Lecture 14 – Depth cues

Today's Learning Objectives:

1. Describe perspective depth cues and their uses in space perception.

2. Practice implementing perspective depth cues.

Types of depth cues

Monocular Depth Cues

Linear perspective

Texture gradients

Size gradients

Occlusion

Depth of focus

Shape from shading

Vertical position

Relative size

Cast shadows

Depth-from-eye

Structure from motion

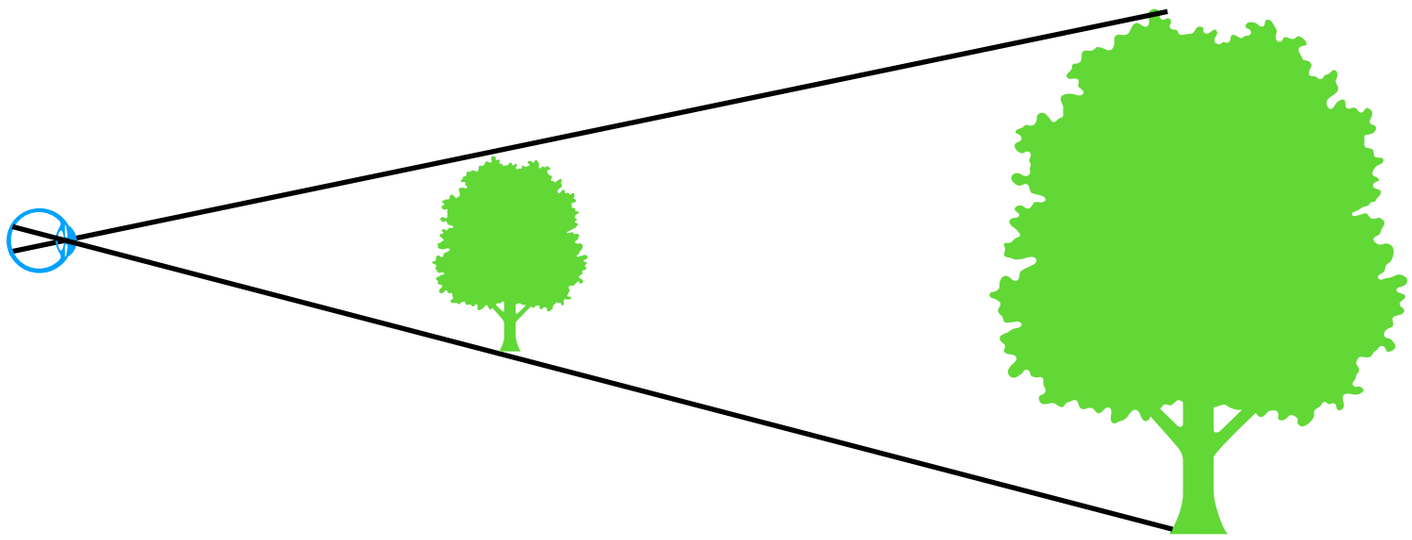
Binocular Depth Cues

Eye convergence

Stereoscopic depth

Perspective Cues & Geometry

- Perspective geometry can be used to create a picture plane, constructed with rays
  - Rays create geometry of linear perspective
  - Subsequent picture is scaled up or down.



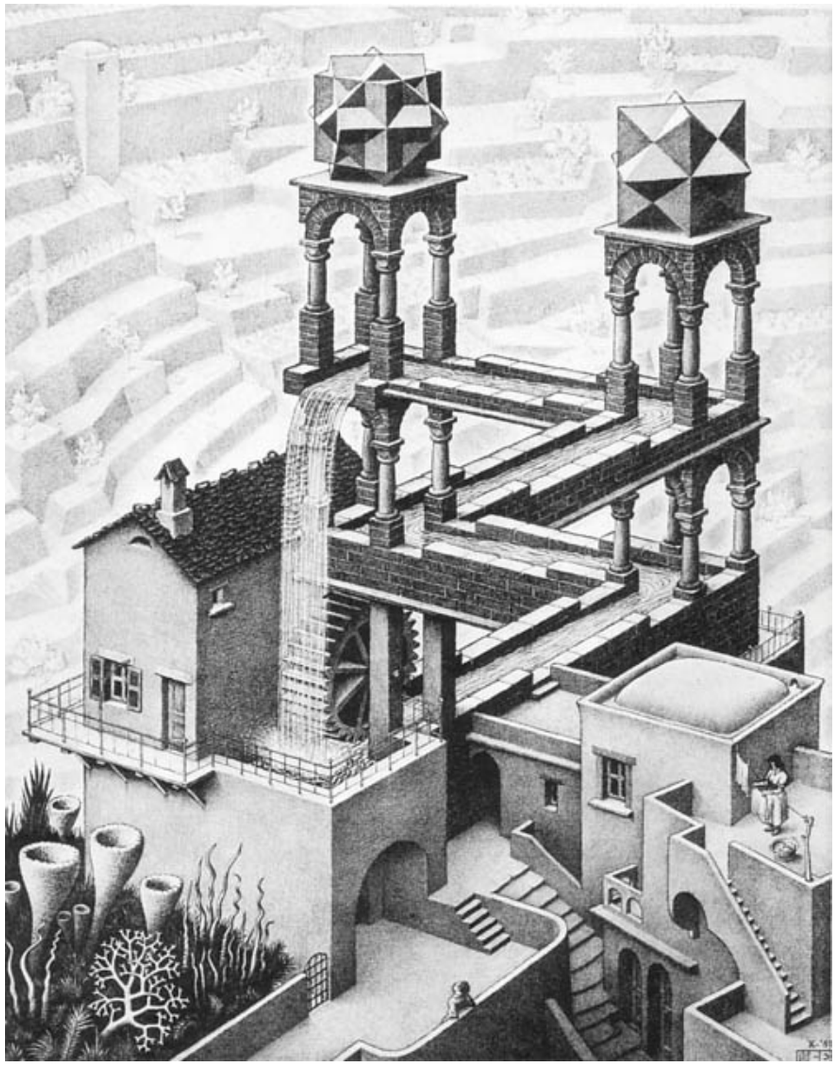
  - If eye is put at correct position to view picture, results in correct perspective.

- A number of depth cues are the result of geometry of perspective.

