

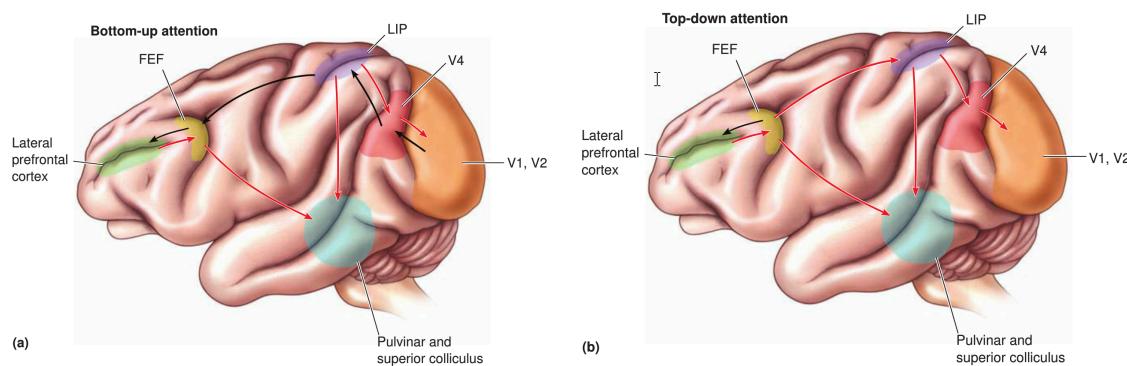
Lecture 39. Attention and Consciousness

Prof. Melissa Warden

Pre-Lecture Preparation

Watch Video 39-1: Brain-wide attentional circuits

Understand these figures:



Required Reading

Be able to explain the following figures from Bear et al.: p.725, Fig. 21.3; p.726, Fig. 21.4; p.727, Fig. 21.5; p.728, Fig. 21.6; p.729, Fig. 21.7; p.746, Fig. 21.23

Optional Reading

Activity changes in early visual cortex reflect monkeys' percepts during binocular rivalry.
Leopold DA, Logothetis NK.

Learning Objectives

1. To learn how attention is defined in the lab and how changes in attention cause measurable changes in behavior
2. To learn how lesions in the primary visual cortex and the parietal lobe can impact attention and perceptual awareness
3. To learn how neural correlates of perceptual awareness can be observed in the brain

Lecture Outline

In this lecture we will discuss what attention is, how changes in attention affect behavior, and how these changes can be measured. We will discuss how lesions in specific brain areas, such as primary visual cortex, parietal cortex, and the corpus callosum (split brain patients) affect attention and conscious perception. Finally, we will discuss the neural correlates of attention and conscious perception in the brain.

1. The definition of attention, and how to measure attention in the lab
 - a. Reaction time
 - b. Signal detection
 - c. Attentional set shifting
 - d. Example: visual pop-out vs visual search
2. Lesions in different brain regions impact attention and perceptual awareness differently
 - a. Visual cortex and blindsight
 - b. Parietal cortex and neglect
 - c. Split brain patients
3. Neural correlates of attention in the brain
 - a. Attentional modulation of neural activity in visual and parietal cortex
 - b. Binocular rivalry and neural activity
4. The frontoparietal attention network

Study Questions

1. What behavioral advantages are produced by attention?
2. Describe how bottom-up and top-down attention differ.
3. How is binocular rivalry used to explore conscious awareness?

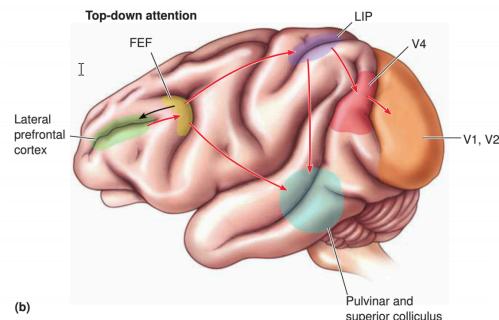
NEUROBIOLOGY AND BEHAVIOR II: INTRODUCTION TO NEUROSCIENCE

BioNB 2220

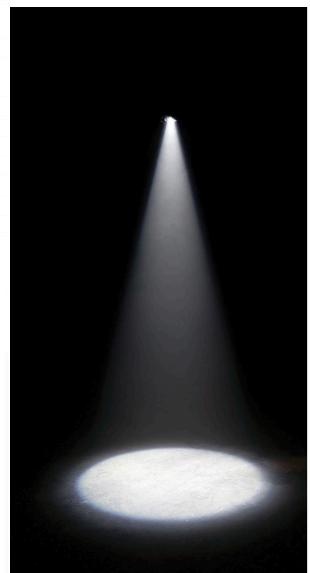
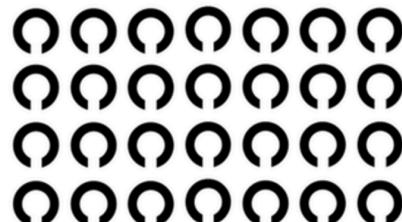
Lecture 39: Attention and
Consciousness

May 1, 2019

Prof. Melissa R. Warden, PhD



(b)



Attention

Cocktail party effect

You are at a crowded party, and you are surrounded by loud music and the chatter of hundreds of people

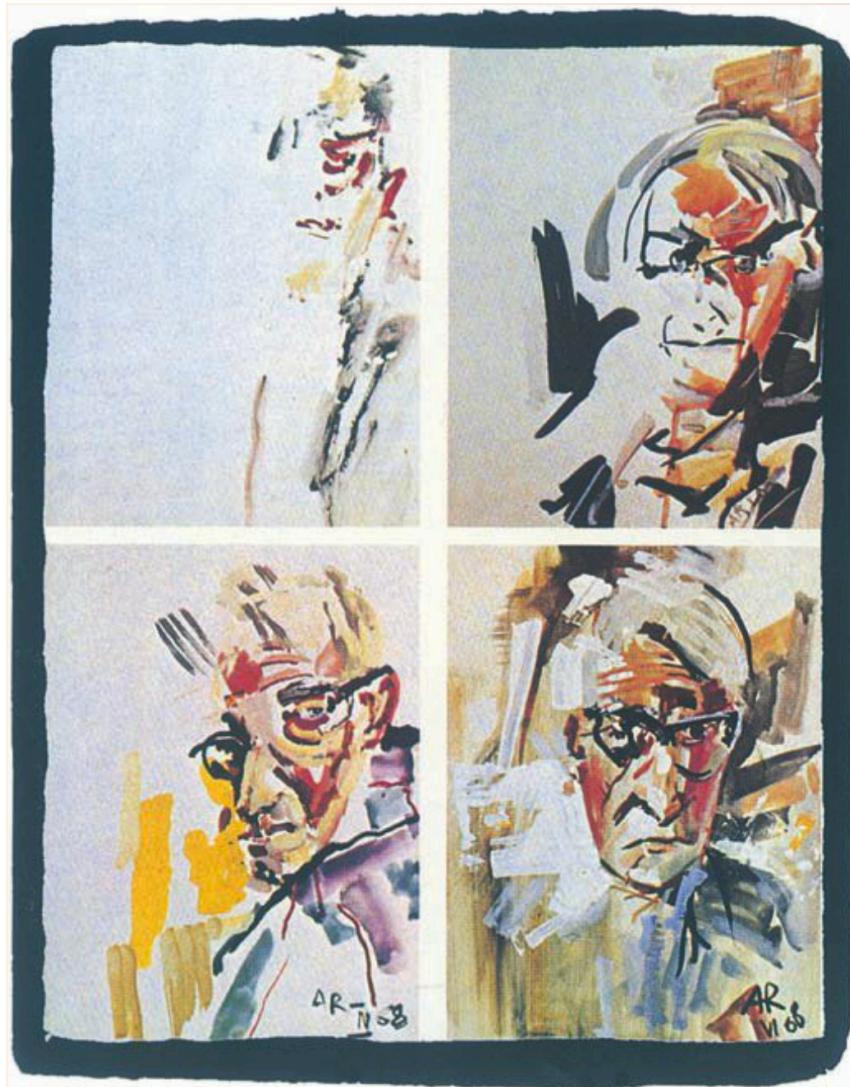
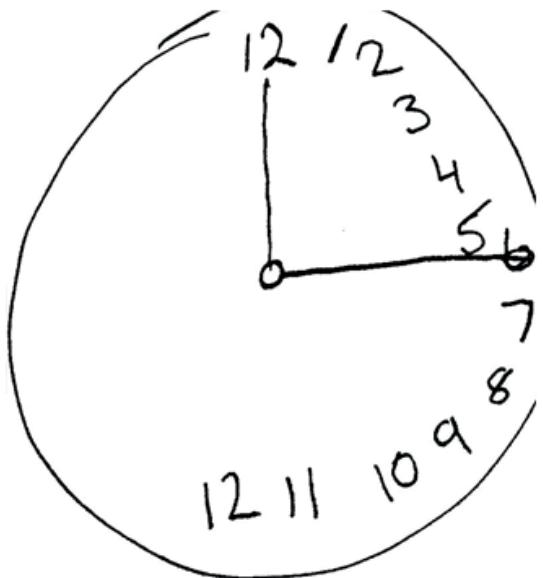
How can you concentrate on the conversation you are currently having without being overwhelmed by all the other conversations?

You are paying attention.



If someone behind you mentions your name, you might (without turning around) focus your attention on this other conversation to hear what they are saying about you. *Covert attention.*

Hemispatial neglect following right parietal cortex damage



Selective attention

Sensory input would be overwhelming if we were to simultaneously and equally process every sight and sound.

