

# Perception

Cognitive Processes

Assoc. Prof. Atanas Kirjakovski

# Grading System

## Course Evaluation

Term	Percentage
Attendance	15%
Mid-term	35%
Final	40%
In-class Project Presentation	10%
Penalty Exam I	100%
Penalty Exam II	100%
MakeUp	40%

### Exams

- ▶ Includes mid-term, final, makeup, excuse, upgrade, and penalty exams.

**Mid-term Exam:** Covers course content taught before the exam.

**Final Exam:** Covers all course content from the entire semester.

**Make-up Exam:** Equivalent to the final exam, replaces final exam results.

**Excuse Exam:** For students who missed mid-terms due to documented reasons.

**Upgrade Exam:** For students with final grades between 30.00 and 49.99, applicable to two courses per semester.

**Penalty Exam:** Extra exam for students who fail a course and need to retake it.

- ▶ Special provisions are available for graduating students, those with disabilities, and students needing to retake failed courses.

### Grading

- ▶ Based on semester activities, midterm, and final exams.
- ▶ Minimum 40 points from final exam required to pass a course.
- ▶ Minimum 50 points from all required to pass a course.

### Grade Announcements

- ▶ Grades are entered into the HELLO system and can be appealed within 48 hours.
- ▶ Students can object the grades via online tool in 48 hours after the grades are announced.

# Grade Calculation

	Percent	Hypothetical Points	Subtotal Points
<b>Attendance</b>	15%	100	15
<b>Midterm</b>	35%	60	21
<b>Final</b>	40%	72	28.8
<b>In-class</b>	10%	40	4
		<b>Total</b>	<b>68.8</b>

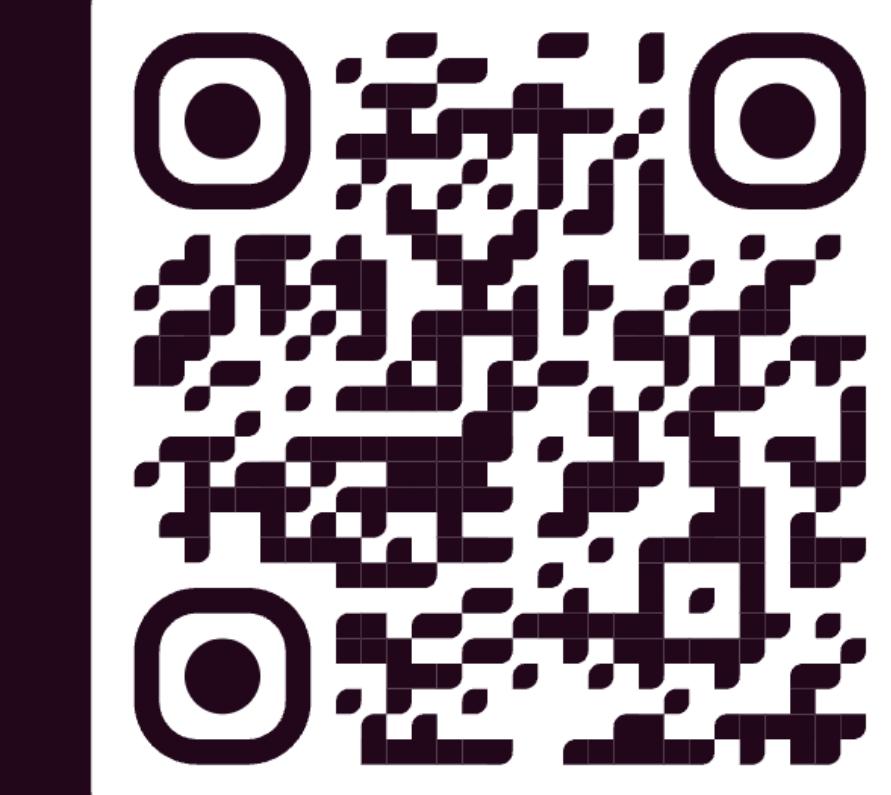
# <https://ibu.kirjakovski.mk>

## PROF. KIRJAKOVSKI IBU BLOG

### 2021

- |        |   |  |
|--------|---|--|
| Jun 12 | MAKE-UP EXAM: Computer Aided Education                  | <a href="#">Computer<br/>Aided<br/>Education<br/>(2020/2021)</a> |
| Jun 04 | IMPORTANT: Repeated Final Exam for Some Students        | <a href="#">Social<br/>Psychology<br/>(2020/2021)</a>            |
| May 24 | LECTURE 11: Organizational Theory, Dynamics, and Change | <a href="#">Organizational<br/>Psychology<br/>(2020/2021)</a>    |
| May 20 | COURSE EVALUATION: Organizational Psychology            | <a href="#">Organizational<br/>Psychology<br/>(2020/2021)</a>    |
| May 20 | FINAL EXAM: Computer Aided Education                    | <a href="#">Computer<br/>Aided<br/>Education<br/>(2020/2021)</a> |

SCAN ME



DO NOT RE-UPLOAD  
THE CONTENT!

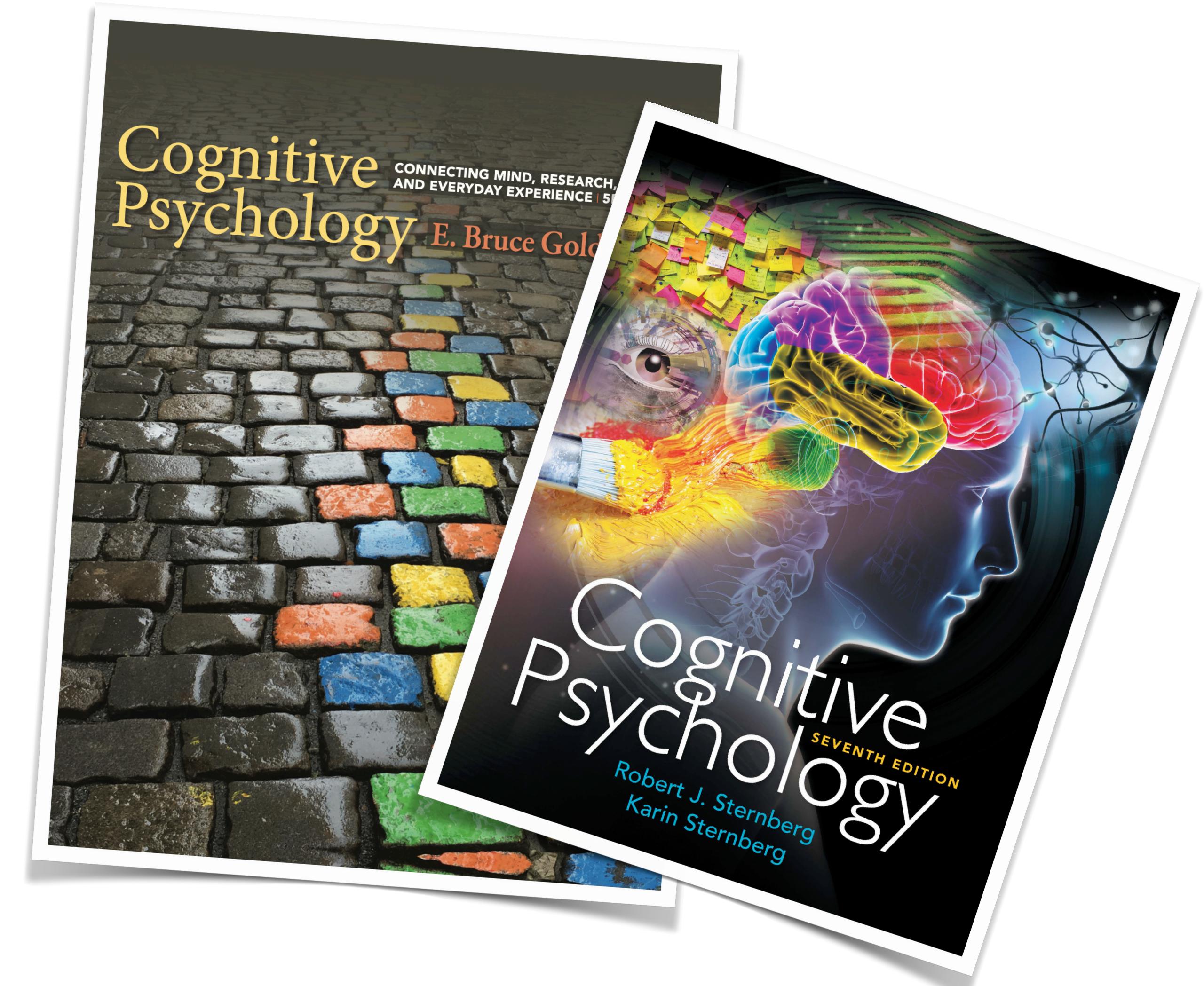
# Academic Calendar

- 1 Oct 2025, Week 1  
**INTRODUCTION TO COGNITIVE PSYCHOLOGY**
- 8 Oct 2025, Week 2  
**COGNITIVE NEUROSCIENCE**
- 15 Oct 2025, Week 3  
**PERCEPTION**
- 22 Oct 2025, Week 4  
**ATTENTION**
- 29 Oct 2025, Week 5  
**MEMORY**
- 5 Nov 2025, Week 6  
**CONCEPTUAL KNOWLEDGE**
- **MIDTERM EXAMS (10–15 NOV 2025)**
- **EXCUSE EXAMS (24–28 NOV 2025)**
- 19 Nov 2025, Week 7  
**VISUAL IMAGERY**
- 26 Nov 2025, Week 8  
**LANGUAGE**
- 3 Dec 2025, Week 9  
**PROBLEM SOLVING & CREATIVITY**
- 10 Dec 2025, Week 10  
**JUDGMENT, DECISIONS, AND REASONING**
- 17 Dec 2025, Week 11  
**HUMAN INTELLIGENCE**
- 24 Dec 2025, Week 12  
**COGNITIVE DISORDERS (+ REVIEW)**
- **WINTER BREAK (31 DEC 2025 – 9 JAN 2026)**
- **FINAL EXAMS (12–17 JANUARY 2026)**
- **MAKEUP EXAMS (19–24 JAN 2026)**

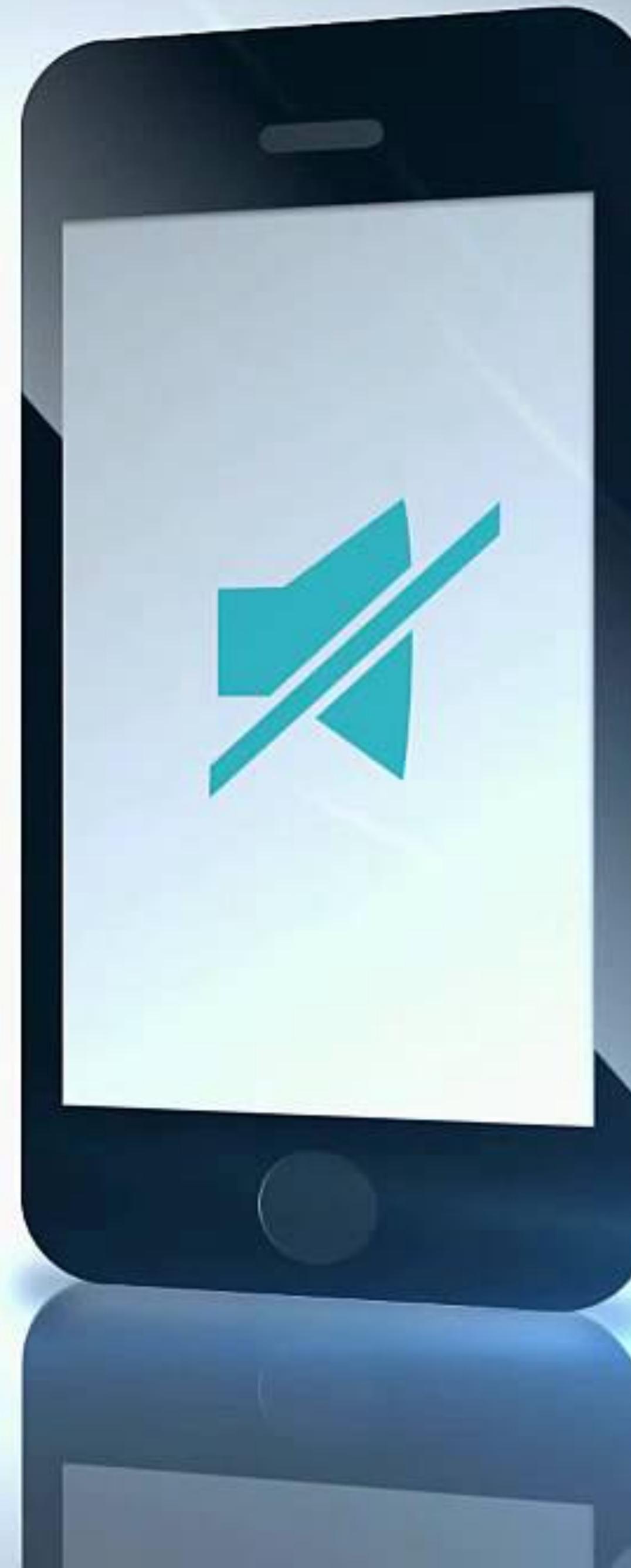
# Study Materials

**Main text:** Goldstein, E. B. (2019). Cognitive psychology: Connecting mind, research, and everyday experience (5th ed.). Cengage Learning.

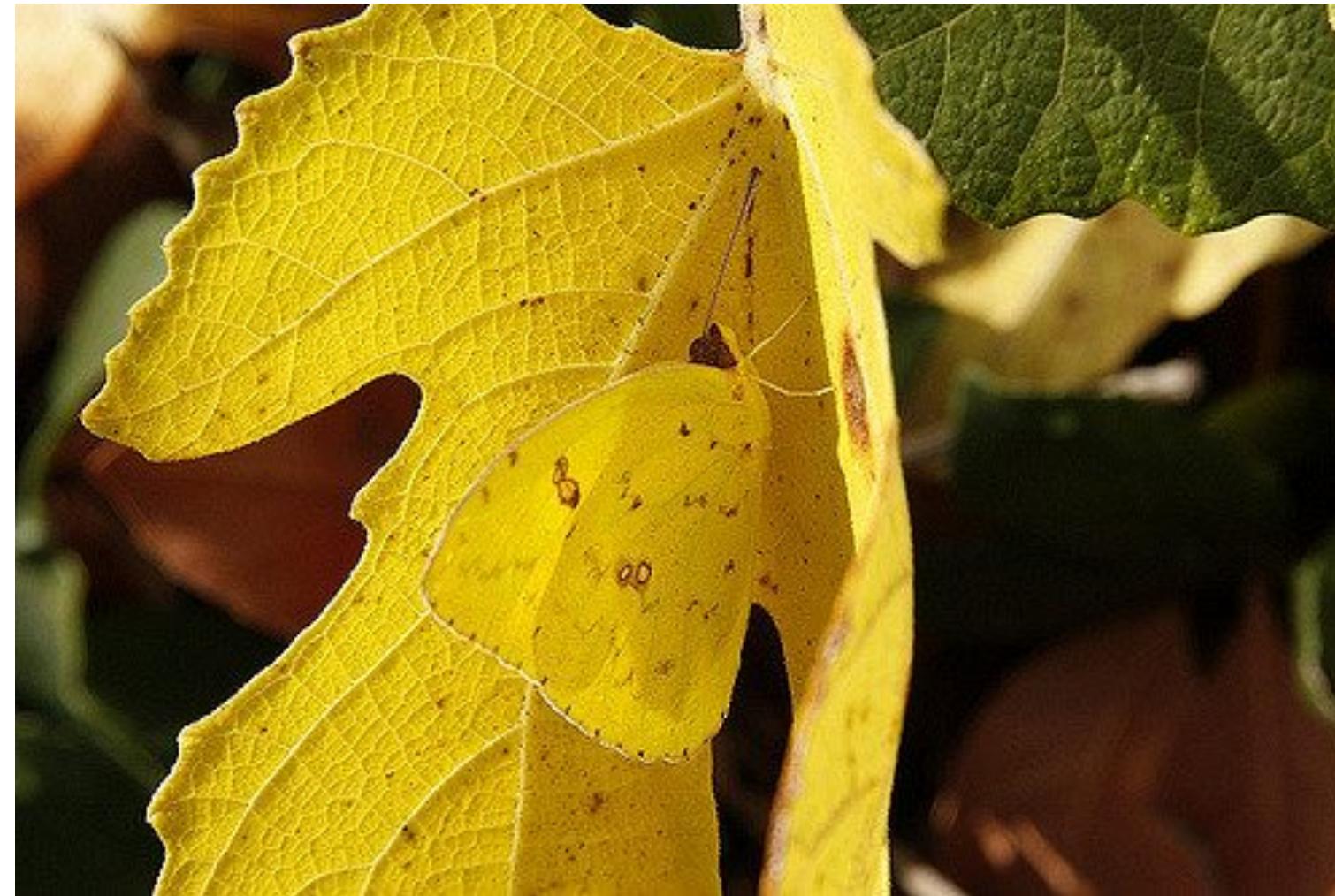
**Supplementary text:** Sternberg, R. J., & Sternberg, K. (2017). Cognitive psychology (7th ed.). Cengage Learning.



