Asymmetry in Size Perception in Visual vs. Pictorial Space

Adam O. Bebko, Nikolaus F. Troje

1York University, BioMotionLab & Centre for Vision Research, Toronto, Canada

Introduction

Leone Alberti, a 15th century artist and architect, thought that paintings should recreate exactly the view seen through an empty frame.

We used virtual reality (VR) to examine Alberti’s assumption that pictures are perceived as frozen views into the world.

Pictures have a dual nature:
• An actual object that exists (visual space)
• A depiction of a scene with its own space (pictorial space)
• We perceive both simultaneously

View Space
What we see in front of us
Space we can act in.
Observer has a well-defined location

Pictorial Space
Scene depicted in a picture
No parallax
Observer has a poorly-defined location

Magic Alberti Frame
Tool in VR (Unity/SteamVR) to explore perception of pictures.
Take pictures with exact retinal size of current view

Current study
Testing Magic Alberti Frame created strong perceptual distortions in size/distance.
Perhaps distortions in Magic Alberti Frame due to interaction between consistent retinal size but changes in perceived size/distance in pictures? Designed experiment to examine size and distance perception in visual vs. pictorial space.

Method
Participants: 20 people recruited from York University community
Apparatus: VR environment viewed with HTC Vive Pro head-mounted display.

Procedure:
1. “Real” visual space Mario 0.8m away
   Wall with window positioned at 11 distances varying logarithmically from 0.5m to 3m
2. Blank Mask
3. Picture of Mario replaced window
   (Same Retinal Size as visual space Mario)
4. Participants scaled picture to match perceived size of visual space Mario

Expected Results and Model
If object perceived to be at location of picture plane...

Object behind picture
Object in front of picture

Participant will scale picture UP
Linear model: \[ \text{Chosen Scale} = c \times \frac{\text{Distance}}{\text{picture size}} - 1 + 1 \]
If pictured object perceived to be at location of picture plane:
\[ c = 1 \]
But previous studies found depth compression in VR. So expect:
\[ c < 1 \]

Object in front of picture
Object behind picture

\[ c = 0.34 \]
\[ c = 0.17 \]

Results

Individual Results

Model Results

Asymmetry between object in front vs. behind picture.
Scaled the picture more when object in front of picture.
Paired-sample t-test on difference in slopes significant (t(19)=3.03, p = 0.0068).

Discussion

Why the asymmetry?
Possible perceptual bias that objects are behind pictures, but where is not well-defined in this case. Objects in front of picture get “pulled” onto picture plane.

Object behind picture
Object in front of picture

Few pictorial depth cues.
Use occlusion cues of wall and picture as reference?

Perceived distance is more ambiguous, but perceived as inside picture
(possibly perceived as “accidental viewpoint”)

Ambiguity whether pictorial object at picture plane or “inside” of picture.
Pictorial object perceived at location of picture plane.

Future directions:
Examine effect of depth cues (parallax, stereo), and rotation in pictorial space.

Applications:
Teleconferencing, digital avatars, mixed reality realism and immersion.

Conclusions

We accept that objects may be at any distance inside pictures.
When object in front of picture, perceived to be at picture plane.
Perhaps perceptual bias that objects are behind pictures?
New useful tool in VR.

References:


Contact: Adam O. Bebko, adambebko@gmail.com
Funding: Supported by NSERC, VISTA