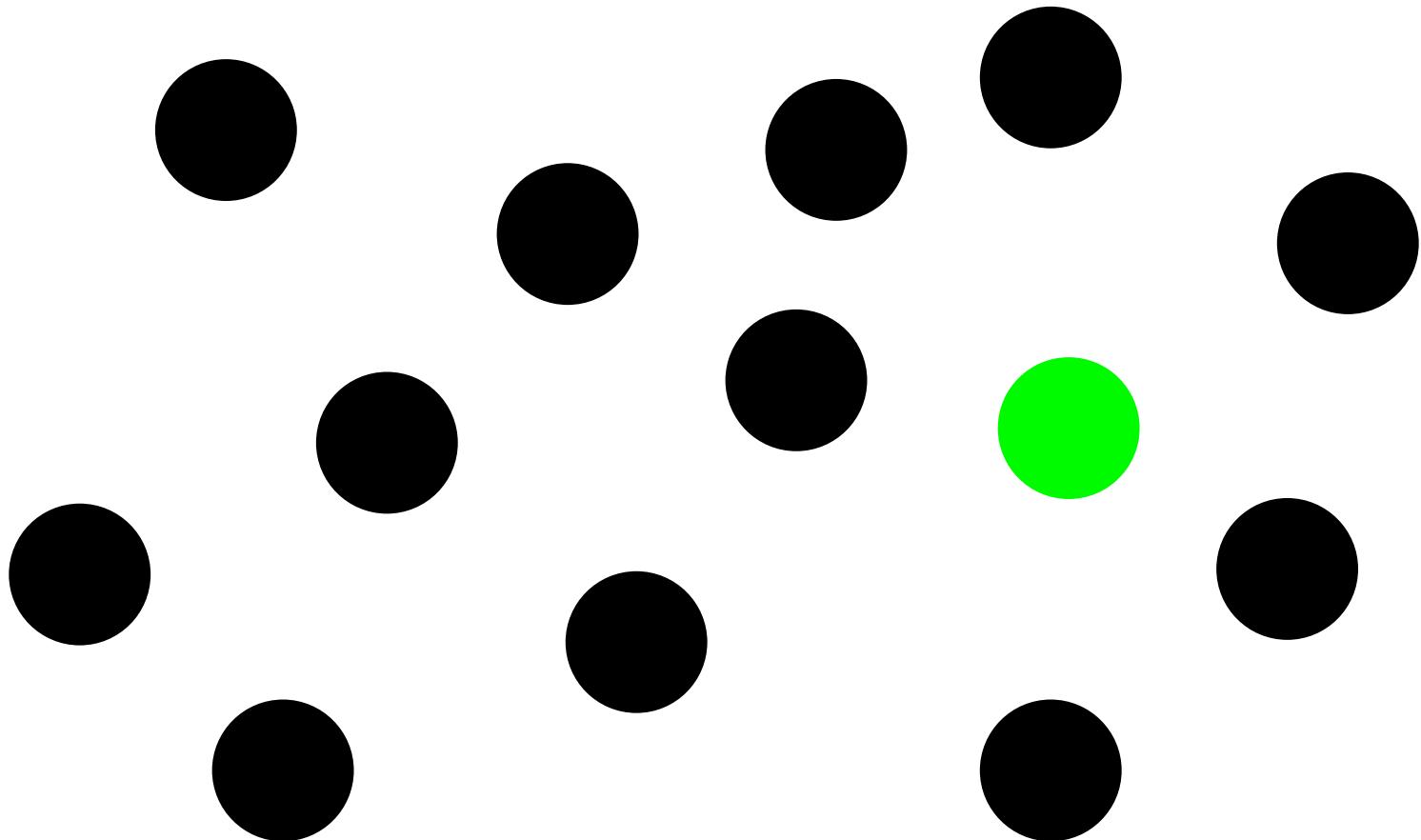
Attention can be used to enhance brain processing of **some** objects. Not the same as arousal, which is unselective.

Attention can have a significant impact on perception and reaction time.

- If you focus your attention on a specific spatial region, you will be more likely to perceive that a very faint stimulus has appeared there
- And you will be faster to respond to information presented in that region

Divided attention is why accidents are more common when people are texting or talking on cell phones.

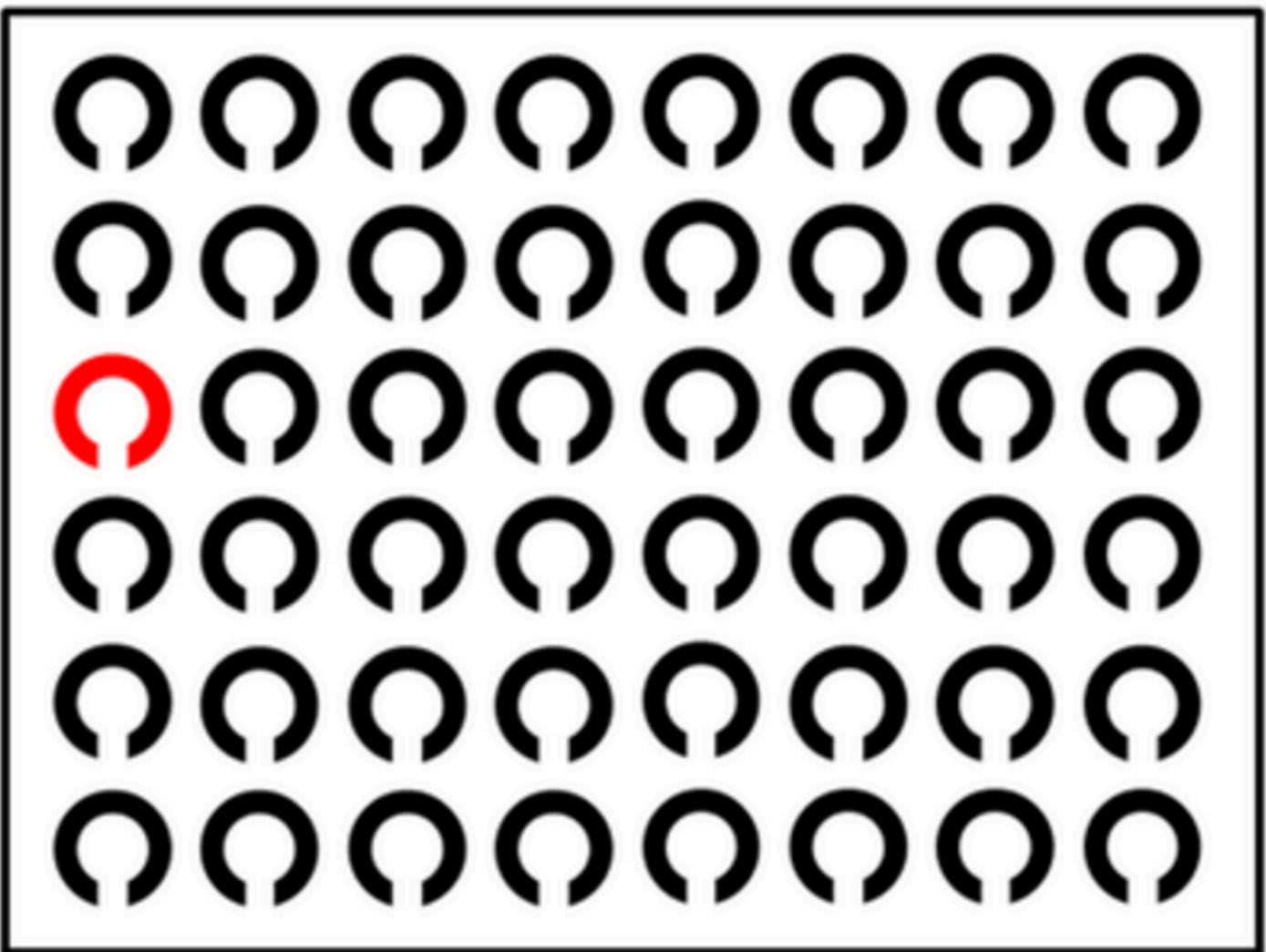
Attentional pop out and serial search



Get your clickers out!