**PLEASE  
SILENCE  
YOUR PHONE**



# What Do You See?



# What Do You See?



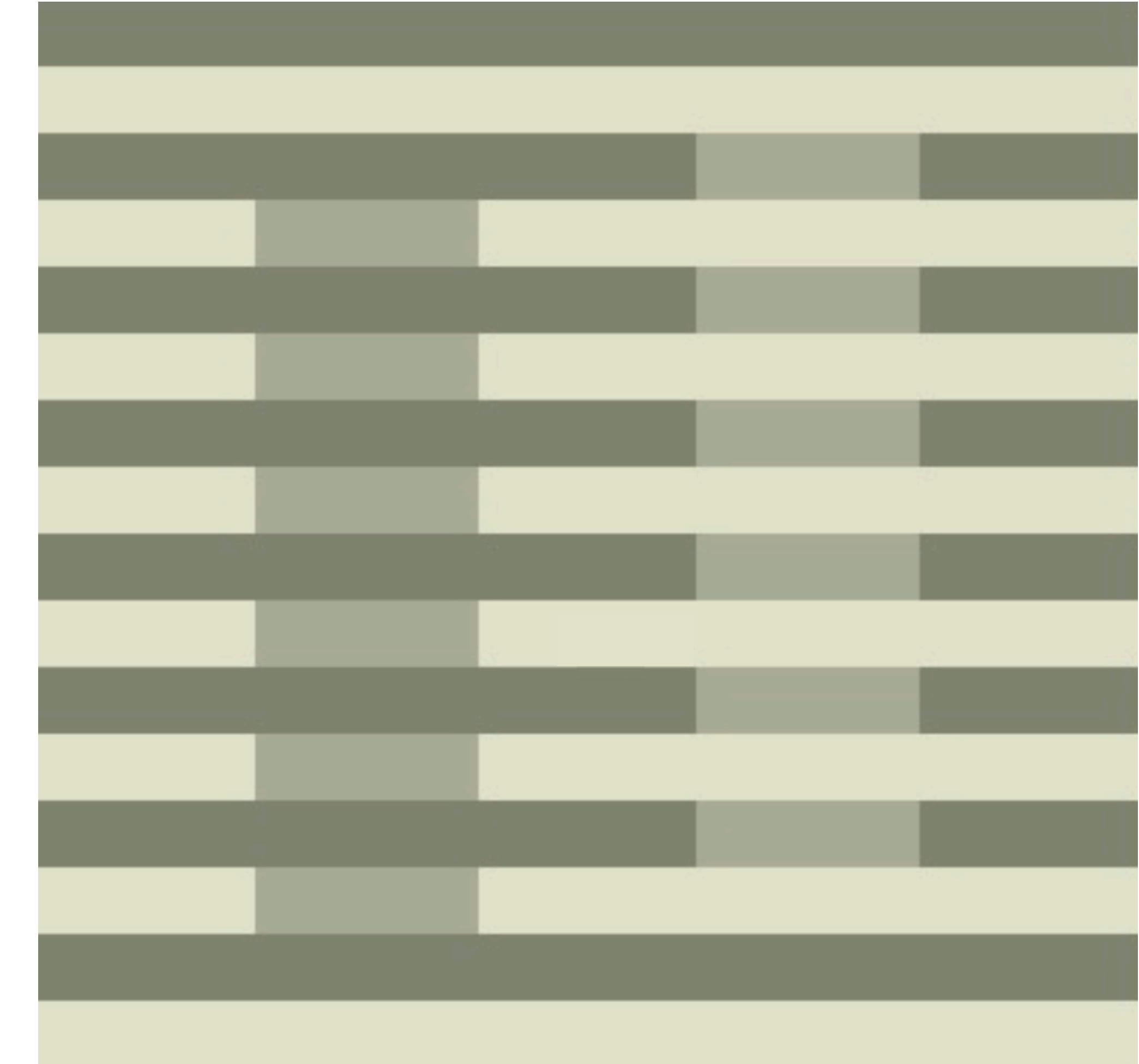
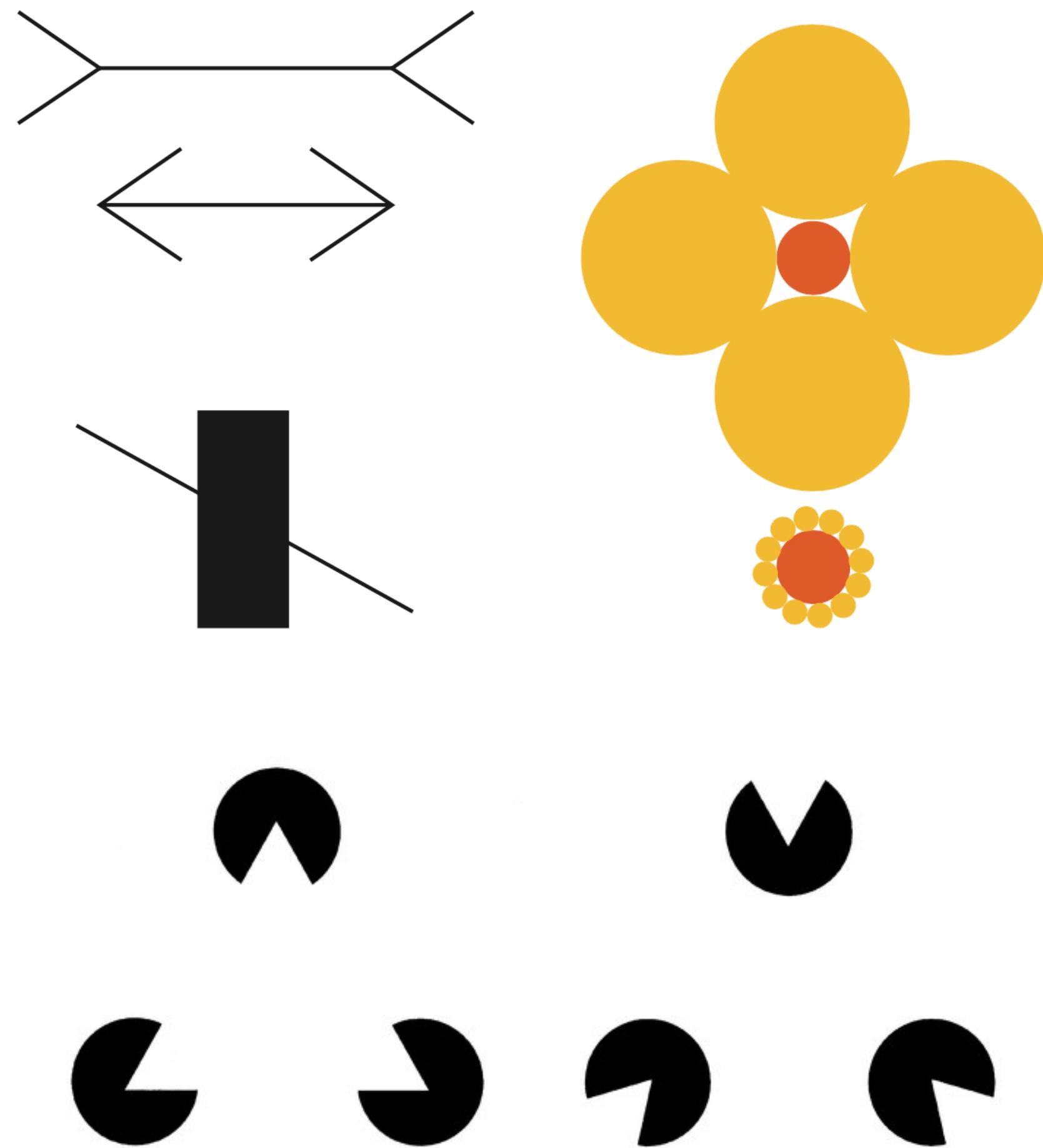
Why these animals evolved in this way?

Why they make the effort to look the way they look?

# Sensation and Perception

- In order for us to be able to function and survive in the environment, we must be “aware” of it and ready to interact with it.
- **Sensation:** The result of neural responses that occur after physical energy stimulates a receptor cell (such as those at the back of the eye, in the ear, on the skin) but before the stimulus is organized and interpreted by the brain.
- **Perception:** The result of neural processes that organize (such as by specifying a particular shape) and interpret (such as by identifying the object) information conveyed by sensory signals.
- Perception involves change based on added information.

# Visual Sensation vs. Visual Perception



# Your Perception

- What is the dark area at A?
- Are the surfaces at B and C facing in the same or different directions?
- Are areas B and C on the same building or on different buildings?
- Does the building at D extend behind the one at A?

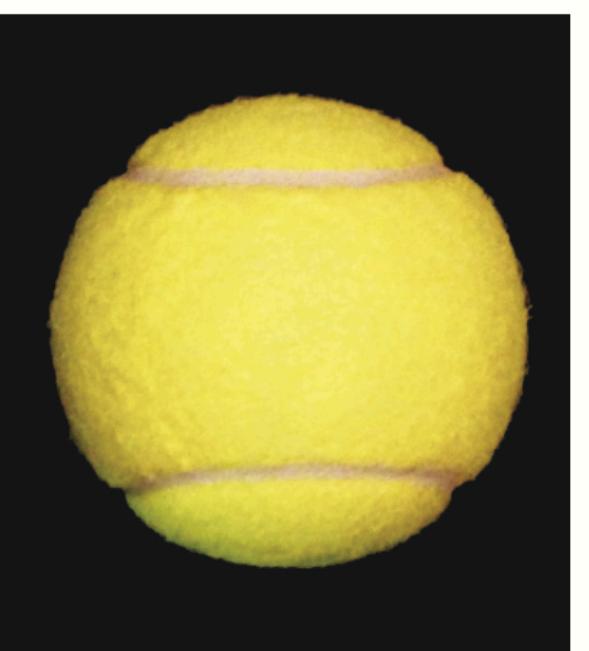


# Perceiving Machines



# Even Computer-Vision Programs Make Mistakes

“A large plane sitting on a runway”



“Tennis balls”



“A young boy holding a baseball bat”

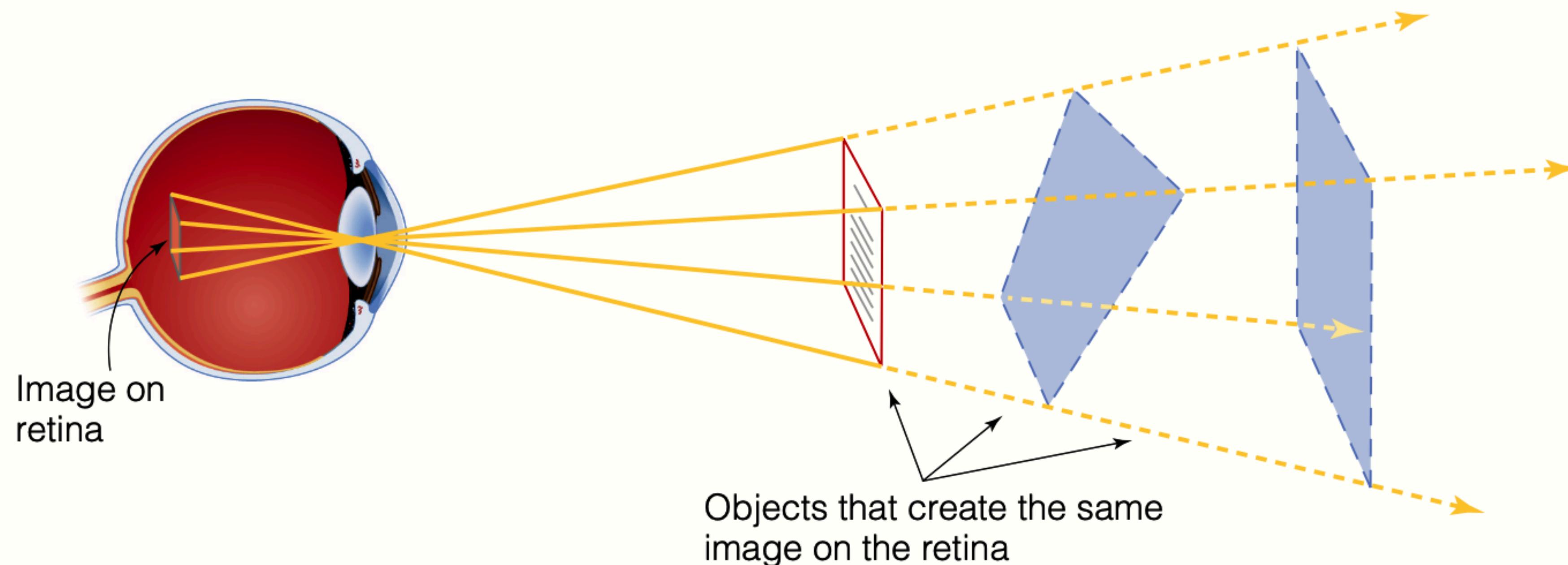
# Why Is It So Difficult to Design a Perceiving Machine?

# Why Is It So Difficult to Design a Perceiving Machine?

- The stimulus on the receptors is ambiguous.
- Objects can be hidden or blurred.
- Objects look different from different viewpoints.
- Scenes contain high-level information.

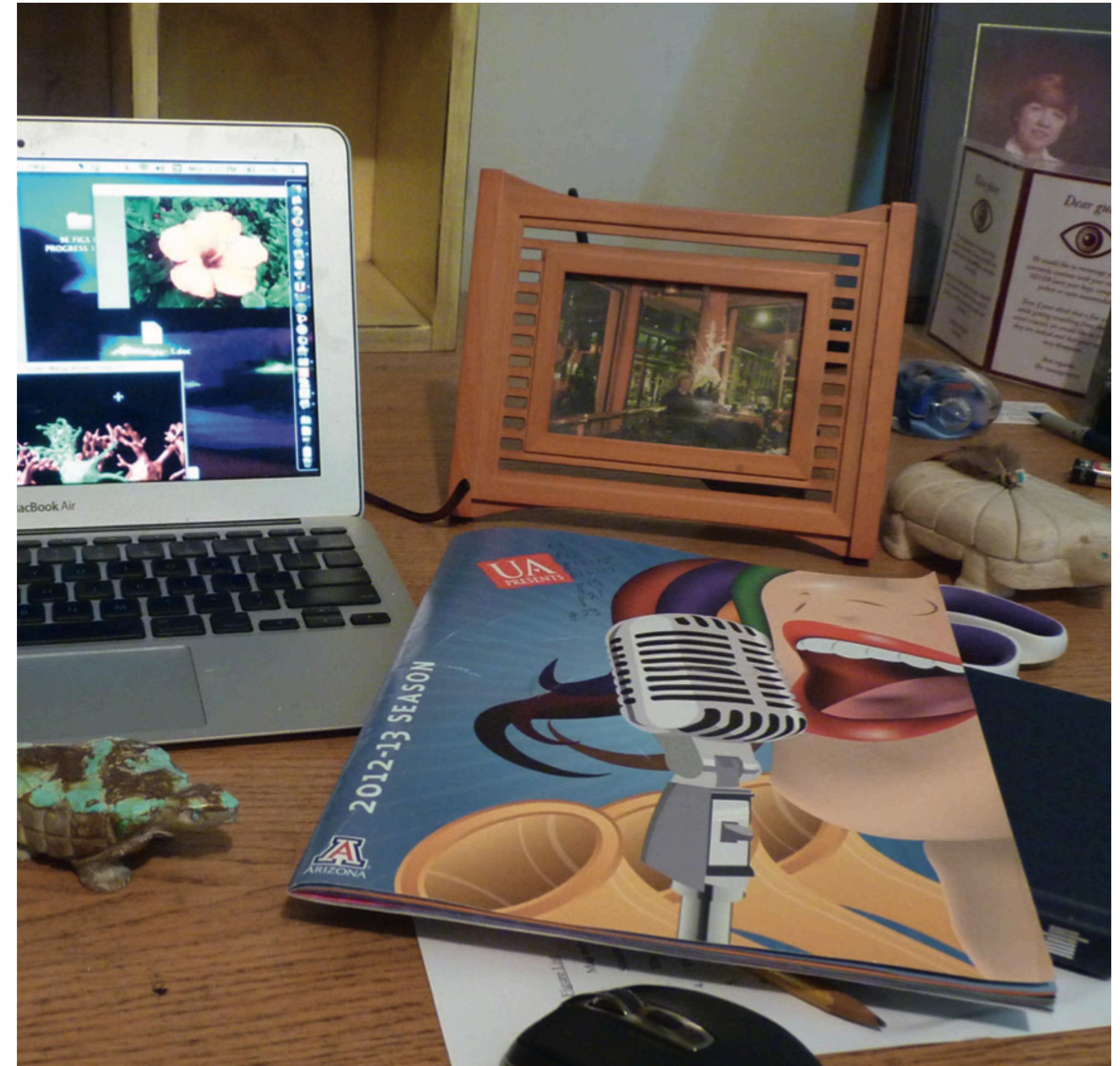
# The Stimulus on the Receptors Is Ambiguous

- Determining the object responsible for a retinal image is the **inverse projection problem**. It involves starting with the retinal image and extending eye rays. Challenges include dimensionality reduction (3D to 2D), ambiguity (multiple 3D scenes can produce similar 2D projections), and information loss (depth, orientation, and object positioning are often lost or obscured in 2D projections).

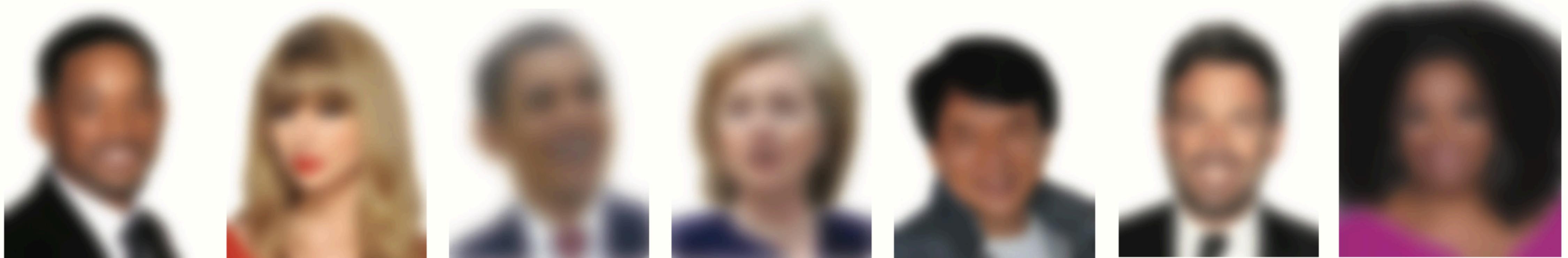


# Objects Can Be Hidden

- Find the pencil.
- Find the scissors.
- Find the glasses.