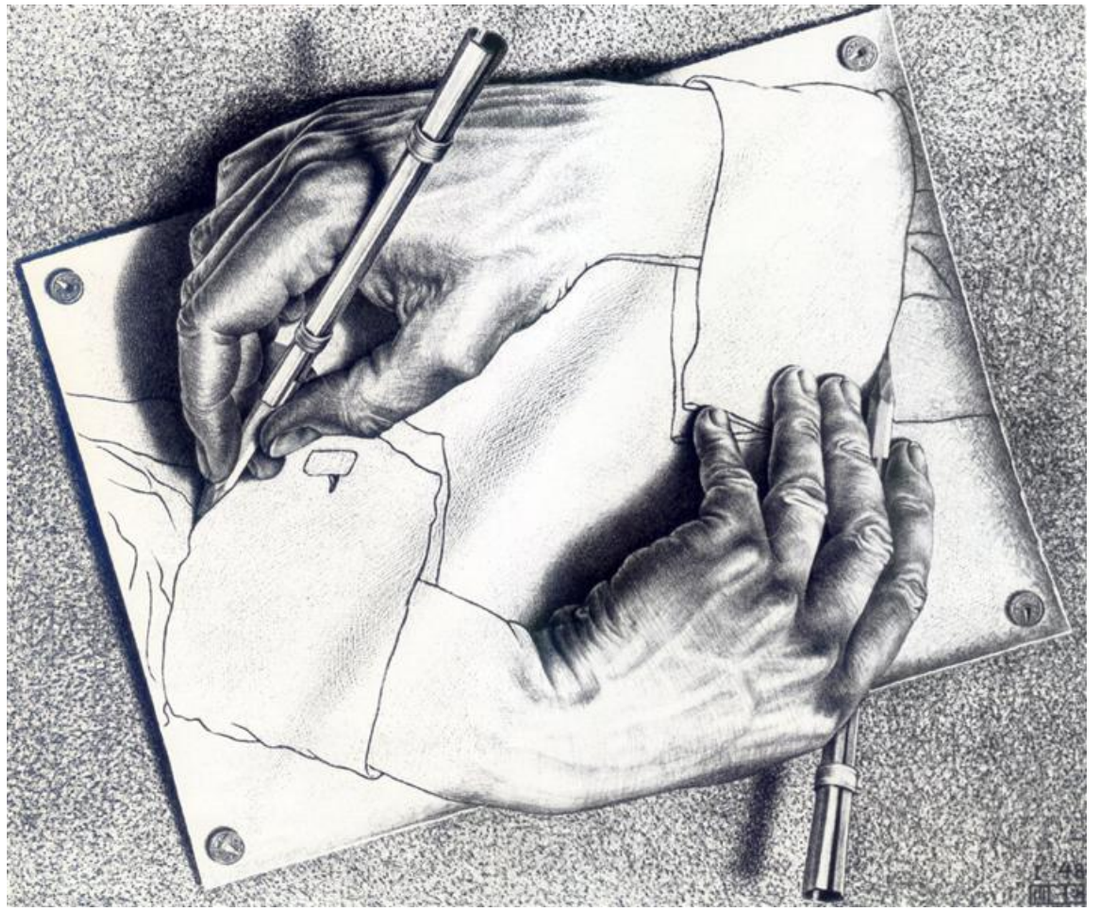
Linear perspective	Cast shadows	Size gradients	Relative size
Texture gradients	Occlusion	Vertical position	Depth of focus

Perspective Cues & Geometry

M.C. Escher
“Waterfall”



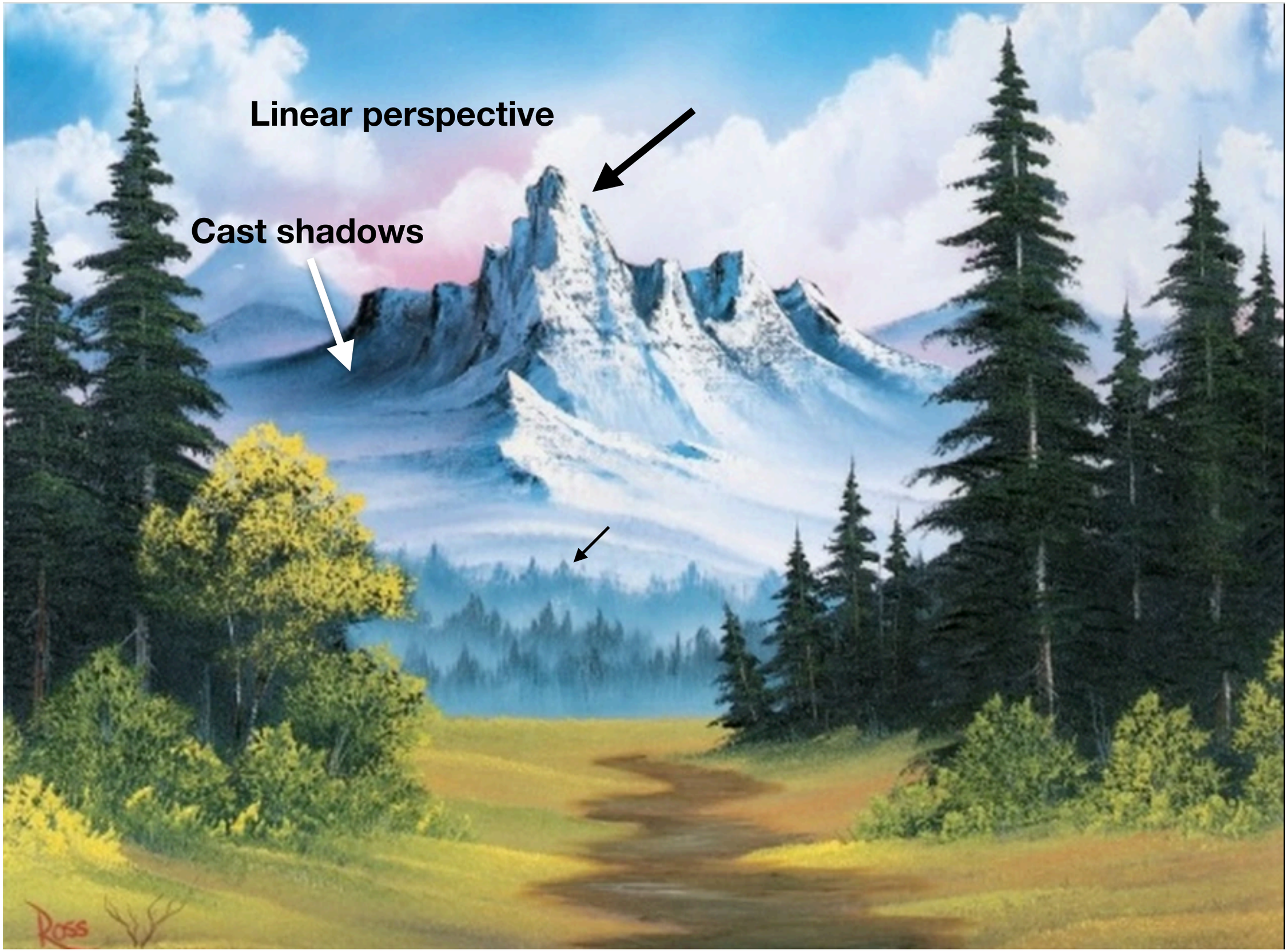
M.C. Escher
“Drawing Hands”