Landolt figure



CLICKER QUESTION

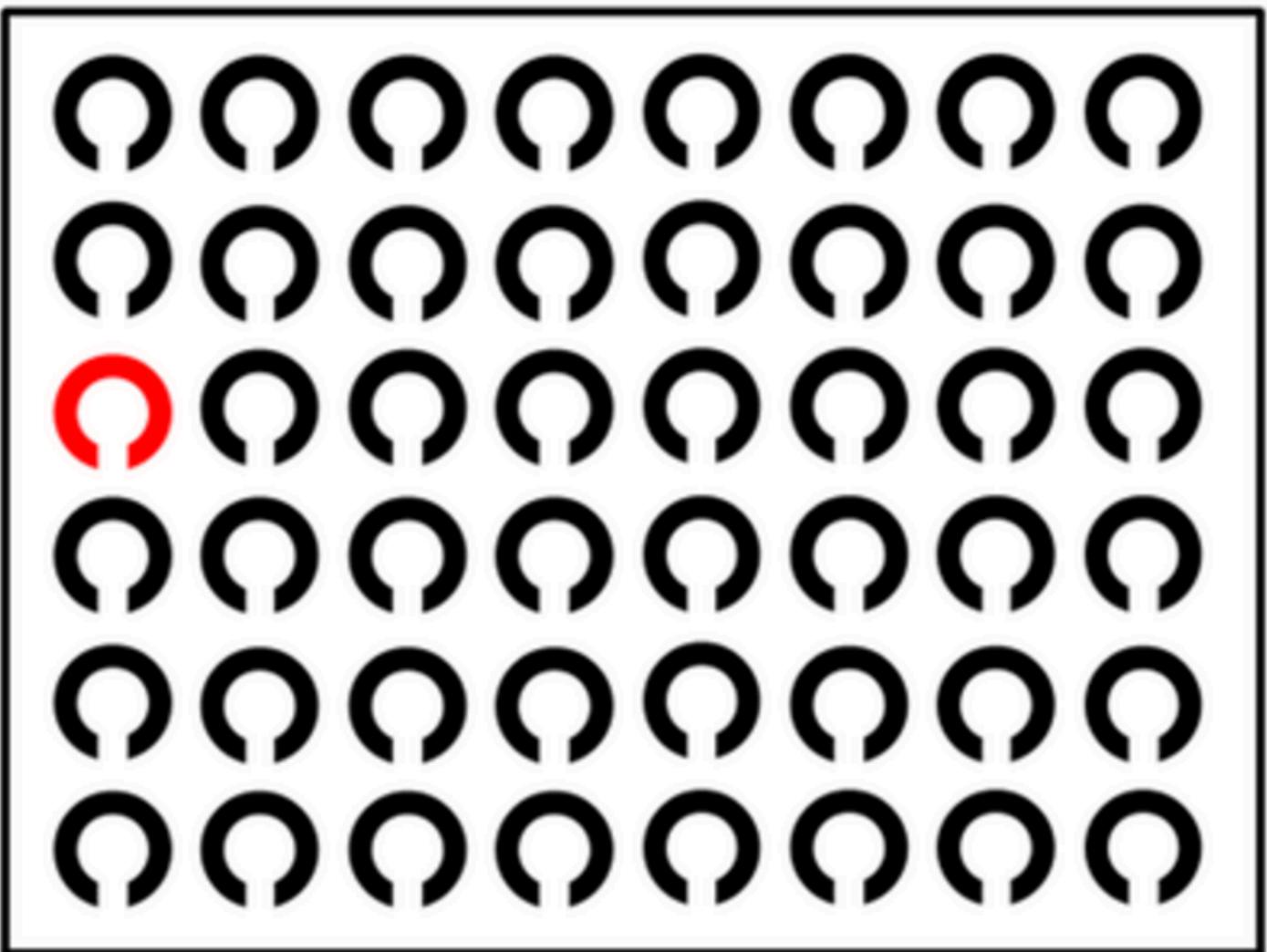
Where was the red Landolt figure?