# Objects Can Be Blurred



# Objects Look Different From Different Viewpoints



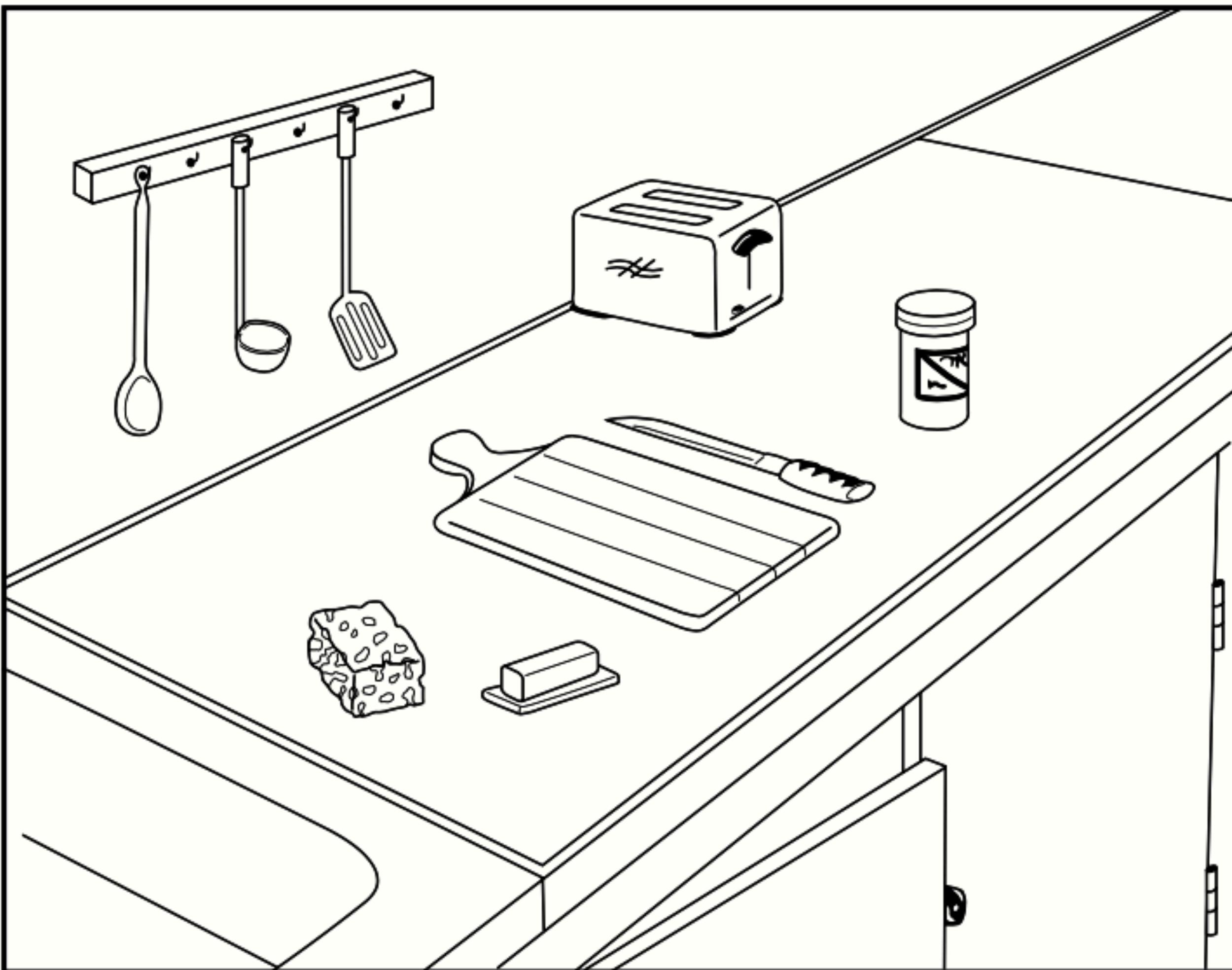
# Scenes Contain High-Level Information



# Human Perception

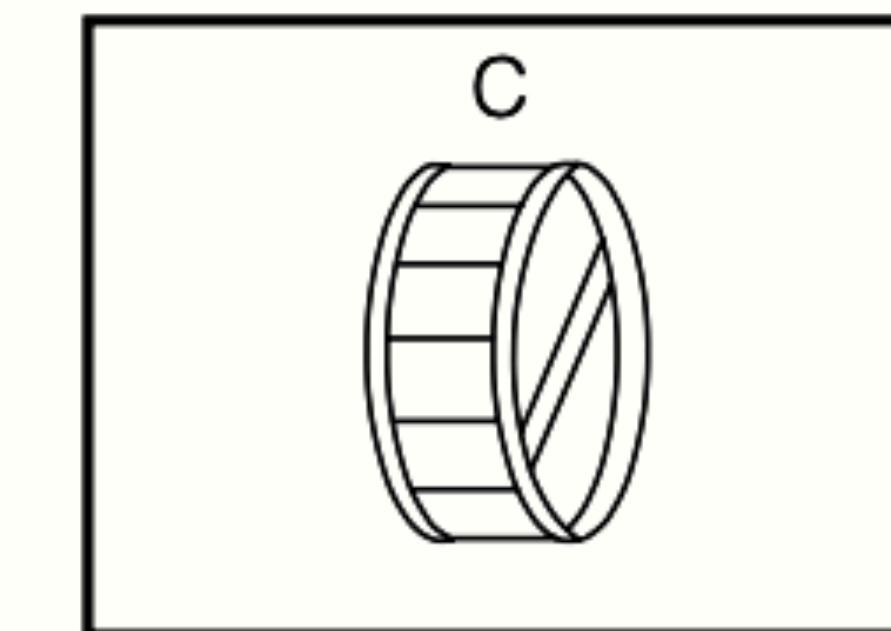
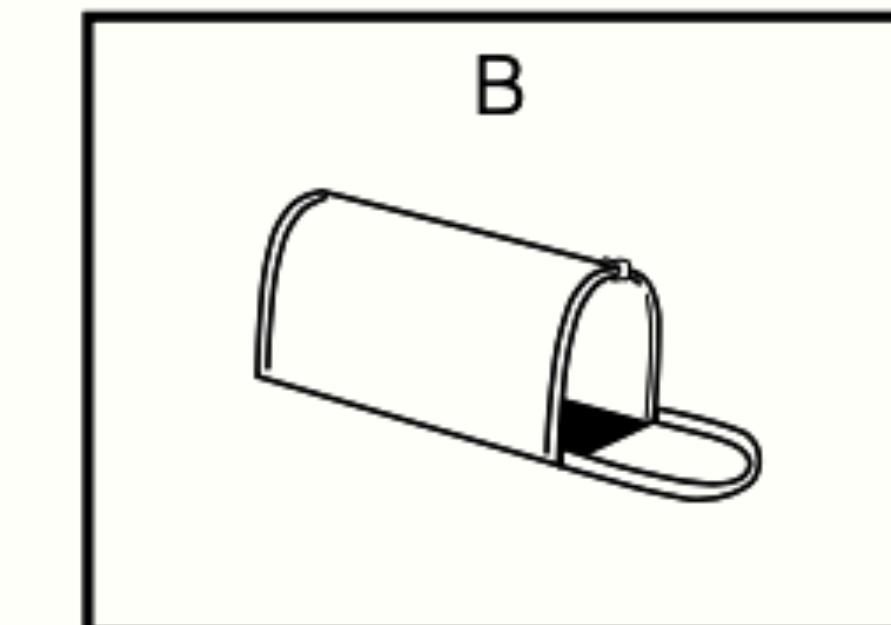
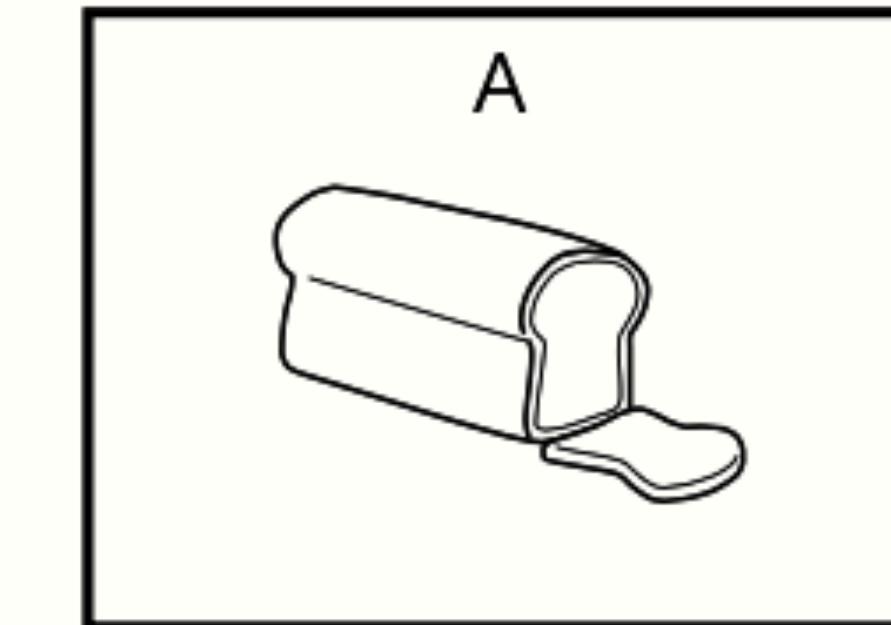
- Perception is built on a foundation of information from the environment.
- **Bottom-up processing:** Processing that is triggered by physical energy striking receptor cells.
- **Top-down processing:** Processing that is guided by knowledge, expectation, or belief.
- Top-down processing can affect the way you interpret the results from bottom-up processing.

# Top-Down Processing



(Palmer, 1975)

Context scene



Target object

# The Stroop Effect

**RED**

**BLUE**

**GREEN**

**BLACK**

**GREEN**

**BLUE**

**BLACK**

**RED**

**BLUE**

**GREEN**

**GREEN**

**RED**

**BLUE**

**BLACK**

**BLUE**

**RED**

**GREEN**

**BLACK**

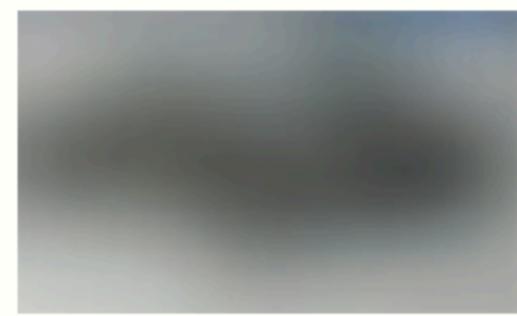
**RED**

**BLUE**

# Perceiving Objects

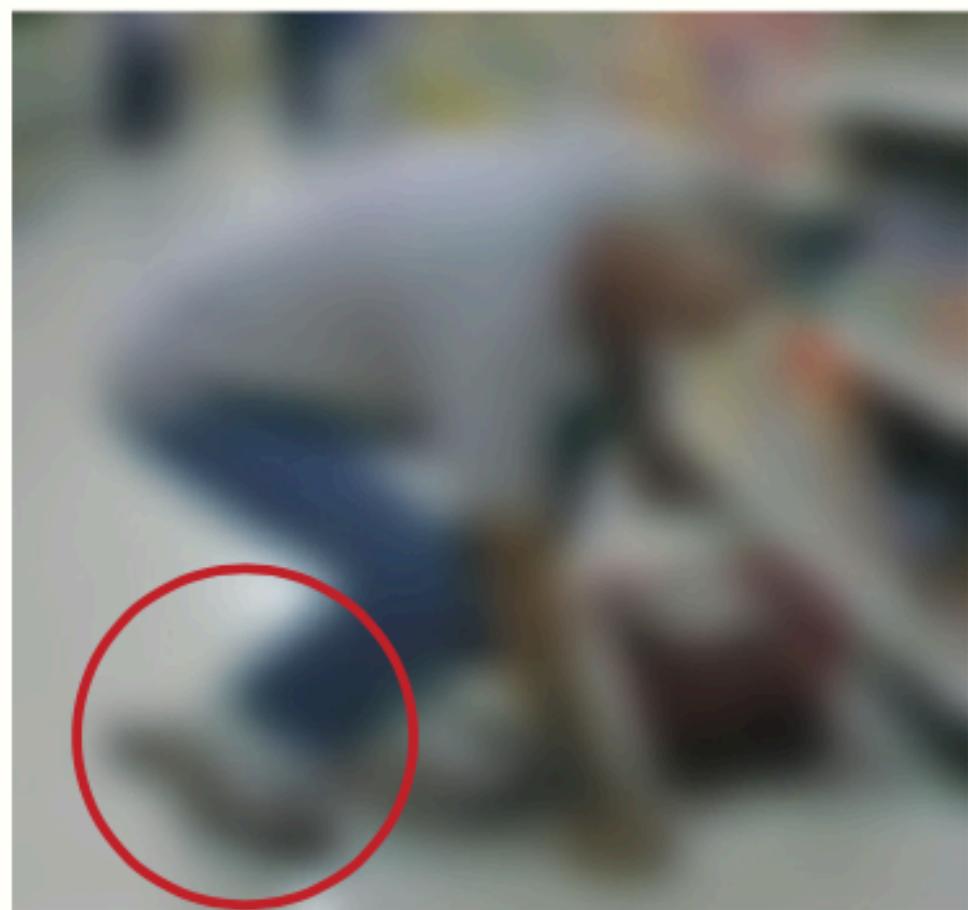
- “The multiple personalities of a blob”.
- We perceive the blob as different objects due to our knowledge of likely objects in different scenes. This top-down knowledge gives humans an advantage over computers.

(Oliva & Torralba, 2007)



blob

(b)

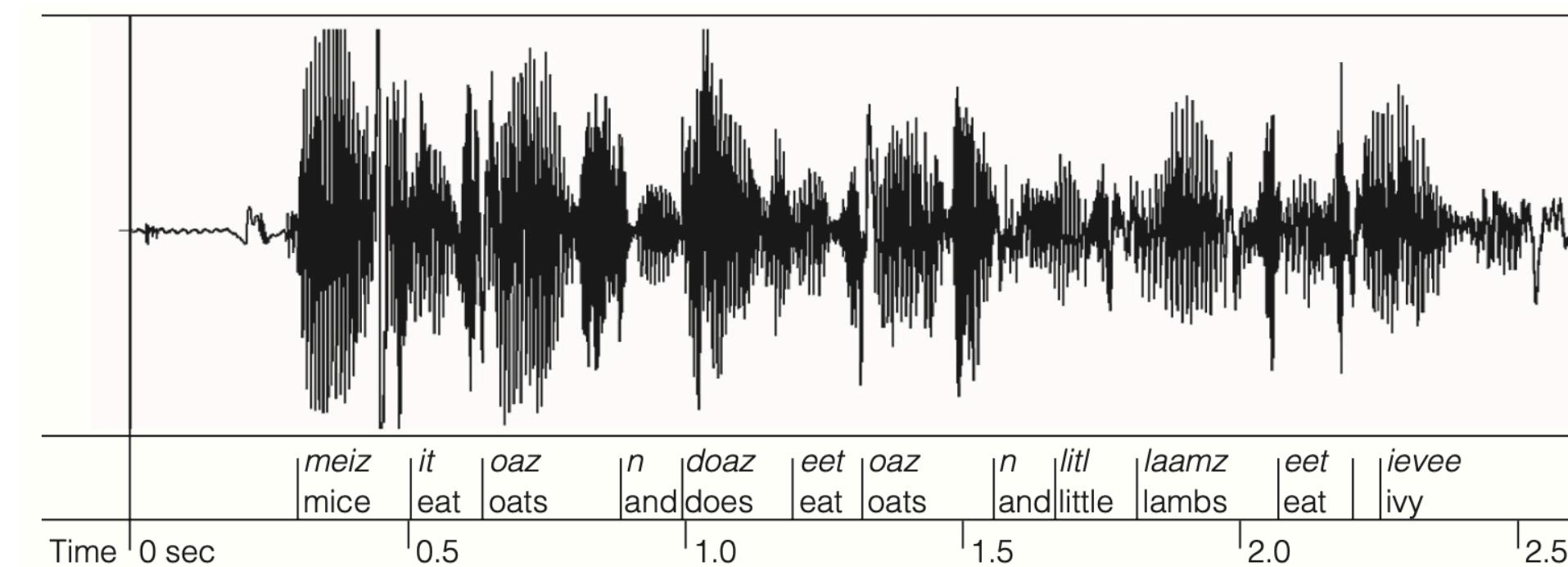


(d)



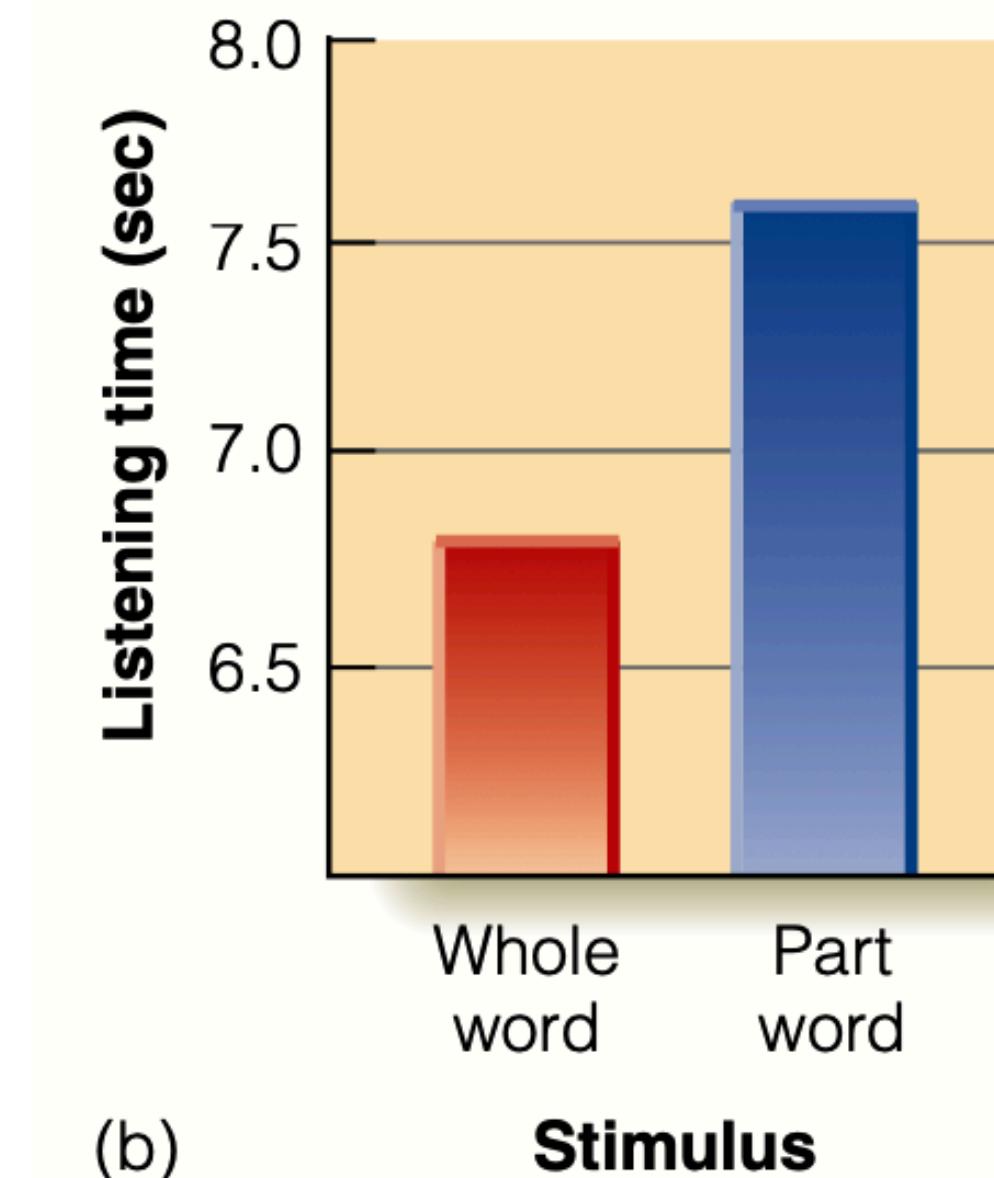
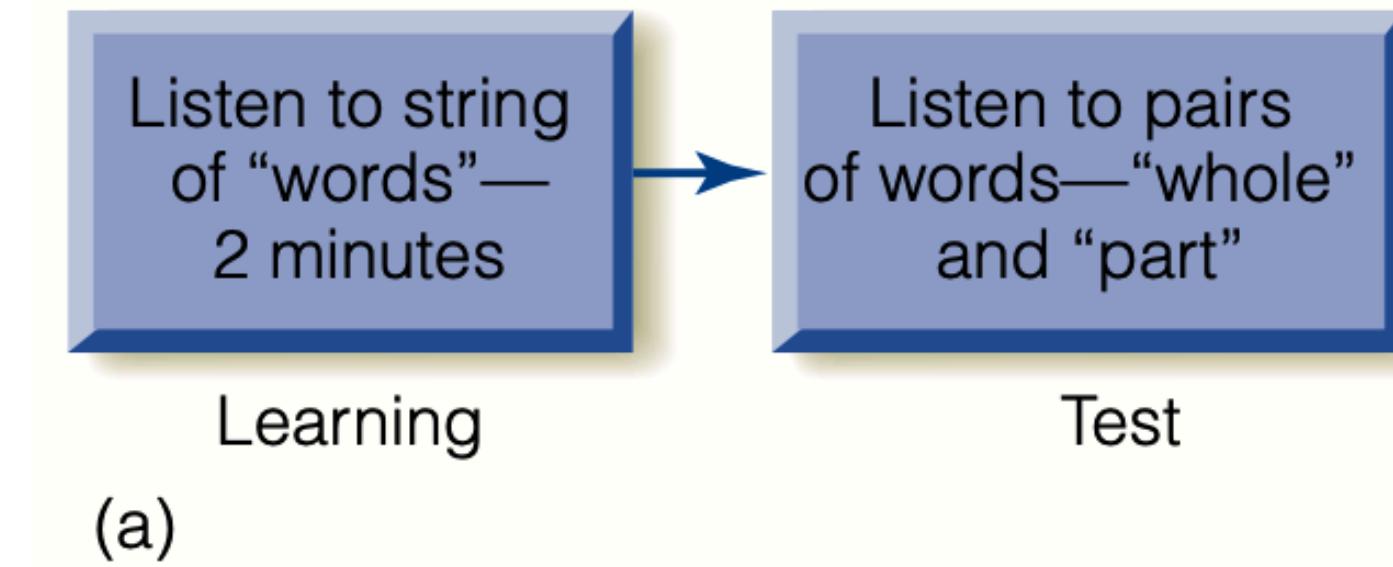
# Hearing Words in a Sentence

- How are able to understand speech?
- **Speech segmentation:** The ability to tell when one word in a conversation ends and the next one begins is a phenomenon.
- The continuous sound signal enters the ears, triggering signals sent to the speech areas of the brain (bottom-up processing). If a listener understands the language, their knowledge creates the perception of individual words (top-down processing).
- While segmentation is aided by knowing the meanings of words, listeners also use other information to achieve segmentation, like **transitional probabilities** and **statistical learning**.



