The Effect of Motion Parallax and Binocular Stereopsis on Viewer Preference and Size Perception in Virtual Reality
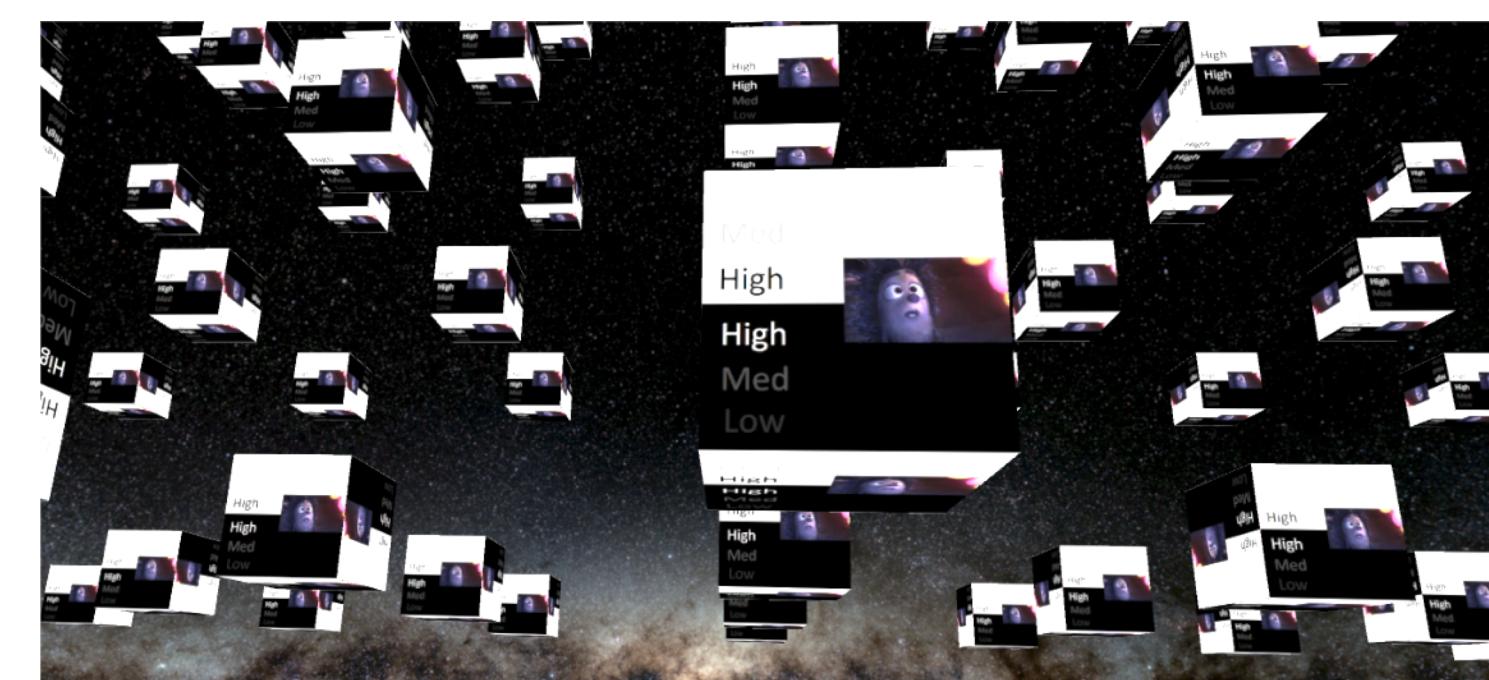
Jayant Thatte (*jayantt@stanford.edu*) and Bernd Girod

Stanford University, California, USA

ECCV 2018 — European Conference on Computer Vision — 8 – 14 September 2018 | Munich, Germany