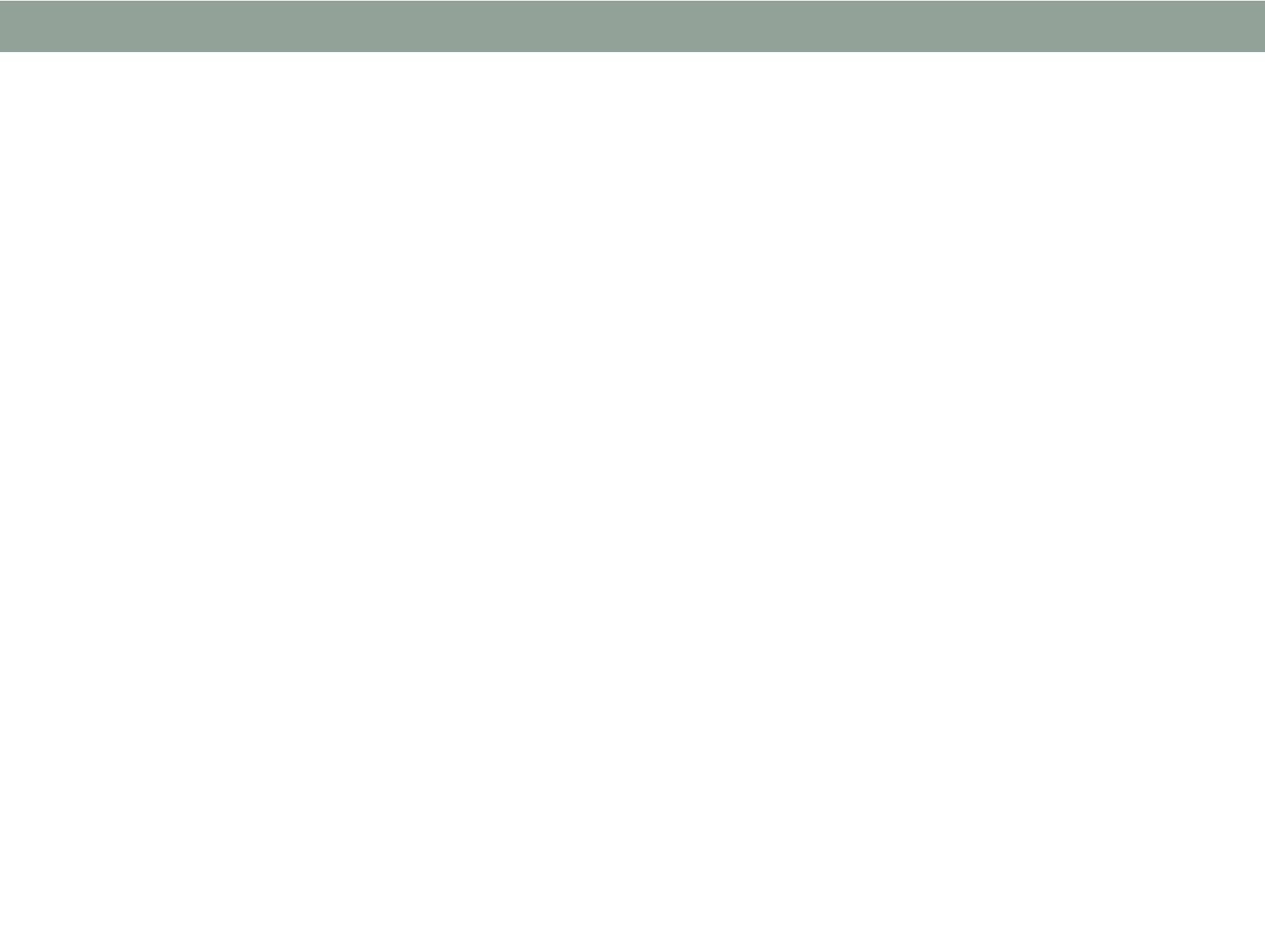
- A. Left side
- B. Right side

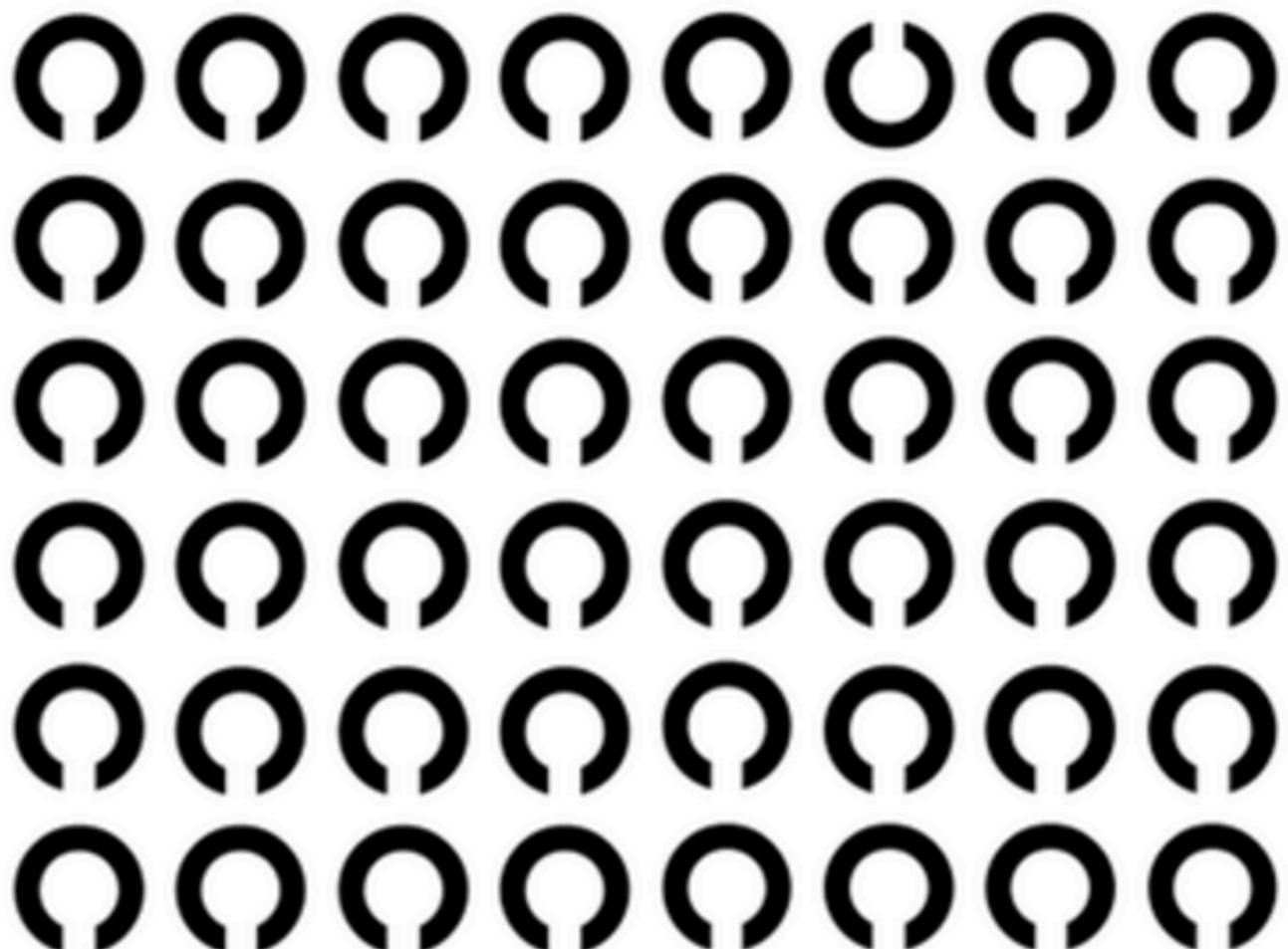
CLICKER QUESTION

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CLICKER QUESTION

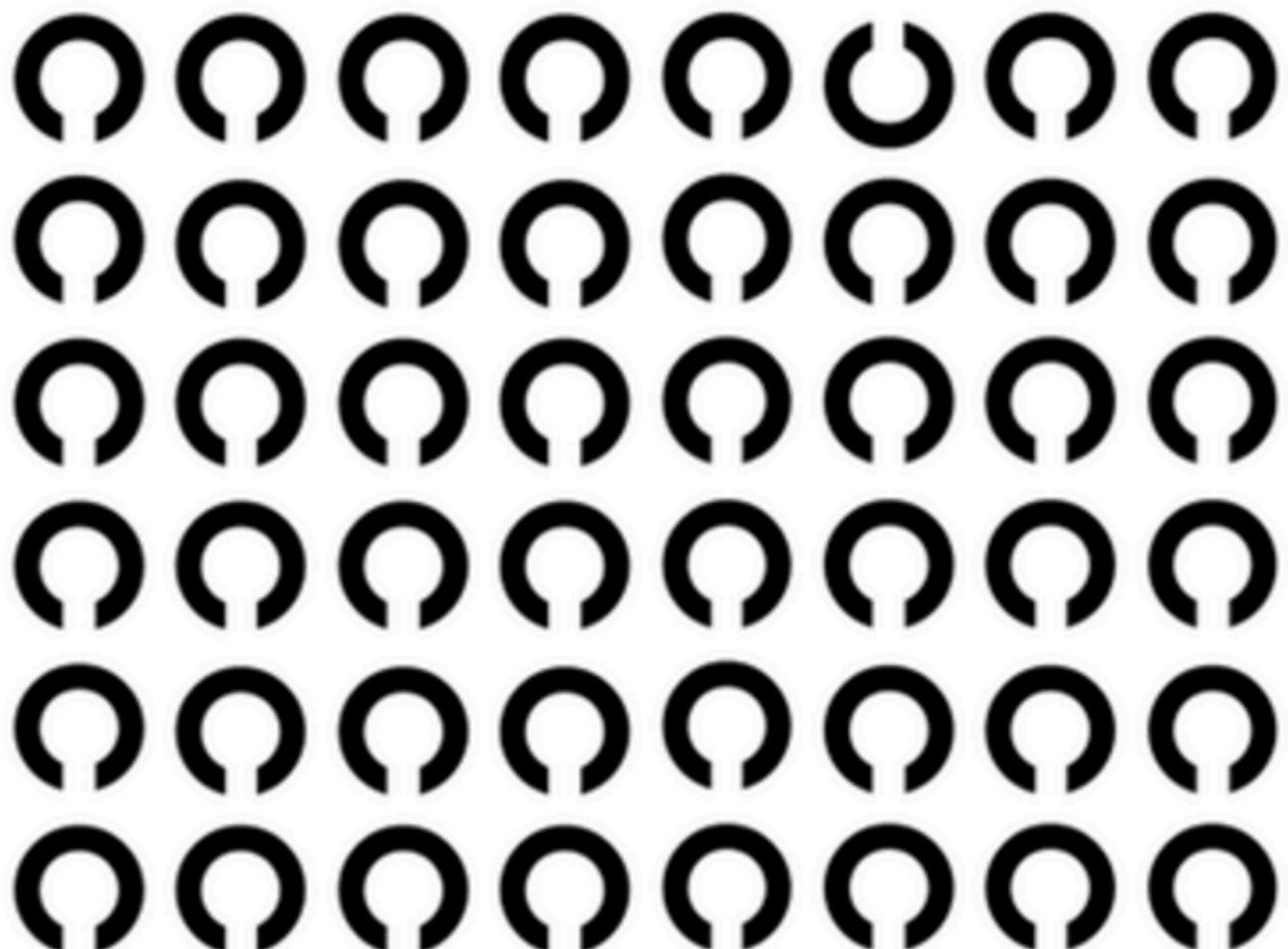
Where was the upside-down Landolt figure?

- A. Top
- B. Bottom

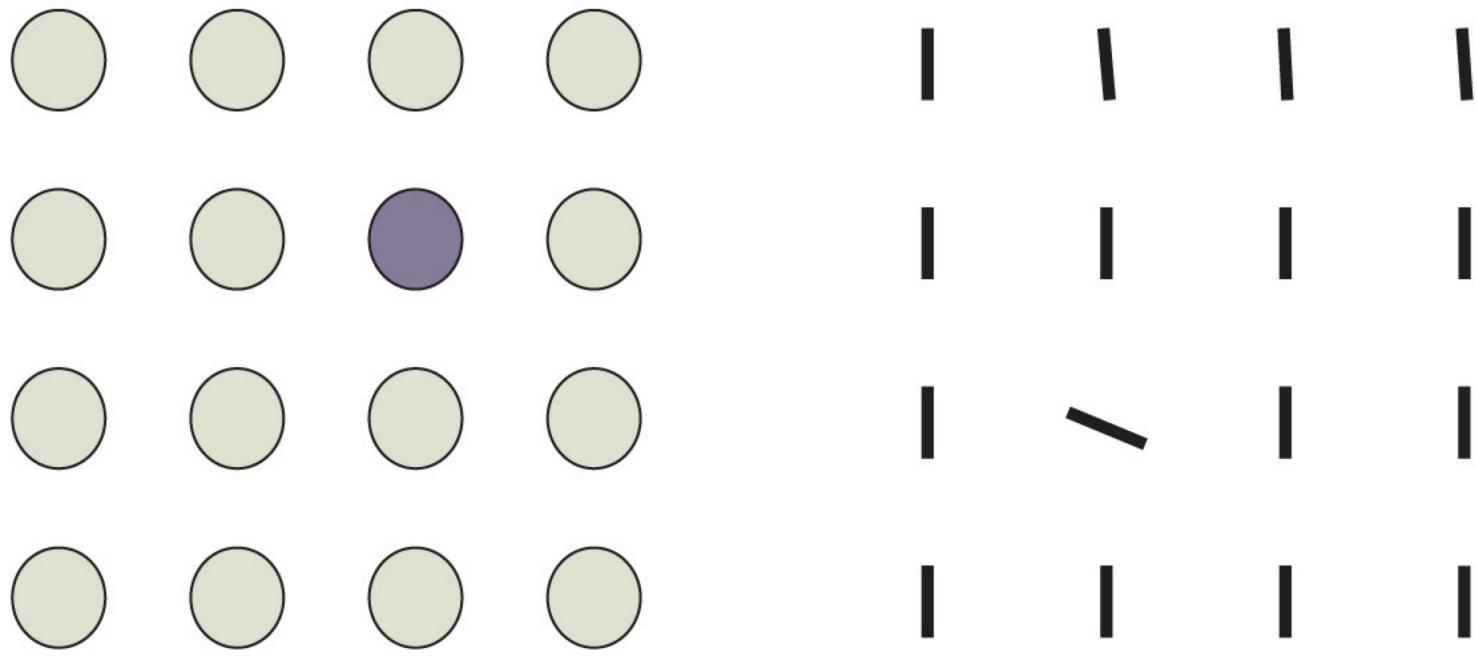
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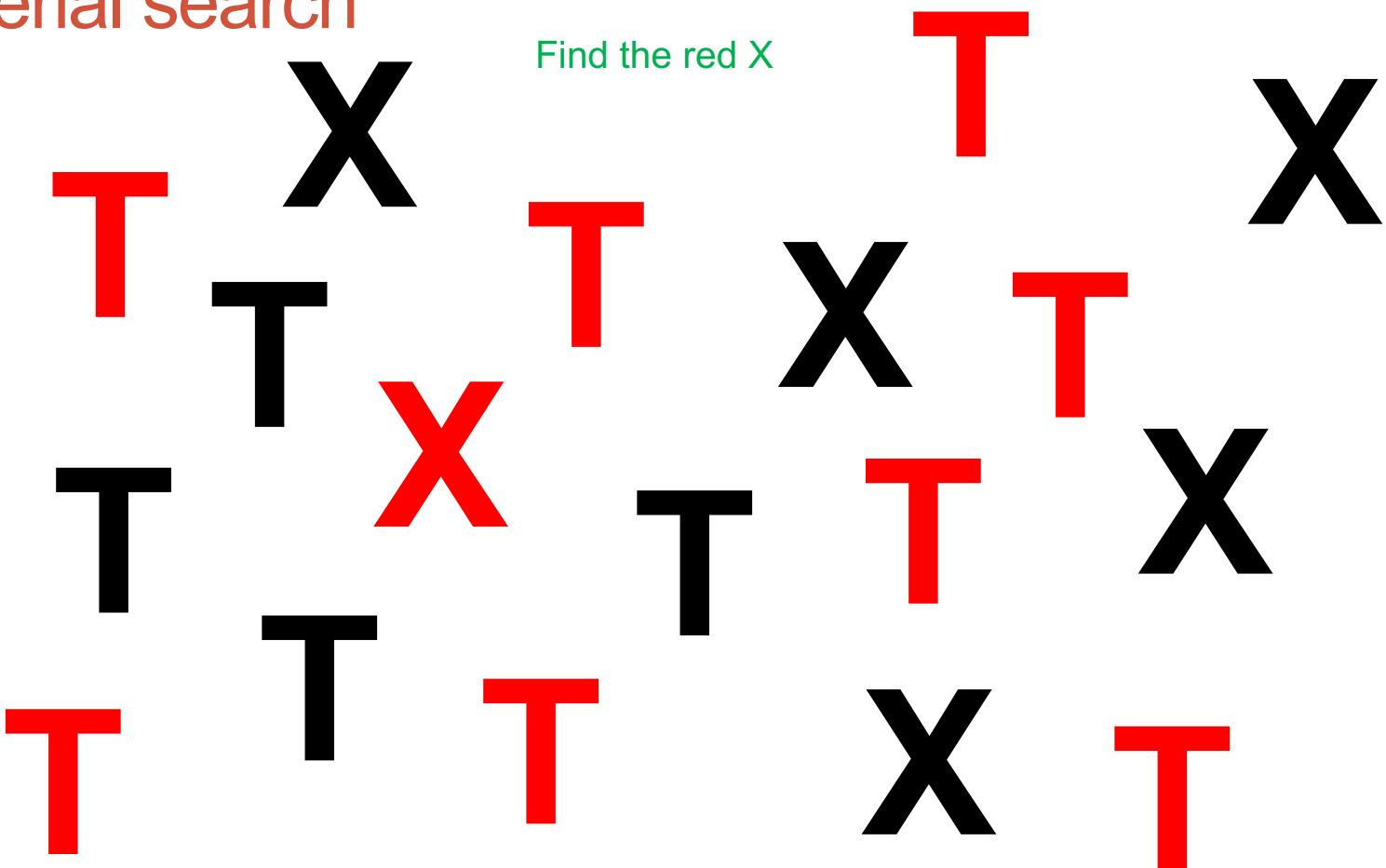
Simple features ‘pop out’