# Babies Segment Speech

- **Transitional probabilities:** The likelihood that one sound will follow another within a word.
- Every language has transitional probabilities for different sounds, and the process of learning about transitional probabilities and about other characteristics of language is called **statistical learning**.
- Even babies can detect perceptual regularities in speech.
- **bidaku padotigolabutupiropadotibidaku** (Saffran and coworkers, 1996)
- For example, infants paid more attention to words like **kupado** than **padoti**.



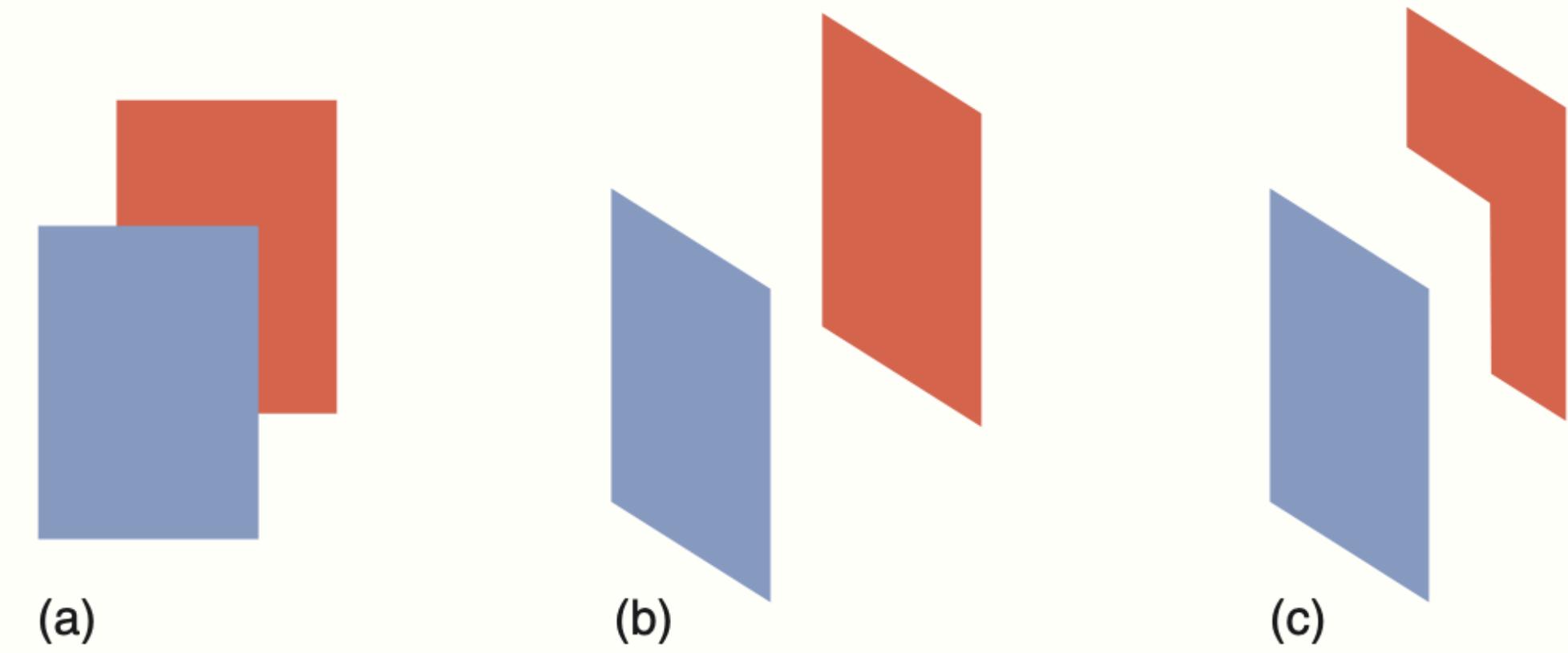
(Saffran and coworkers, 1996)

# Concepts of Object Perception

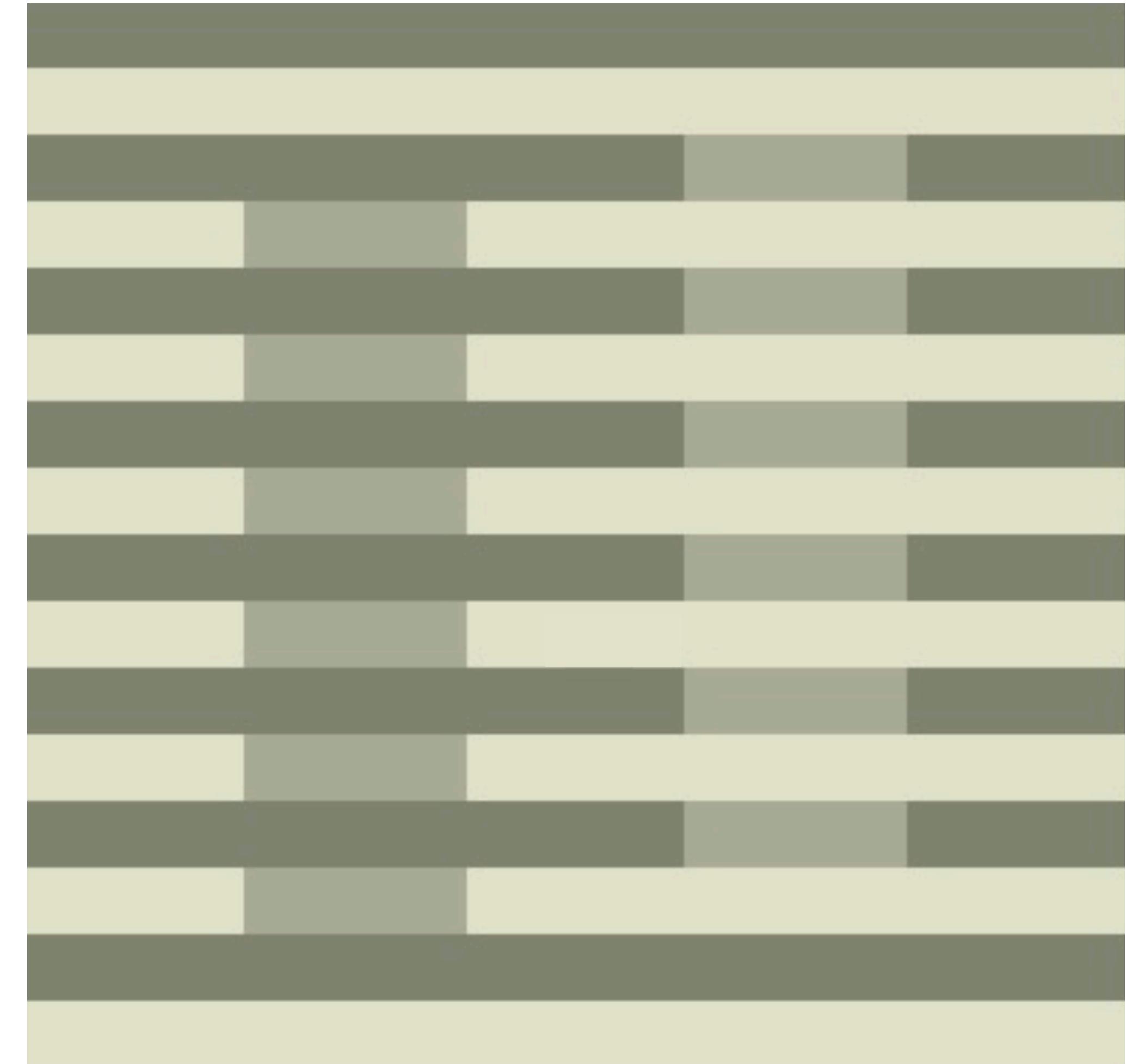
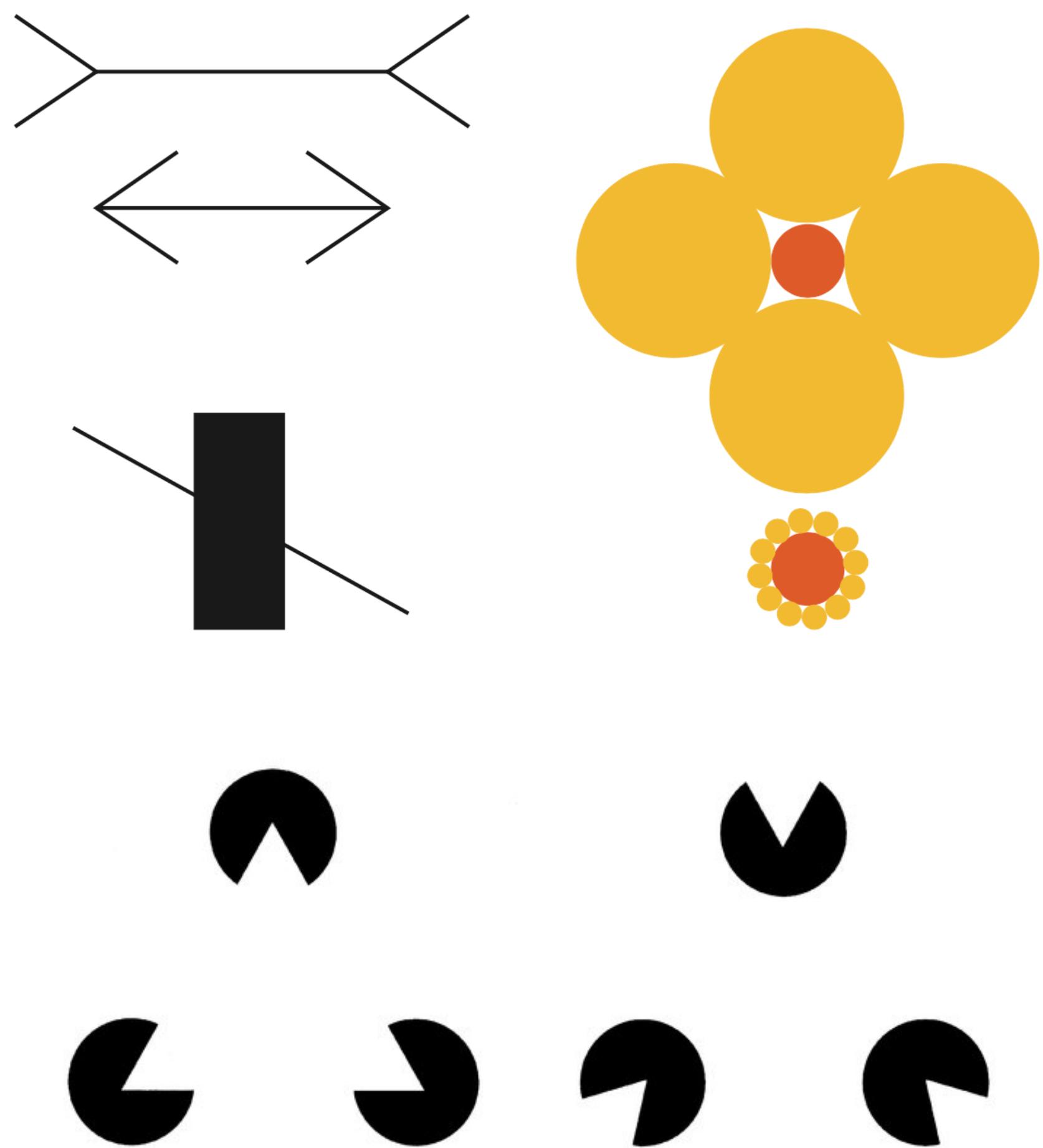
- Helmholtz's Theory of Unconscious Inference
- The Gestalt Principles of Organization
- Regularities of the Environment
- Bayesian Inference

# Helmholtz's Theory of Unconscious Inference

- One of Helmholtz's contributions to perception was based on his realization that the image on the retina is ambiguous.
- Helmholtz's question was, “How does the perceptual system determine that a retinal pattern was created by overlapping rectangles?” His answer was the **likelihood principle**, which states that we perceive the most probable object that caused the stimuli. Helmholtz believed this judgment occurs **unconsciously**, based on assumptions about the environment.



# The Gestalt View

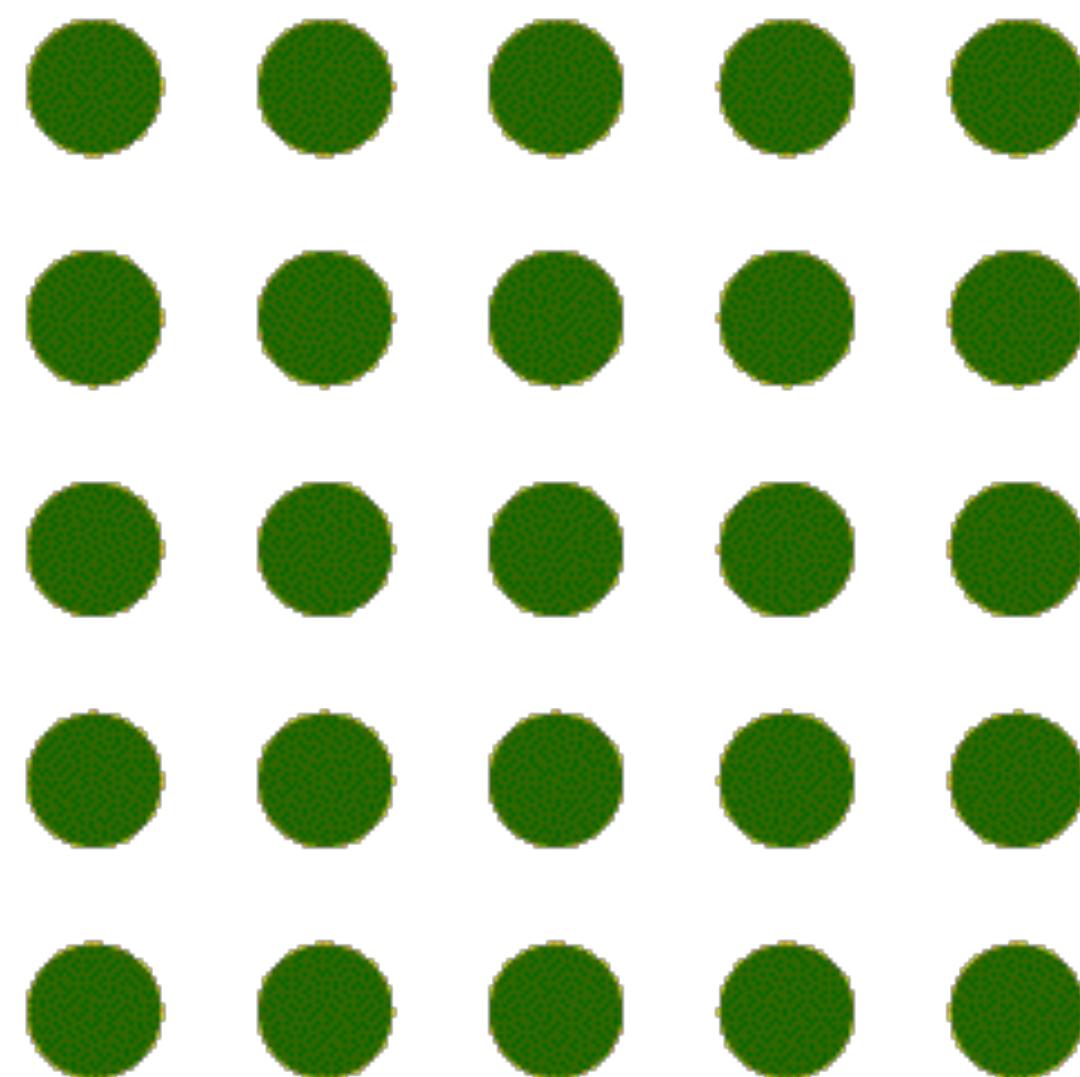


# The Gestalt Principles of Organization

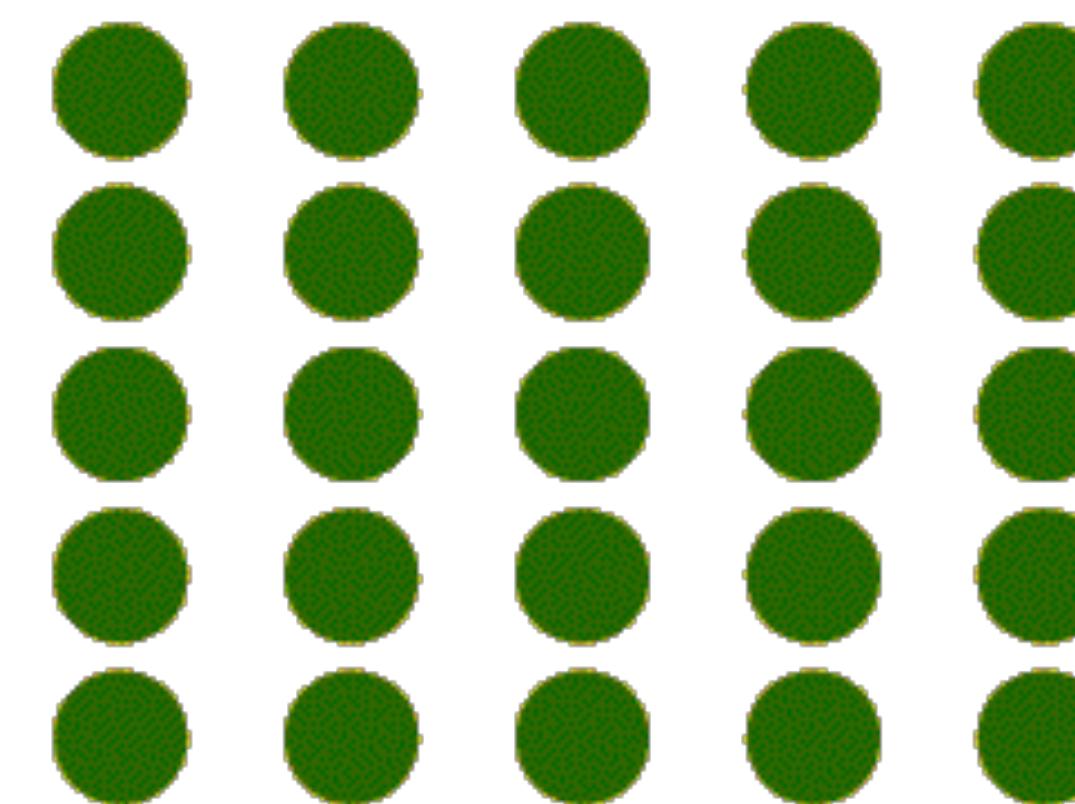
- Gestalt psychologists discovered a set of laws that describe how the brain organizes sensory characteristics. Most important are:
- **Proximity:** Visual characteristics that are near one another tend to be grouped together.
- **Similarity:** Similar visual characteristics tend to be grouped together.
- **Continuity** (also called good continuation): Visual characteristics that fall along a smooth curve or a straight line tend to be grouped together.
- **Closure:** The visual system tends to fill in missing parts of a shape.
- **Good Form:** Visual characteristics that form a single shape tend to be grouped together.