Depth Cues according to Bob Ross

Perspective Cues

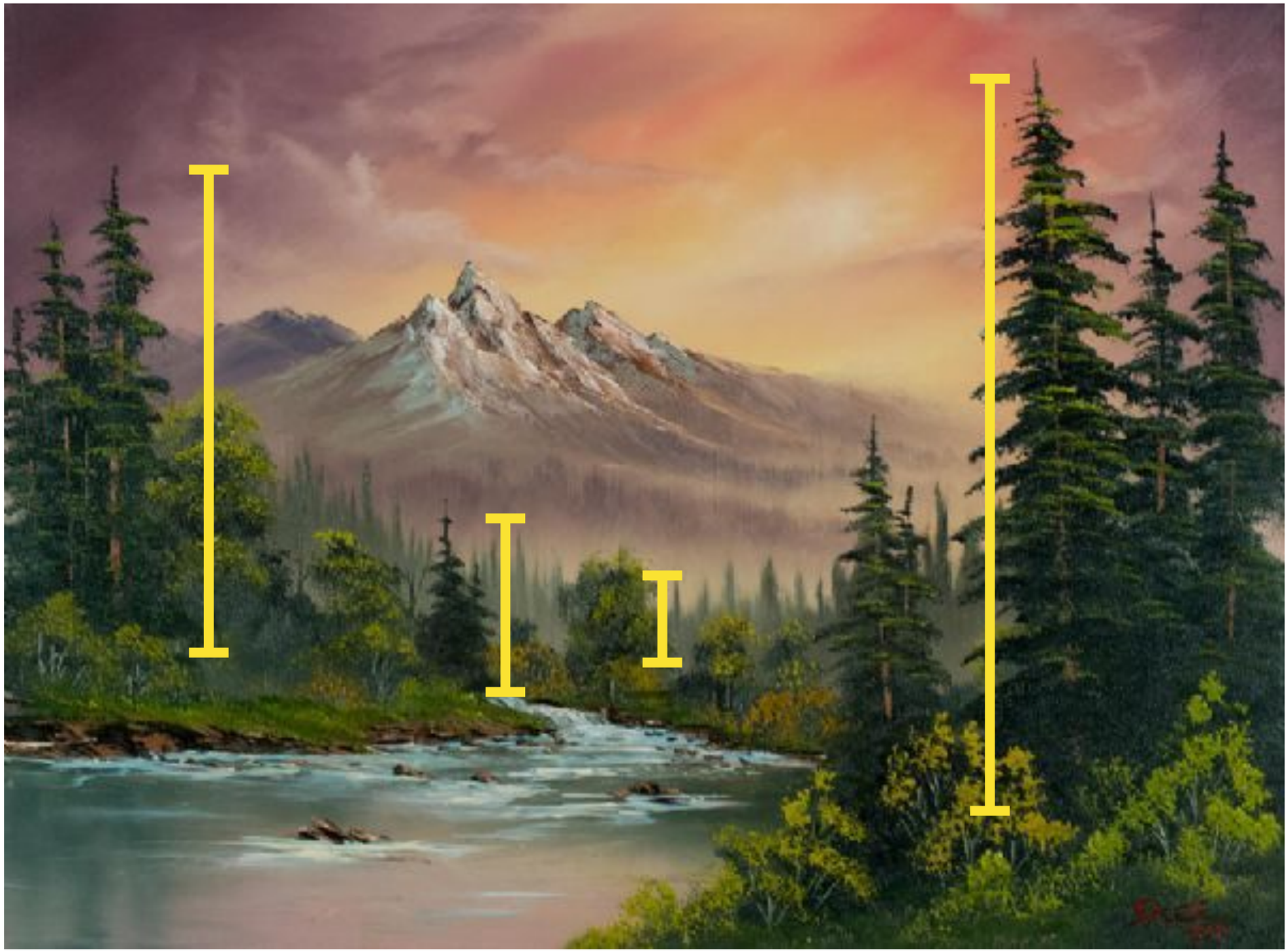
Relative size of familiar objects



Bob Ross

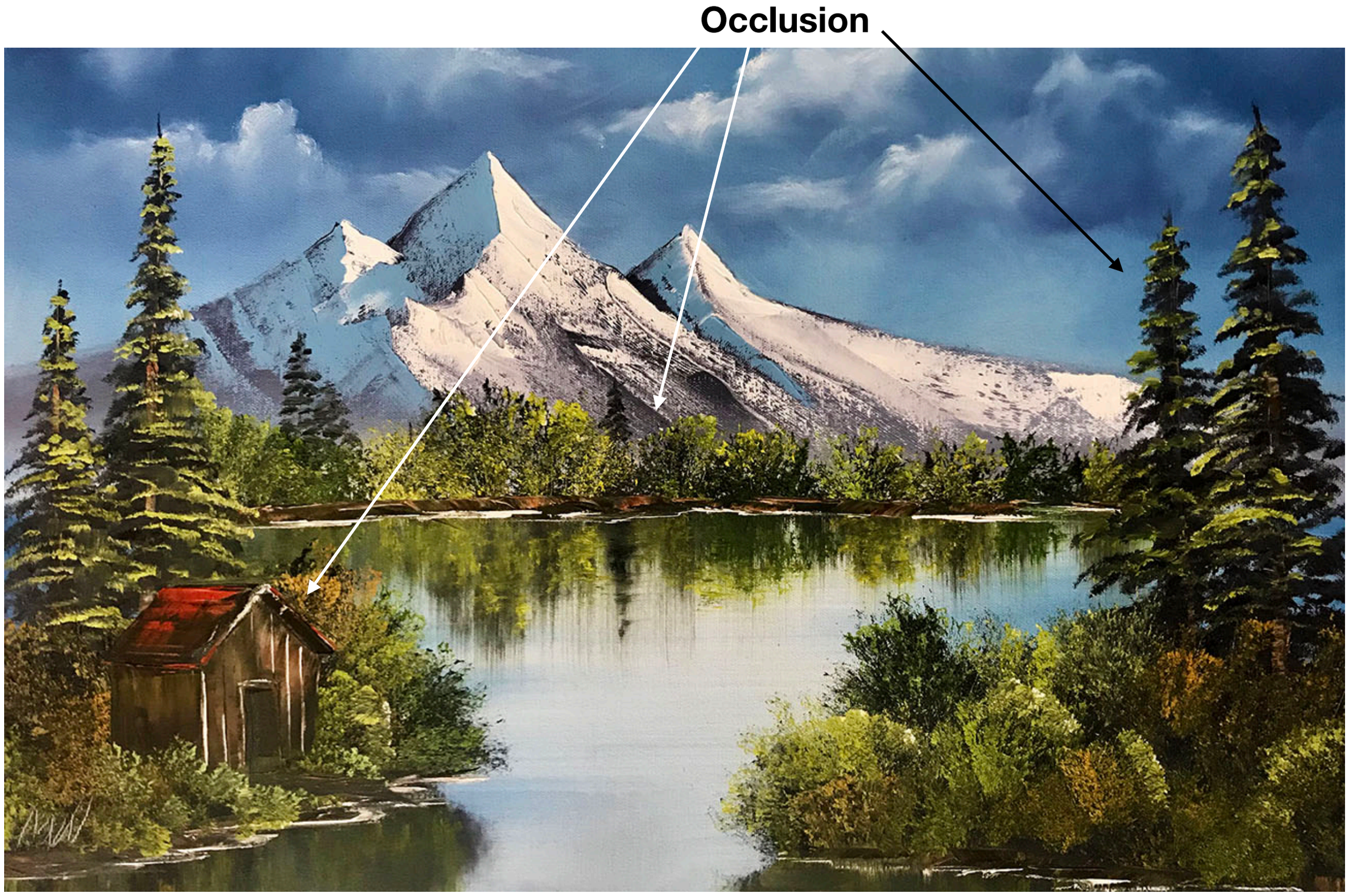
Perspective Cues

Relative/known size



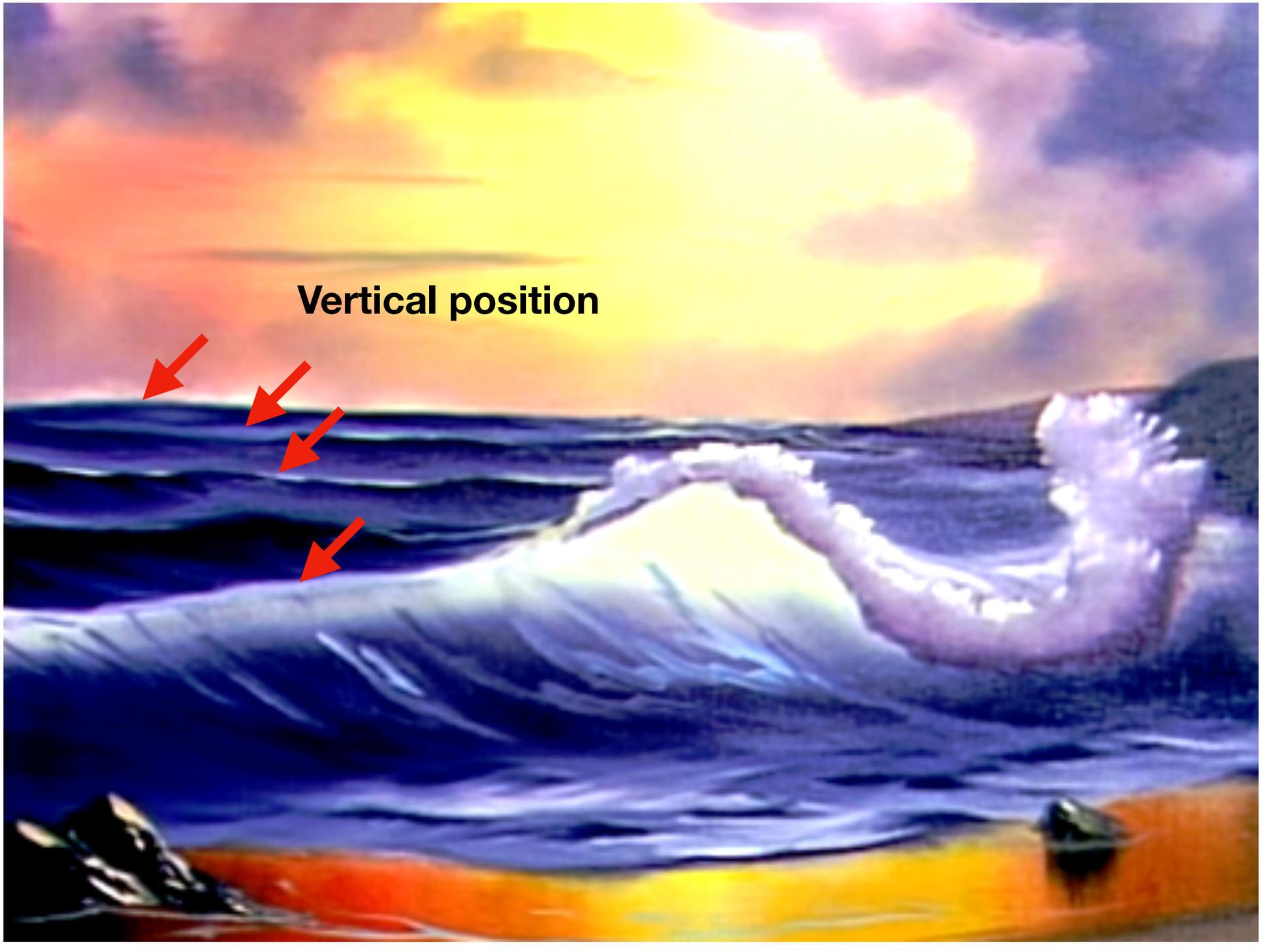
Bob Ross

Perspective Cues



Bob Ross

