Visualization for Data Science
Perception 4 Design I

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Learning Outcomes

- Differentiate between sensory and arbitrary aspects of representations and describe their characteristics
- Differentiate between cognition and perception
- List the three main stages of visual information processing
- Describe the human vision system and its limitations by contrasting with cameras and by using examples
- Discuss the implications that sensory and arbitrary aspects of representations may have on visualization design
- Describe Change and Inattentional blindness

Sensory vs. Arbitrary Symbols

- Sensory symbols: aspects of representation that derive their **expressive power** from their ability to use the perceptual processing power of the brain **without learning**.
- *Arbitrary symbols:* aspects of representation that must be learned, because the representations have no perceptual basis.

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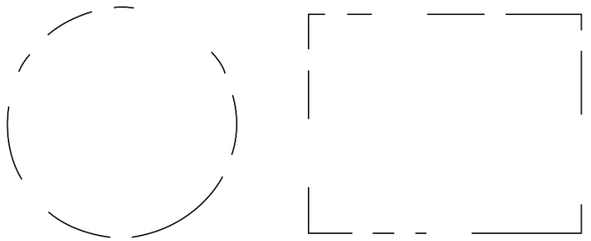
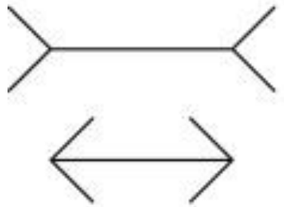
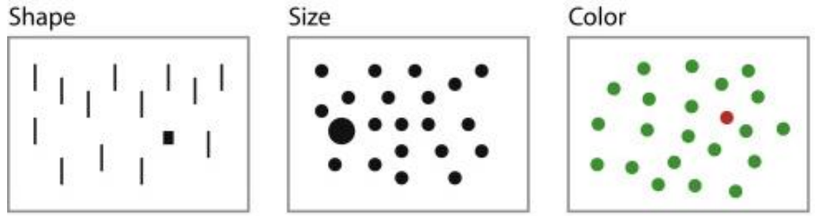
Properties of Sensory Representations



- Understanding without training
- Resistance to alternation denotation
- Sensory immediacy
- Cross-cultural validity

one to one





Design Tip: *Design by taking into account human sensory capabilities in such a way that important data elements and data patterns can be quickly perceived (more in Gestalt)*

Properties of Arbitrary Symbols

- Hard to learn
- Easy to forget
- Embedded in culture and applications

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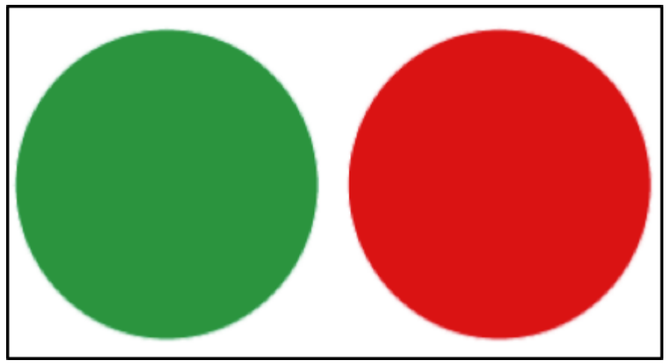