# Gestalt Laws: Proximity

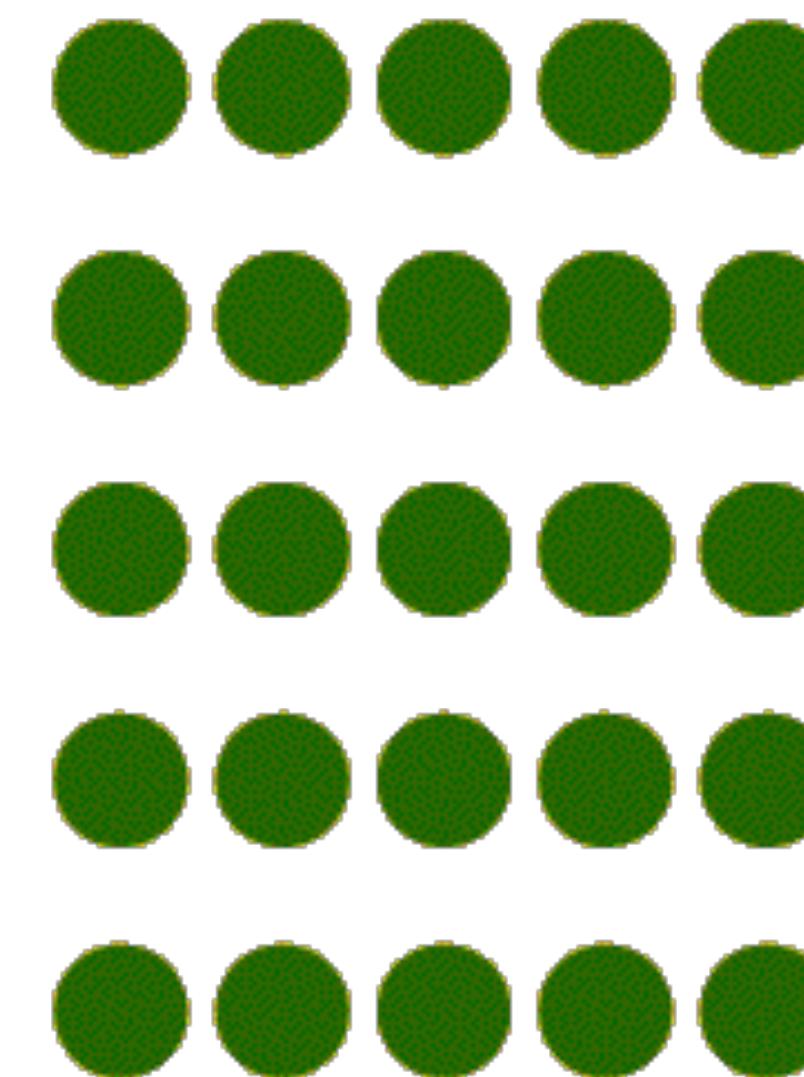
Initial stimulus



Vertical grouping

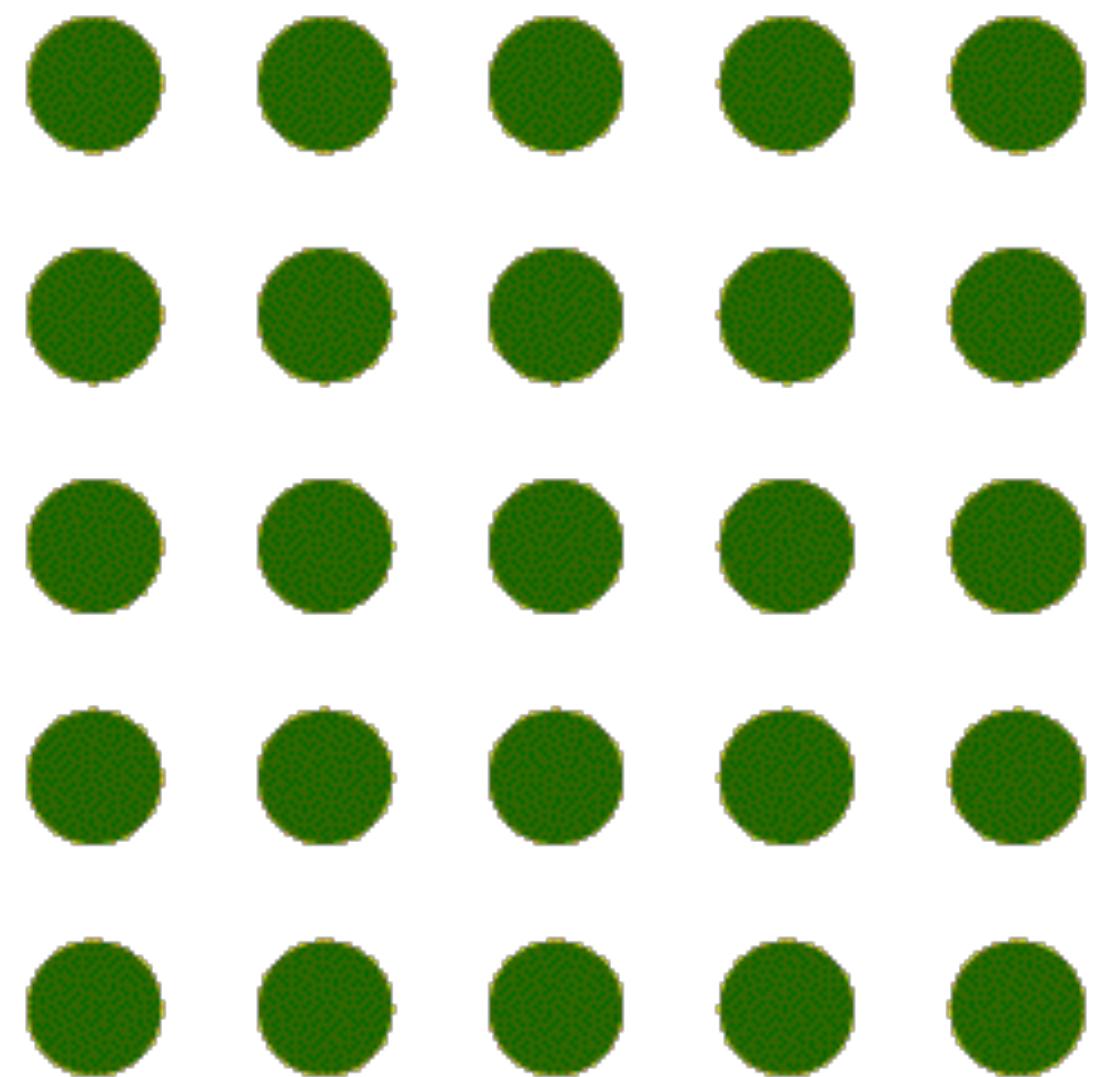


Horizontal grouping

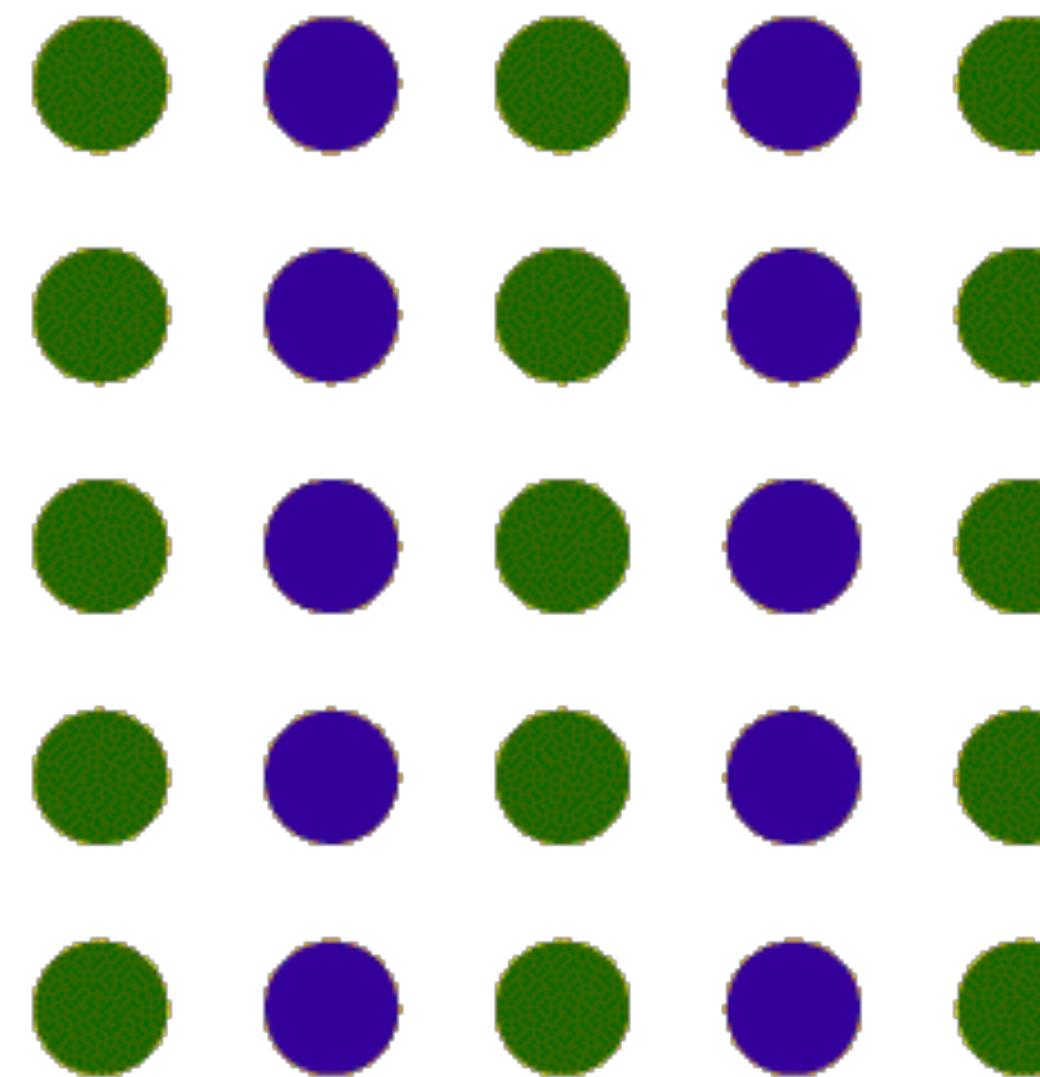


# Gestalt Laws: Similarity

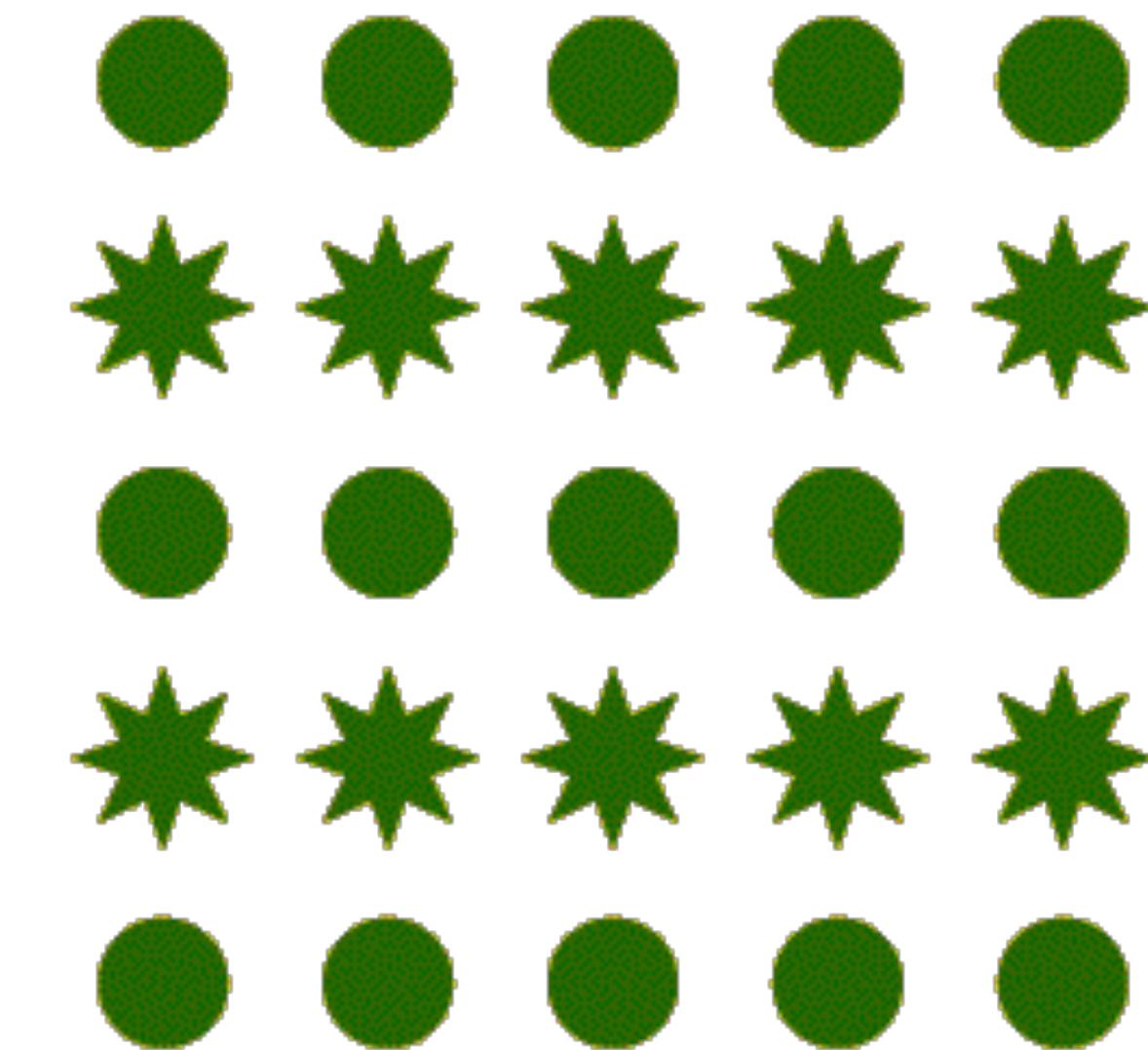
Initial stimulus



Grouping by color

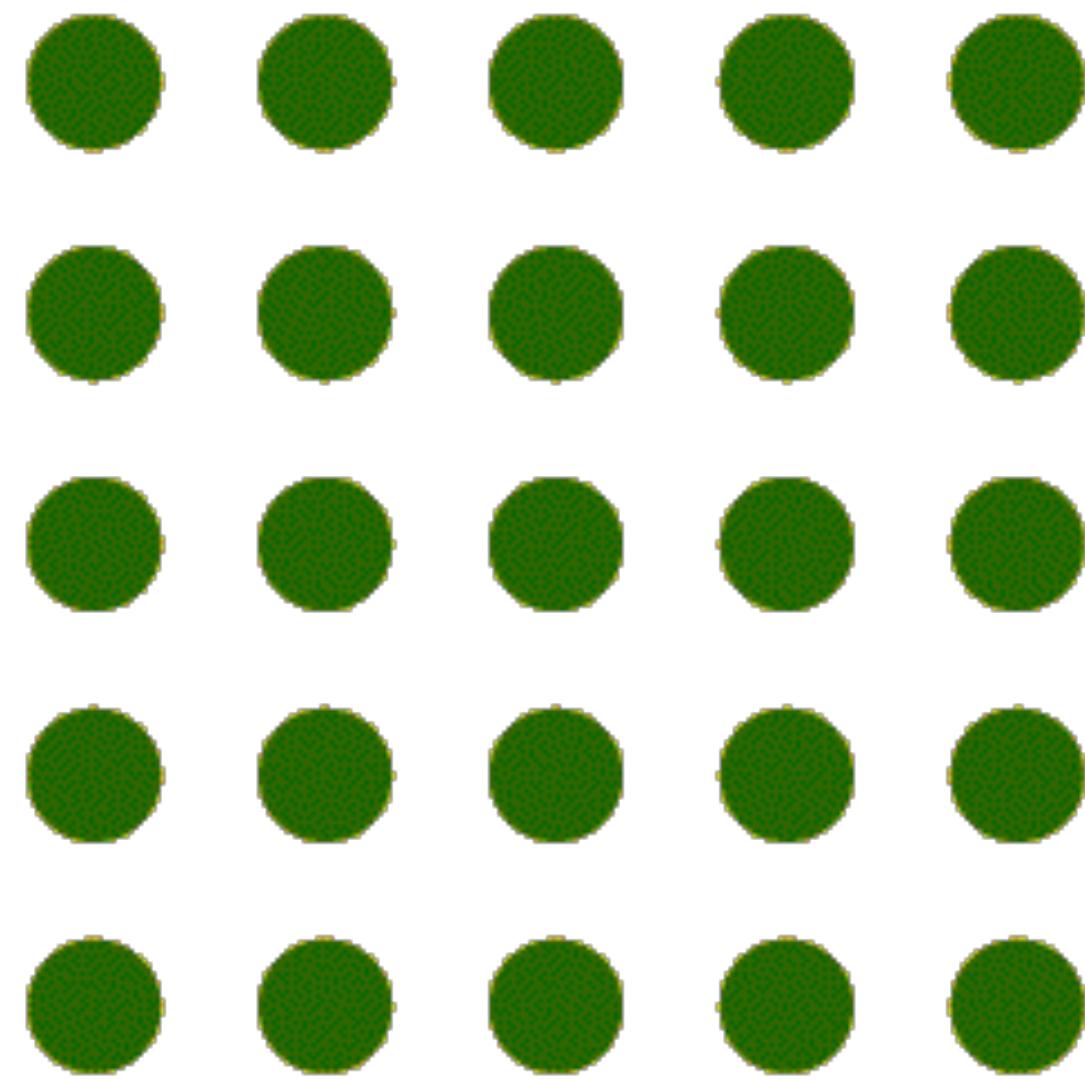


Grouping by shape

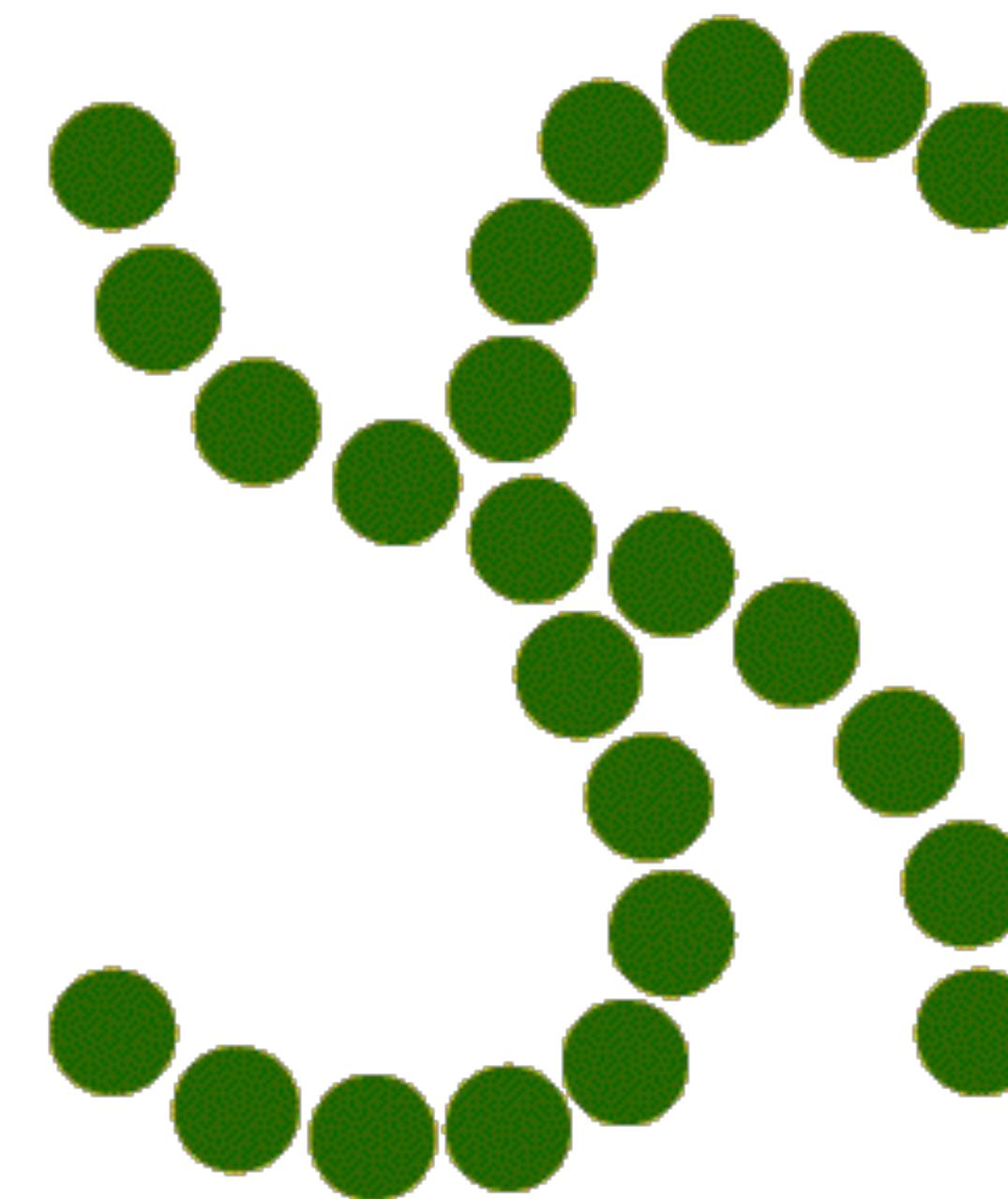


# Gestalt Laws: Good Continuation

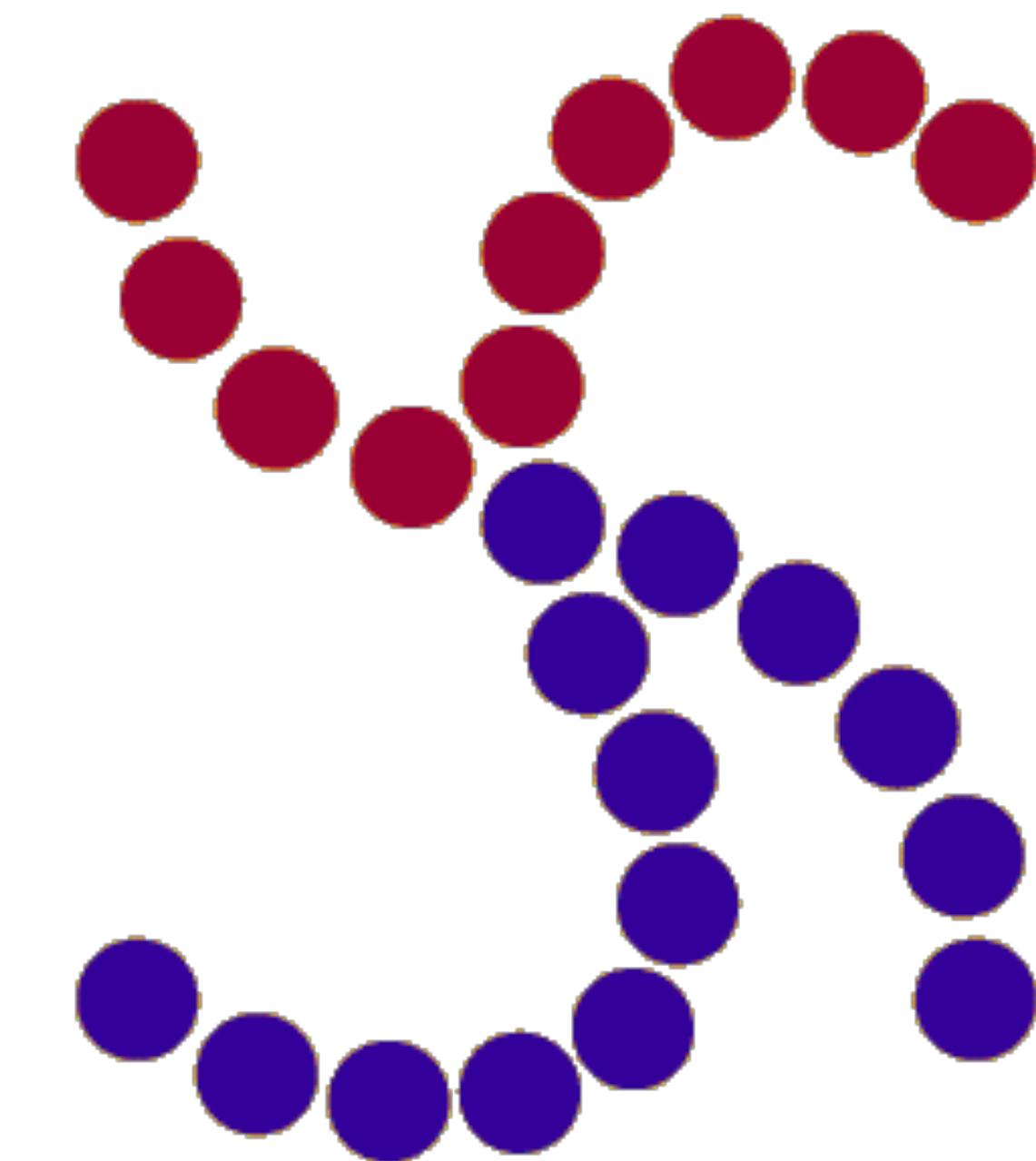
Initial stimulus



Continuation forming “X”



Continuation by similarity



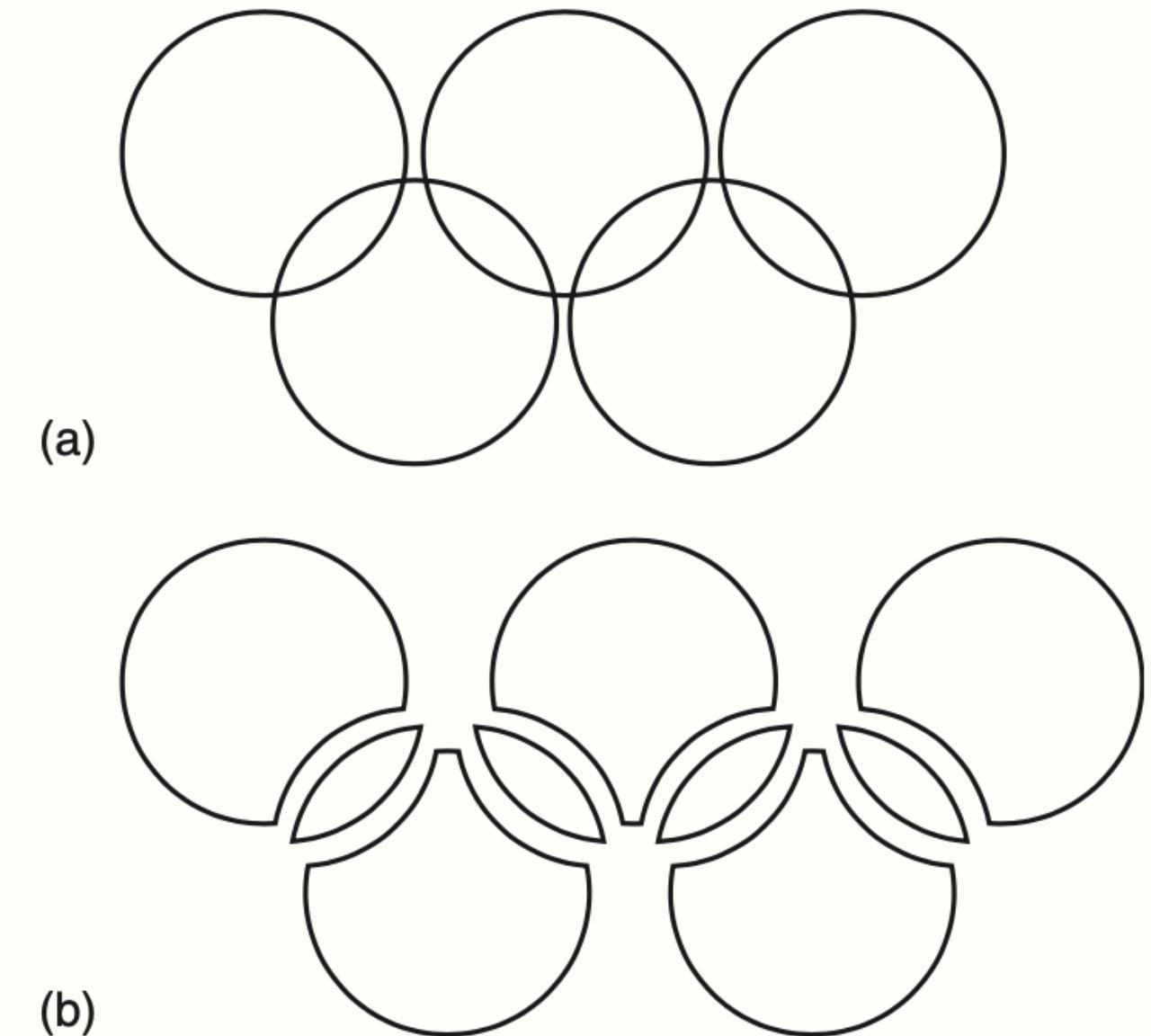
# Gestalt Laws: Good Continuation



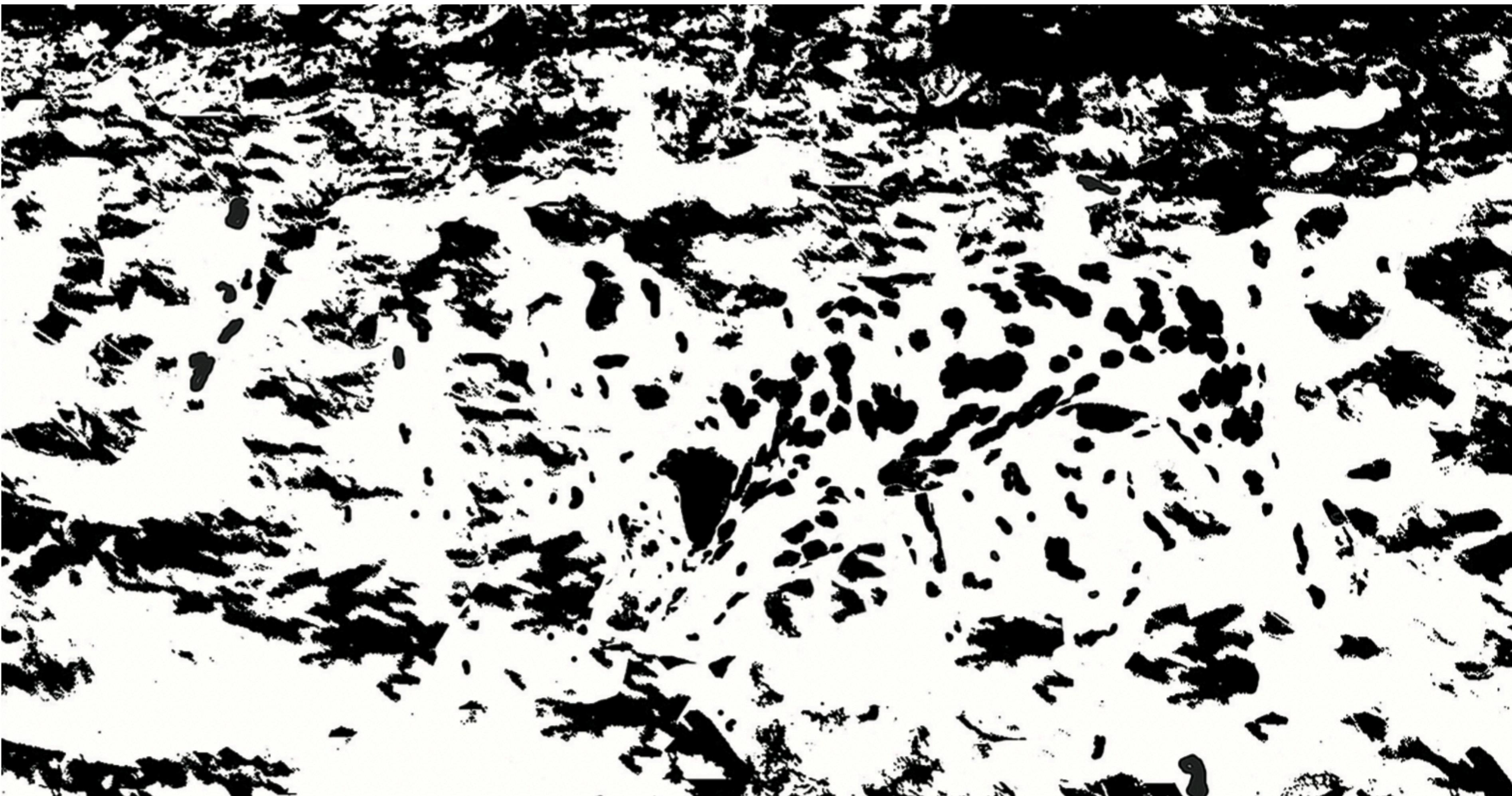
(a)



(b)



# Perception Organization



# Perception Organization



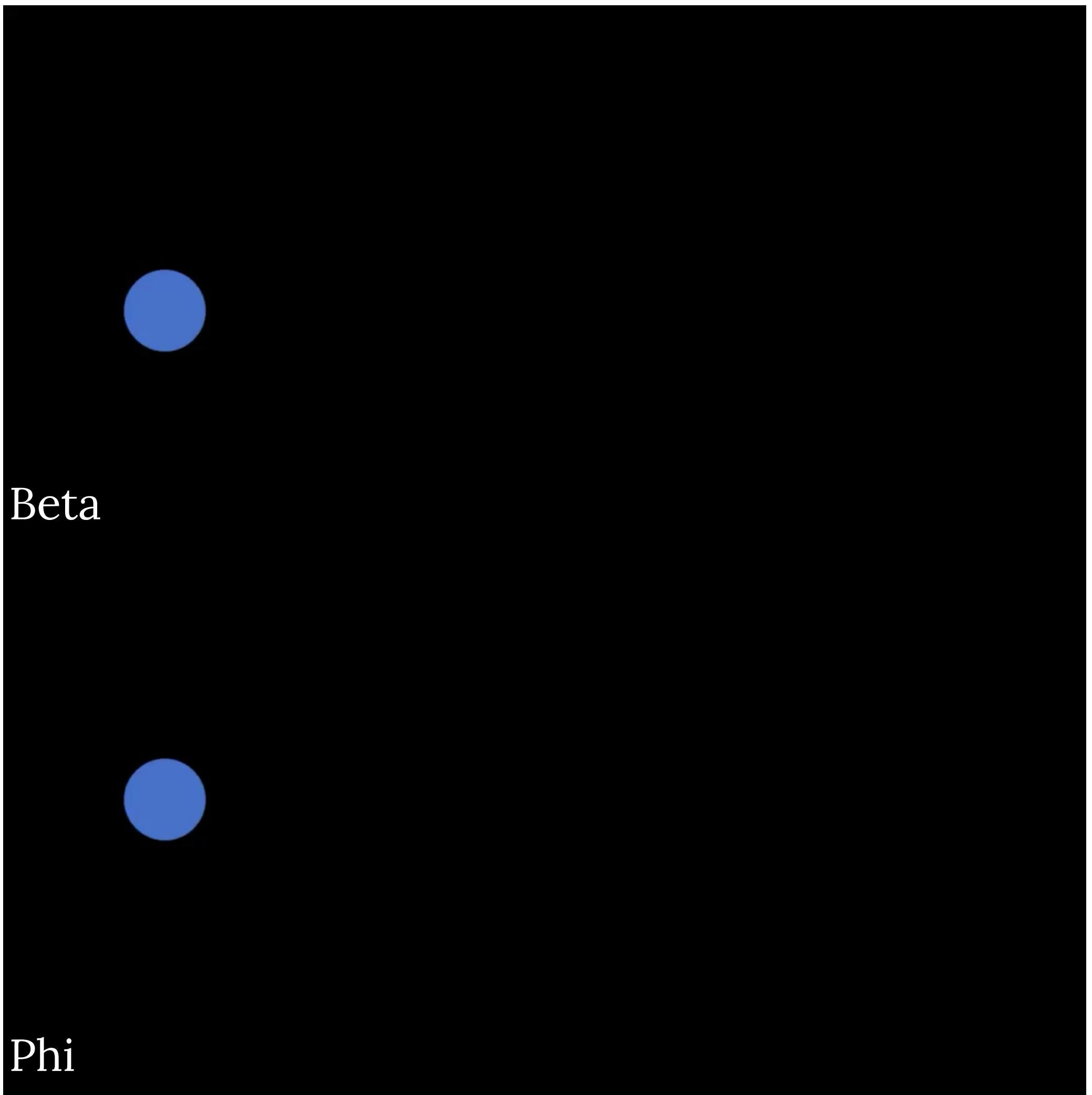
# Gestalt Laws in Art



“Waves” by Wilma Hurskainen

# Apparent Movement

- **Apparent movement:** When movement is perceived, but nothing is actually moving.