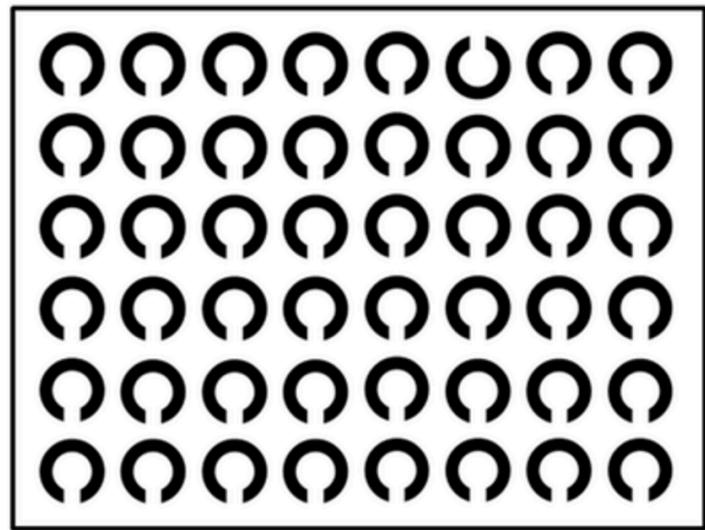
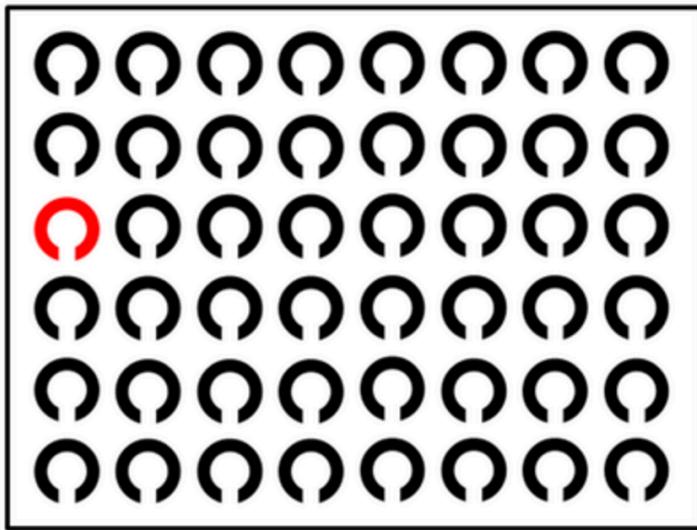
Color

Orientation

Complex features and conjunctions require serial search



Pop-out and serial search attention have different neural mechanisms



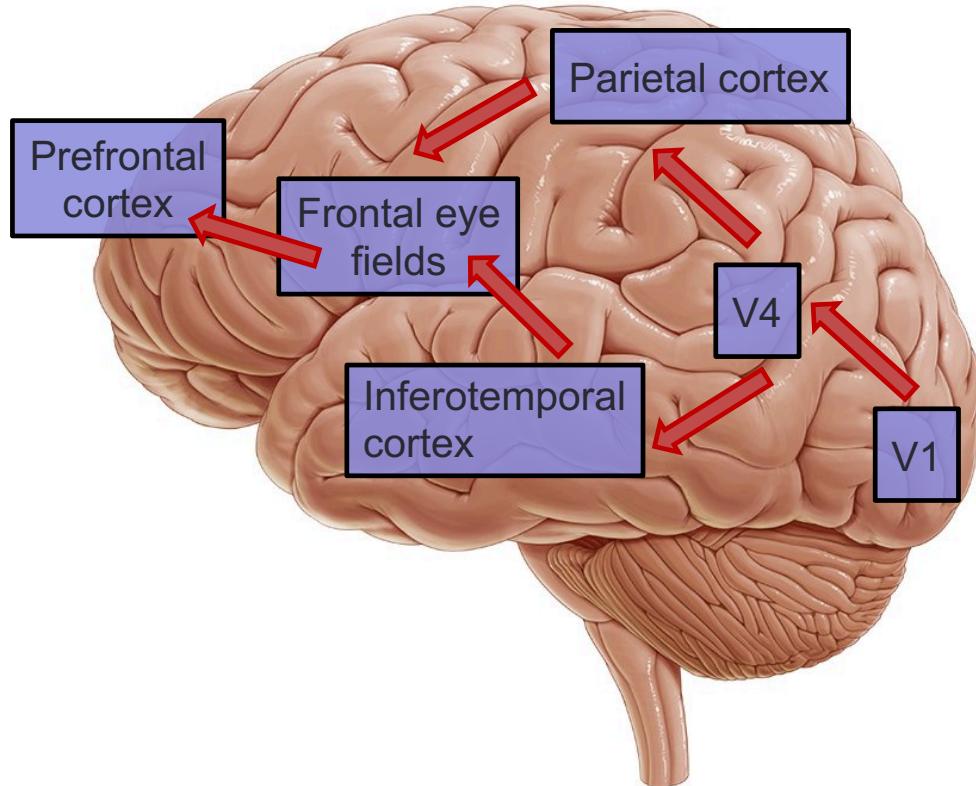
Pop-out search is bottom up

Attention is controlled
by visual cortex

Serial search is top down

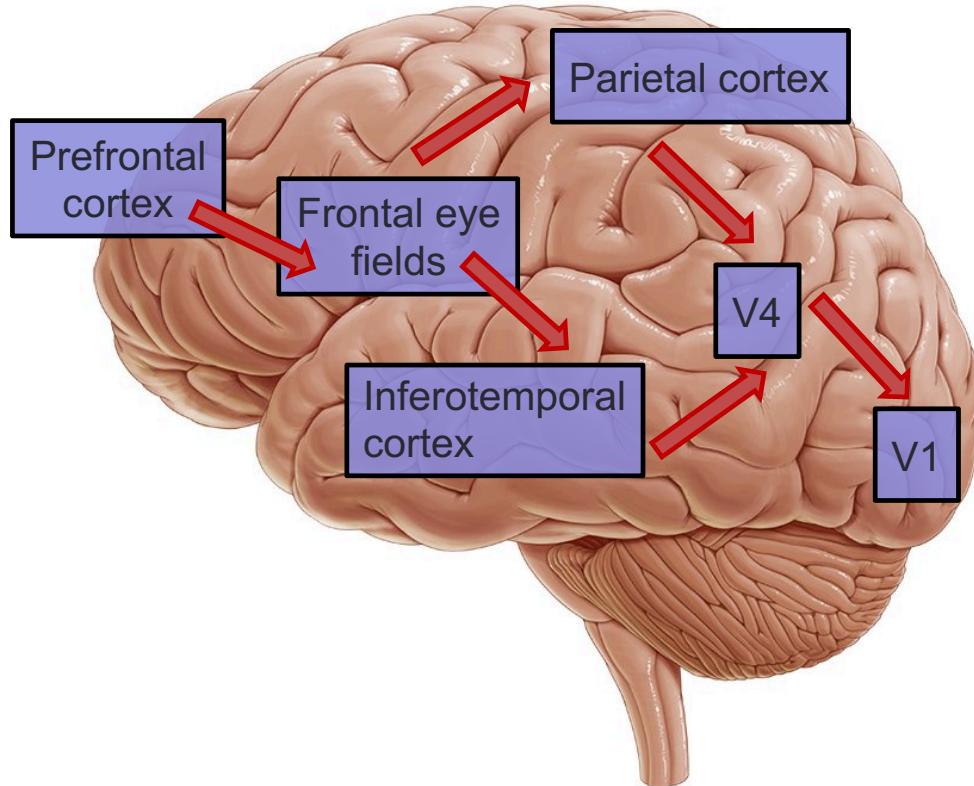
Attention is controlled
by frontal cortex