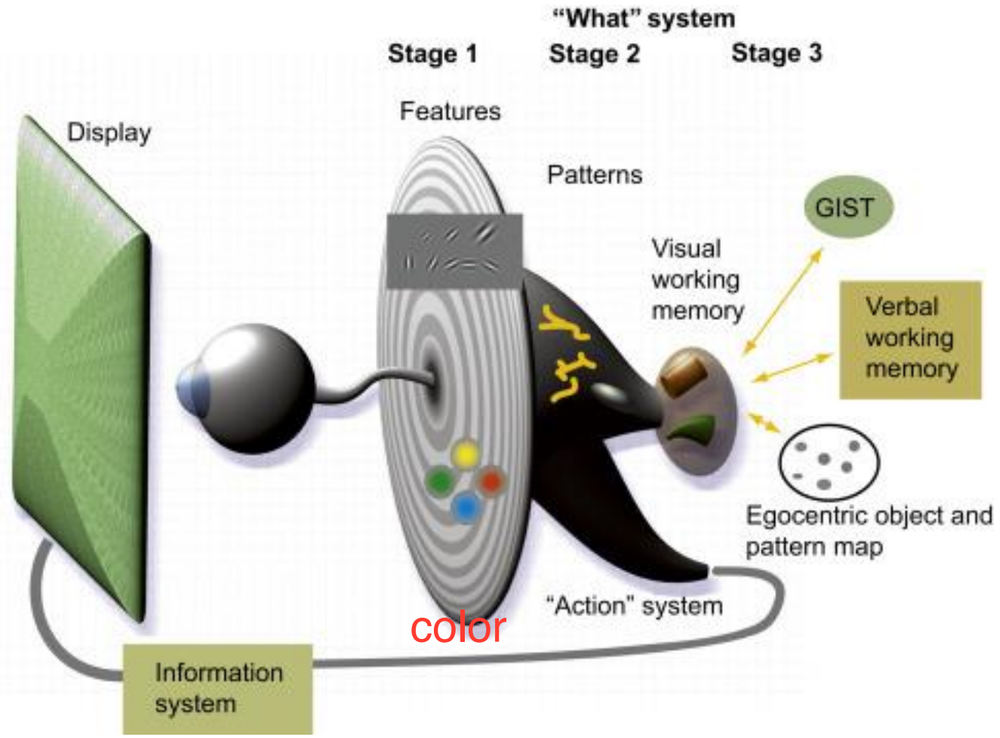
Simplified Visual Information Processing

- Parallel Processing to Extract Low-Level Properties of the Visual Scene – billions of neurons working in parallel

- Pattern Perception: visual field is broken down into regions and simple patterns.

- Visual Cognition: information is reduced to only a few objects held in visual working memory by active mechanisms of **attention**

key part



Perception

from the physical stimulus to recognizing information, this includes identification and interpretation of sensory information

shaped by learning, memory, expectation

typically not conscious and reflexive

e.g. Hear someone speak

color

Cognition

the processing of information, applying knowledge

Recognizing objects (e.g. chair), relationships between objects (water bottle on table)

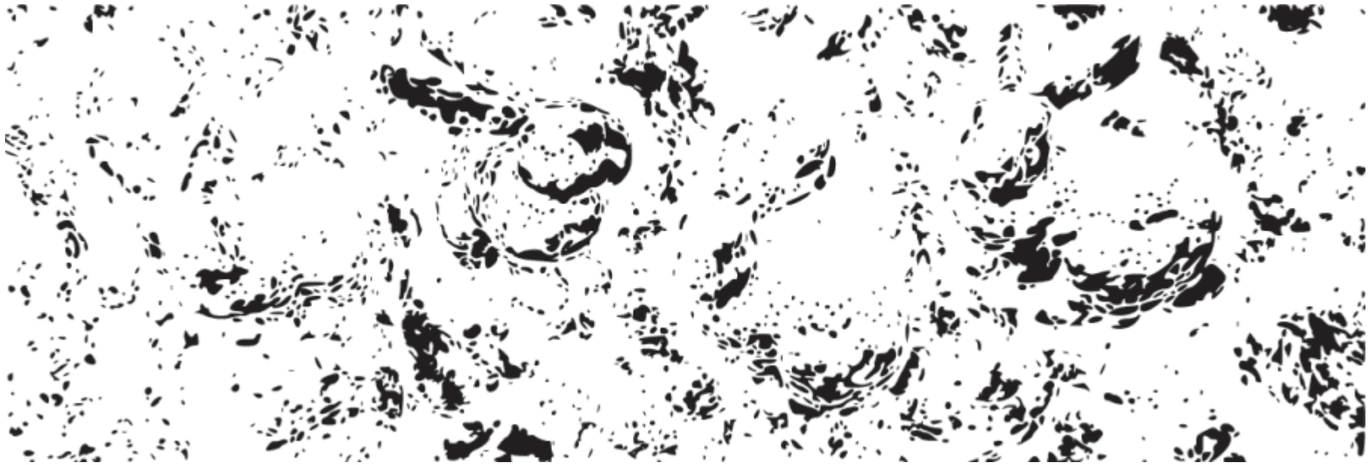
Precipitated by higher-level cognitive activities: drawing conclusions, forming hypotheses, problem solving, learning,

e.g., Understand the language and the words

word

RED	GREEN	BLUE	YELLOW	PINK
ORANGE	BLUE	GREEN	BLUE	WHITE
GREEN	YELLOW	ORANGE	BLUE	WHITE
BROWN	RED	BLUE	YELLOW	GREEN
PINK	YELLOW	GREEN	BLUE	RED