- Three components create apparent movement: a flashing light, a brief darkness, and another flashing light.
- Gestalt psychologist Max Wertheimer concluded that apparent movement can't be explained by sensations and that **the whole is different from its parts.**



# Regularities of the Environment

- Certain characteristics of the environment occur frequently.
- **Physical Regularities:** Physical regularities are regularly occurring physical properties of the environment.
- **Oblique effect:** People perceive horizontals and verticals more easily than other orientations.
- **Semantic regularities:** The characteristics associated with the functions carried out in different types of scenes including their meaning.

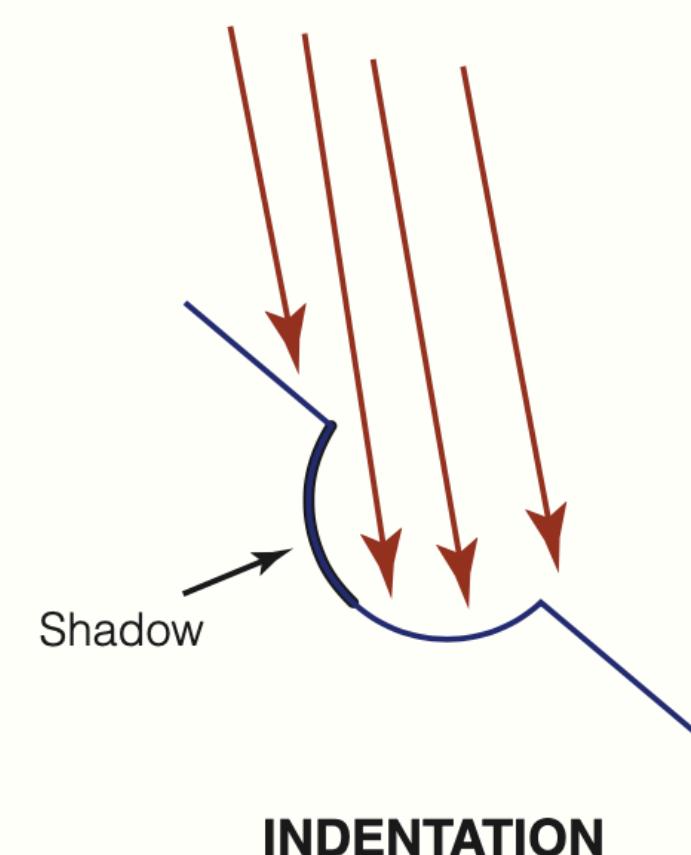


# Light-From-Above

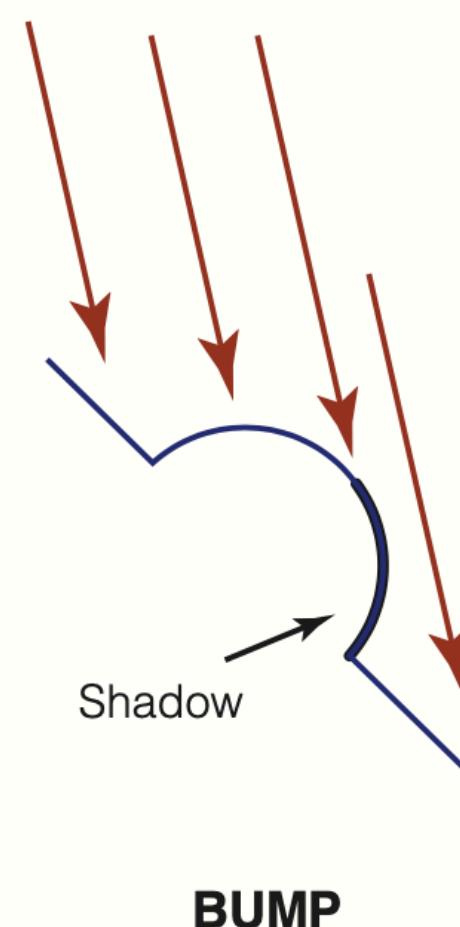
- **Light-from-above assumption:** We usually assume that light is coming from above, because light in our environment, including the sun and most artificial light, usually comes from above.