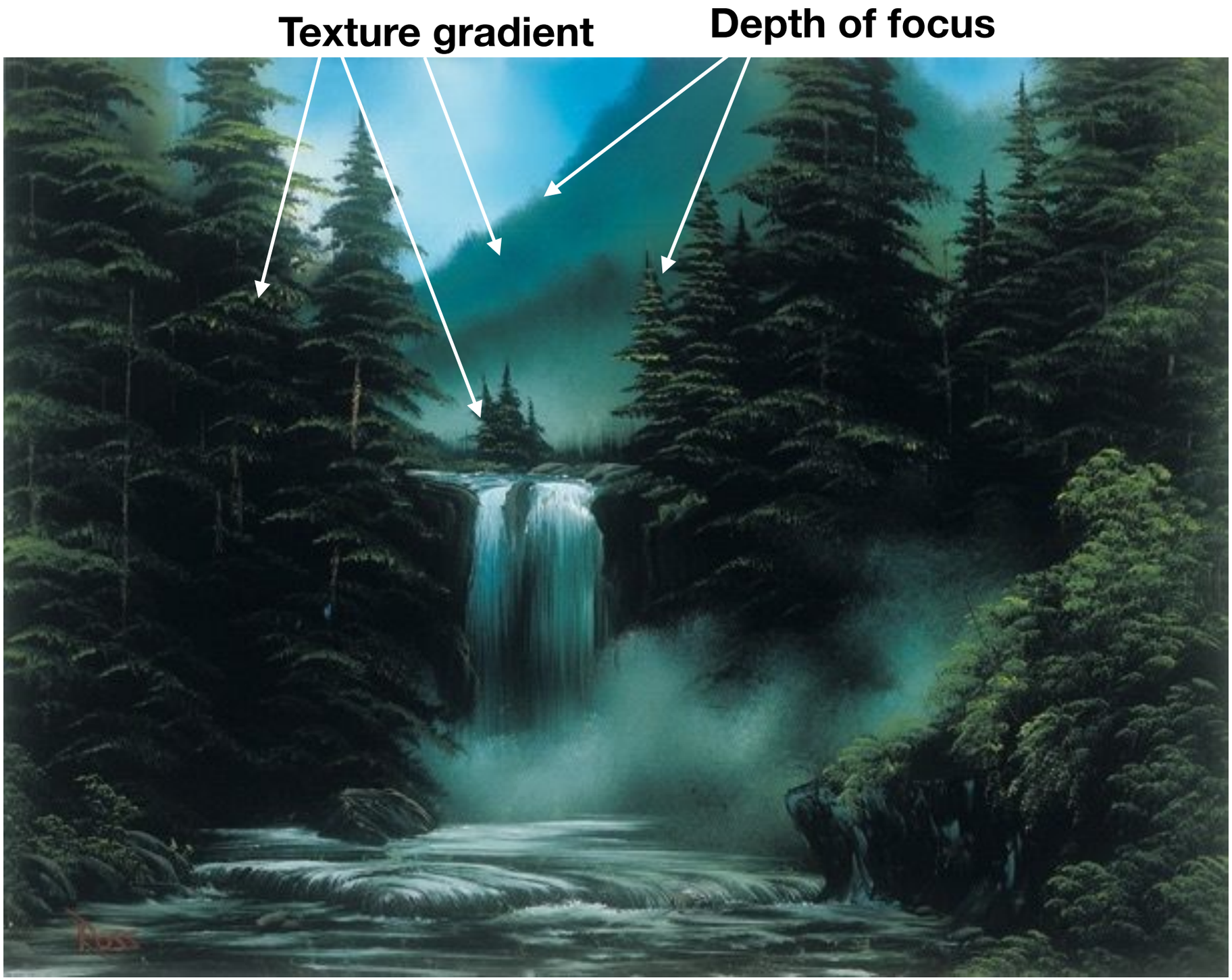
Perspective Cues



Bob Ross

Cast shadows

Perspective Cues



Bob Ross

Size Constancy

- Two choices when confronted with depth cues:

<u>Choice 1: Accurate size of actual object</u>

Mountain >> Tree

<u>Choice 2: Accurate size of object in picture (or on retina)</u>