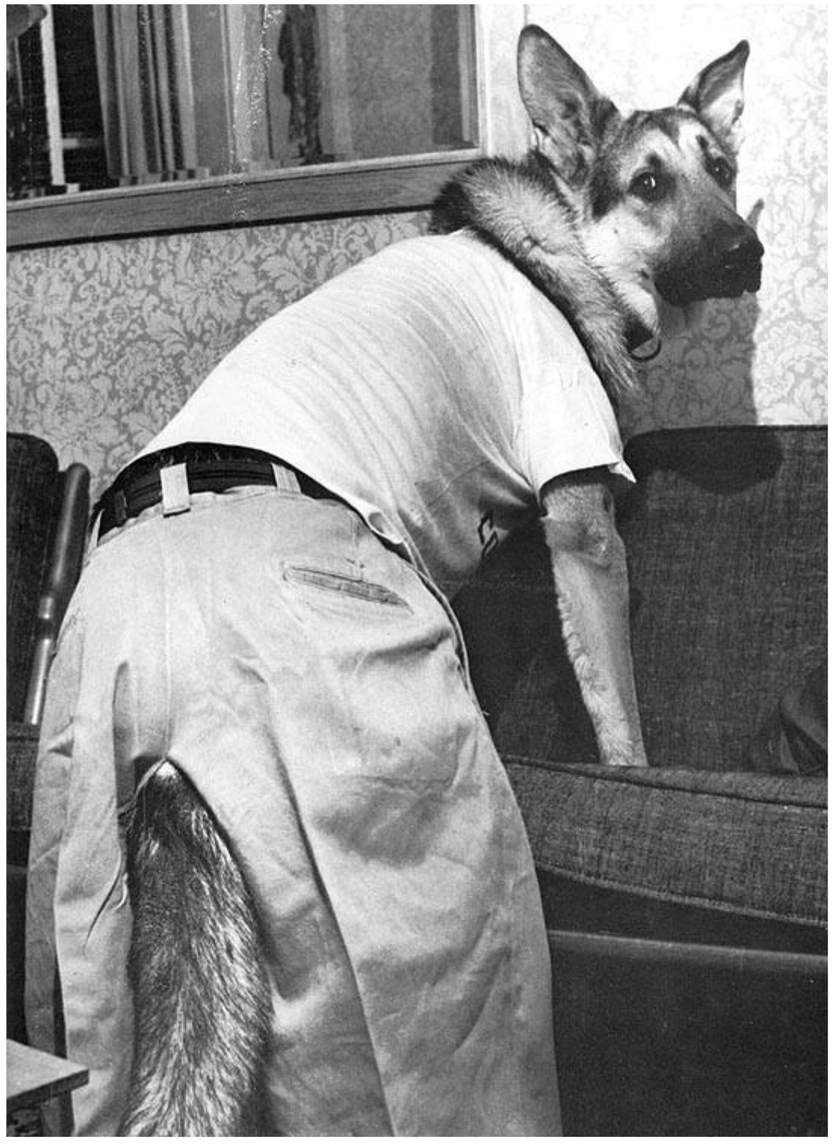
Emergence



http://graphics.stanford.edu/~niloy/research/emergence/emergence_image_siga_09.html