(b)



(d)



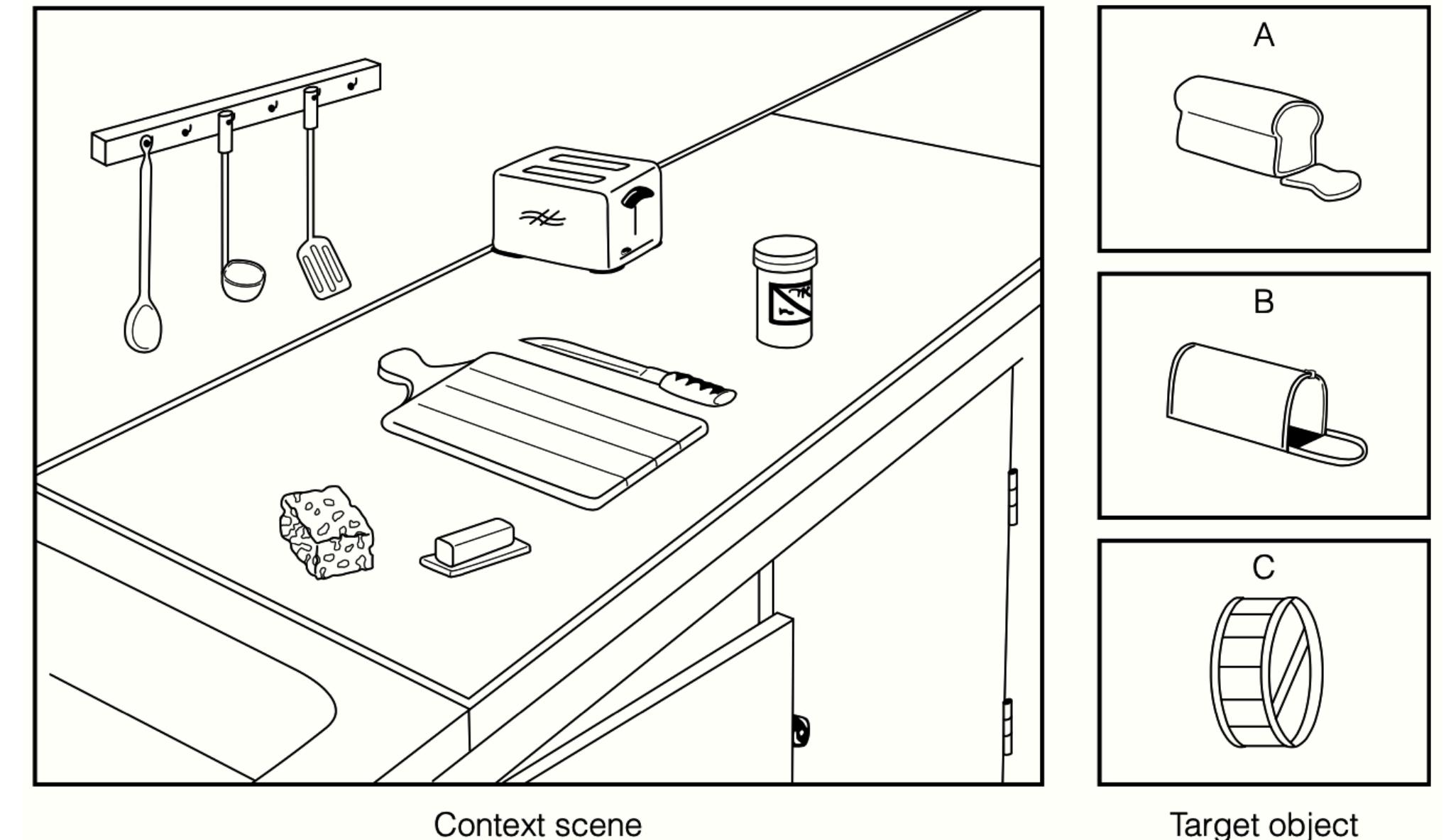
# Visualizing Scenes and Objects

Your task in this demonstration is simple. Close your eyes and then visualize or simply think about the following scenes and objects:

1. An office
2. The clothing section of a department store
3. A microscope
4. A lion

# Scene Schema

- **Scene schema:** This knowledge of what a given scene typically contains and the expectations created by scene schemas contribute to our ability to perceive objects and scenes.
- Although people make use of regularities in the environment to help them perceive, they are often unaware of the specific information they are using.



# Perceptual Set Violations

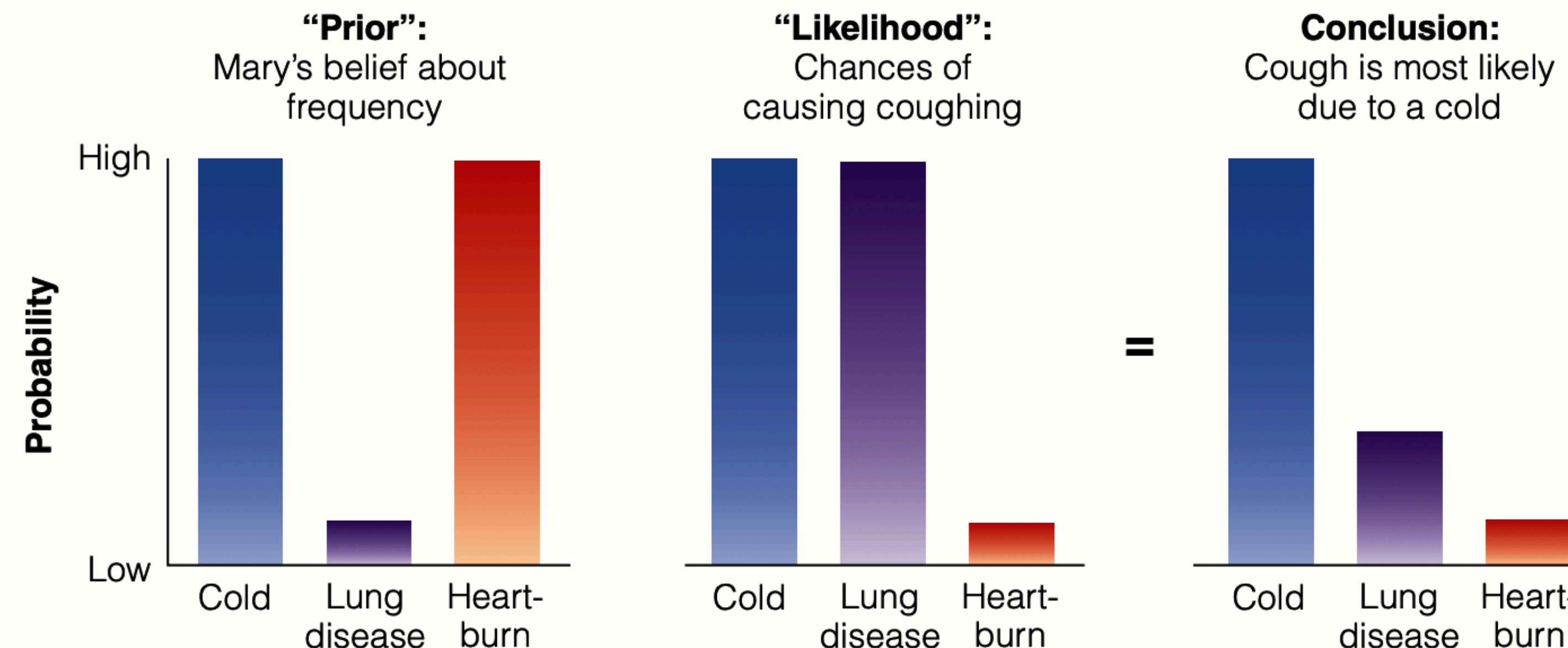


# Perceptual Set Violations



# Bayesian Inference

- **Bayesian inference**, named after Thomas Bayes (1701–1761), proposes that our estimate of an outcome's probability is determined by two factors: the **prior probability** (our initial belief) and the **likelihood of the outcome** (the extent to which available evidence supports it).

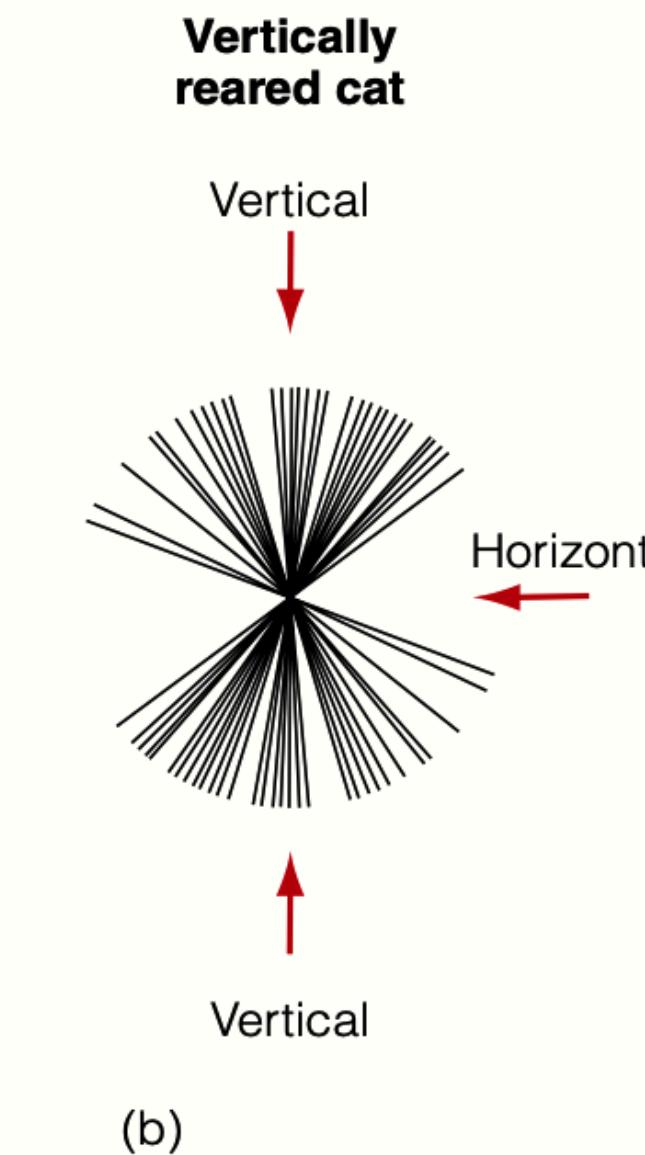


# Neurons are Shaped by Experience

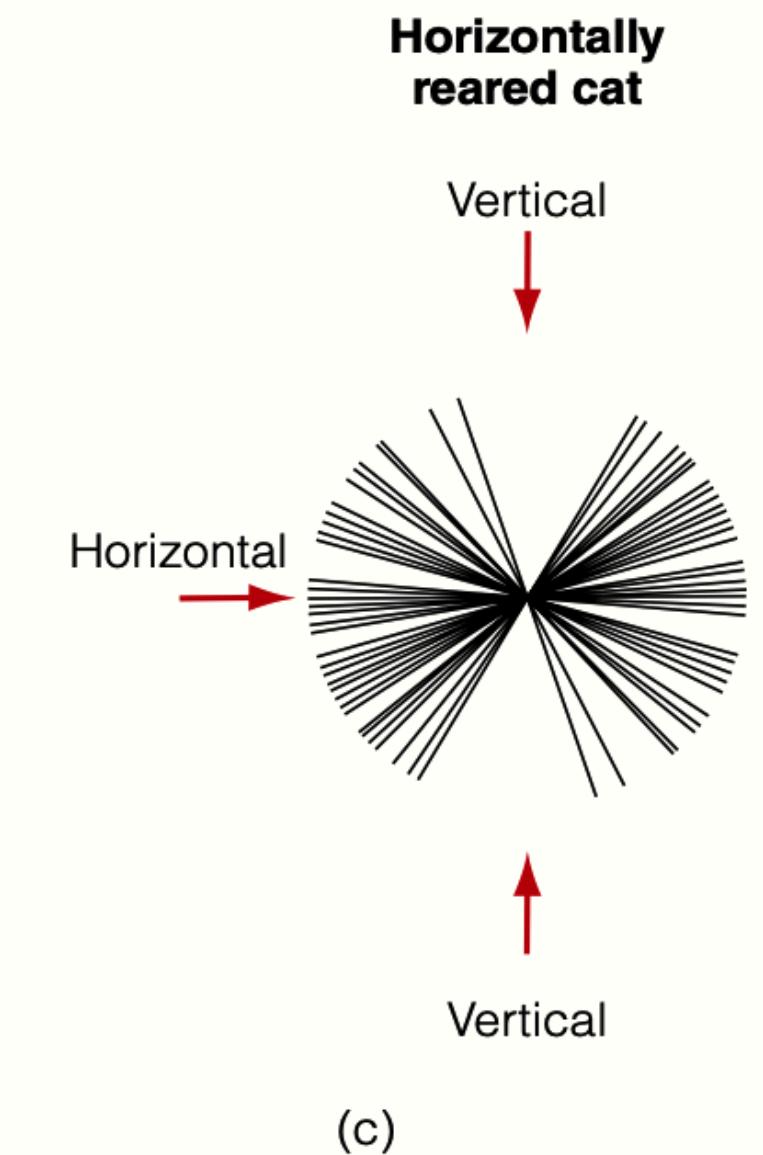
- **Experience-dependent plasticity:**  
The structure of the brain is  
changed by experience.



(a)



(b)

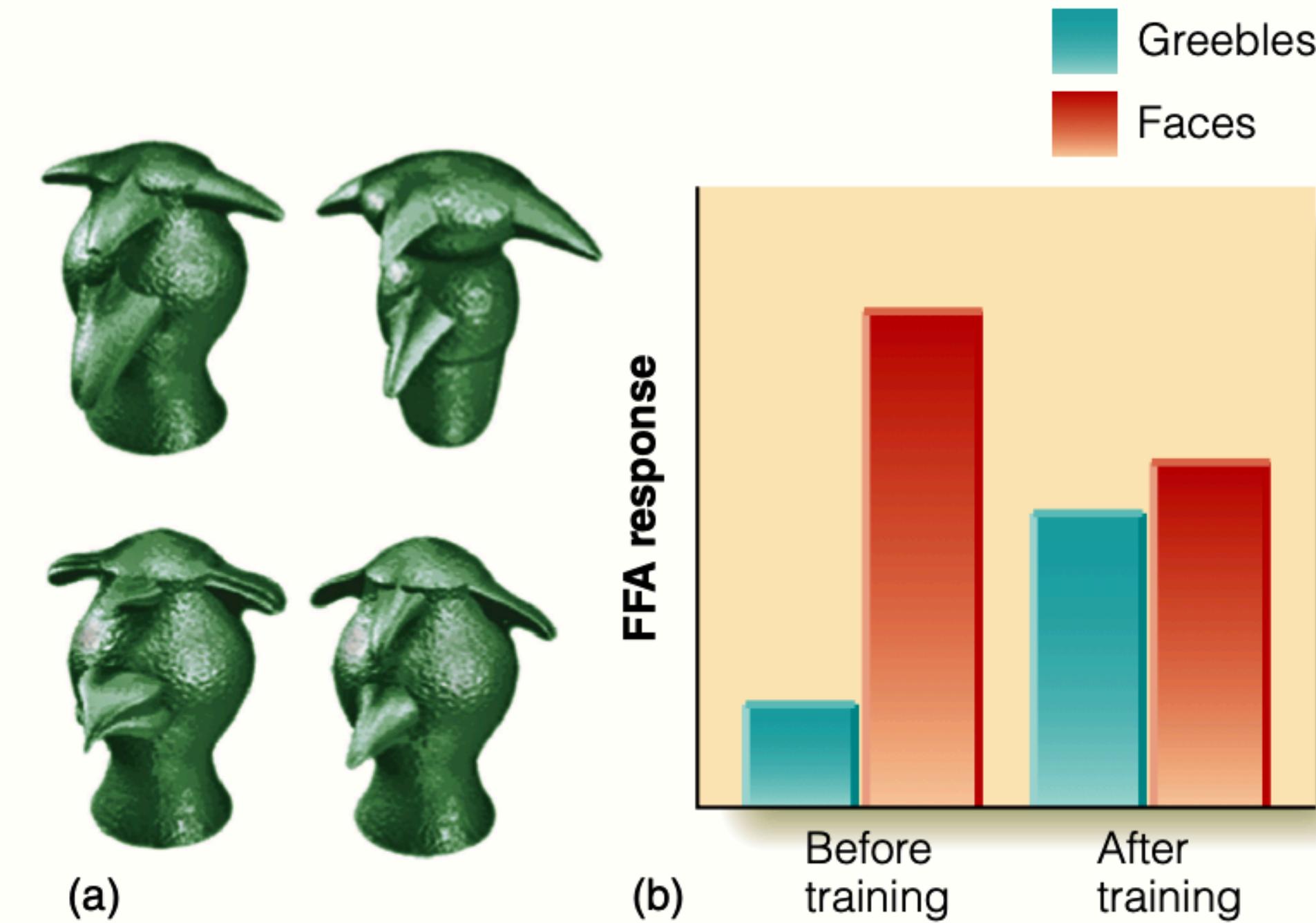


(c)

*(Blakemore and Cooper, 1970)*

# Experience-Dependent Plasticity in Humans

- fMRI has shown that there's a temporal lobe area called the **fusiform face area (FFA)** with neurons that respond best to faces. Researchers trained these neurons to respond to computer-generated beings called "**greebles**."



(Based on Gauthier et al., 1999)

# Movement Facilitates Perception

- Movement helps us perceive objects in the environment more accurately.
- One reason this occurs is that moving reveals aspects of objects that are not apparent from a single viewpoint.



# The Interaction of Perception and Action

- Movement is important because it helps us perceive objects by revealing additional information about them and because it involves the continuous coordination between perceiving stimuli and taking action toward them.