Tree >> Mountain

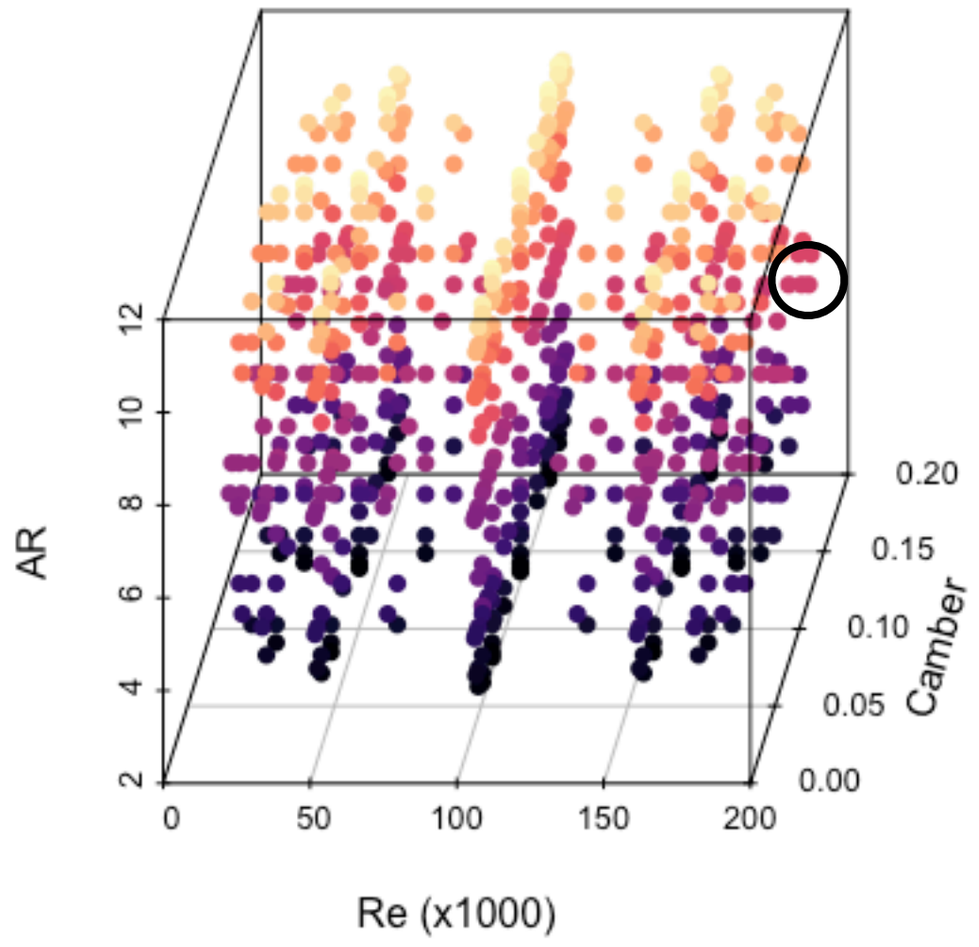
- Brains default to accurate size of actual object (choice 1), called **size constancy.**

- Designers have choice to represent accurately either the **real size of object** through depth cues ***OR*** size of the **object on picture plane.**
  BE THOUGHTFUL.

