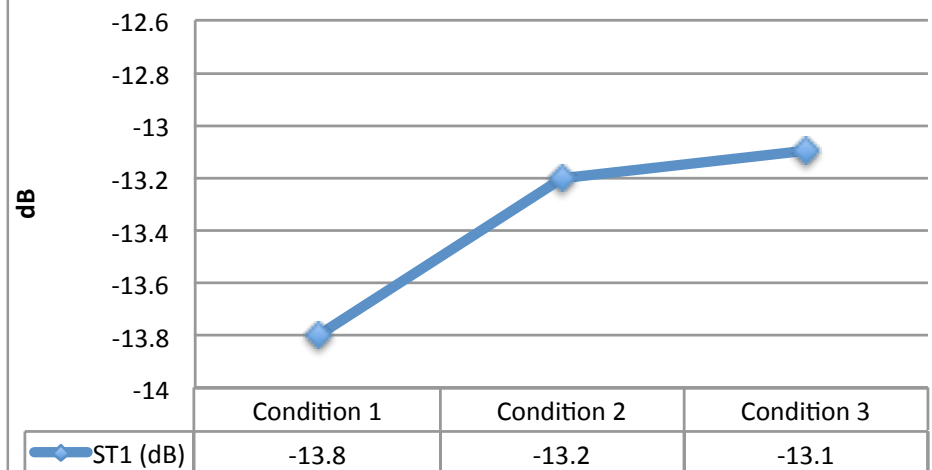
T30 (Reverb time)



IACC (Spatial impression)



ST1 (Stage support)