Bottom-up attention



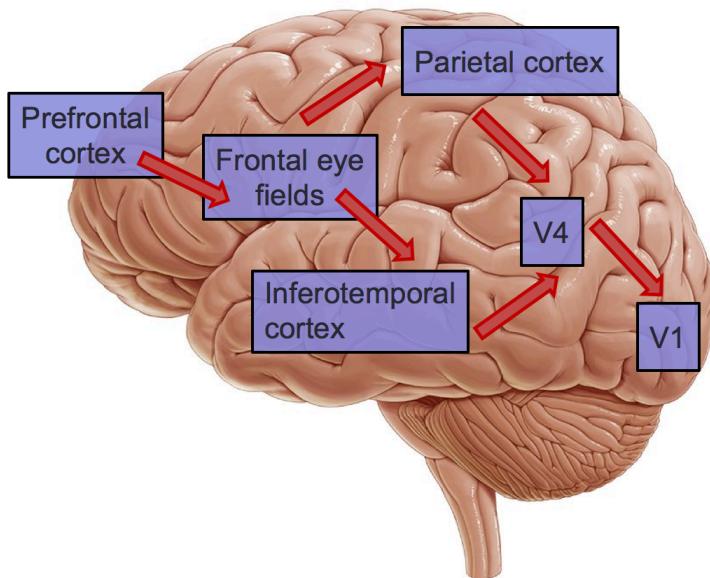
Initiated in sensory cortex, driven by stimulus

Top-down attention



Initiated in frontal cortex, driven by internal goals

Top-down attention



Prefrontal cortex sends signals to other brain areas to direct the focus of attention

Frontal eye fields implement eye movements and directed attention

Parietal cortex constructs a visual salience map: what features of the visual world should receive prioritized processing?

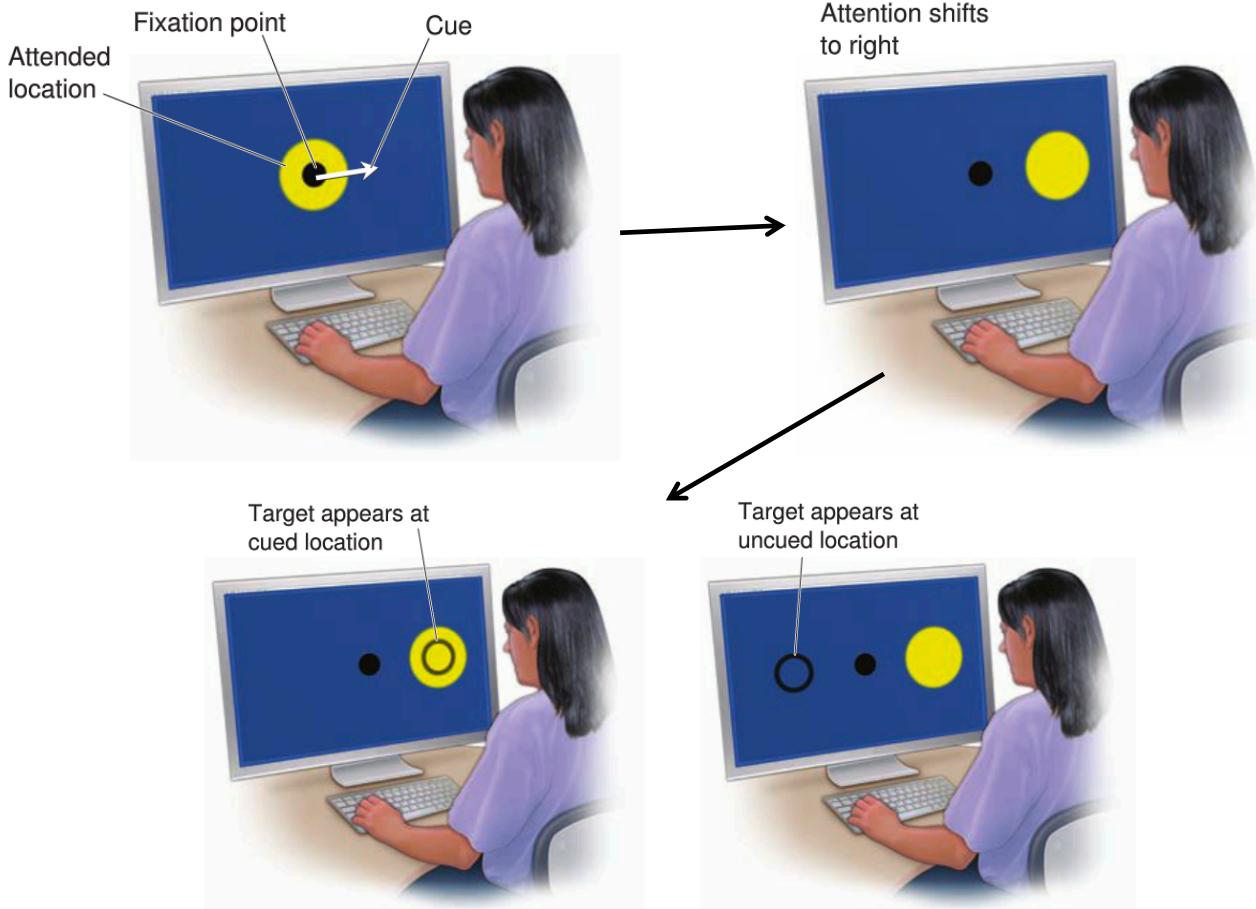
Initiated in frontal cortex, driven by internal goals

How does attention affect sensory processing?

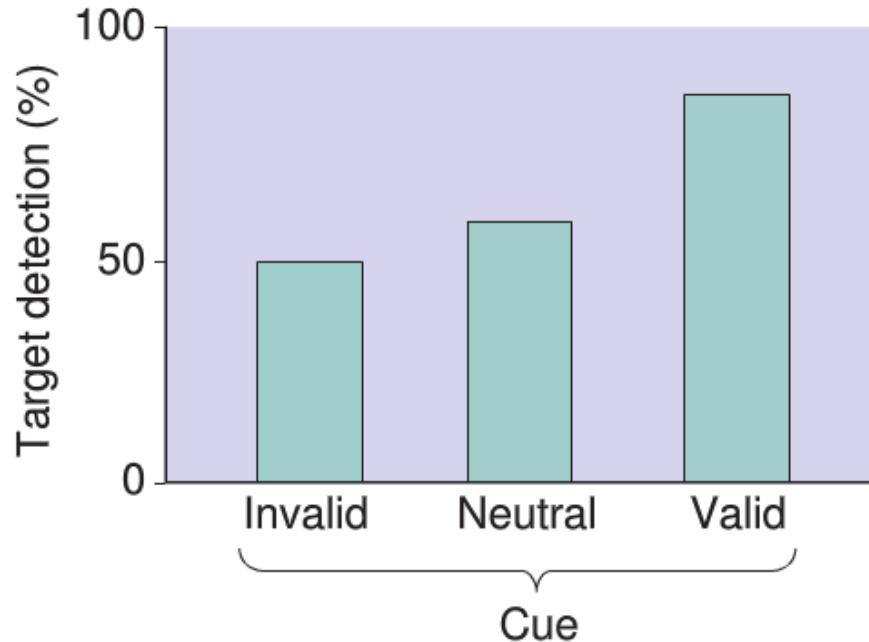
Attention to a location in space:

- Improves the ability to detect that something has changed at that location
- Shortens the time it takes to react to changes at that location

The effect of attention on visual detection

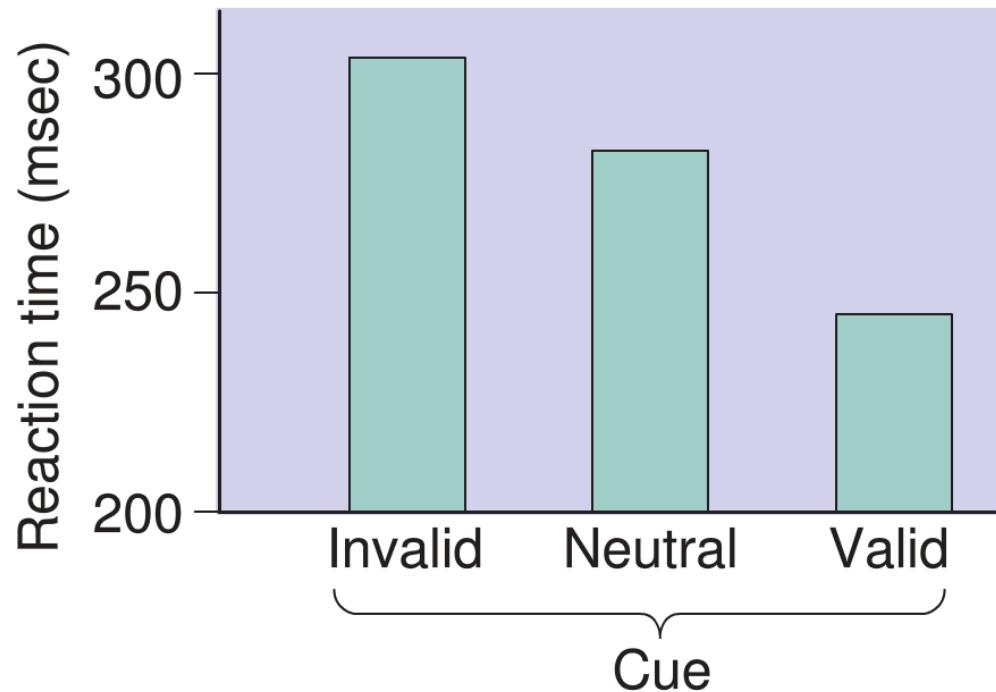


The effect of attention on visual detection



Attention increases our visual sensitivity, and makes things easier to detect

The effect of attention on reaction time



Attention decreases reaction time

How does attention affect neural activity?