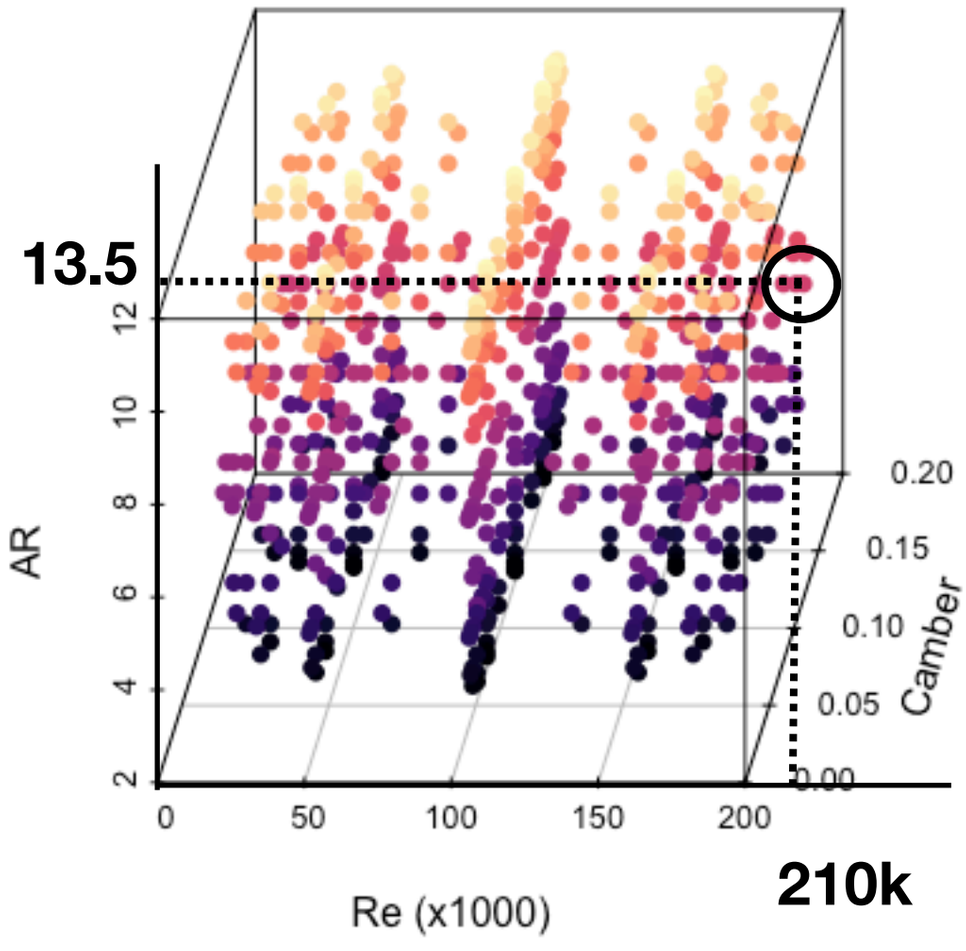
Size Constancy in 3D Plots

- 3D Scatterplots are problematic in this aspect because it's nearly impossible to be both accurate in actual position and accurate in object position on the page.