Abstract
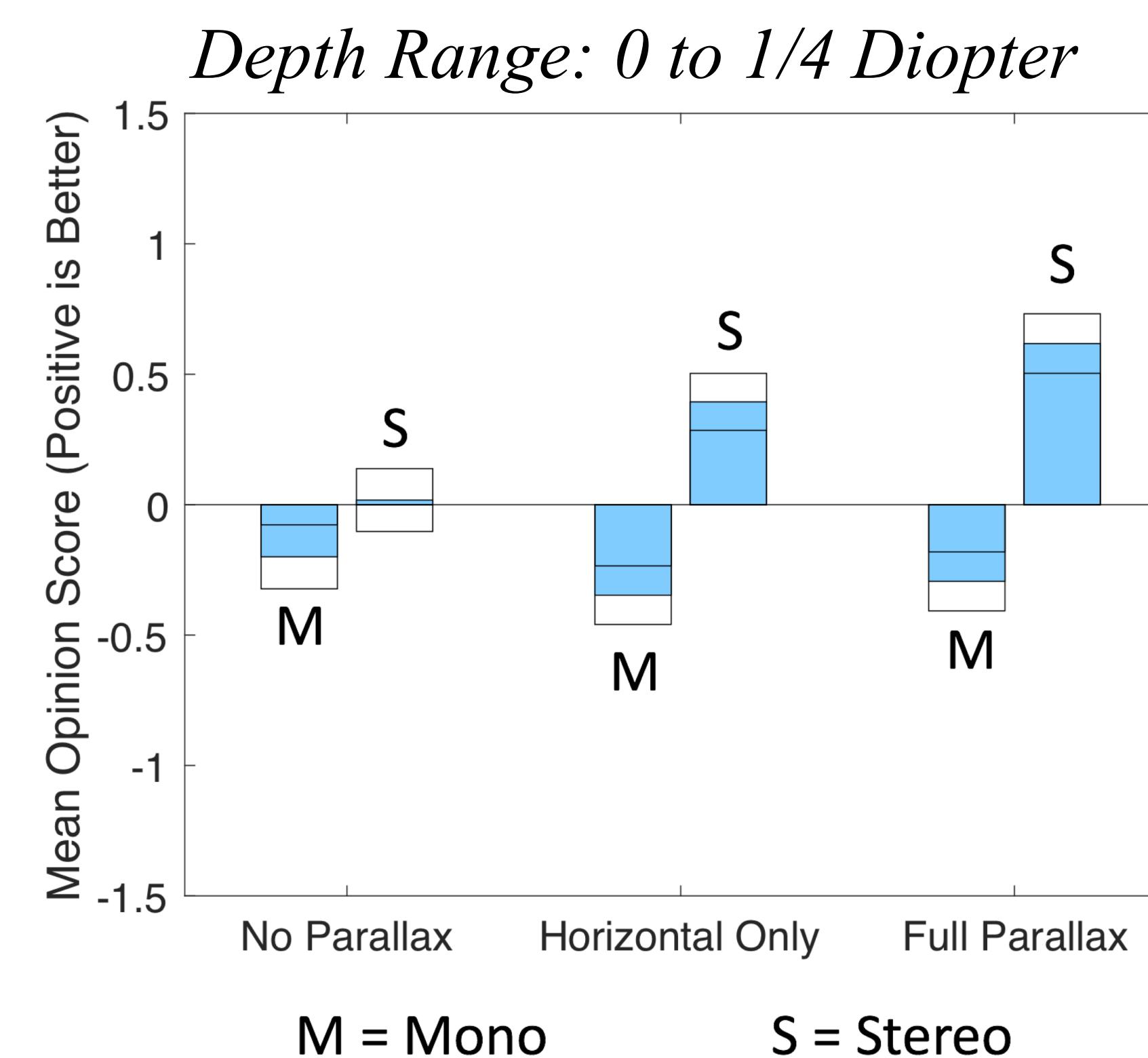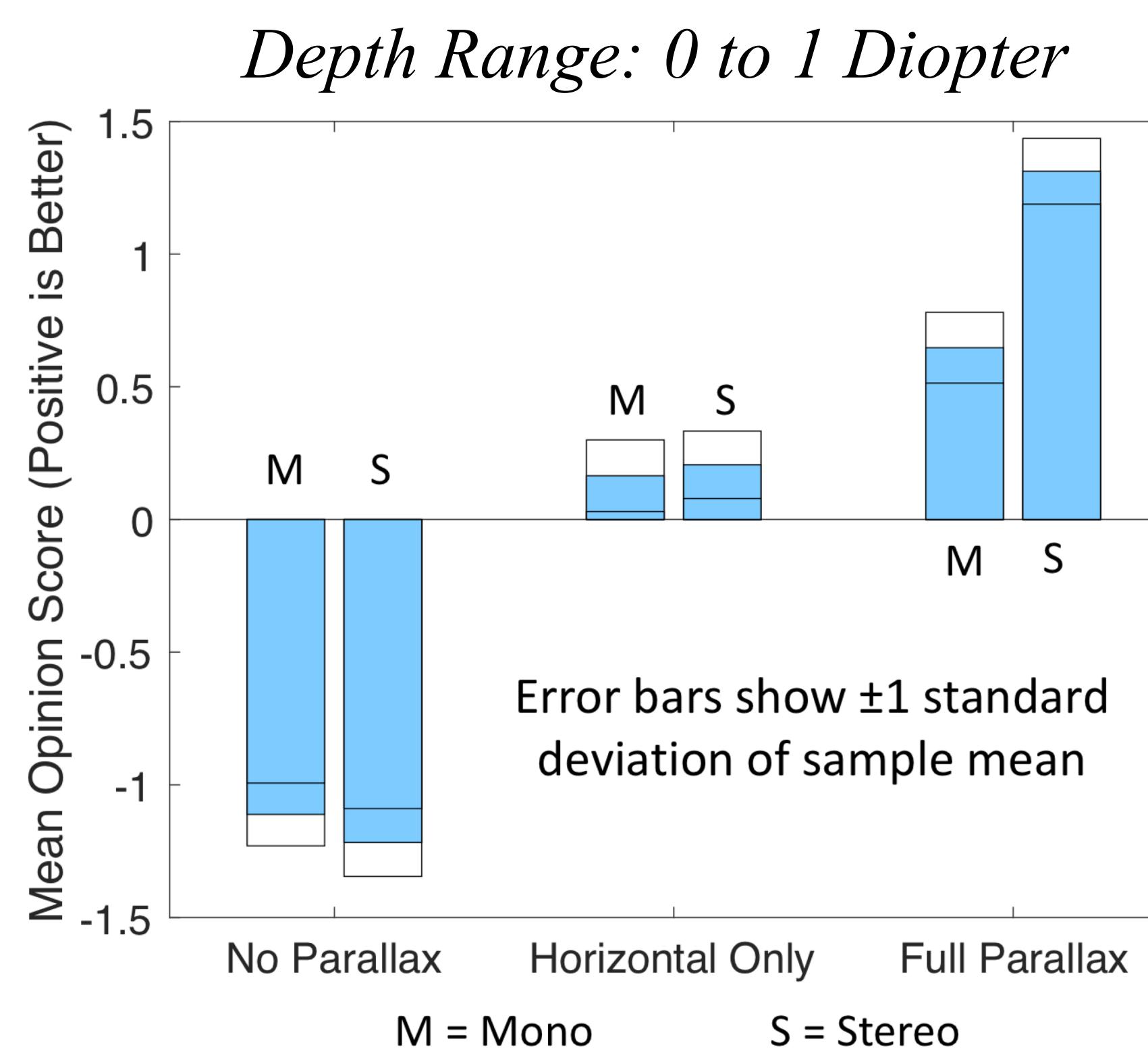
In this work, we show that rendering accurate motion parallax is crucial for a better overall quality of experience in virtual reality. Similarly, rendering a virtual environment in stereo seems to be important for accurate size perception, which is a factor towards making the experience more realistic. In addition, we also show that it is possible to render virtual reality with motion parallax using a depth-based stacked panoramic data representation.

