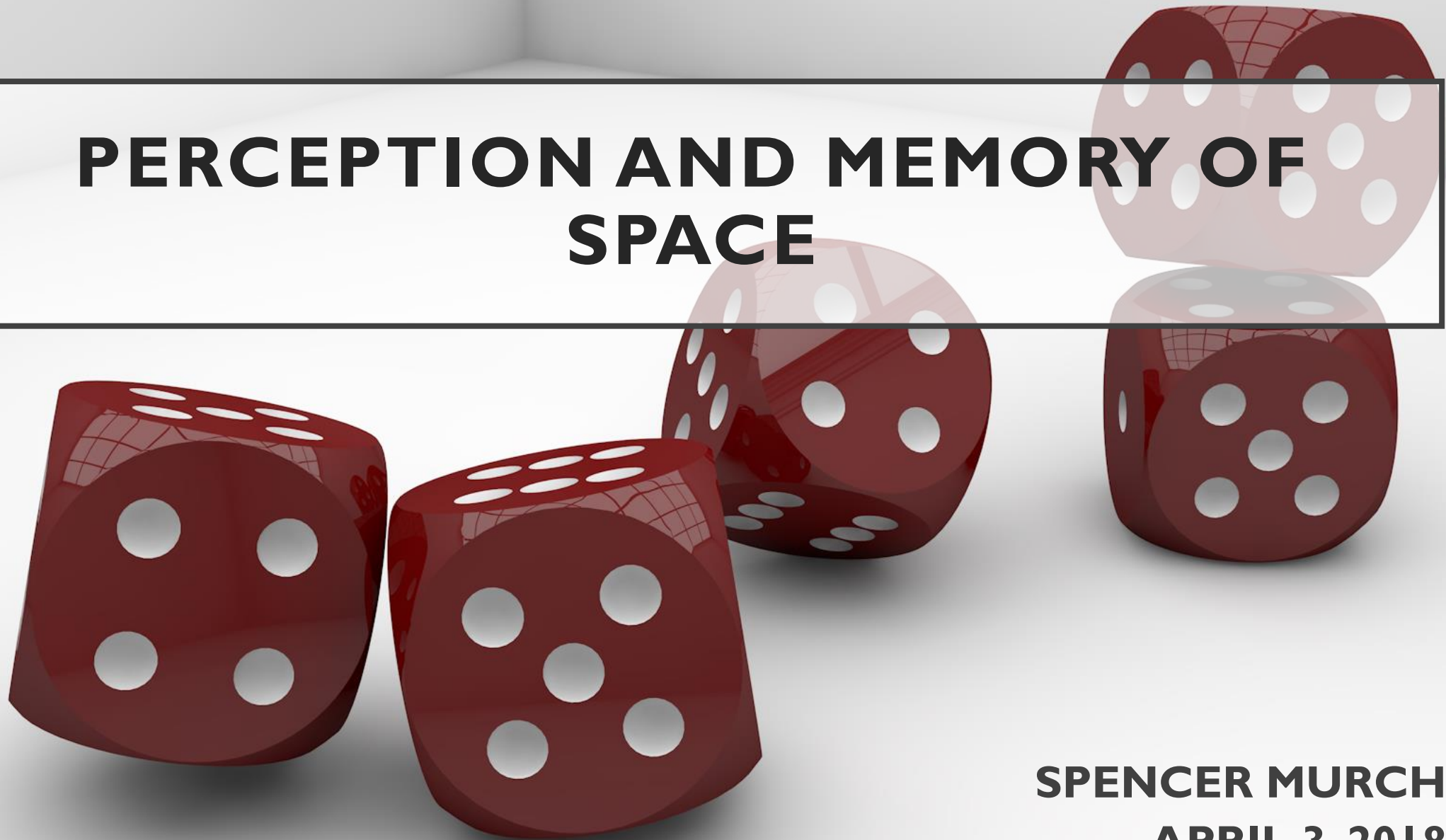


# PERCEPTION AND MEMORY OF SPACE



**SPENCER MURCH**  
**APRIL 3, 2018**

# COGNITIVE MAPS

*“...there is a school of animal psychologists which believes that the maze behavior of rats is a matter of mere simple stimulus-response connections. – According to this 'stimulus-response' school the rat in progressing down the maze is helplessly responding to a succession of external stimuli – sights, sounds, smells, pressures, etc. These external and internal stimuli call out the walkings, runnings, turnings, retracings, smellings, rearings, and the like which appear.*

*The rat's central nervous system, according to this view, may be likened to a complicated telephone switchboard.”*

