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Designing an Interactive and Collaborative Experience in Audio Augmented Reality

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Introduction

Audio Augmented Reality (AAR) Context

AAR consists of adding spatial audio entities into the real environment [1]. So far, AAR Research has mainly been focusing on the perception of sound quality [2], realism, or discrimination between real and virtual sources [1]. Yet, interaction and collaboration remain under-researched. One of the big challenges is acoustic transparency, so that the user can stay connected to his environment as if they had no headphones. Bose Frames audio sunglasses [3] are a newly available wearable AAR consumer technology that is perfectly acoustically transparent. We here use it as the basis of the AAR game design.

### Previous AAR collaborative studies

- LISTEN (2003)[4]: wireless streaming of individualised-rendered binaural audio (indoor- max. 8 users)
- SoundDelta (Mariette and Katz, 2009)[5]: Mobile multi-user AAR art/research project - personalized audio to a large number of users over specific area (indoor or outdoor)
- Eidola multiplayer (Moustakas et al., 2011)[6]: Two-player game prototype - potential to achieve high levels of immersion and great novelty for the users

Research questions

RQ1: How can spatial audio prompt and support actions in interactive AAR experiences?
RQ2: How does distinct auditory information influence collaborative tasks and group dynamics?
RQ3: How can gamified participatory AAR enhance storytelling?