Viewer Preference Study

- 6 VR render settings: {Mono, Stereo} x Parallax: {None, Horizontal Only, Horizontal & Vertical}
- Users rated every setting against every other, based on the overall experience, on a 7 point comparative scale (-3 to +3)

Test Scene: Cubes in Space

Depth Range: 0 to 1 Diopter

Error bars show ±1 standard deviation of sample mean

M = Mono   S = Stereo

Depth Range: 0 to 1/4 Diopter


M = Mono   S = Stereo
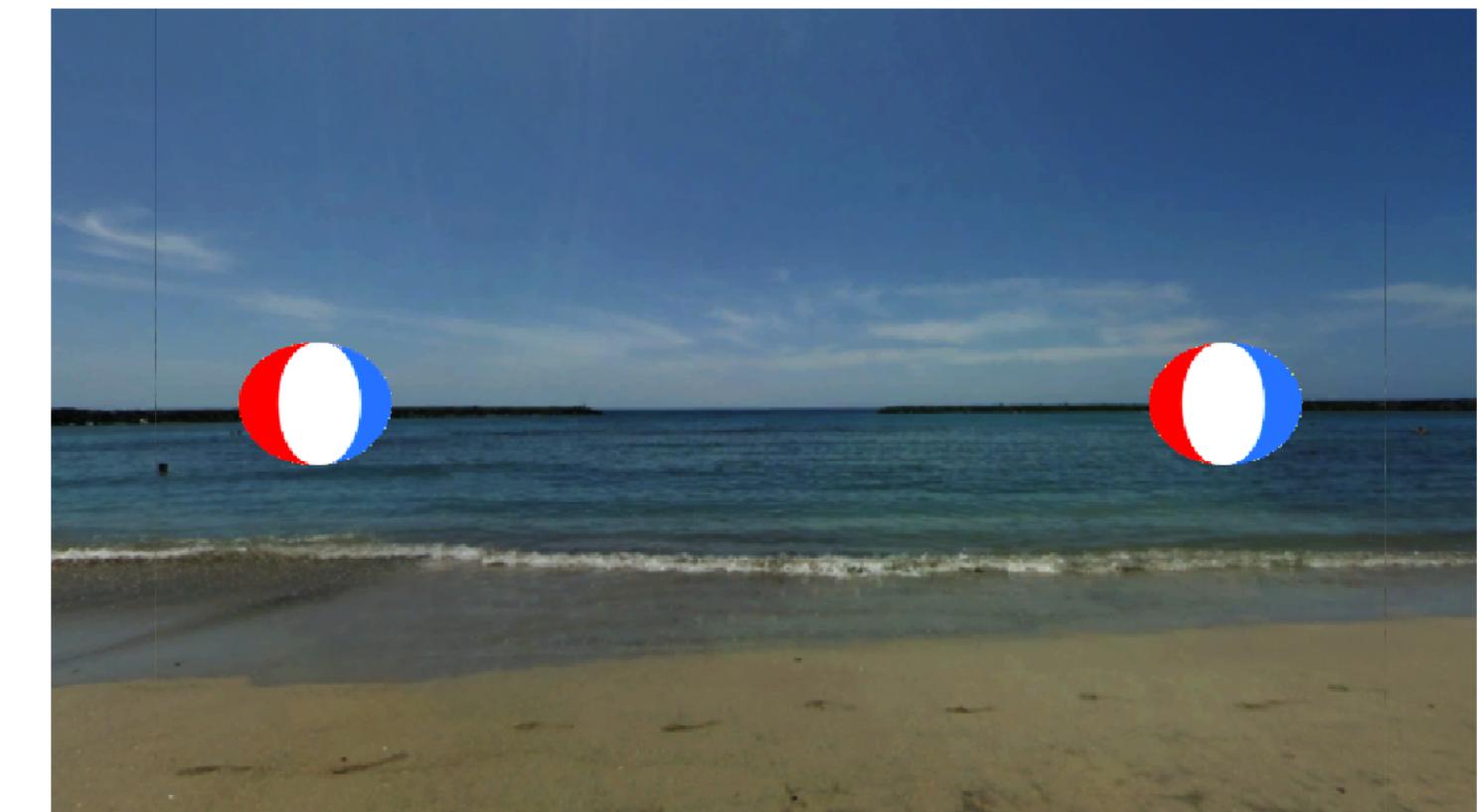