*E.C.Tolman, The Psychological Review, 1948*



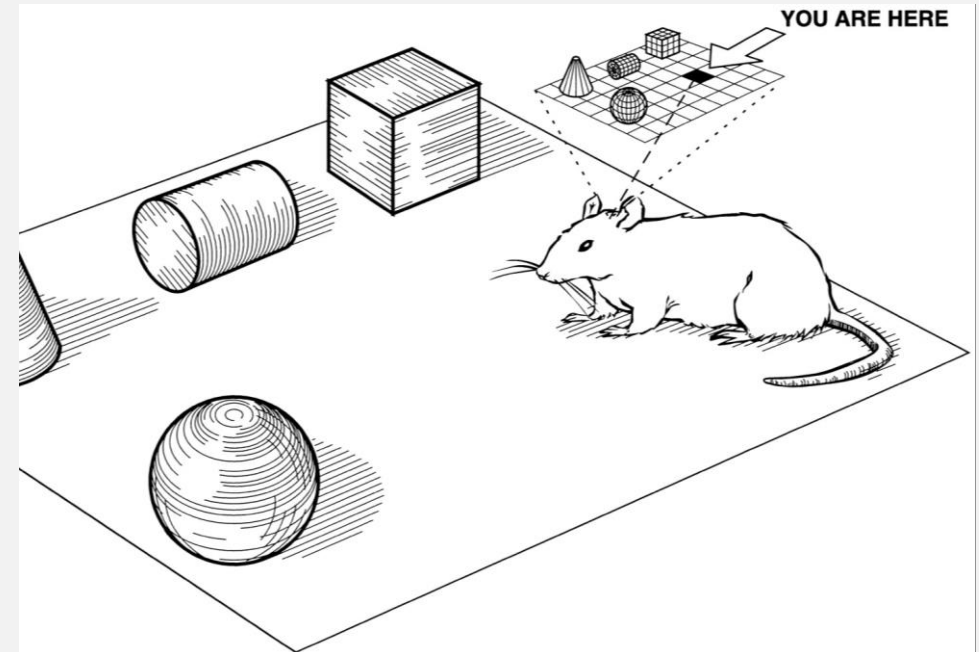
# COGNITIVE MAPS



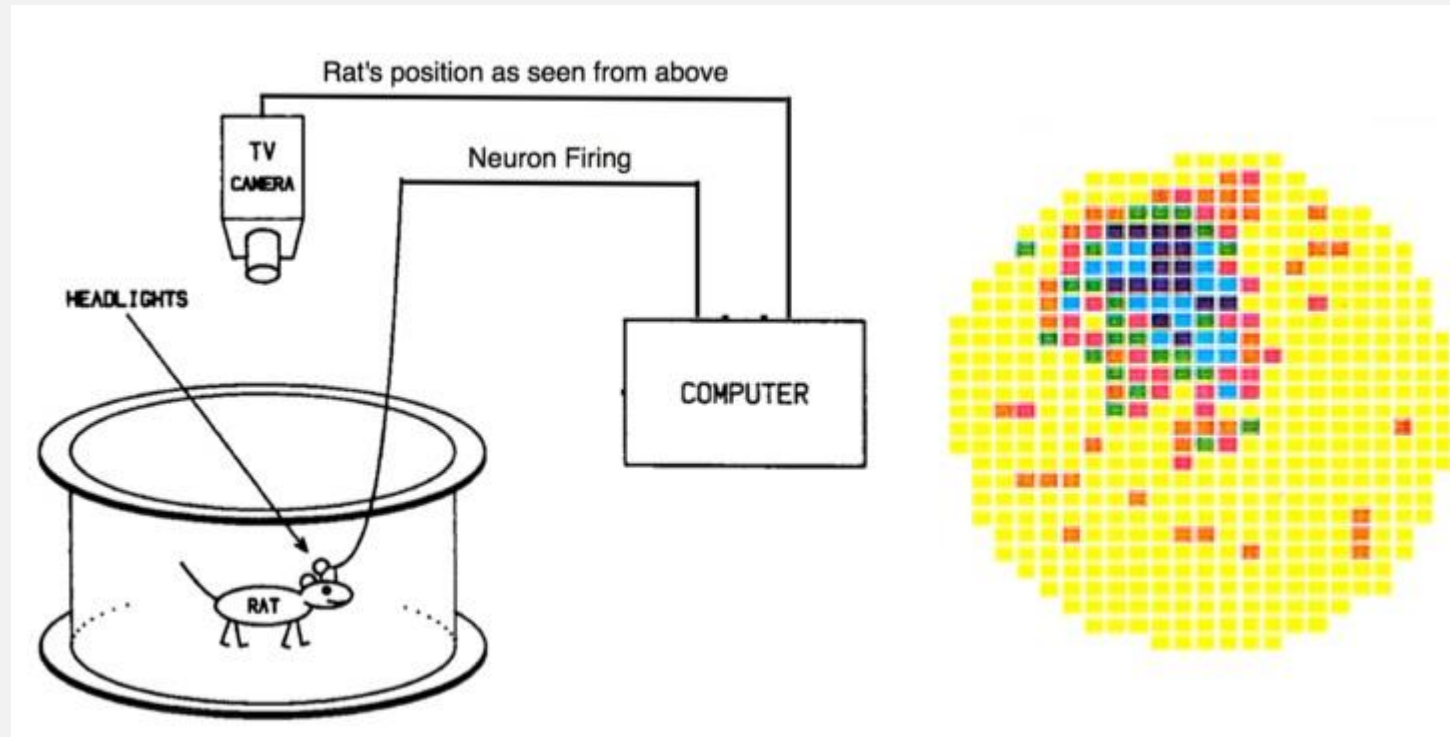
# COGNITIVE MAPS

*“We assert that the central office itself is far more like a map control room than it is like an old-fashioned telephone exchange. The stimuli, which are allowed in, are not connected by just simple one-to-one switches to the outgoing responses. Rather, the incoming impulses are usually worked over and elaborated in the central control room into a tentative, cognitive-like map of the environment. And it is this tentative map, indicating routes and paths and environmental relationships, which finally determines what responses, if any, the animal will finally release.”*

*E.C. Tolman, The Psychological Review, 1948*

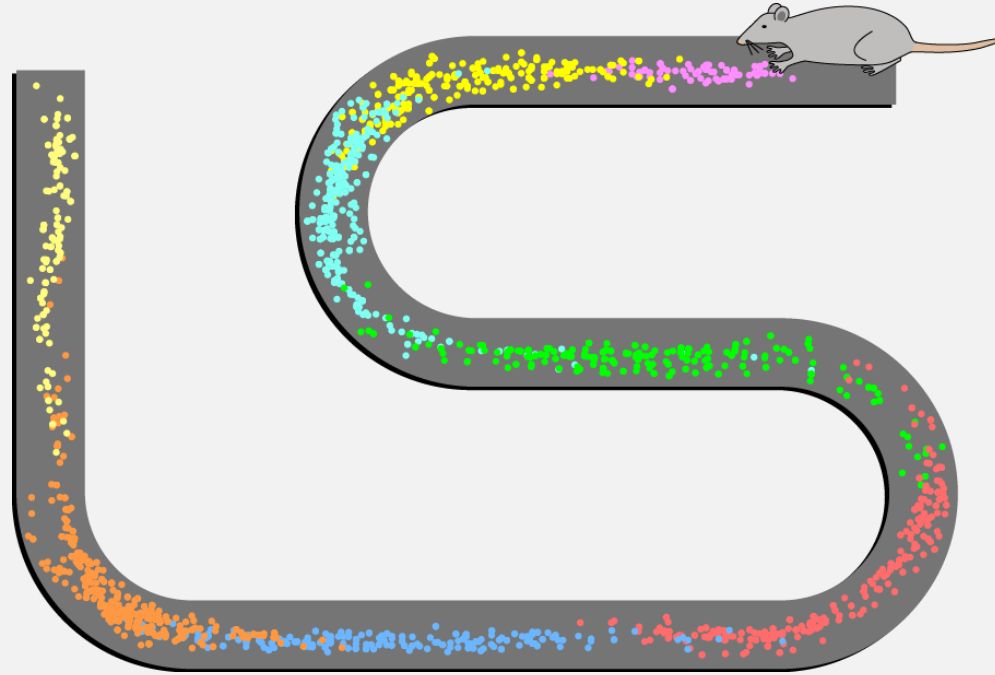


# HIPPOCAMPAL PLACE CELLS



(O'Keefe and Nadel 1978)

# HIPPOCAMPAL PLACE CELLS



O'Keefe and Nadel (1978) argued that these place cells represent Tolman's vision of a cognitive map of allocentric (extrapersonal) space, as well as the animal's location within it.