AAR Architecture
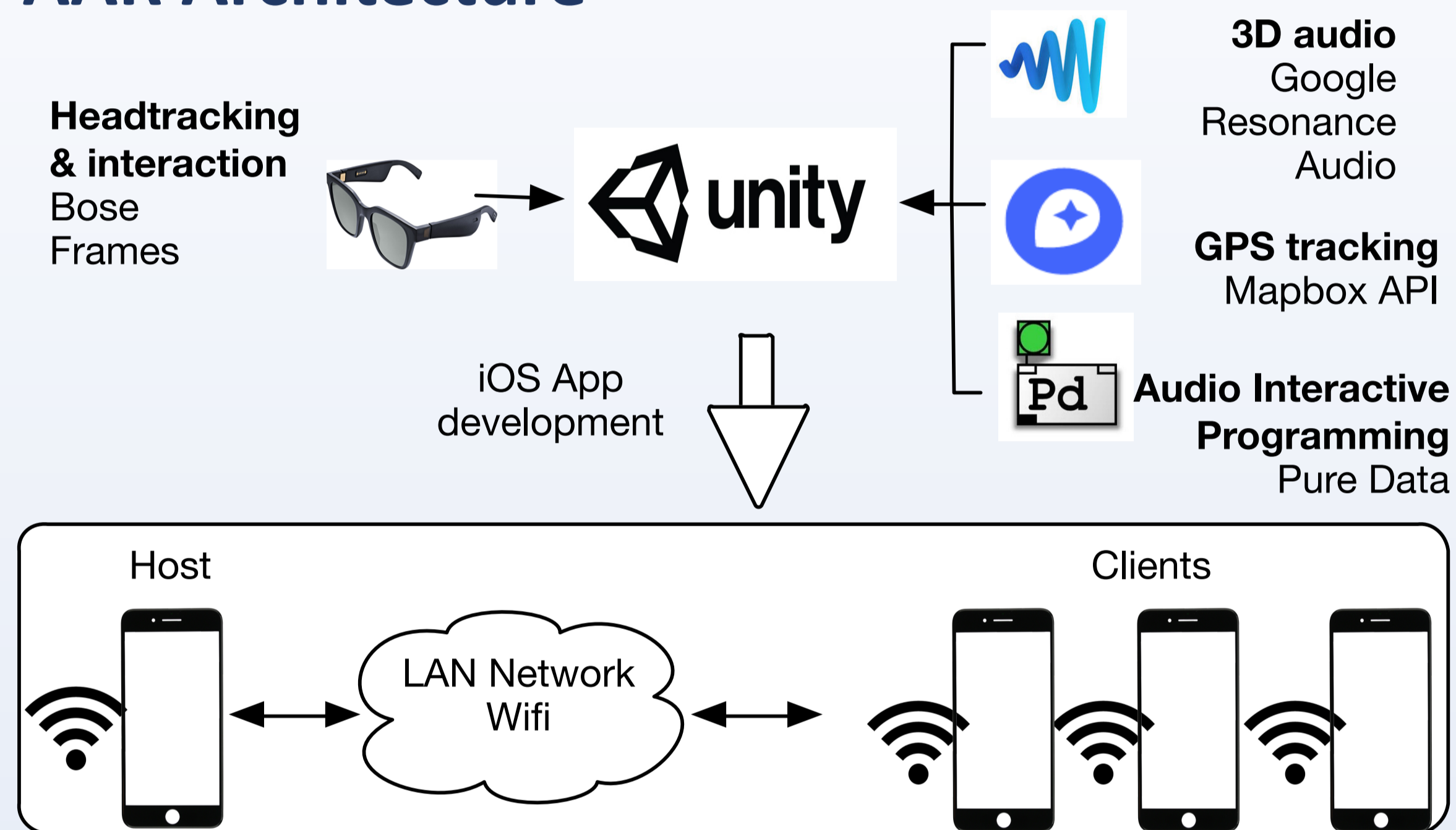
Game Design: *Please Confirm you are not a Robot*
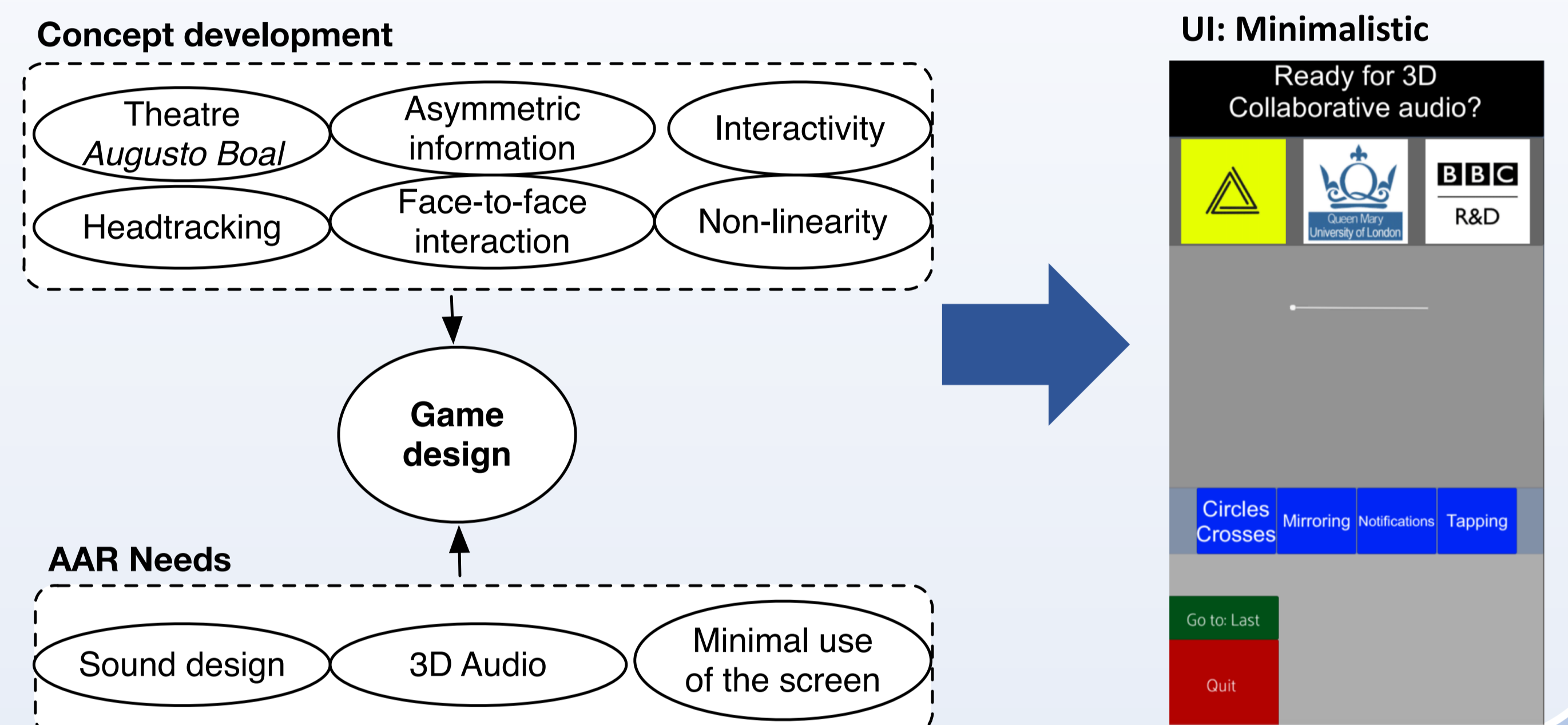
User Experiments

Duration: 1h30
Place: BBC Broadcast Centre
4 groups of 4 participants (11 males, 5 females, M = 28 years, SD = 18 years) + 1 Pilot group

Experience: 4 mini-games
1. Circles & Crosses: Draw circle and cross in the air using the whole body
2. Mirroring: Pair up with one participant and mimic his/her movements
3. Notifications: Localize and shut auditory notifications off
4. Tapping for likes: Give likes to the other participants