Spotlight of attention can influence brain activity



Subjects in fMRI scanner

Instructed to keep their eyes pointed at the center of the circle for the whole task.

Pattern in all sectors changed every 2 seconds

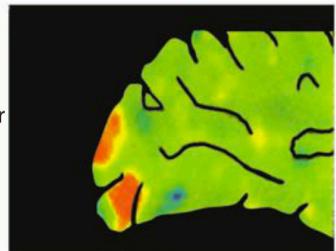
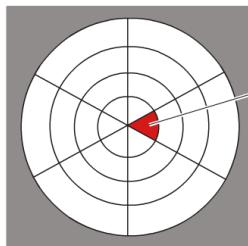
- Blue or orange
- Horizontal or vertical

Subjects cued to attend to one sector. Location of cued sector changed periodically.

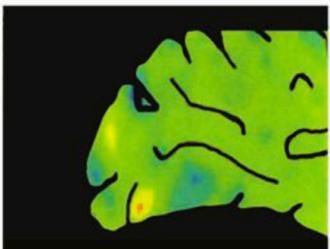
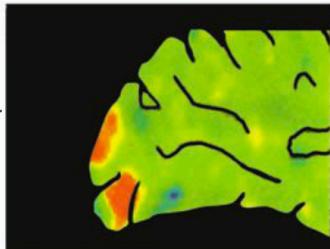
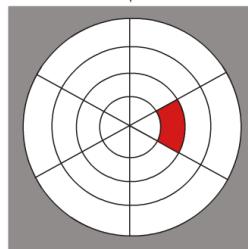
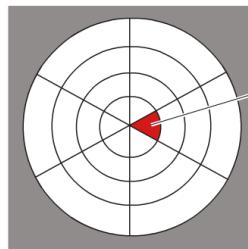
Task:

- Press one button when lines were:
 - blue and horizontal
 - or orange and vertical
- Press the other button when lines were:
 - blue and vertical
 - or orange and horizontal

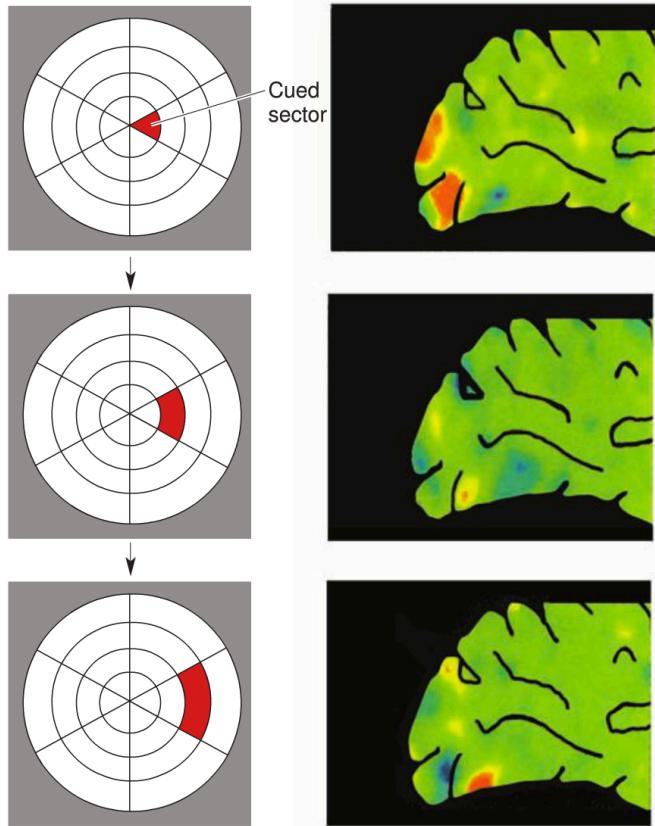
Spotlight of attention



Spotlight of attention



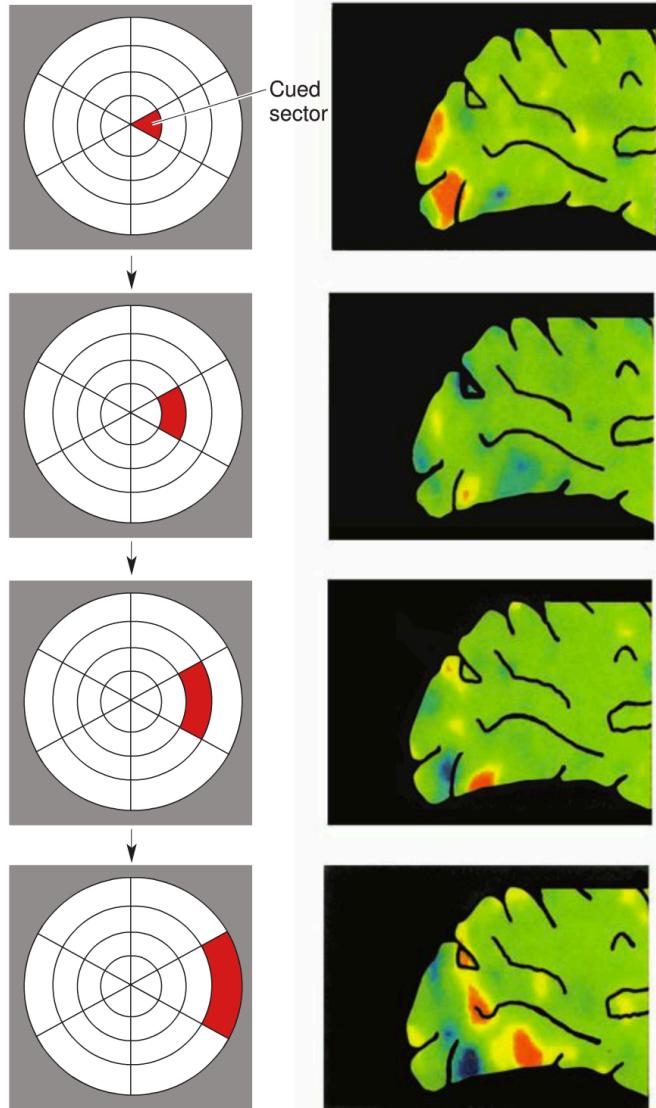
Spotlight of attention



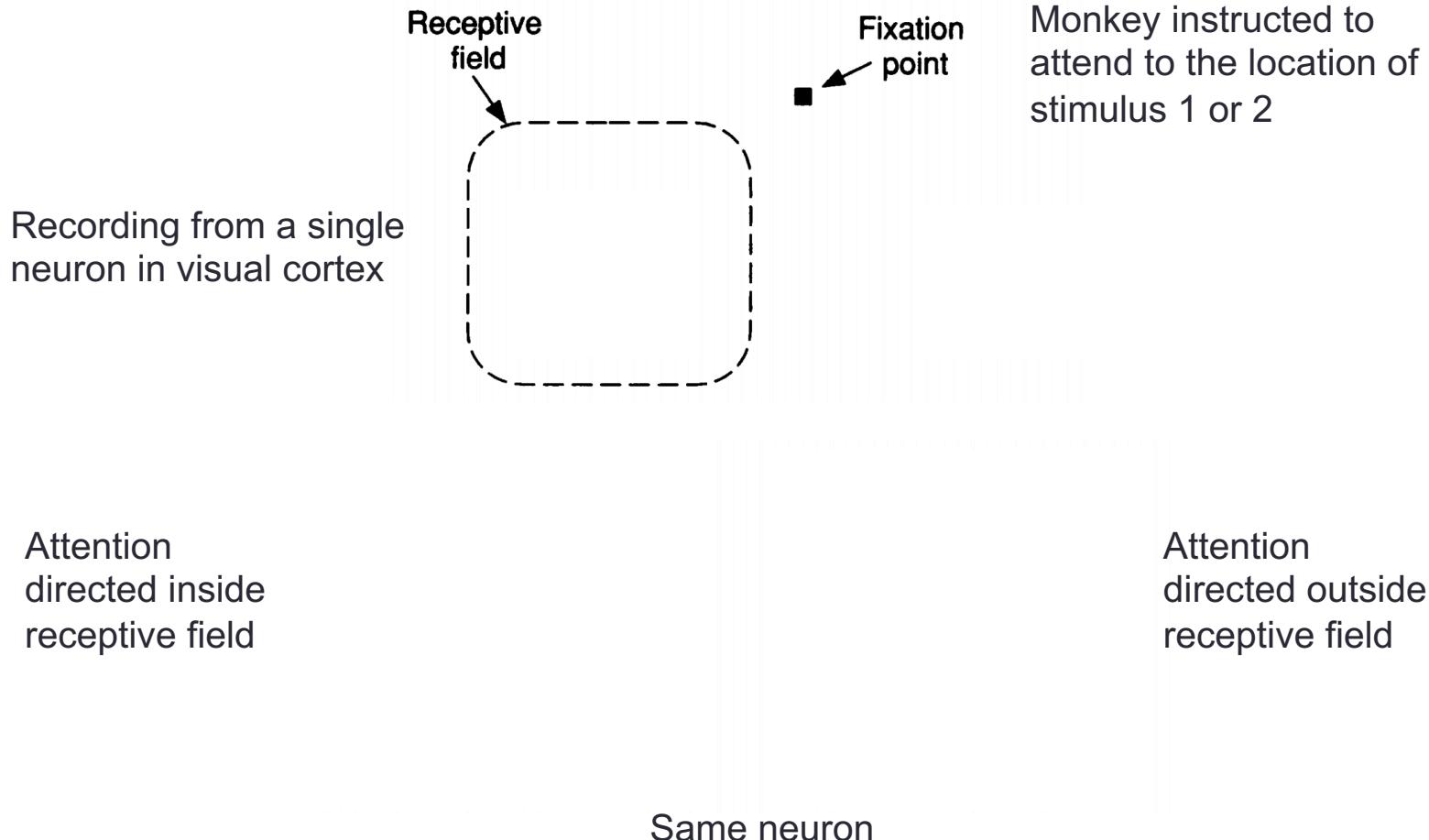
Spotlight of attention



The occipital pole represents areas of space near the center of the visual field, and becomes more active when attention is focused there.