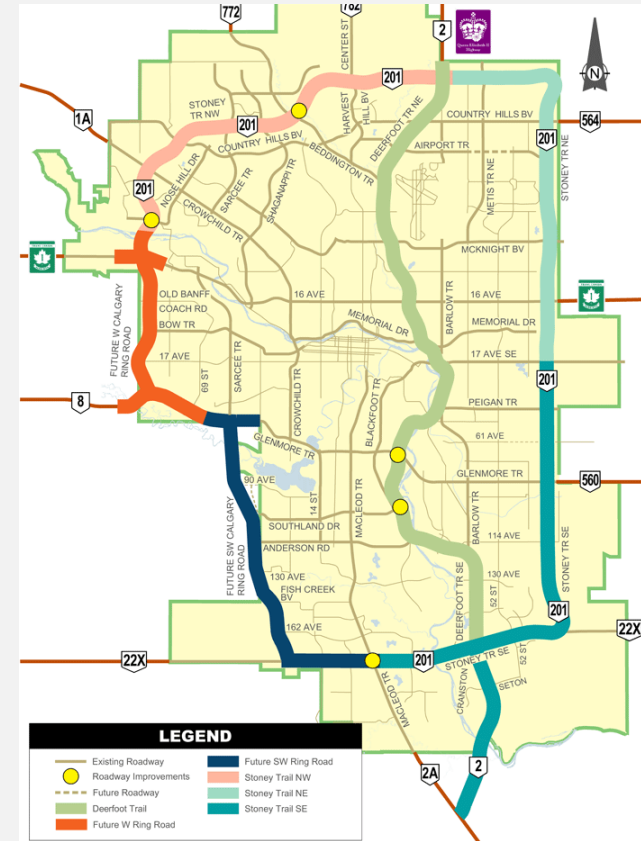


# MAP-MAKING

- Cognitive maps of cities (ex.) accrue as a combination of many trips along different paths, with exposure to different landmarks, nodes, boundaries and districts.
- Early exposure adds anchor points – i.e. major details. Later exposure adds less crucial, more minor detail.



# PATH HIERARCHIES IN THE CITY





# COGNITIVE DISTANCE

- Objective distance refers to the actual space between two points.
- Cognitive distance refers to the space between two points on a cognitive map, which may not reflect Euclidian space.
- The cognitive distance of paths into a city may be longer than the distance of the path out of the city.



# DEEP SPACE

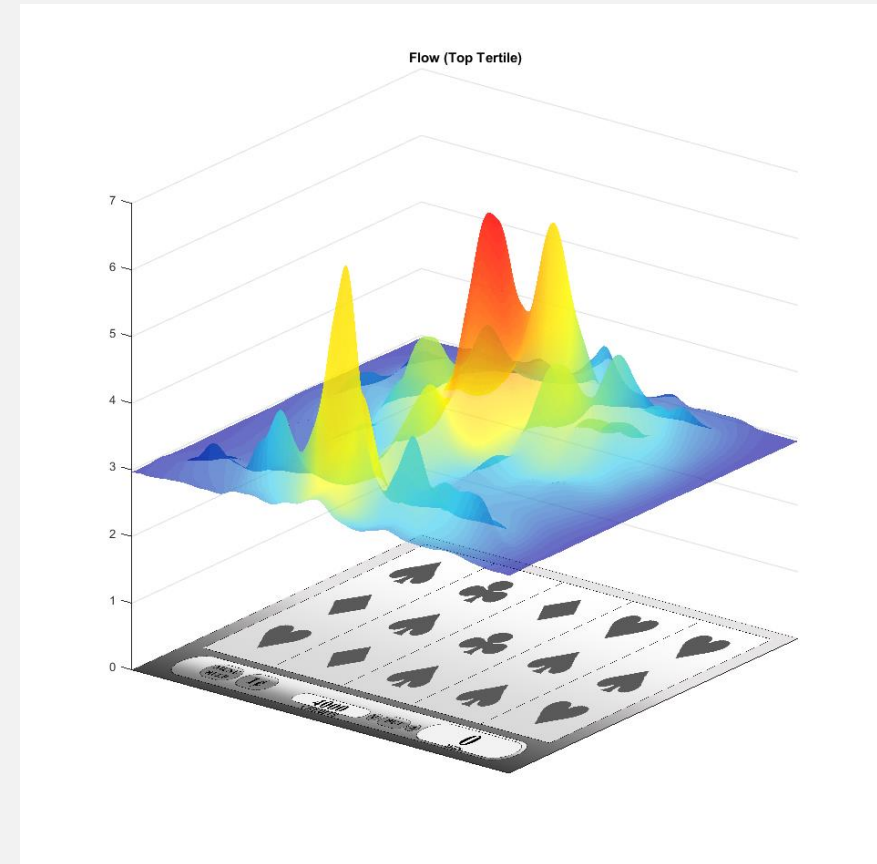
*“Deep space is the illusion of a three-dimensional world on a two-dimensional screen surface. It's possible to give an audience the experience of seeing a three-dimensional space (height, width, and depth) even though all of the depth is illusory. The depth is not actually there; it can never be there because the screen upon which the picture exists is flat.”*

(Block, 2008)

# 3D GRAPHICS: DEPTH CUE THEORY

*“Because it is so inexpensive to display data in an interactive 3D virtual space... It is inevitable that there is now an abundance of ill-conceived 3D design.”*

(Ware, 2012, p. 239)



# DEPTH CUES

## Visual clues about 3D space.

### Monocular static (pictorial)

- Linear perspective
- Texture gradient
- Size gradient
- Occlusion
- Depth of focus
- Shape-from-shading
- Vertical position
- Relative size to familiar objects
- Cast shadows
- Depth-from-eye accommodation