Our perception is based on priors

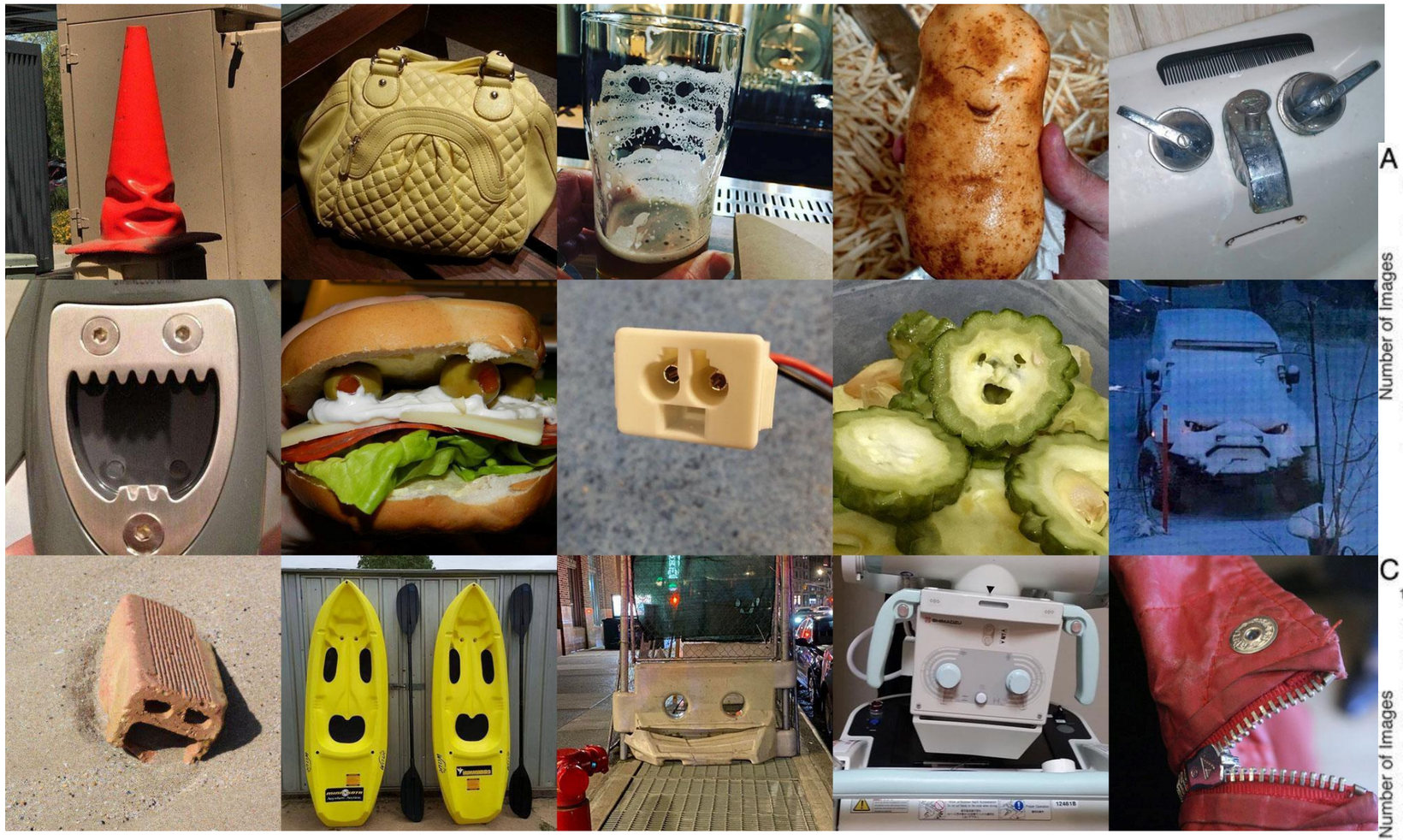
- We have a model of the world
- We try to fit what we see into this model.
- We get confused if something we see does not fit our priors *(resistance to expectation)*