According to depth cues



According to position on page

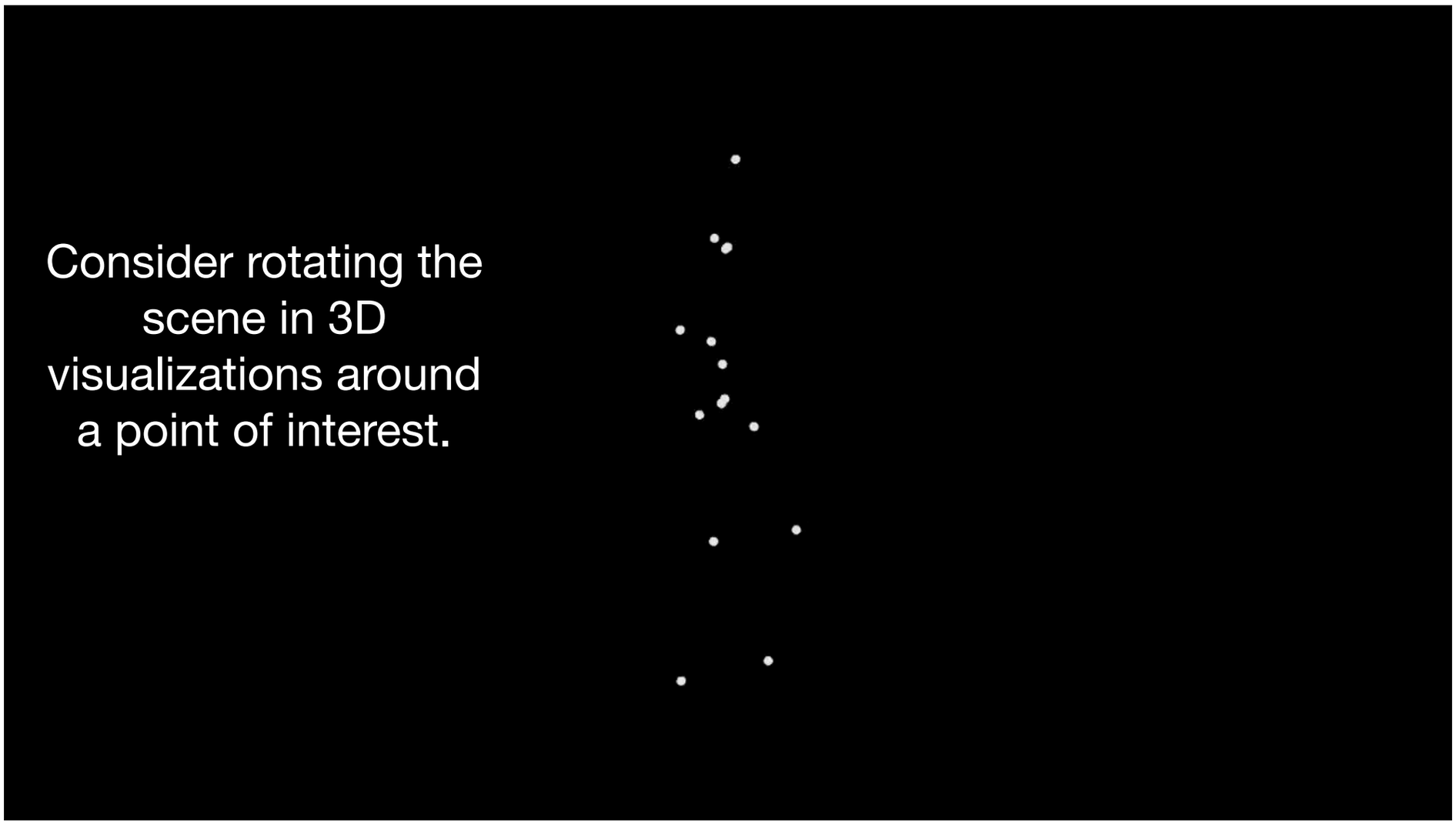


- Tips:
  - Use 3D judiciously
  - DO NOT use 3D for reporting data, only showing ***qualitative patterns.***
  - Use the ***best possible*** depth cues for 3D plots.

Structure from Motion

- **Motion parallax**: things that are close appear to move quickly, things far away appear to move more slowly.

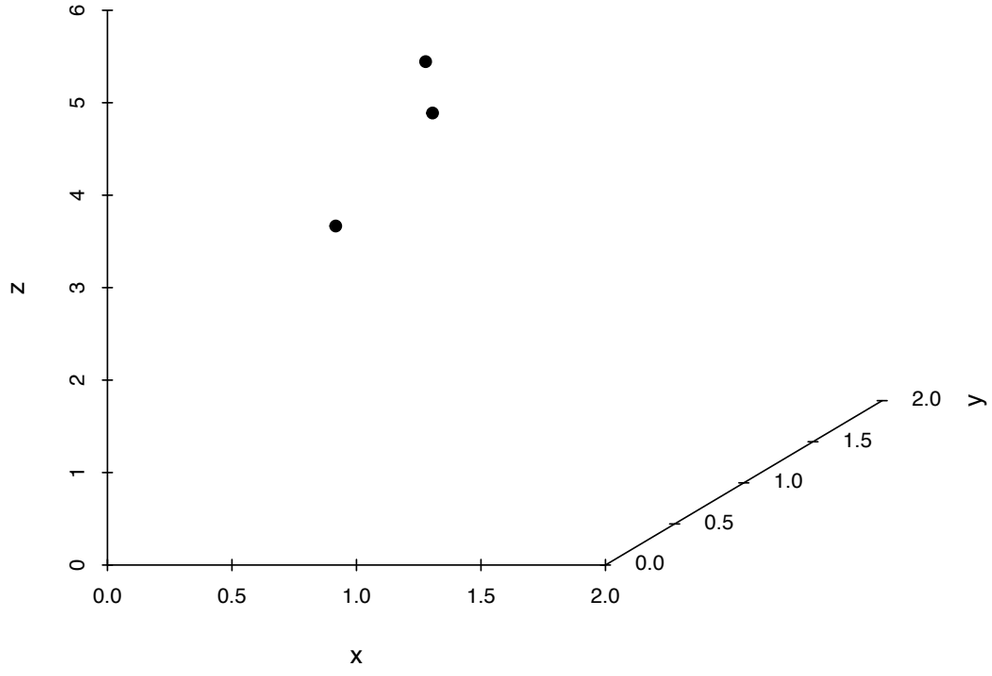
- **Kinetic depth effect**: brain assumes things are rigid in 3D space, so movement in 2D is interpreted as 3D.



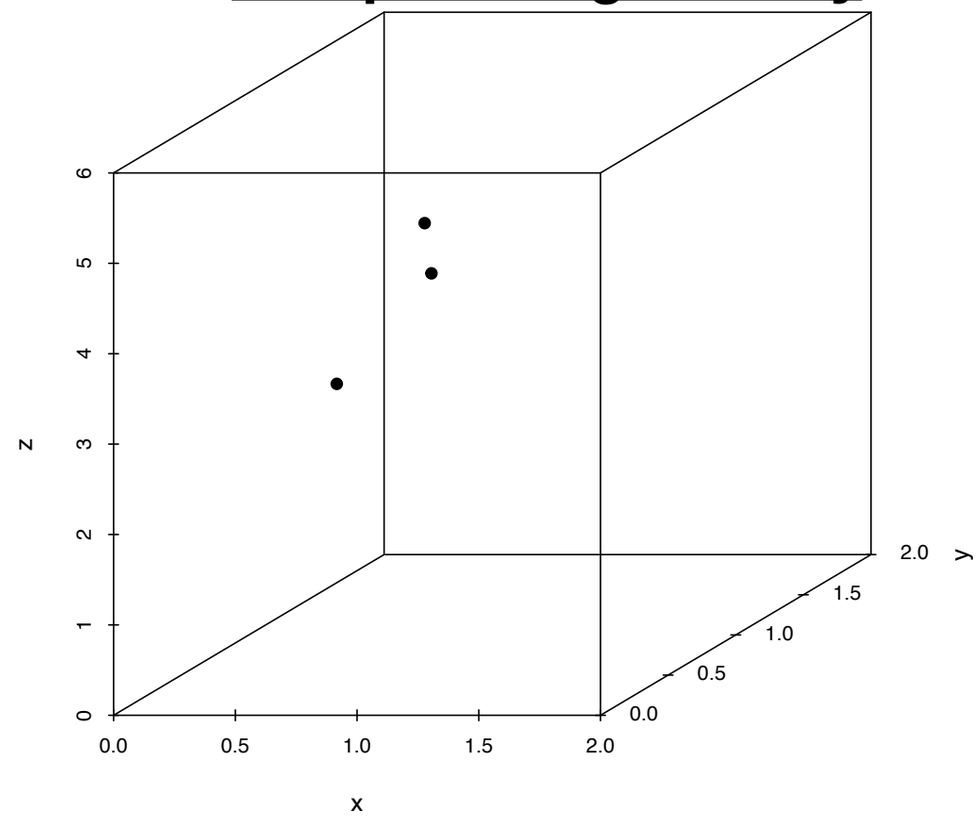
Wikipedia: https://en.wikipedia.org/wiki/Structure_from_motion_(psychophysics)