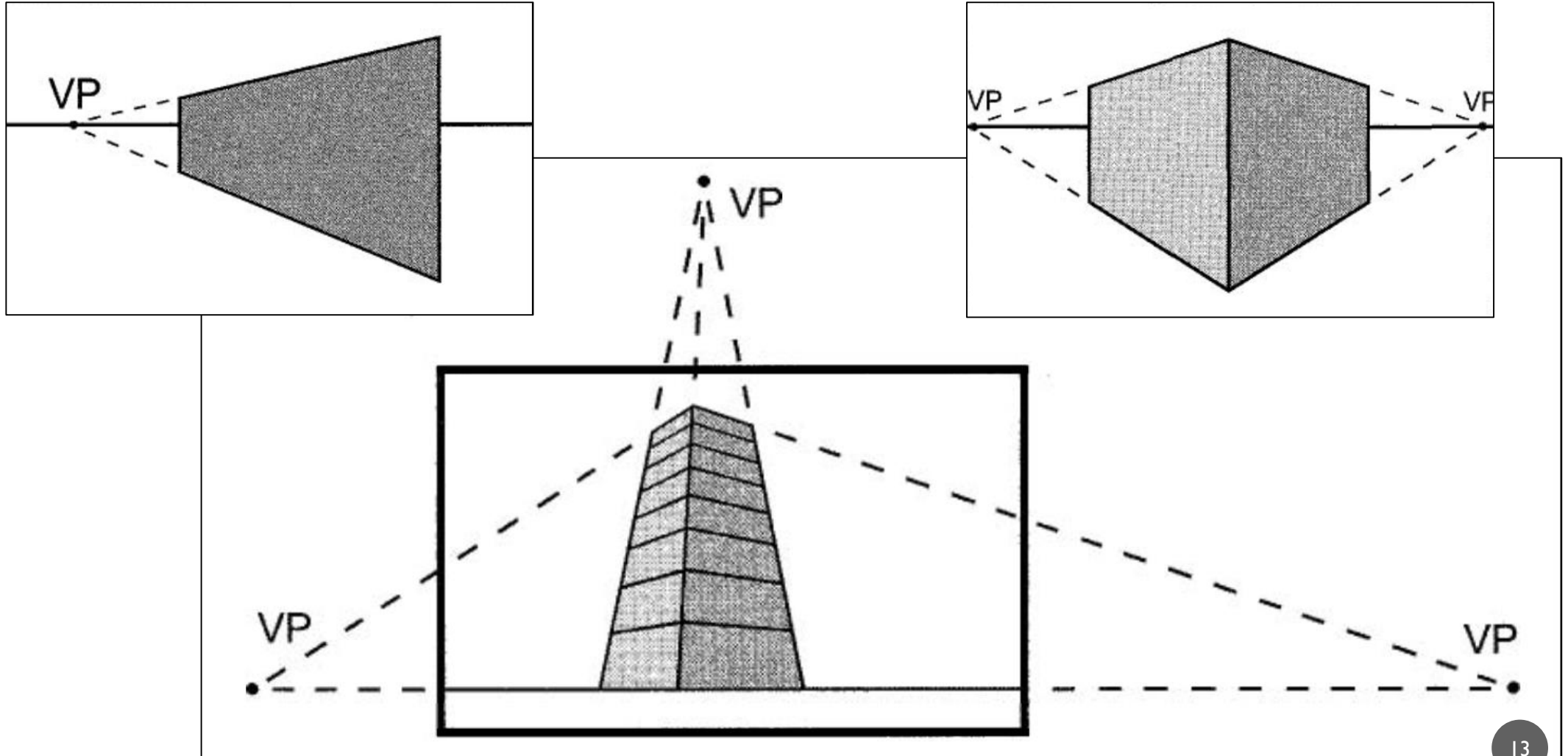
### Monocular dynamic (moving picture)

- Structure-from-motion (kinetic depth, motion parallax).

### Binocular

- Eye convergence
- Stereoscopic depth

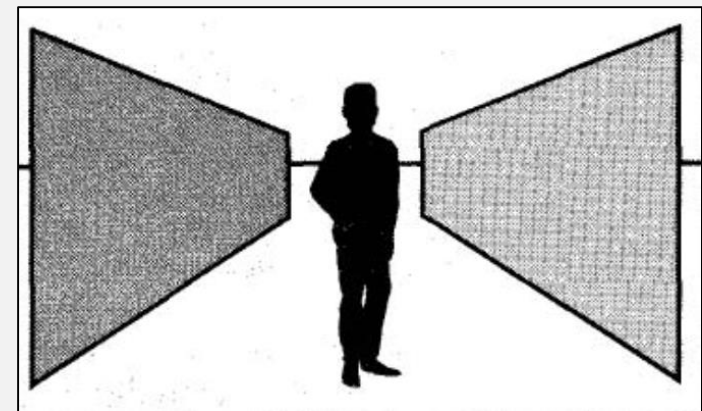
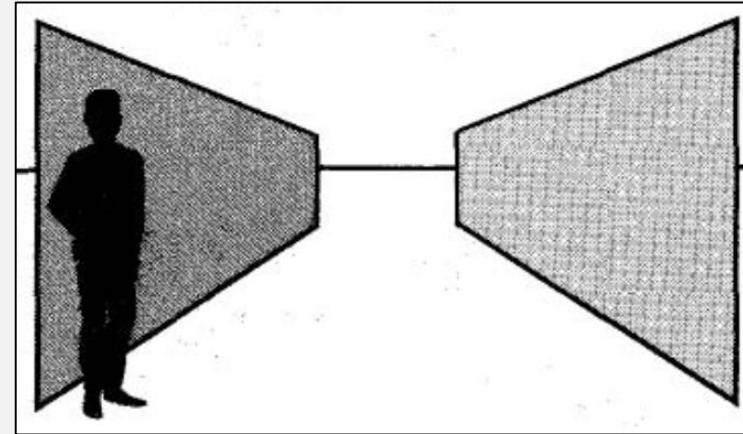
# PERSPECTIVE





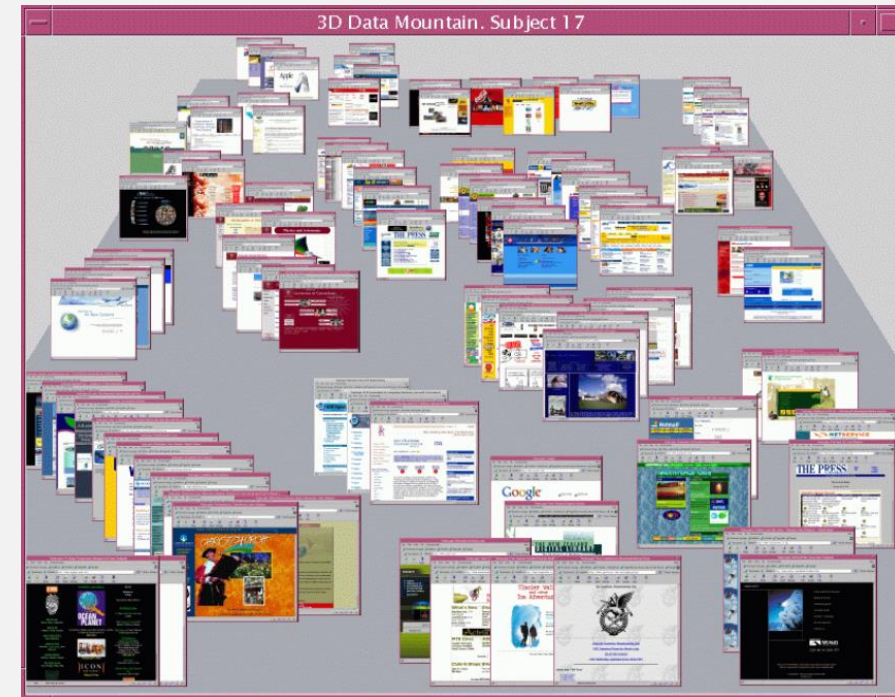
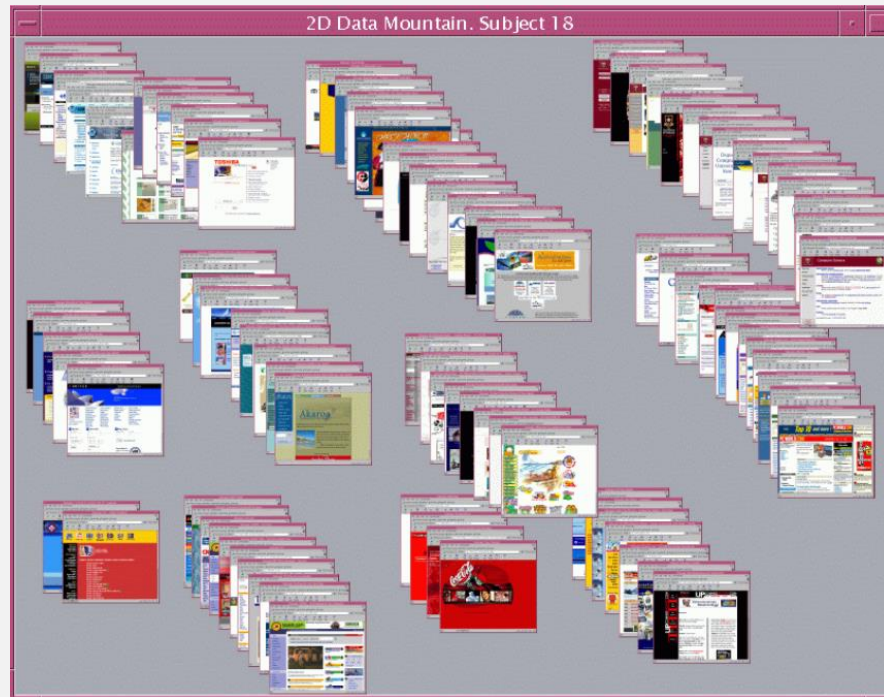
# PERSPECTIVE