Conclusions
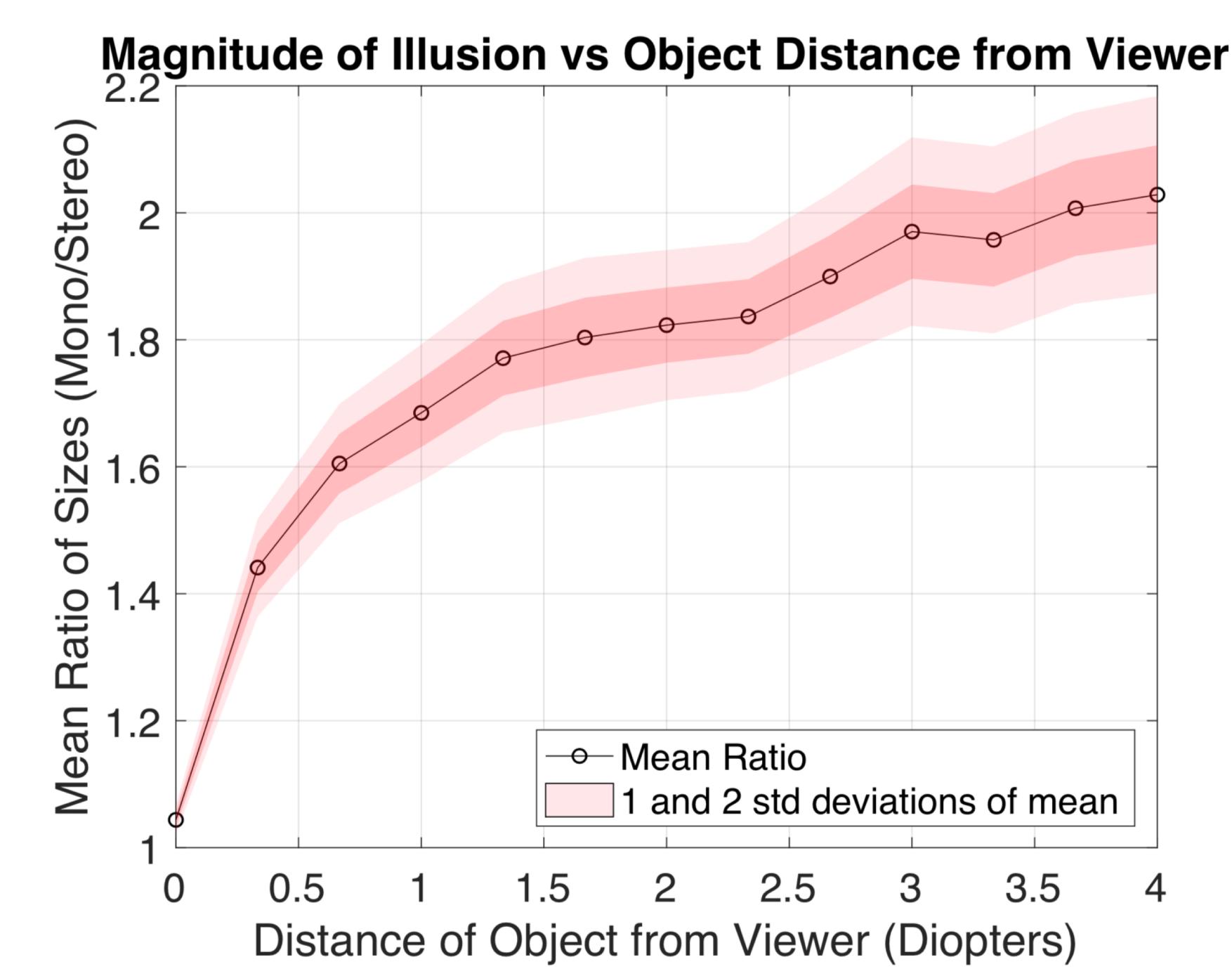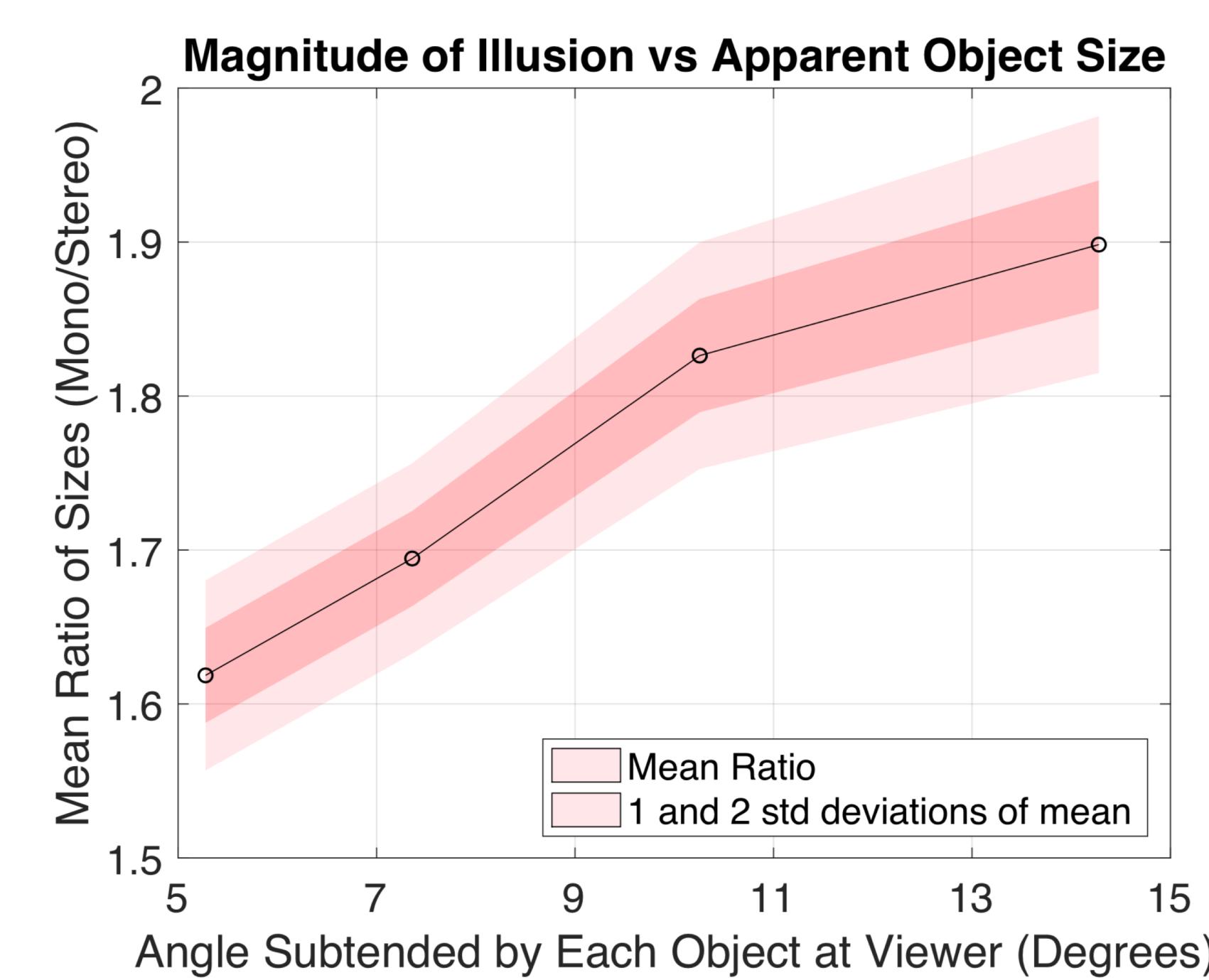
1. Stereo only improves the experience when parallax is also present. Without parallax, stereo and mono perform comparably