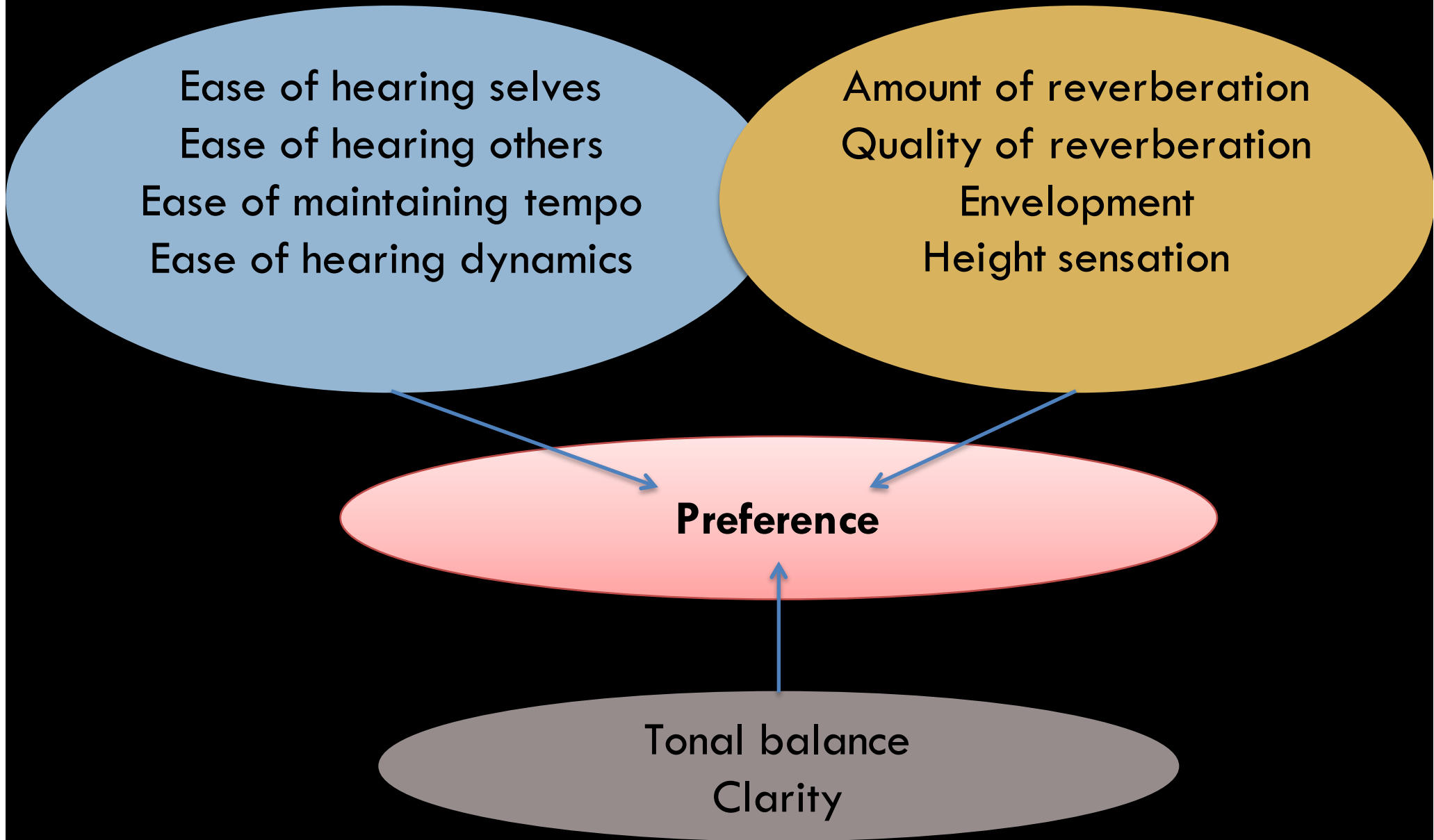
11 questions for musicians

Ease of hearing selves
Ease of hearing others
Ease of maintaining tempo
Ease of hearing dynamics

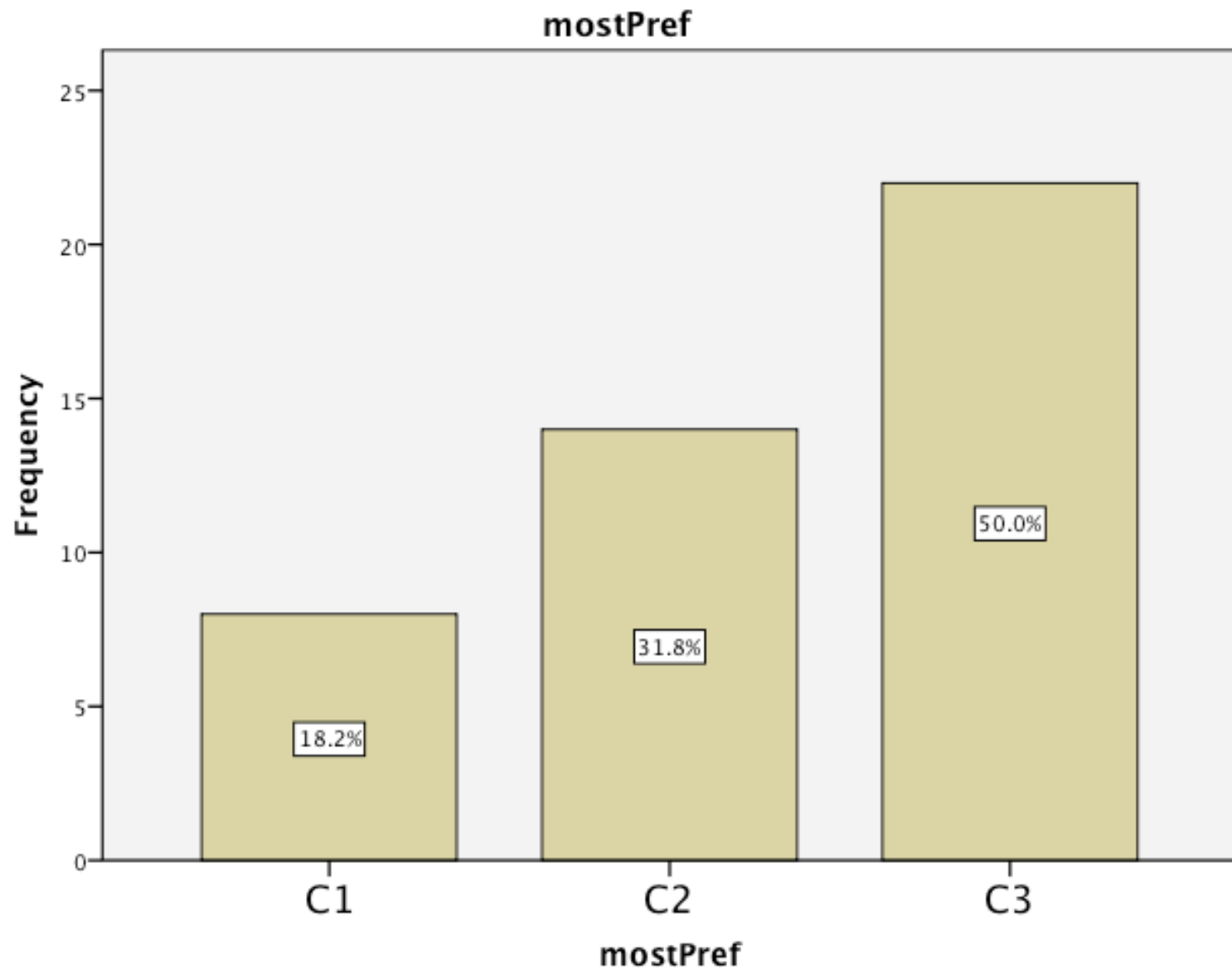
Amount of reverberation
Quality of reverberation
Envelopment
Height sensation