- Vanishing points tend to attract attention, perhaps away from objects (or people) of interest.
- Place important objects over the vanishing point.



# PERSPECTIVE CUES

Visual clues about a particular viewpoint.

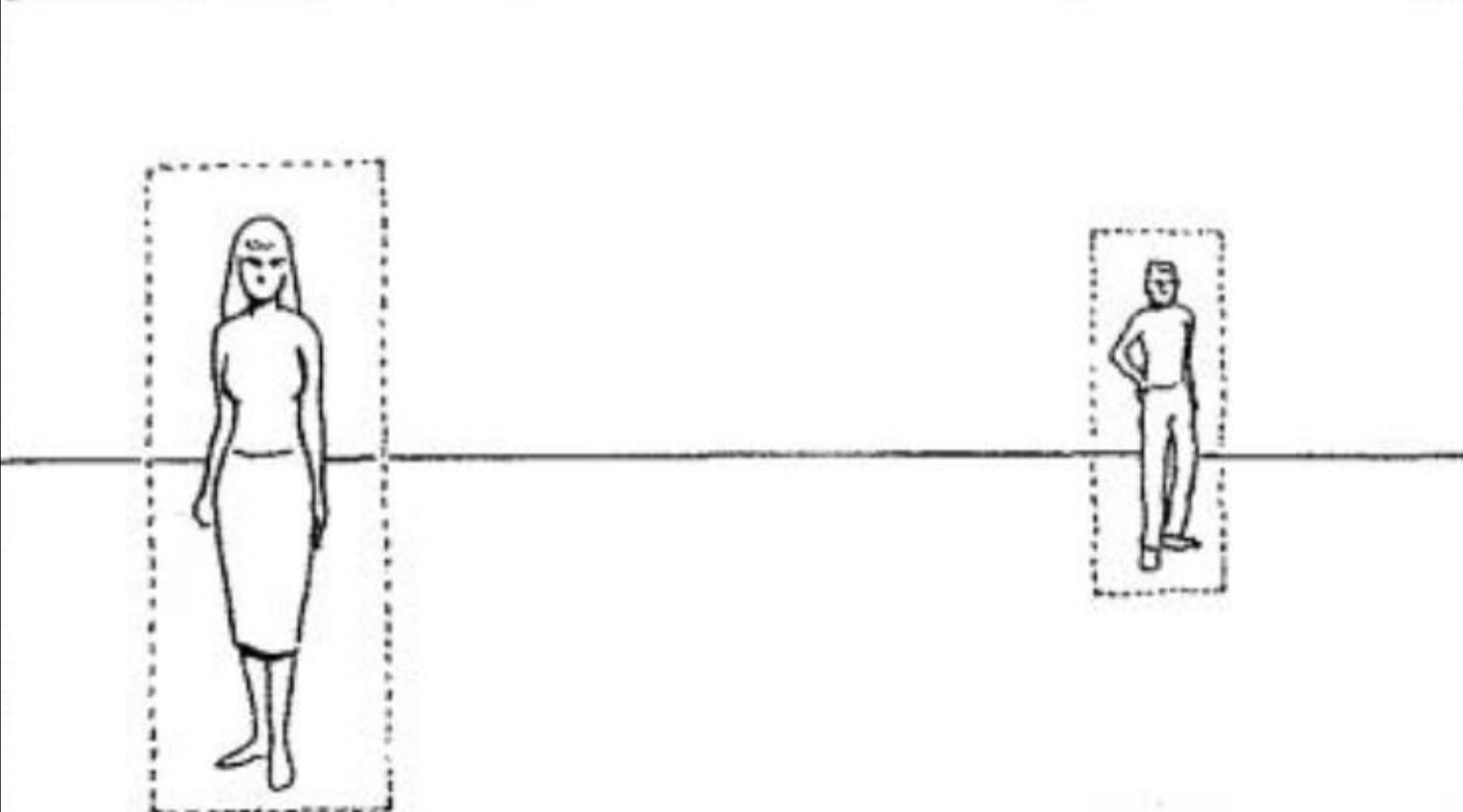


# ROBUSTNESS OF LINEAR PERSPECTIVE

- We quickly become unaware of distortions in 3D objects – perceptual mechanisms account for ‘rigidity’ of objects.
- Still, avoid extreme off-axis viewing angles to reduce noticeable distortion.