2. For nearby objects (left graph), motion parallax is more crucial than stereo.

3. Both motion parallax and stereo vision play a more noticeable role for scenes with larger depth range (larger differences across settings in the left graph, compared to right)

Size Perception

Setup: The participants were shown 2 identical objects, placed equally far from the viewer -- one rendered with stereo disparity and the other monoscopic (same view in both eyes). The participants adjusted their relative size until the two objects had equal apparent angular size. The ratio of sizes picked by the participants was noted.
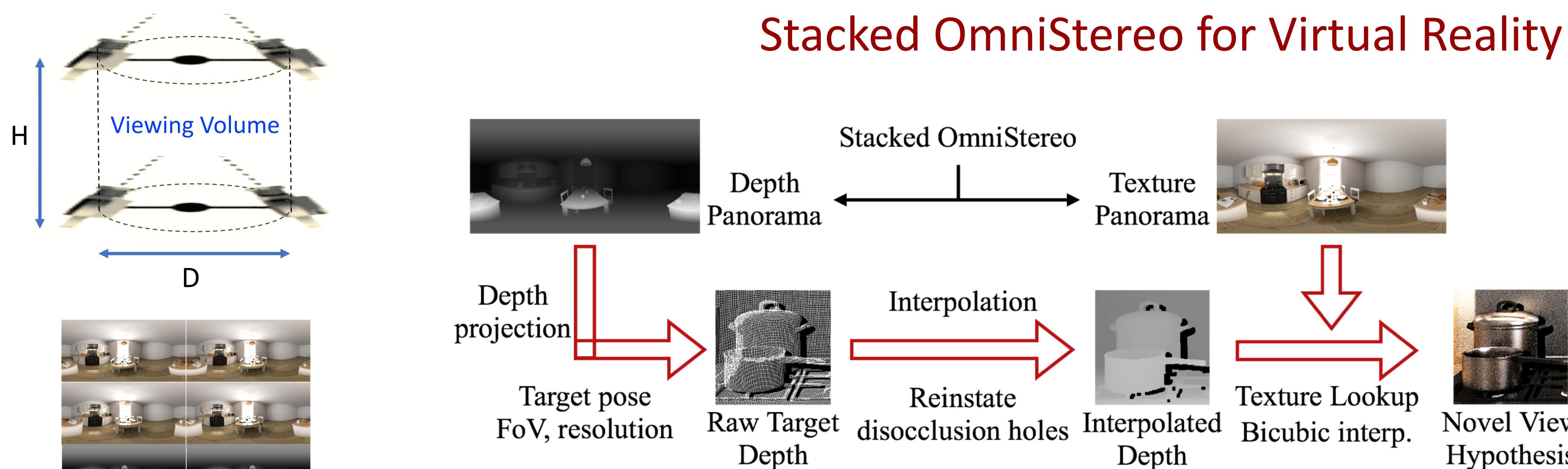

One of the test scenes showing the two objects
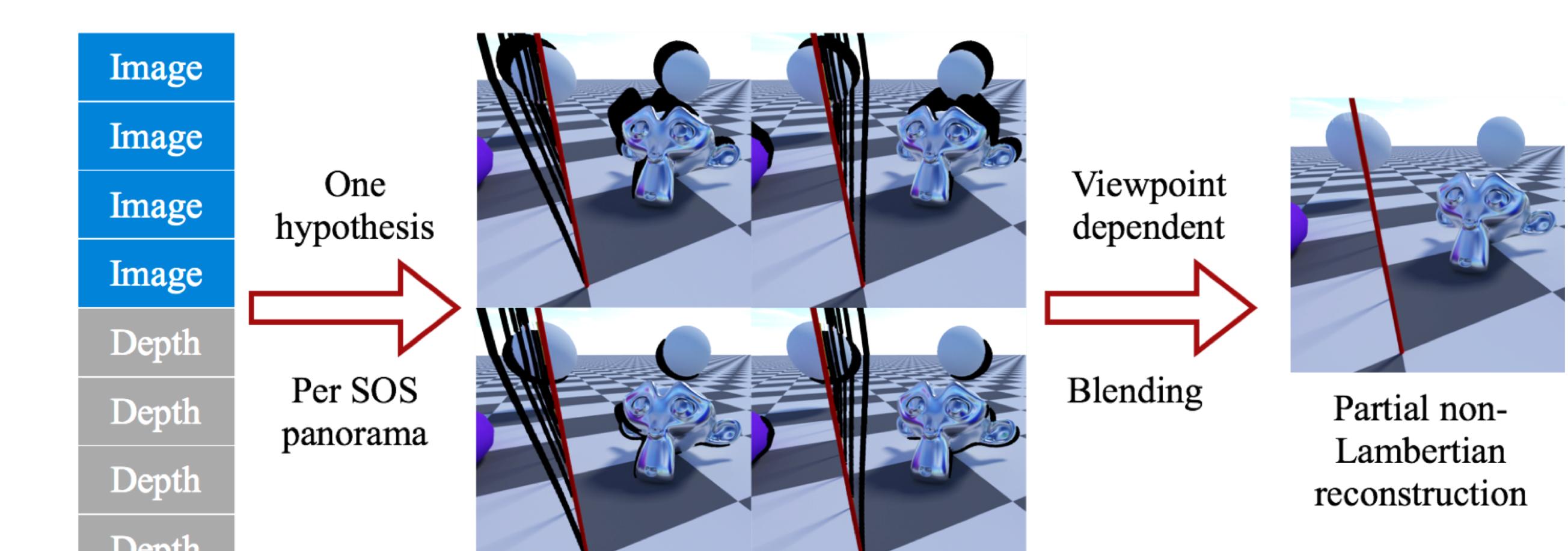
Conclusions