Methodology
1. Before: Consent form + pre-study questionnaire
2. Questionnaire after each game
3. Post-study questionnaire + guided group discussion.
During each experiments: audiovisual recording + 2 researchers (at least) taking notes

Results

Research questions
RQ1: Spatial audio
- Engagement: Participants liked the 3D audio aspects
- Sound localisation: high headtracking latency
- Potential: Unsure real vs virtual sources

RQ2: Asymmetric information
- Difficulty to listen to different layers at the same time
- Prompts communication

RQ3: Gamified AAR and storytelling
- Good engagement and long attention span
- Human interaction potentials: Movement + gesture interaction + 3D audio
- Appropriation of roles: Theatre

Other findings
- Ice-breaking activity (iOS scale) ➡
- Feeling of presence (hints): No need to be immersed to feel engaged!
- Design recommendations
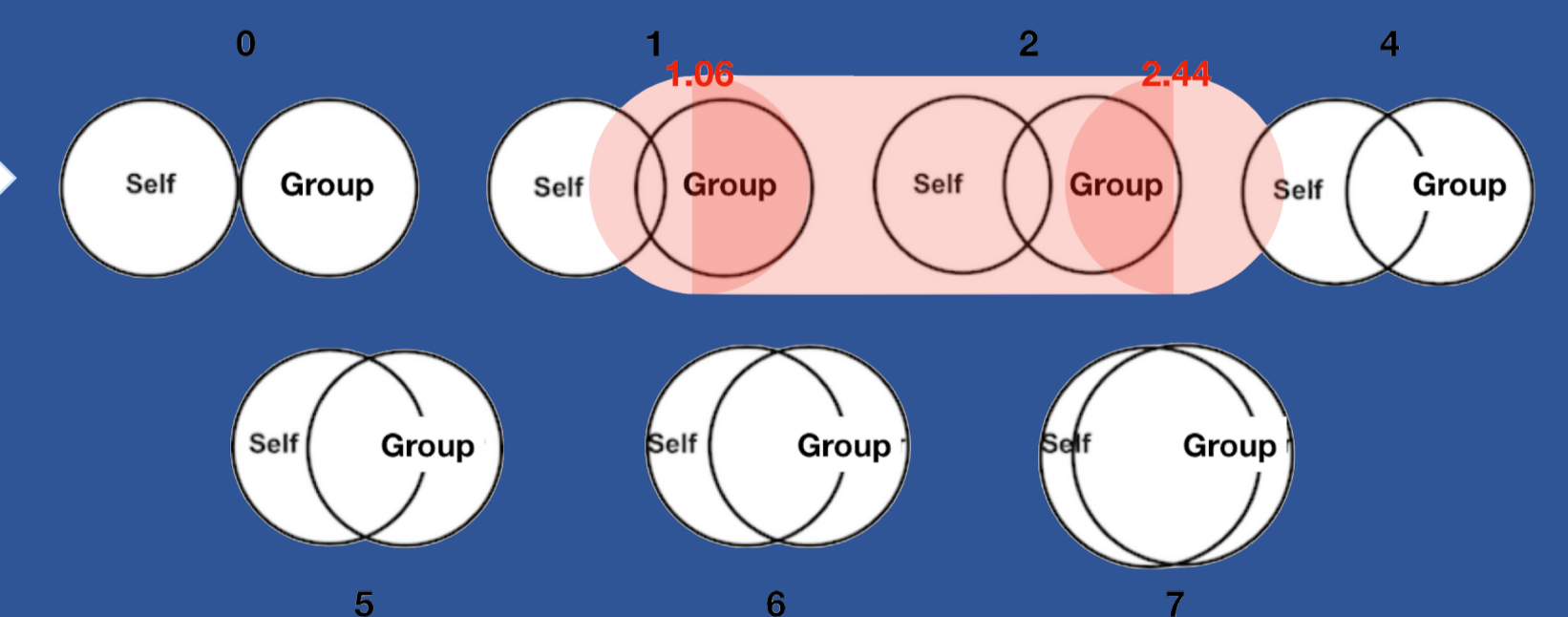
Conclusion

In this study, we designed and evaluated an AAR collaborative and interactive game using Bose Frames Audio Sunglasses. The user experiments mainly revealed a great potential of collaborative AAR for human interaction. Moreover, it allowed to draw some design recommendations for AAR games, mostly regarding the importance of auditory feedback. Additionally, the results gave hints about the feeling of presence, by highlighting that good engagement and performance do not need a full immersion.

Blending theatre and AAR presents a great potential for communication, art and human interaction, and requires more investigation. This study offers new insights about human factors in AAR, and is the first one that investigate the use of Bose Frames for AAR.

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