# DISTANCE BY FAMILIAR SIZE





# DISTANCE BY FAMILIAR SIZE





# TEXTURAL DIFFUSION

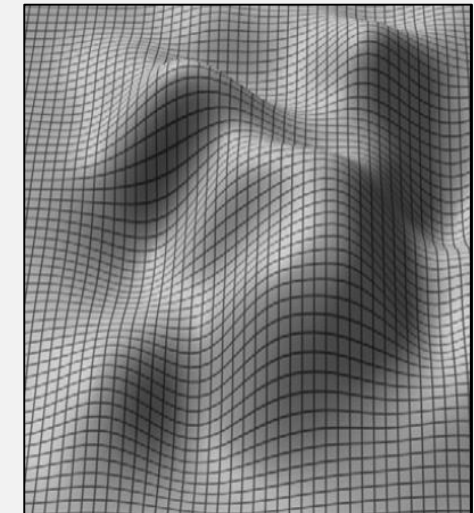
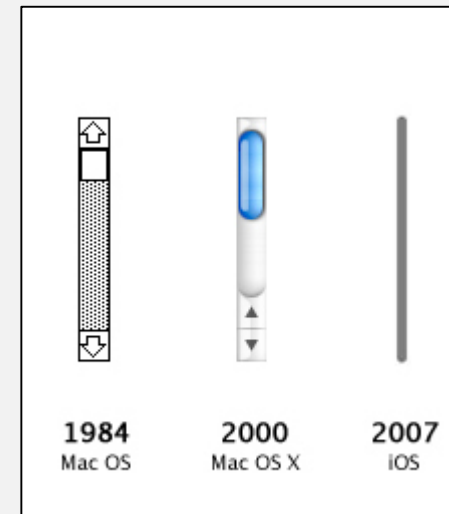
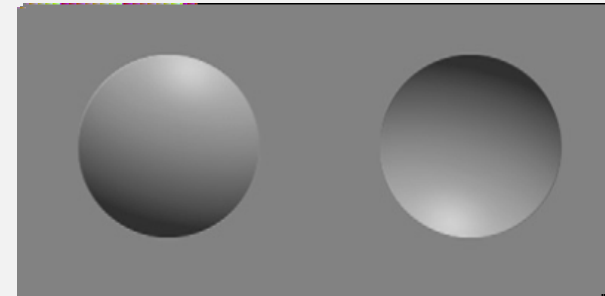
- Things farther away are resolved in less definition. Lack of detail predicts distance.



Here, you could rely on any of size, perspective or textural diffusion to infer distance.

# SHADING & LIGHT SOURCES

- 2D shading can reveal surface shape.
- The brain assumes a single light source to separate concavities from convexities
- Subtle shading and grid textures can reveal or imply shape.



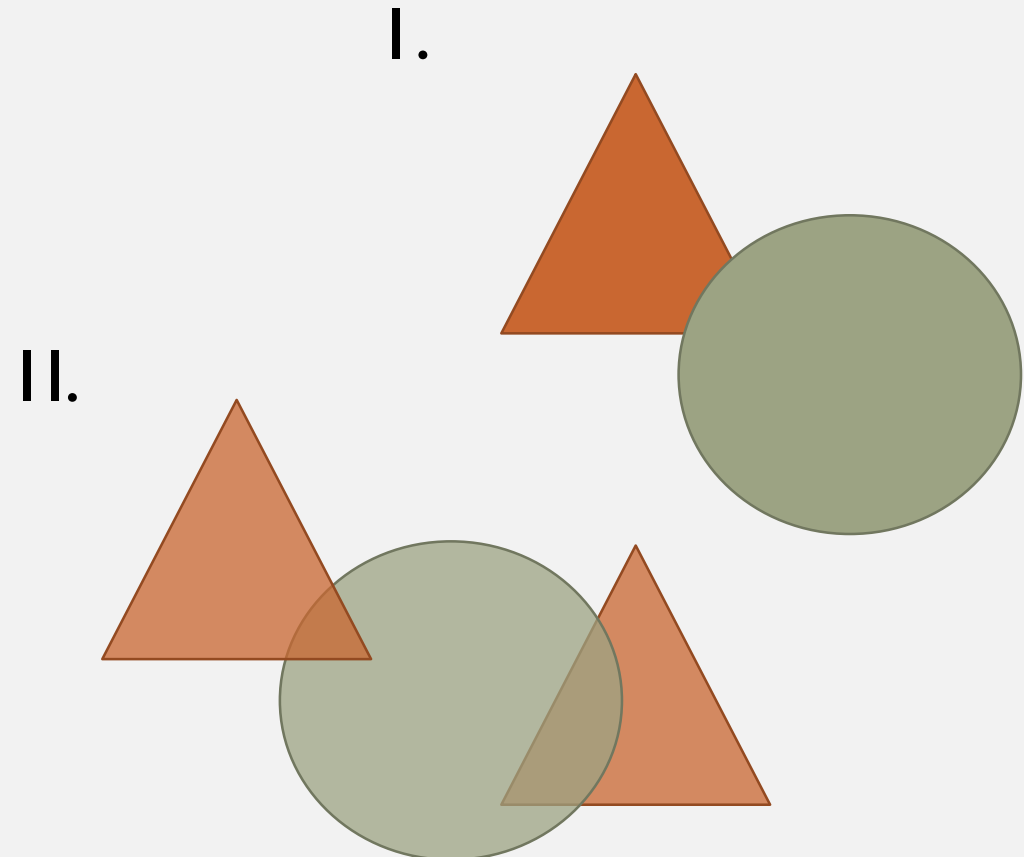
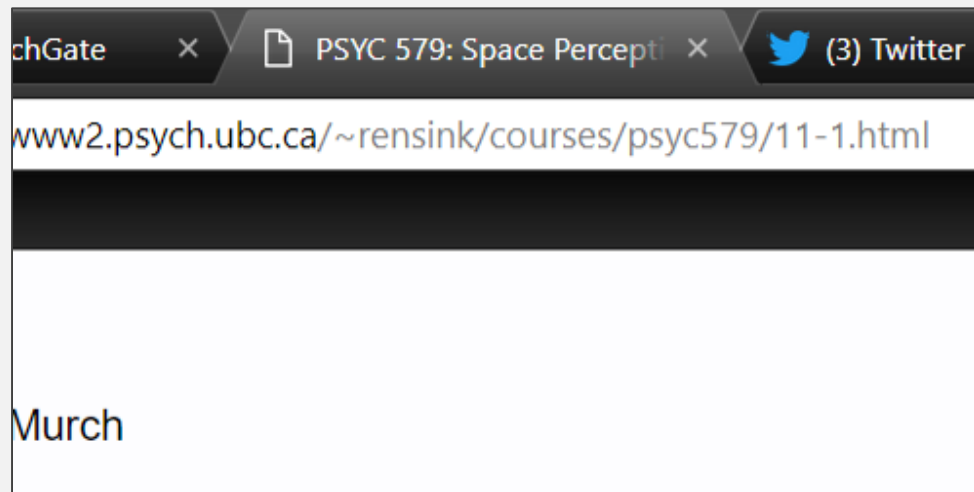
# DEPTH CUES FOR FOCUS

- Blur is an ambiguous depth cue



# OCCCLUSION

- Binary information only.
- Partial occlusion with translucency.
- Can be subtle