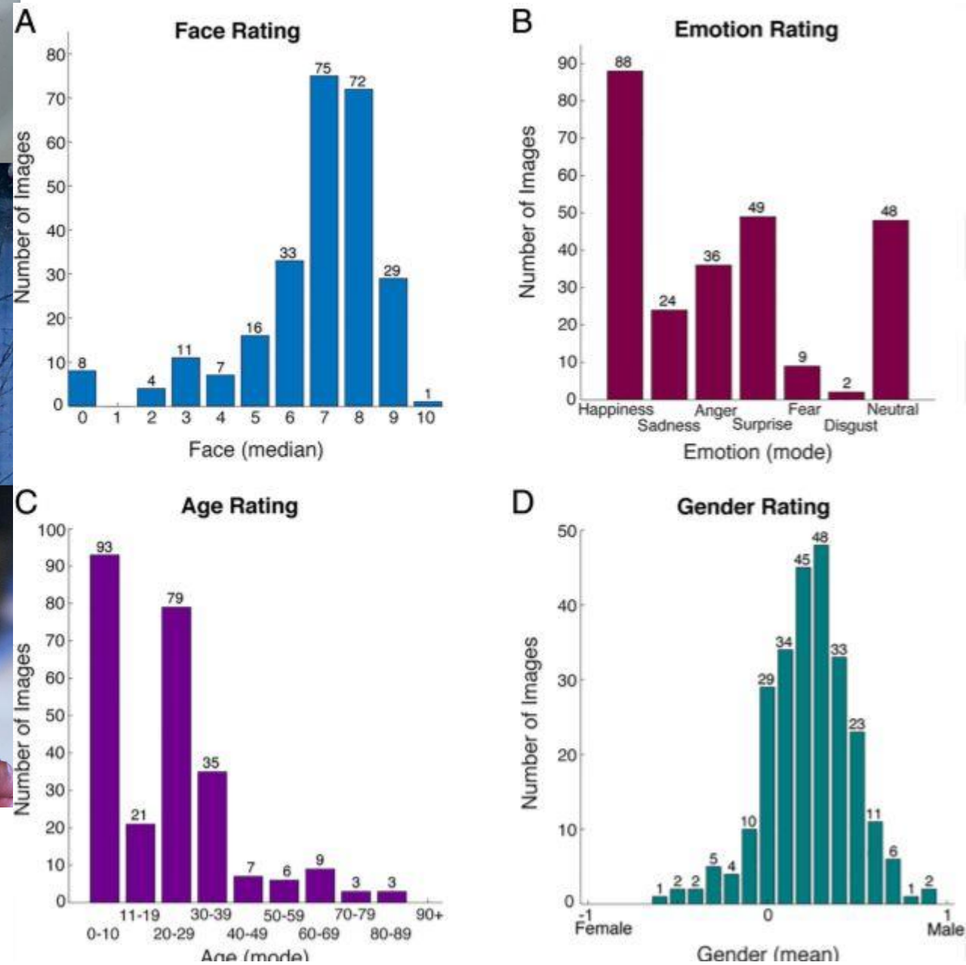



dribbleglass.com

Pareidolia

see but there not





https://www.sciencealert.com/turns-out-our-brains-perceive-the-faces-of-pareidolia-with-an-unfortunate-side-of-gender-bias

Vision is “constructed” and dynamic

*“What you see when you see a thing depends on what the thing **is**. What you see the thing **as** depends on what you **know** about what you are seeing.”*

Zenon Pylyshyn
Canadian Cognitive Scientist and Philosopher

*“What we **perceive** is more a **property** of what we are doing and what **problems** we are trying to solve **than** what is **actually** coming in through our **eyes**”*

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Professor at University of New Hampshire
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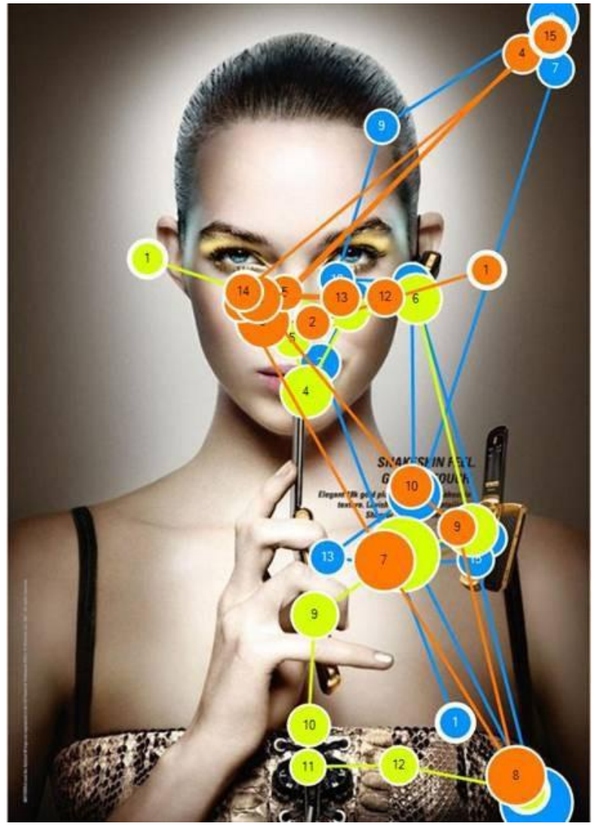
Human Visual System