1. Objects rendered monoscopically are perceived to be larger than they are.

2. The magnitude of this illusion is higher for objects that are closer and larger

3. Presence or absence of motion parallax plays no role in the perceived size

4. While all participants shared the trend, the magnitude of the illusion shows significant variation across the population
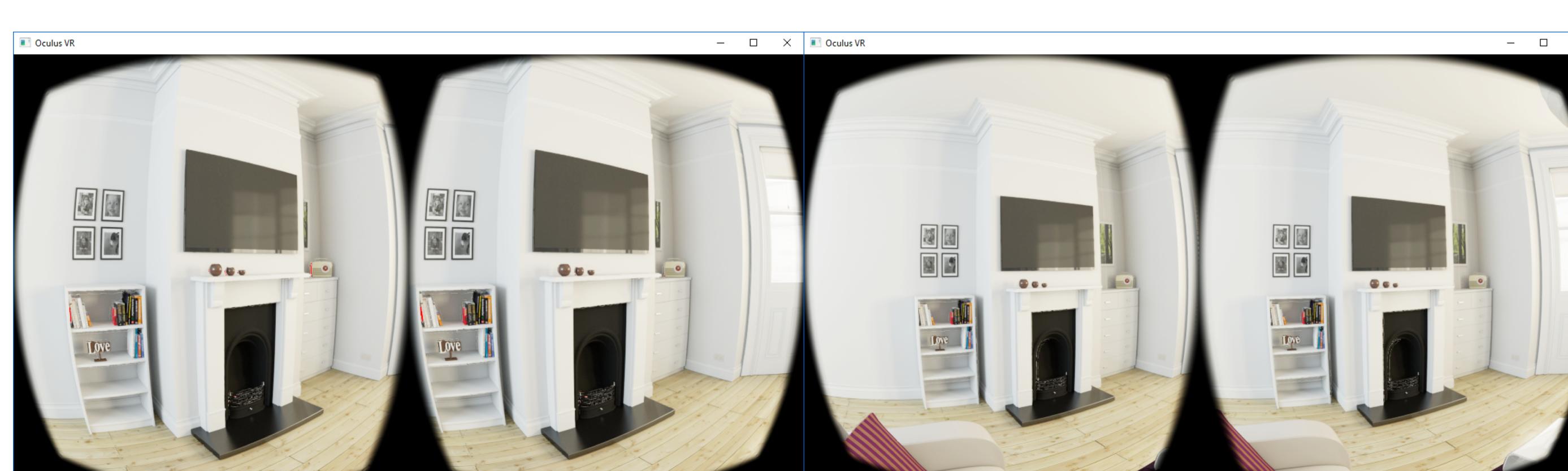
Stacked OmniStereo for Virtual Reality with Motion Parallax

Stacked OmniStereo Representation

Rendering viewport hypothesis from Stacked OmniStereo

Hypothesis merging gives the final synthesized view

Example Views Rendered from Stacked OmniStereo: Stereo with 1344 x 1600 per eye, at 45 fps on 6 GB NVIDIA GTX 980 Ti