

Augmented Stage Support in Ensemble Performance using Virtual Acoustics Technology



Doyuen Ko

Belmont University, Nashville, USA

Montreal Symphony Hall



Review

- **Direct sound** – controlled by orchestra setup, risers and screens. Level and frequency content are important.
- **Early reflections** – Controlled by stage shell and reflectors/canopy. Level, direction and distribution are important.
- **Late reflections** – Controlled by stage shell and main hall. Level and reverberation time are important.

Previous studies

- Need heavy reflecting, diffusing surfaces on the side, rear walls and if possible ceiling (*Shankland*)
- Early reflections are the main factor for achieving support (*Gade*)
- Reflecting elements at back wall and ceiling maintain directional cues from the hall (*Nakayama*)
- A reflector behind the choir improves balance and ensemble with orchestra (*Marshall*)
- At least 2-3 early reflections should arrive before 30ms (*Benade*)



Experiment

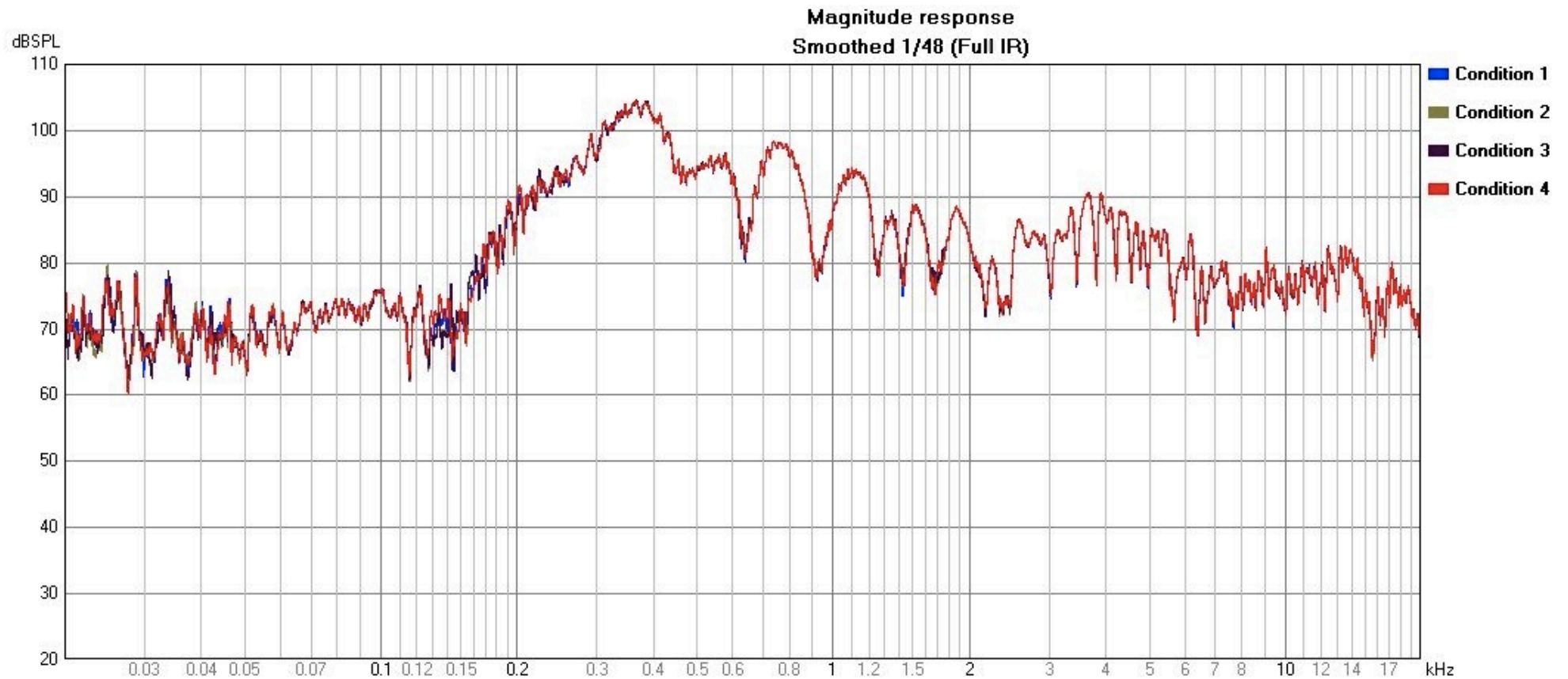
- 15 musicians playing in a chamber orchestra
- 4 different acoustic conditions presented in a random order
- Asked to fill out a questionnaire after playing in each condition
- A short break and tuning between conditions