Vision works as sequence of fixations and saccades

fixations: maintaining gaze on single location (200-600 ms)

saccades: moving between different locations (20-100 ms)



face first

Vision not similar to a camera

More similar to a dynamic and
ongoing construction project

Ames Room

https://www.youtube.com/watch?v=hCV2Ba5wrcs

https://www.youtube.com/watch?v=gJhyu6nlGt8

Human Visual System

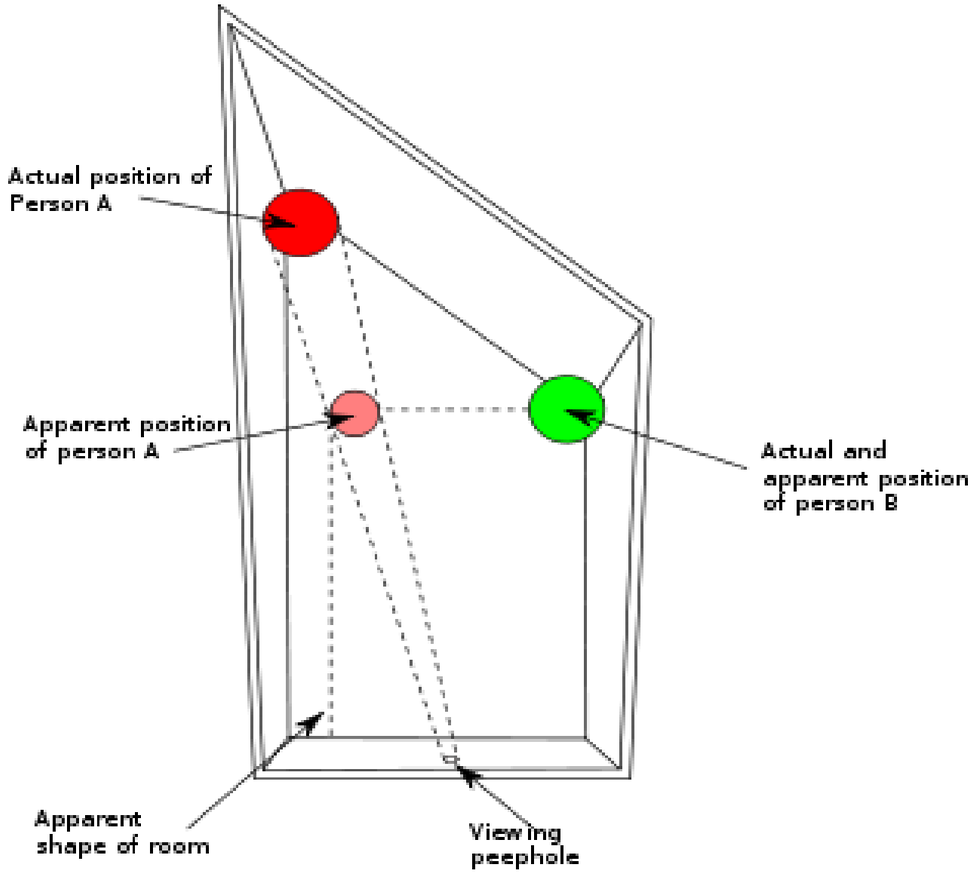
No general purpose vision

What we see depends on our goals and expectations

Relative judgments: strong

Absolute judgments: weak

Ames Room



Change Blindness

An interruption in what is being seen renders us “blind” to significant changes that occur in the scene during the interruption.

- Details of an image cannot be remembered across separate scenes except in areas with focused attention
- Interruption (e.g. a blink, eye saccade or blank screen) amplifies this effect
- Not failure of vision system
- failure due to inappropriate **attentional** guidance