Artificial spatial cues

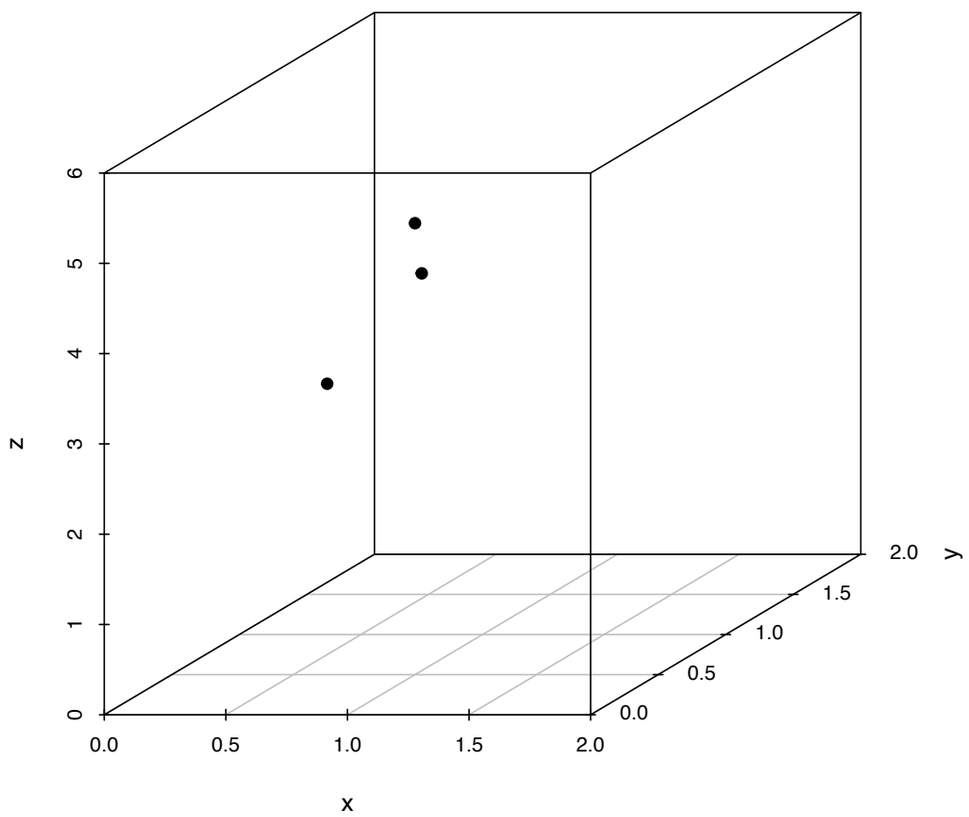
No cues



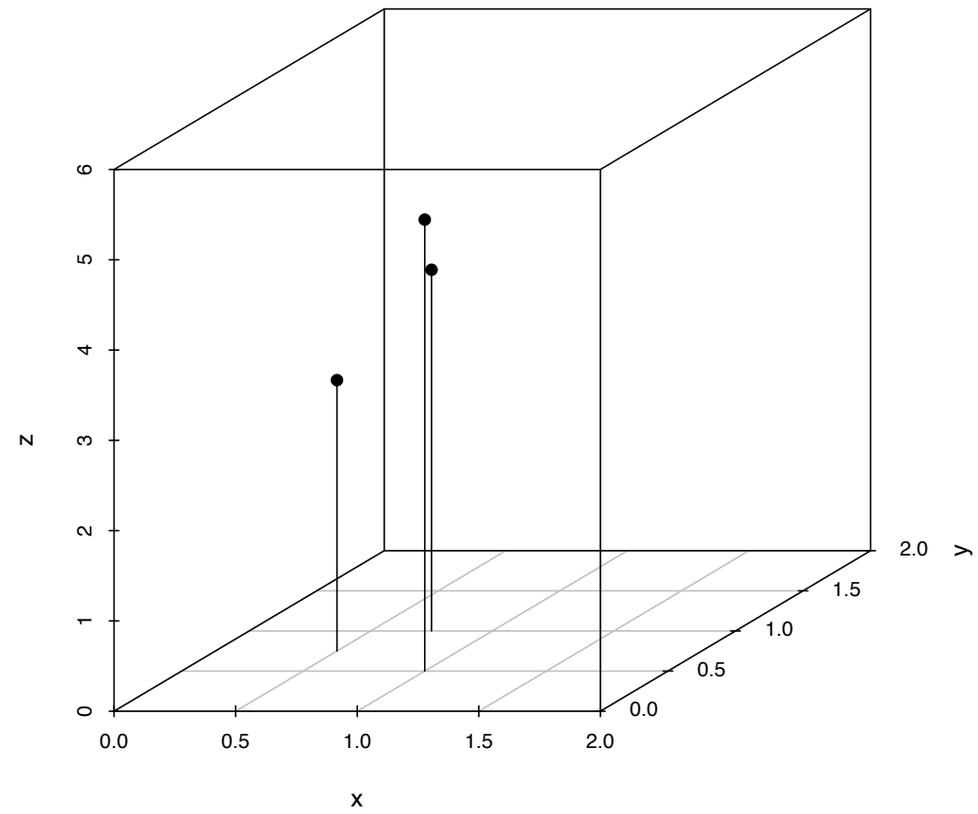
Perspective geometry



Grid perspective



Dropped lines



Types of depth cues

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Linear perspective

Texture gradients

Size gradients

Occlusion

Depth of focus

Structure from motion

Shape from shading

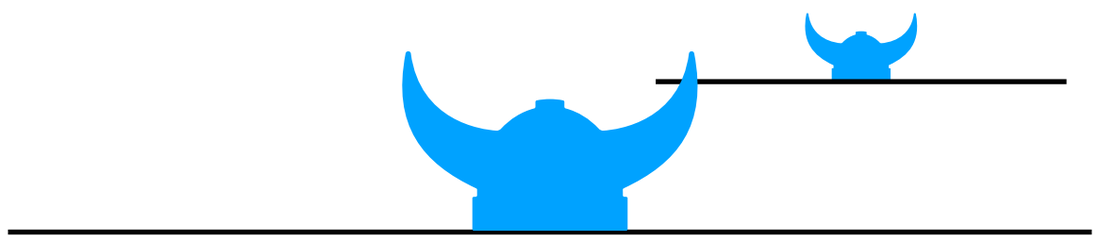
Vertical position

Relative size

Cast shadows

Depth-from-eye

Individual work: pick one monocular depth cue and implement it with a simple image or shape. You can do this in R, Powerpoint (Keynote), or GiMP.



Relative object size
Vertical position
Occlusion