(a) Perceive cup



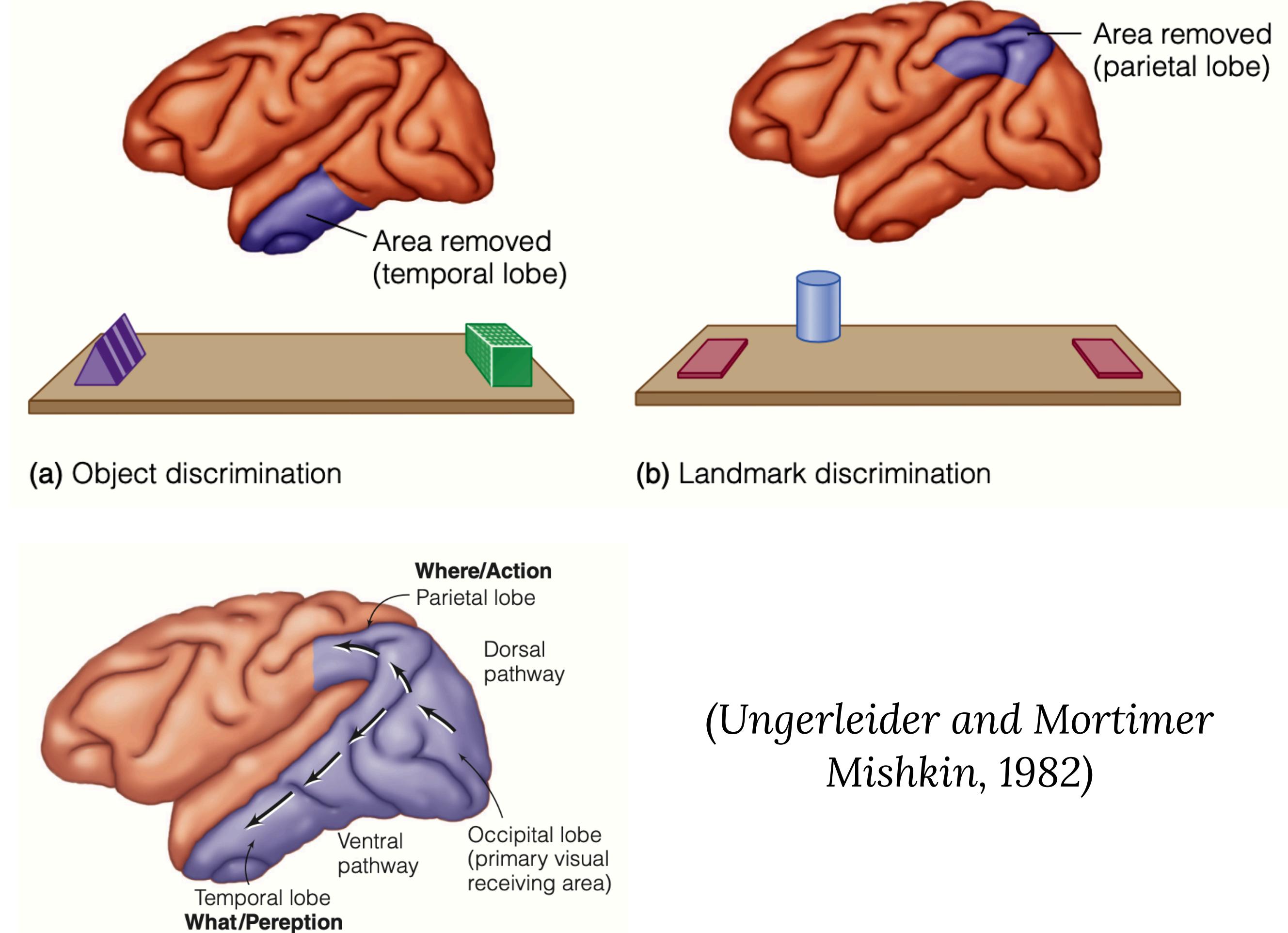
(b) Reach for cup



(c) Grasp cup

# Perception of Action: Physiology

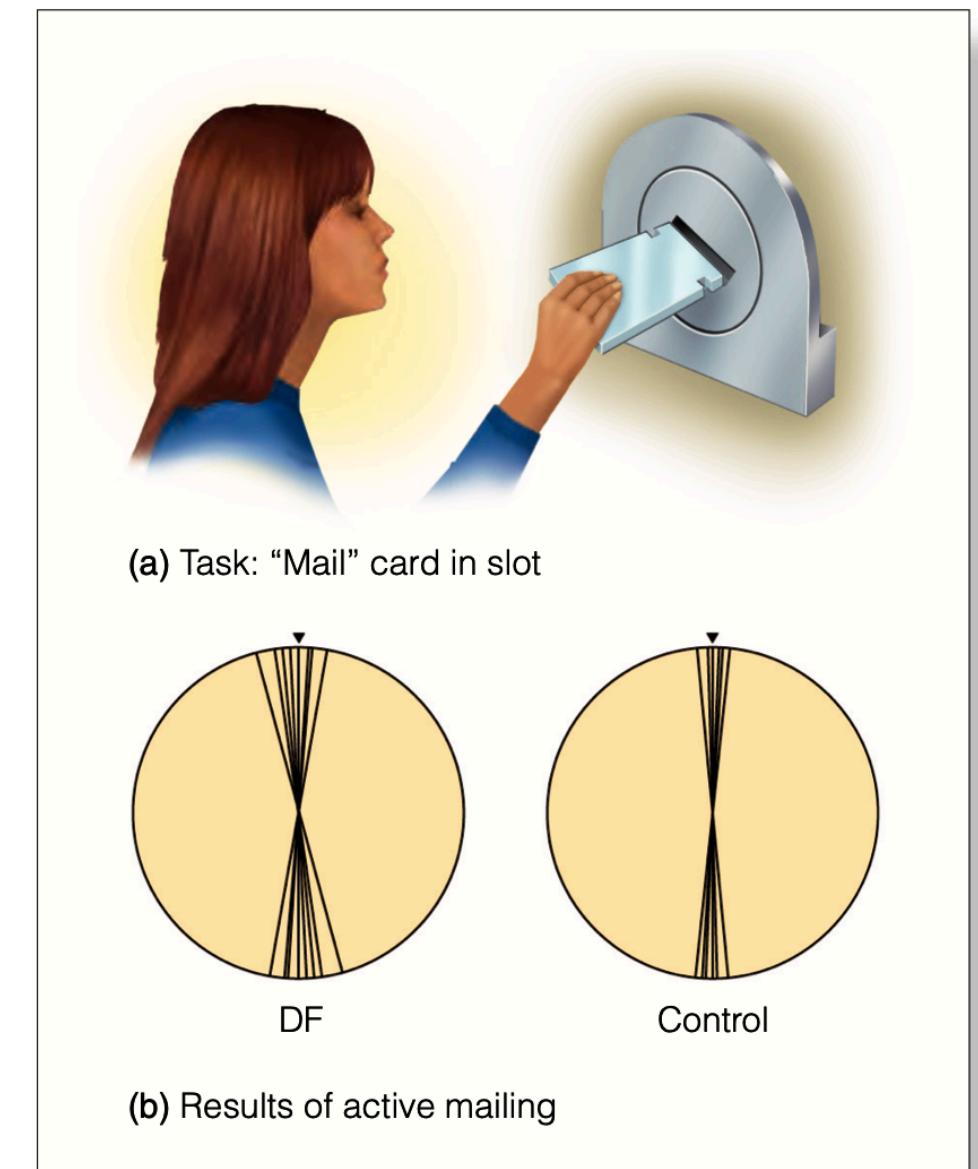
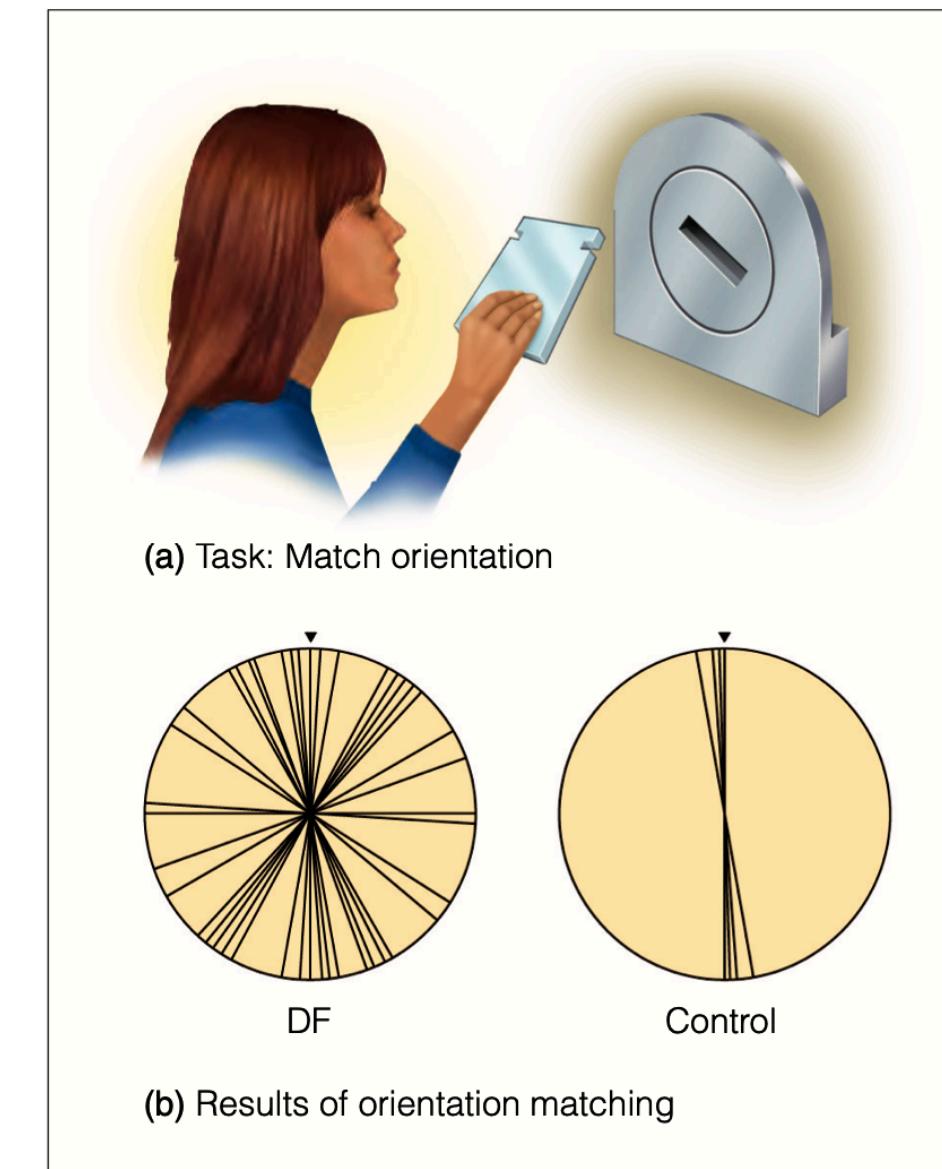
- There are two processing streams in the brain – one involved with perceiving objects, and the other involved with locating and taking action toward these objects.
- **WHAT** and **WHERE** Streams.



(Ungerleider and Mortimer  
Mishkin, 1982)

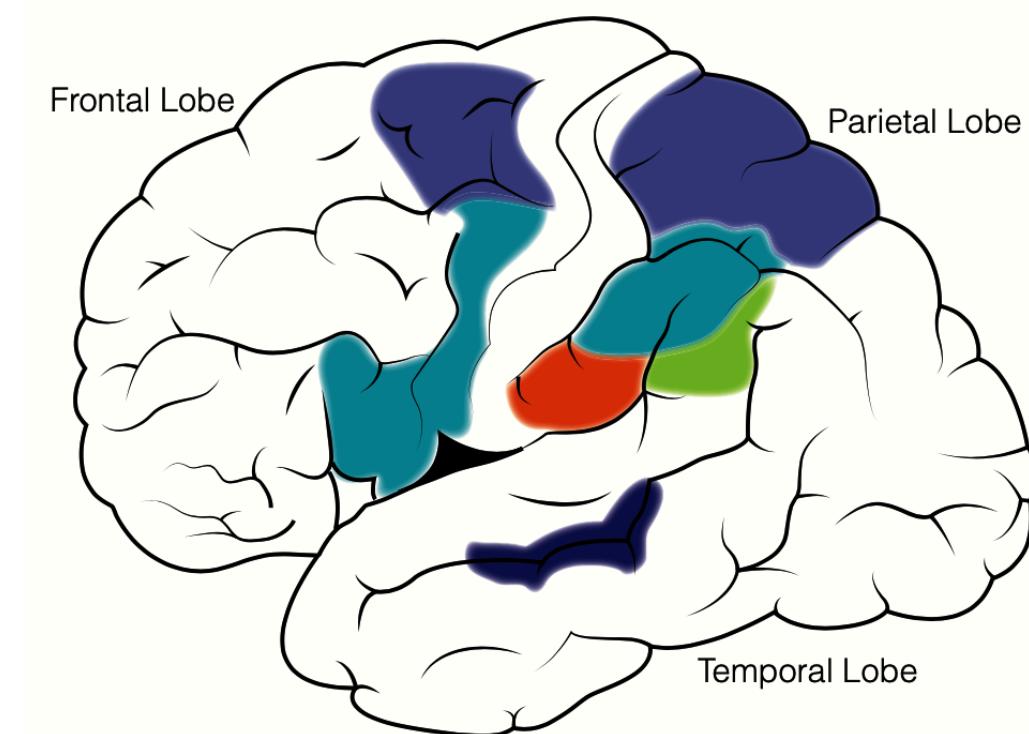
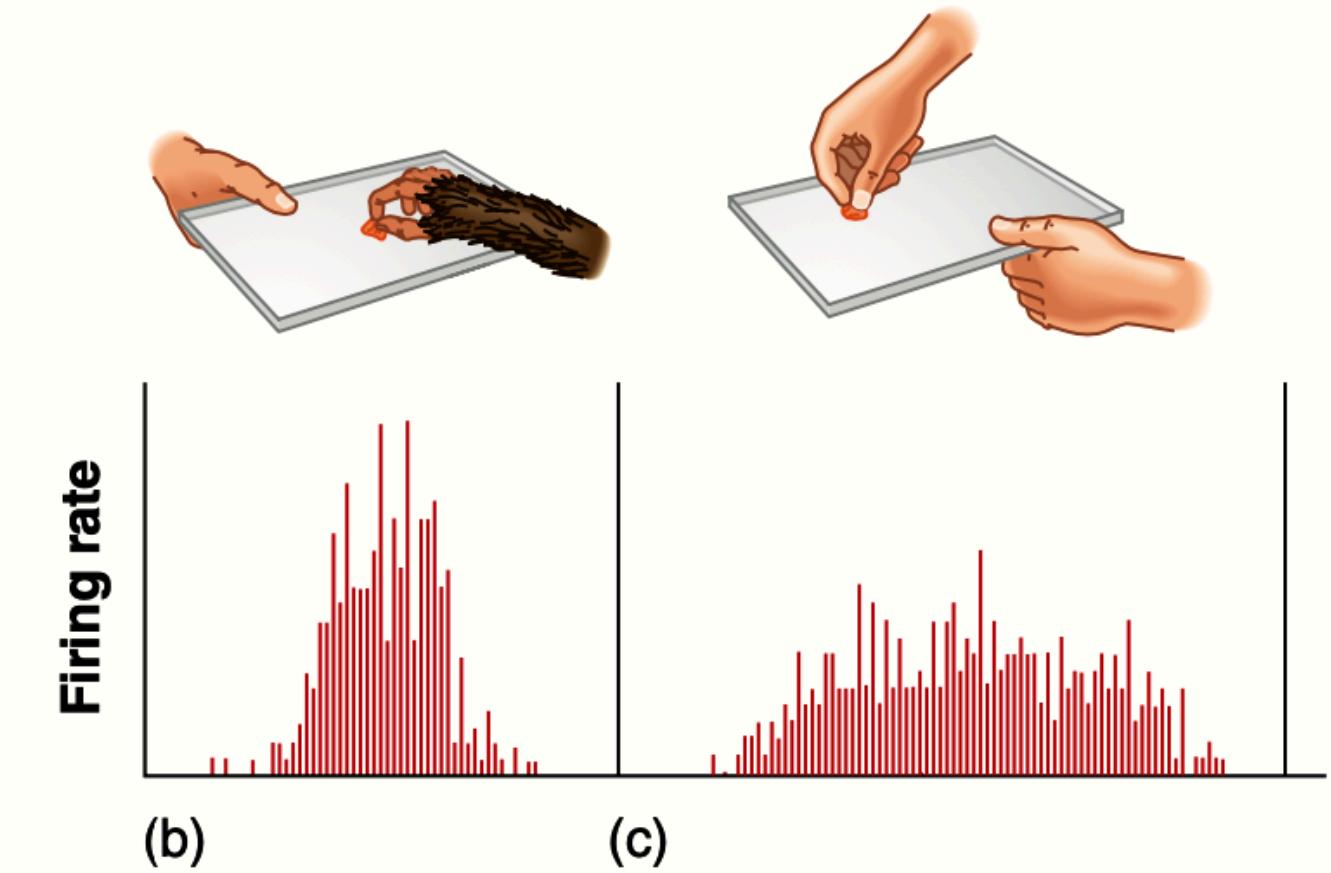
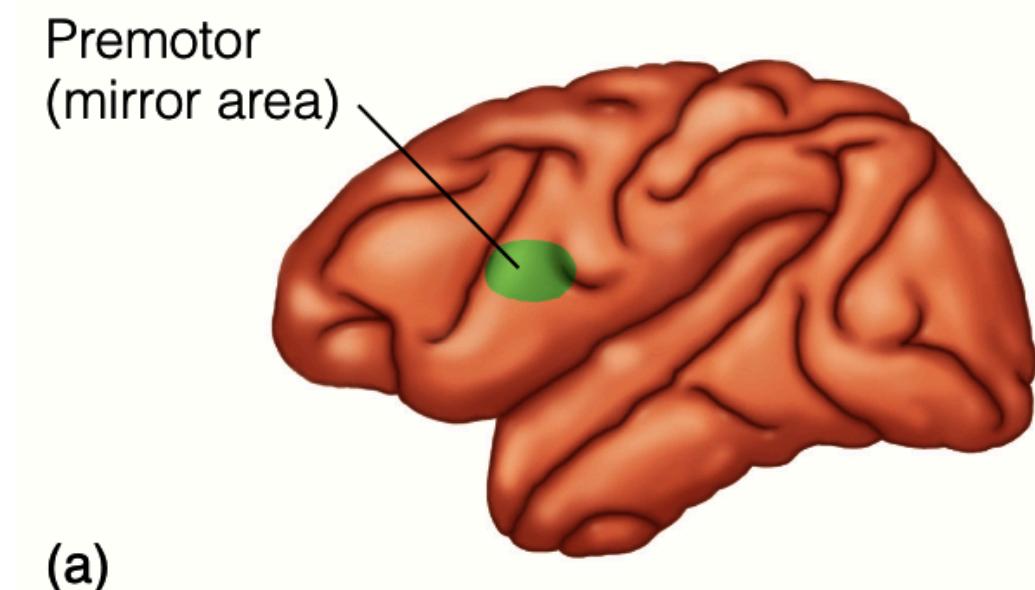
# Perception and Action Streams

- David Milner and Melvyn Goodale (1995) used neuropsychology to reveal two streams: one involving the temporal lobe and the other involving the parietal lobe.
- **Perception pathway** (from the visual cortex to temporal lobe; “what” pathway).
- **Action pathway** (from the visual cortex to the parietal lobe; “how” pathway).



# Mirror Neurons

- **Mirror neurons:** Neurons that react when a monkey observes someone else grasping an object, like food on a tray, and when the monkey itself grasps the food.
- **Mirror neuron system:** Neurons are distributed throughout the brain in a network.
- What's the purpose of these mirror neurons? One idea is they help us figure out what someone's trying to do.



*(di Pellegrino and coworkers, 1992)*

# Questions, comments?