Experiment conditions

- Condition 1 – VAT system **off**
- Condition 2 – System on with **ER, mid and late reverberation**
- Condition 3 – System on with **ER, mid and extended late reverberation**
- Condition 4 – System on with **increased ER level without mid and late reverberation**

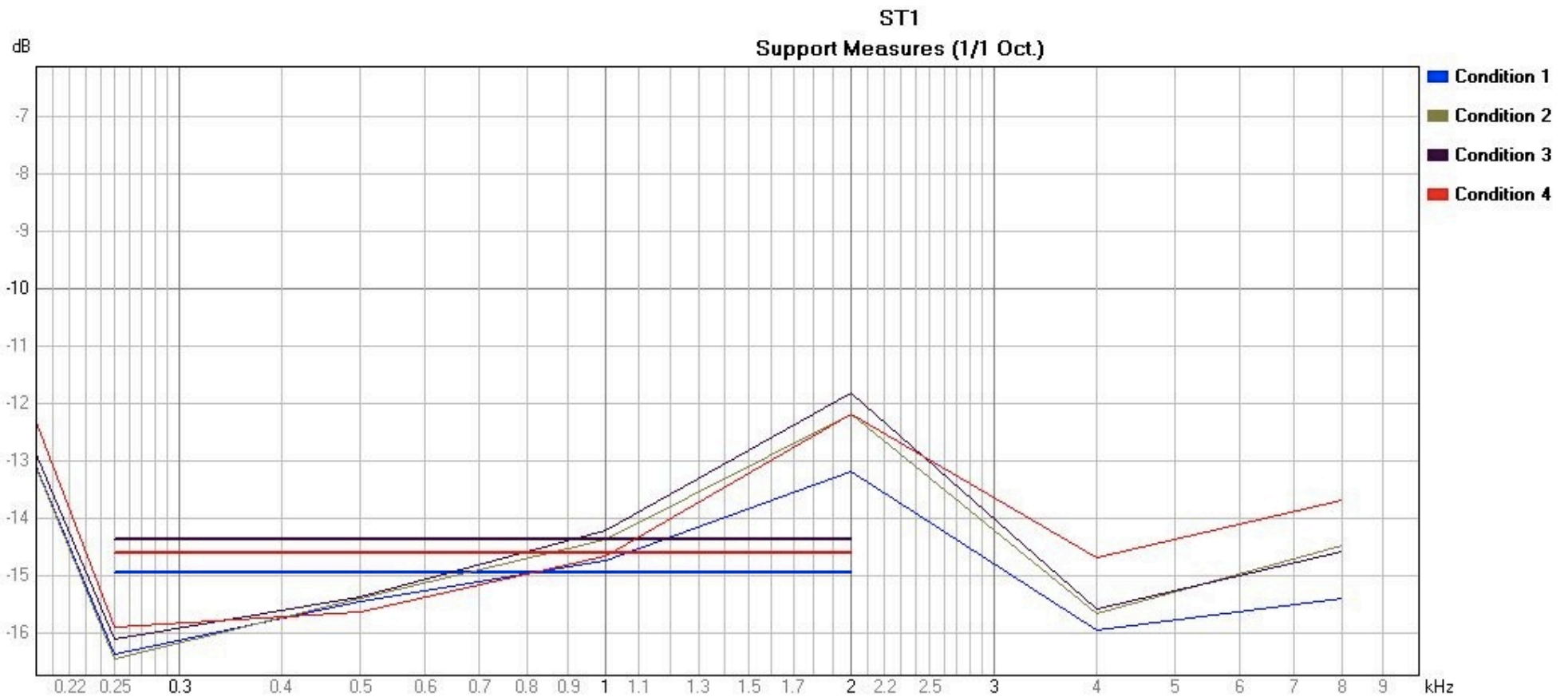
Magnitude response



Reverb time (T30)



Stage support (ST1)