# COMBINING DEPTH CUES

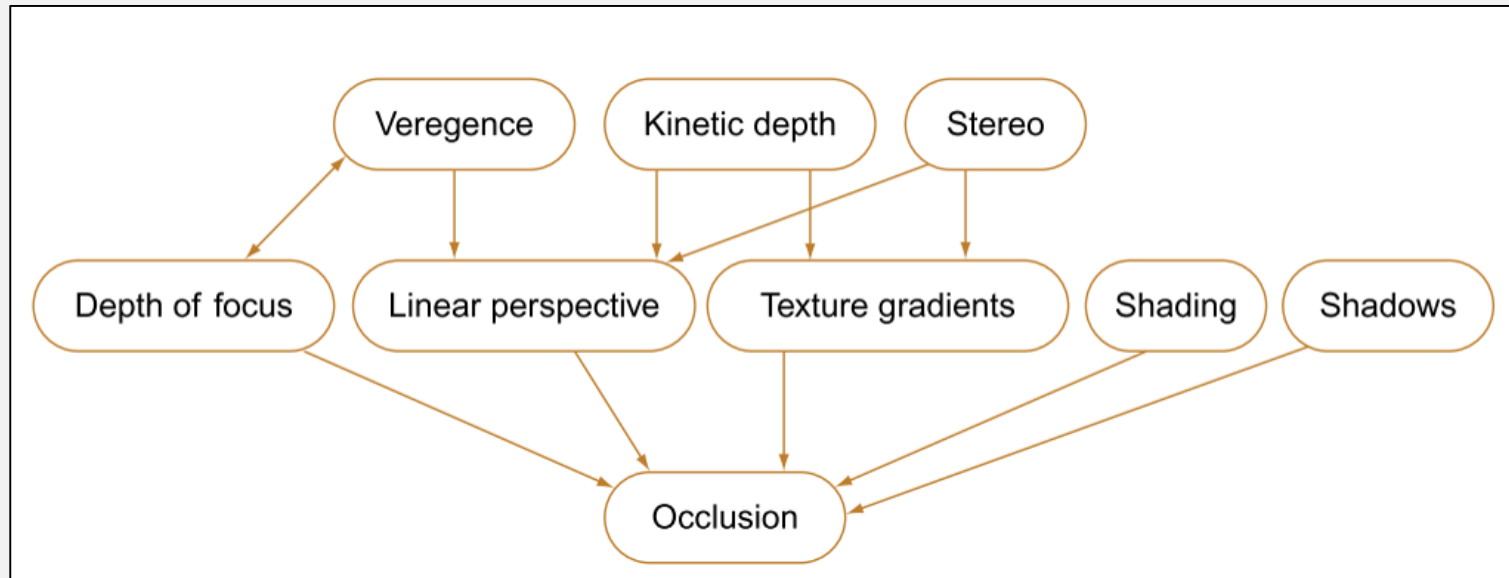
- It is not advisable to use every depth cue at your disposal. This adds cost and may not account for gaze location.
- Some cues contribute to an additive depth profile (shadow, focus, relative size) while others may supersede and introduce binary perceptual effects (occlusion).



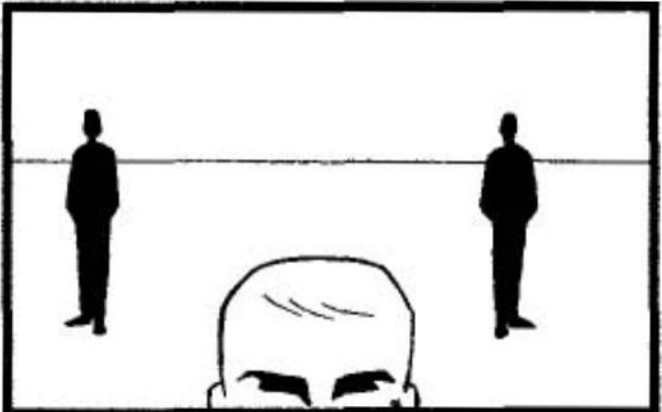
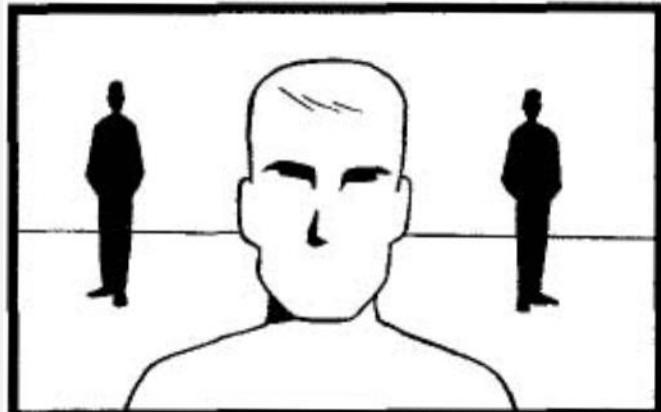
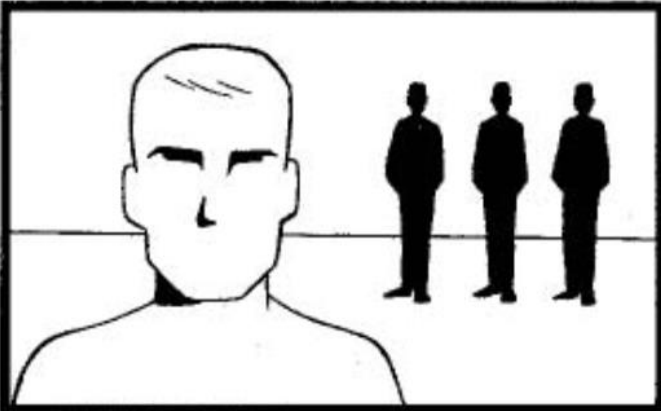
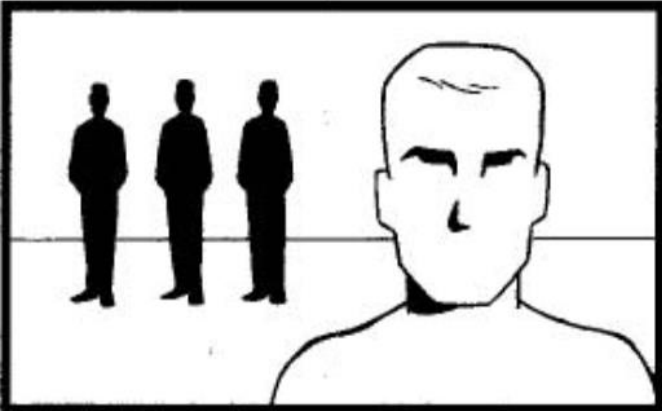


# COMBINING DEPTH CUES

- Some cues need to be presented in tandem in order to work.