https://www.csc2.ncsu.edu/faculty/healey/PP/movies/Airplane.gif

https://www.csc2.ncsu.edu/faculty/healey/PP/movies/Dinner.gif

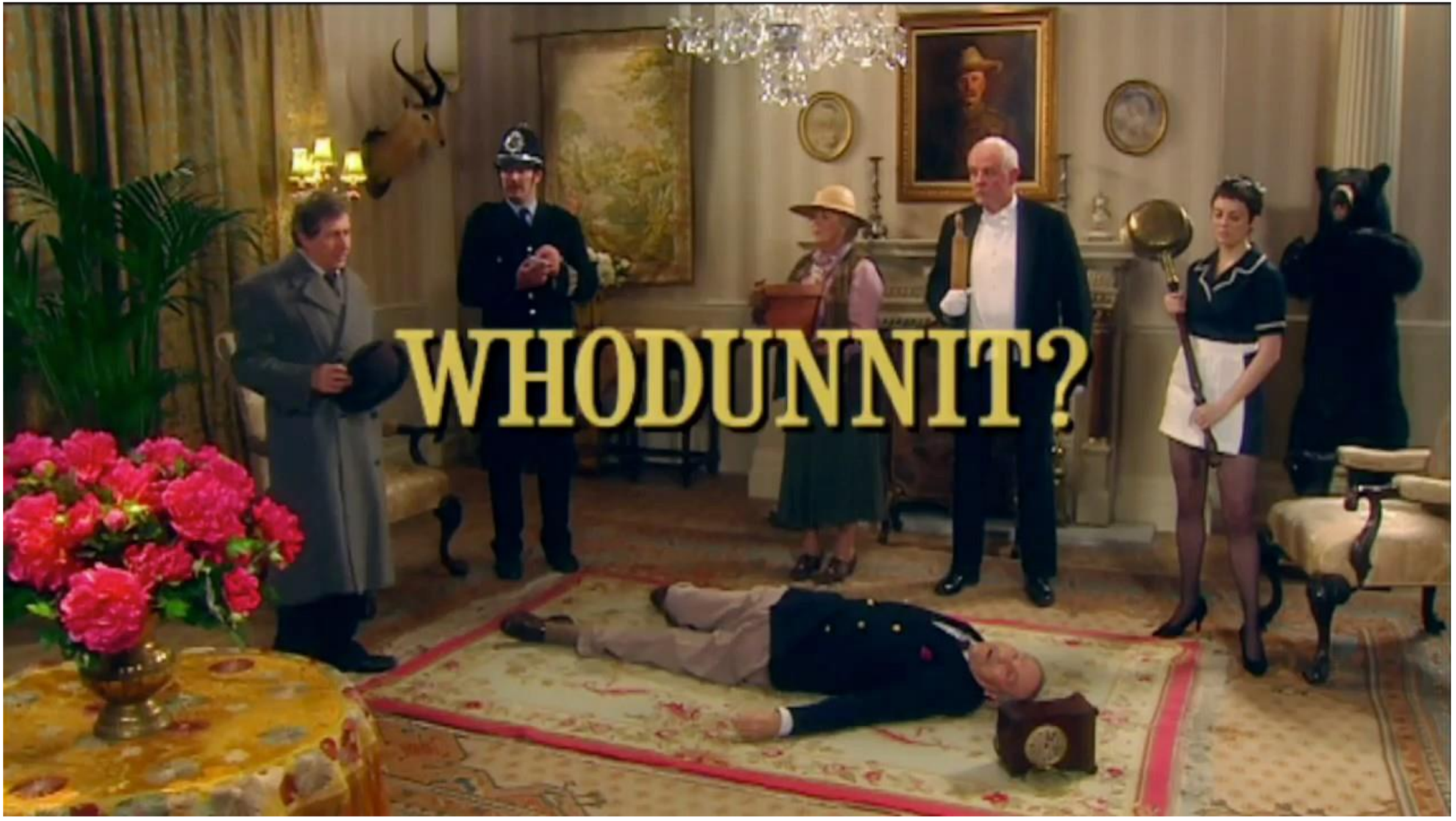
https://www.csc2.ncsu.edu/faculty/healey/PP/movies/Harborside.gif

Causes of Change Blindness Theories

- Overwriting: the blank screen overwrites the image so information that was not abstracted from it is lost
- First Impression: initial view is abstracted, if scene is not perceived to have changed, then features of the scene should not need to be re-encoded
- Nothing is Stored: there is no internal representation of the details, only abstract concepts are committed to memory. If we need something specific we go back to the image.
- Everything is Stored, Nothing is Compared: we compare only when we are forced to (e.g. asked a question)
- Feature Combination: details across views are combined to form one holistic representation of the scene (as long as they make sense)
- Emerging Theories– attention is required to detect changes, changes that are unexpected can be missed. Changes to semantically important objects are detected faster than changes elsewhere.

(In)Attentional Blindness

- Sometimes called perceptual blindness
- Occurs when a person fails to perceive an unexpected stimulus in plain sight, primarily because their attention is on something else and/or it is impossible to focus on all the stimuli in the scene.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Take Home Points

- To find meaning in what we see **we must selectively pay attention** to what is important
- Low-level vision is driven by object features rather than a conscious effort where to look (e.g., pre-attentive processing)
- Attention is driven by preexisting knowledge, expectations, and goals stored in long-term memory

https://www.youtube.com/watch?v=VkrrVozZR2c

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Next on Viz

- Work through Tooling Tutorial 4 before Wednesday

https://pages.github.ubc.ca/kemiola/DSCI320-22W2/lectures/4_Channels_n_Marks.html

- Assignment 1 will be posted on Wednesday – due a week from then.