Preference

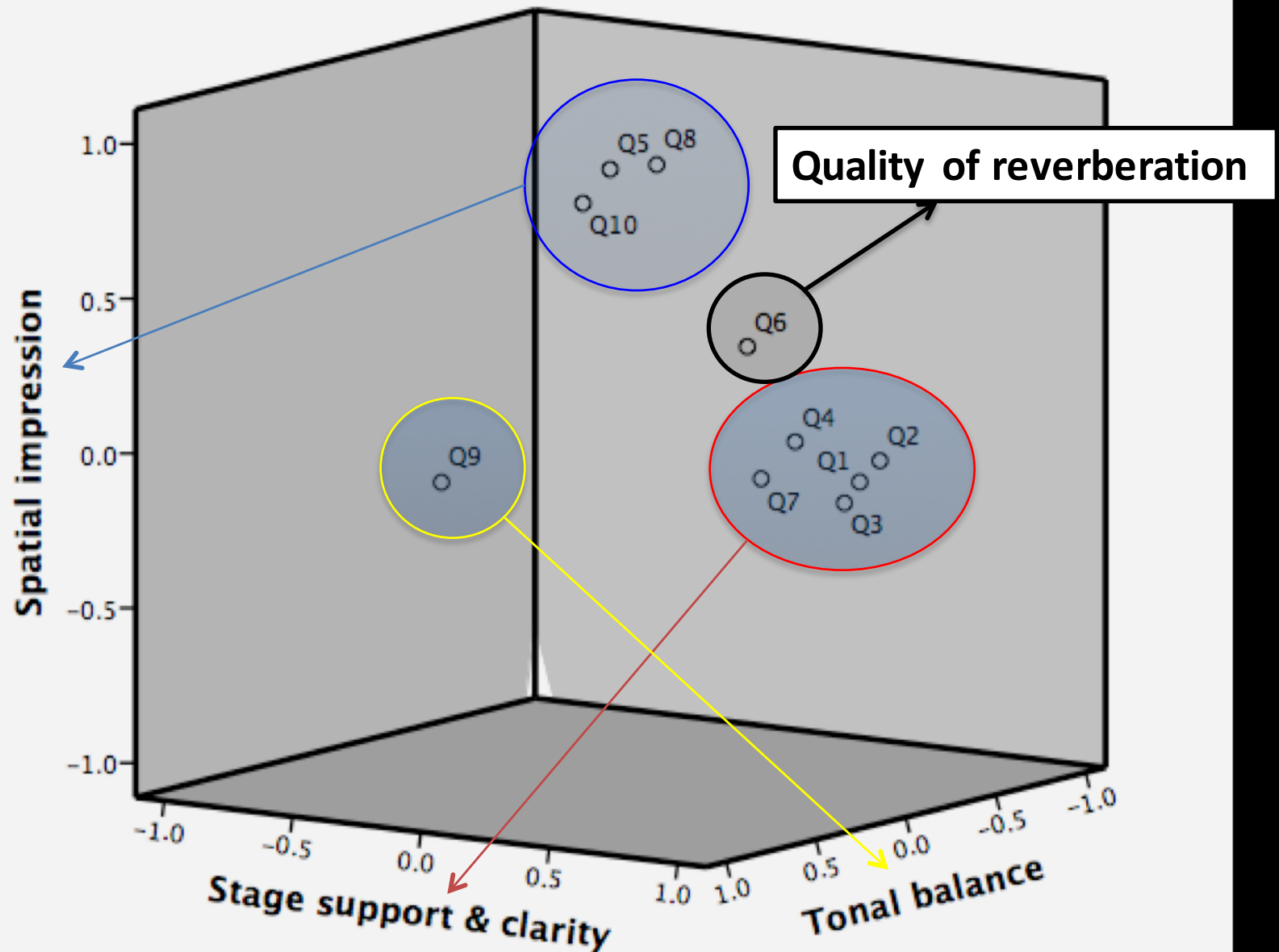
Tonal balance
Clarity



Preference

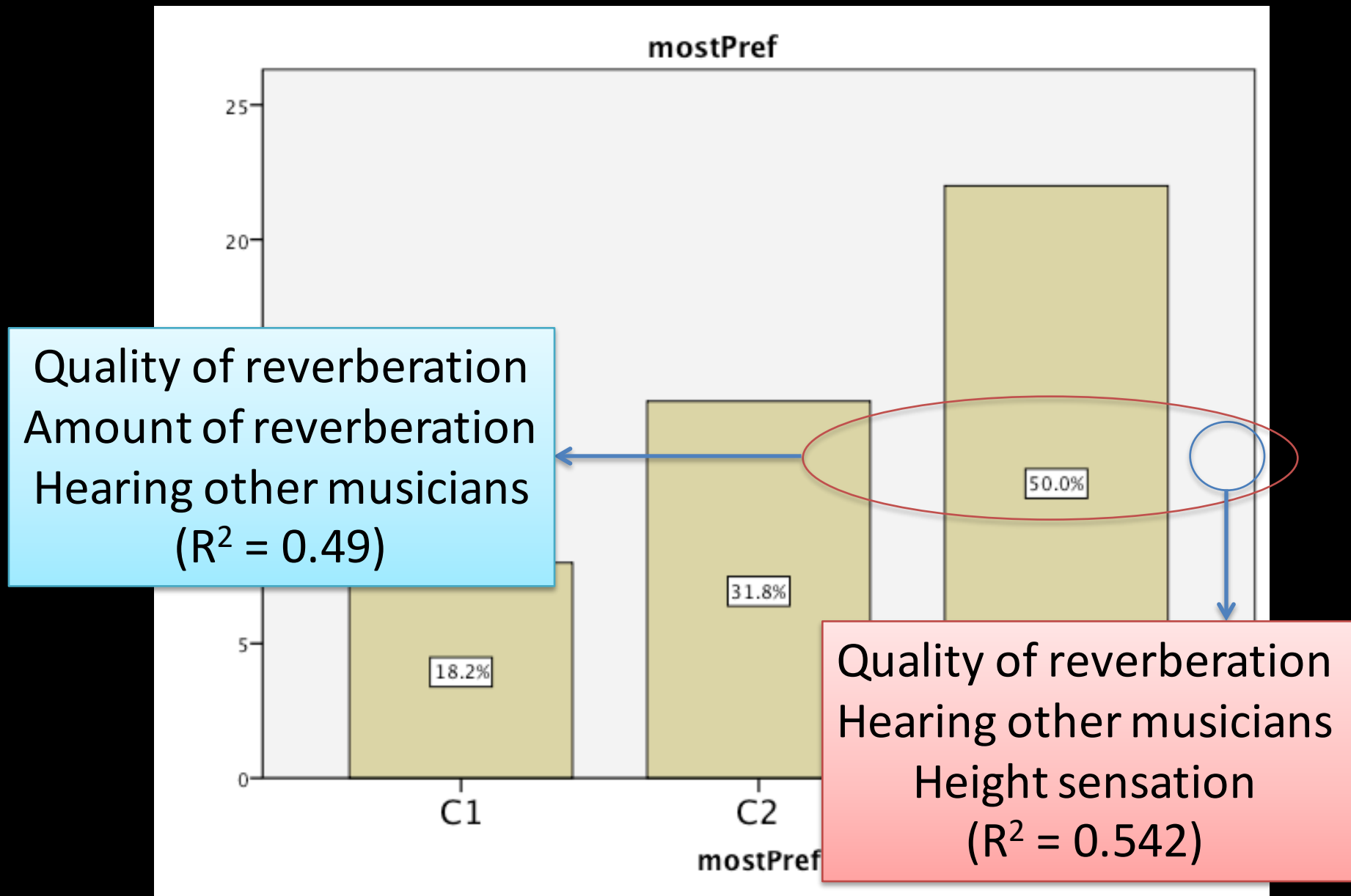


Factor analysis



Multiple Regression Analysis (MRA)

Dependent variable: preference



Conclusion

- The results show a **strong preference** for enhanced acoustics over inherent acoustics of the space.
- Factor analysis revealed musicians are able to reliably distinguish and describe the acoustic differences between three acoustic conditions. Three primary underlying perceptual dimensions are: **Stage support, spatial impression and tonal balance.**
- **‘Quality of reverberation,’ ‘Amount of reverberation,’ ‘Hearing other musicians’ and ‘Height sensation’** were four most salient attributes explaining musicians’ preferences on acoustic conditions.