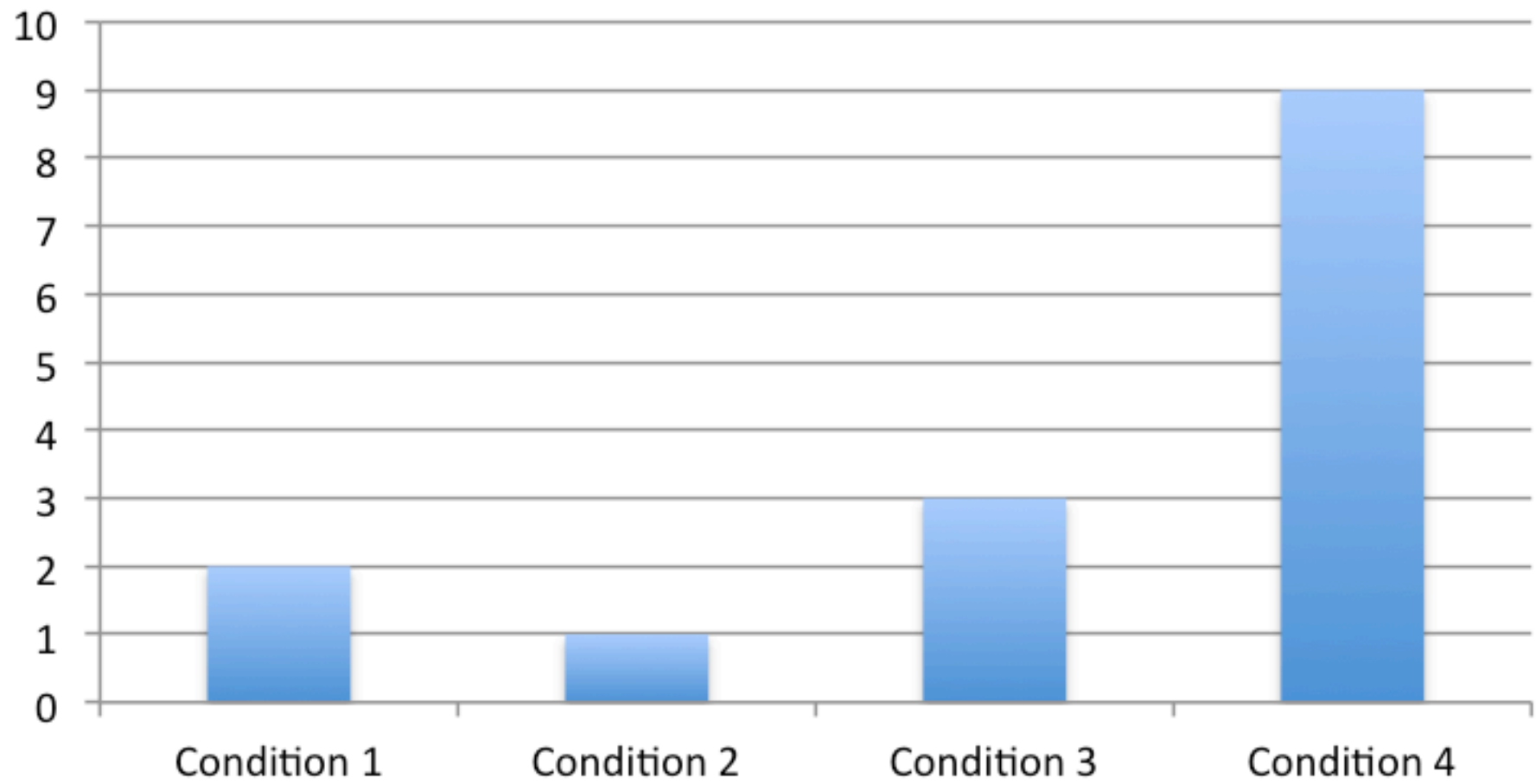




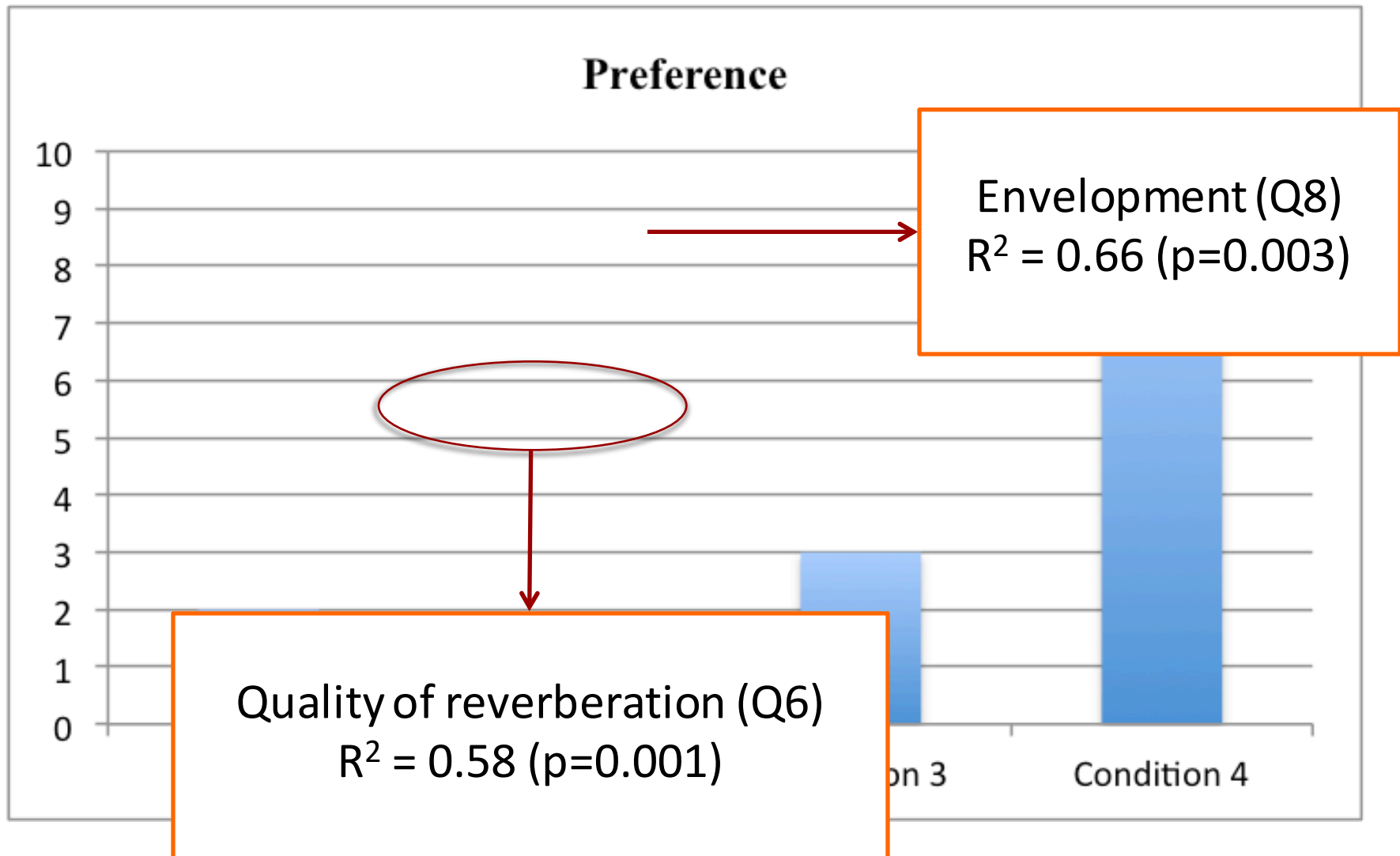
The Questionnaire

Question Number	Questions
1	Ease of hearing own instrument
2	Ease of hearing others
3	Ease of maintaining tempo
4	Ease of hearing dynamics
5	Amount of reverberation
6	Quality of Reverberation
7	Clarity
8	Envelopment
9	Tonal balance
10	Height sensation
11	Width sensation
12	Enjoyment of playing
13	Feeling of intimacy

Preference



Multiple regression analysis



Conclusion

- The VAT system effectively augmented key acoustic parameters such as **reverb time** and **stage support**.
- The musicians preferred playing in a less reverberant, but still **supportive** and **enveloping** acoustic condition (condition 4).
- **‘Envelopment’** and **‘Quality of reverberation’** were two most significant attributes of musicians’ preference.