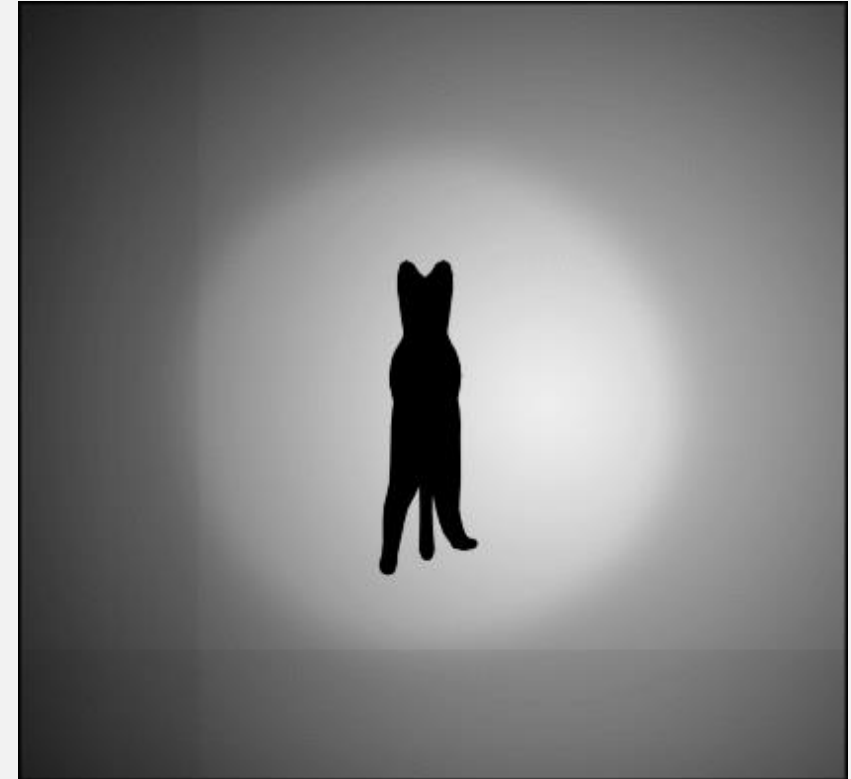


# MOTION PARALLAX

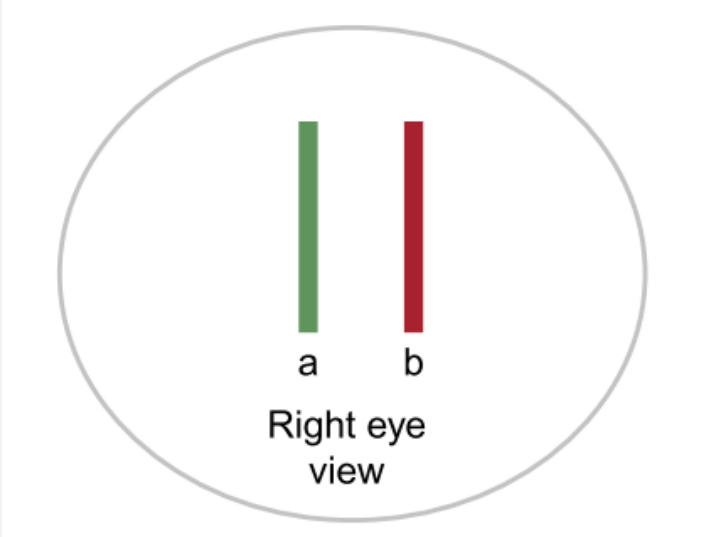
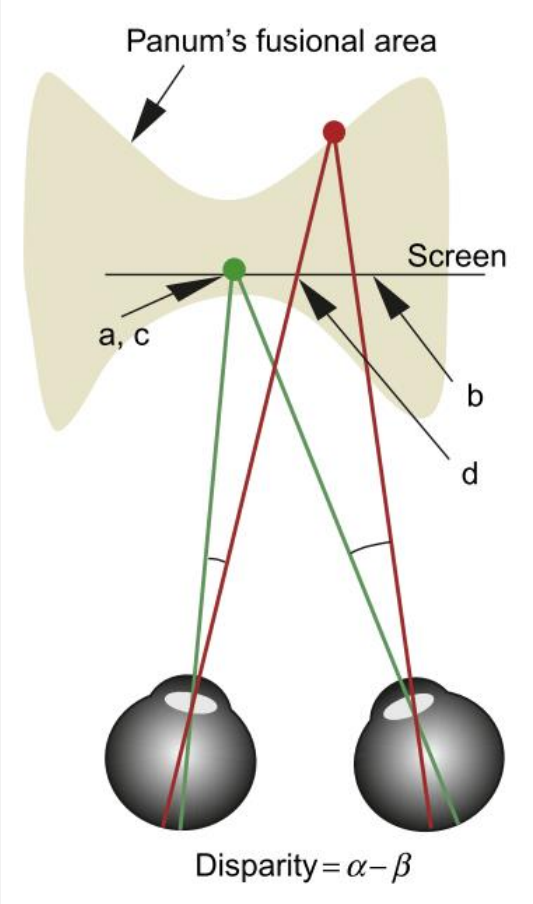
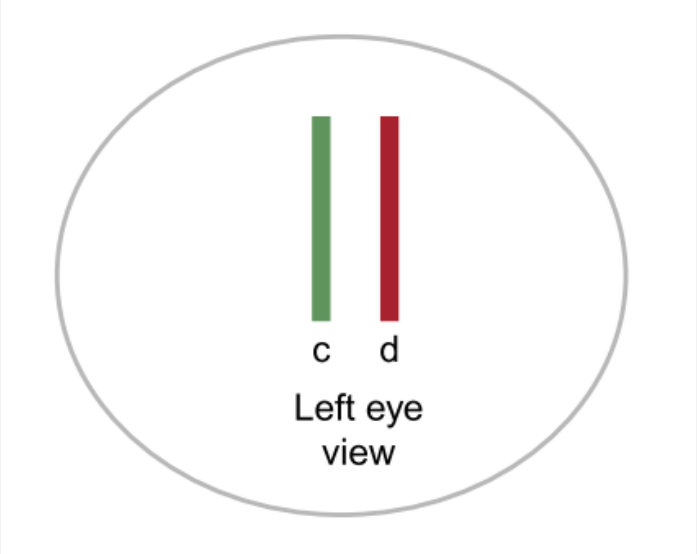


# KINETIC DEPTH

“[3D objects] can change shape by rotating or turning in space. If an object can rotate, there must be a third dimension that allows the rotation to occur,” (Block, 2008).



# STEREOPSIS



# STEREOPSIS: FRAME CANCELLATION





# CONCLUSIONS

- We store space information for navigation in long term memory.
- Perspective is a powerful depth cue, but may not aid search.
- Some depth cues need motion or two (equally strong) eyes to work.
- Conflicting cues can interfere with a depth profile – Keep it simple!



***Thank you***