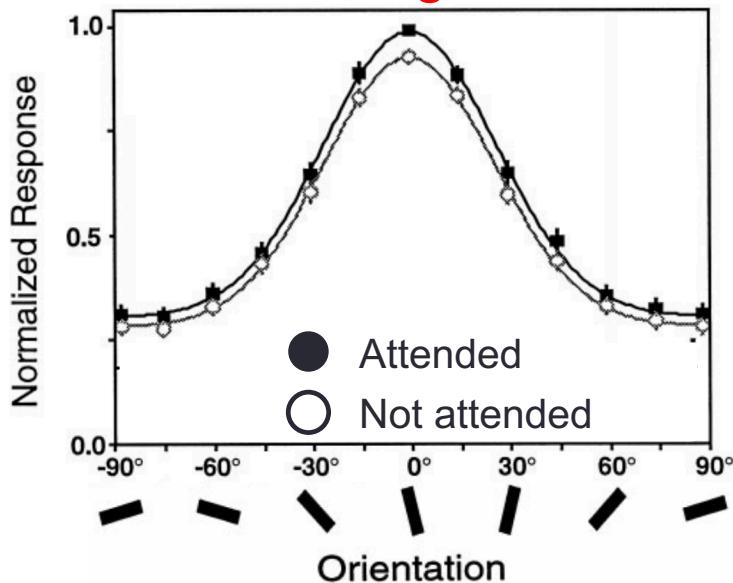


Spatial attention amplifies how single neurons respond to visual stimuli

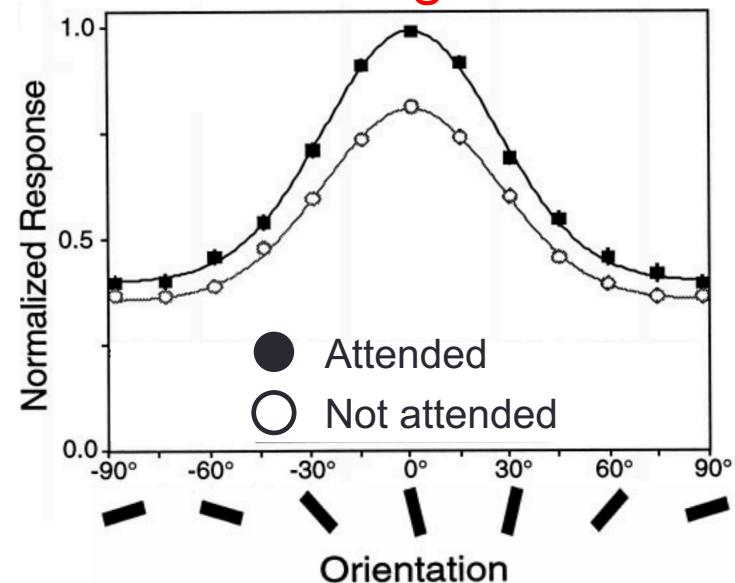


Attentional amplification increases as we ascend the visual hierarchy

V1 tuning curve



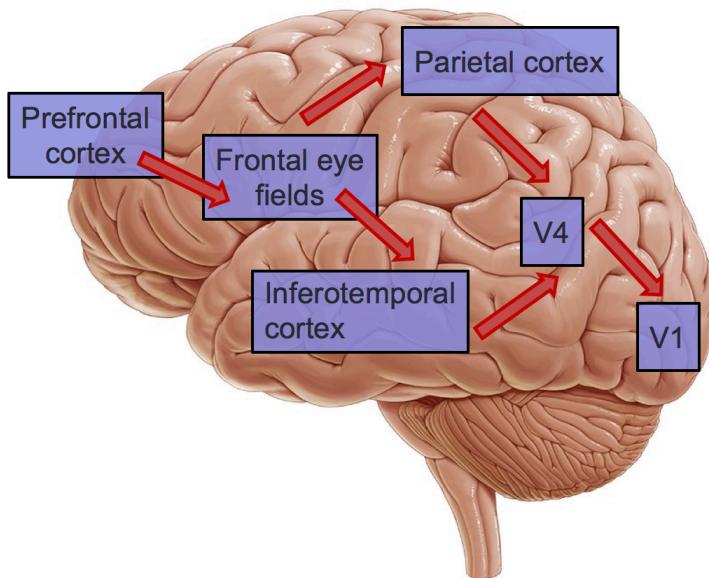
V4 tuning curve



Response to oriented bar at different orientations
0 degrees = preferred orientation (highest firing rate)

How is attention voluntarily directed?

Top-down attention



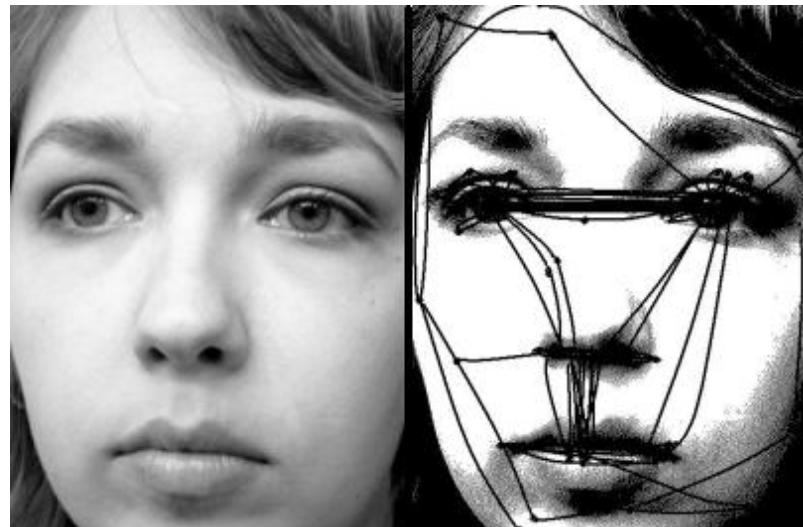
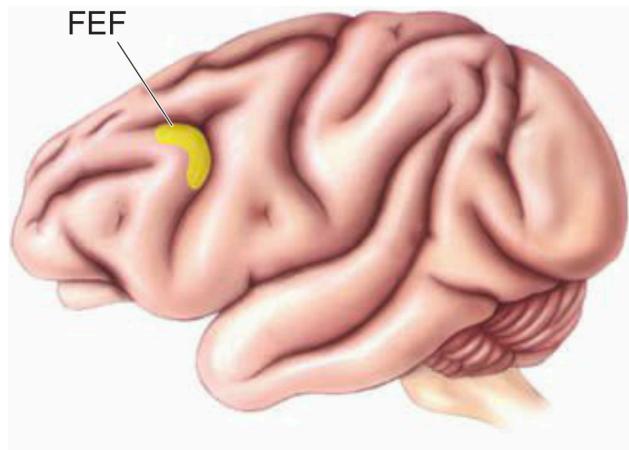
Prefrontal cortex sends signals to other brain areas to direct the focus of attention

Frontal eye fields implement eye movements and directed attention

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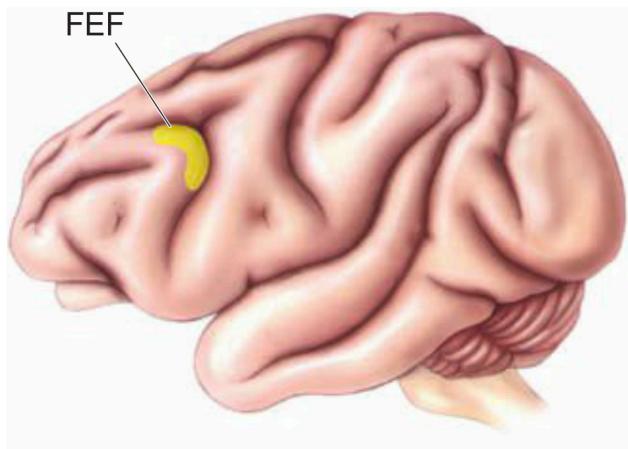
Initiated in frontal cortex, driven by internal goals

Frontal eye fields (FEF)

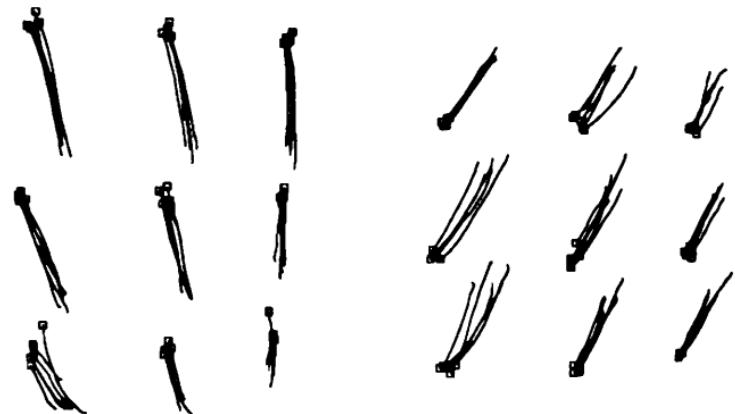


Eye-movement center in frontal cortex

Frontal eye fields (FEF)



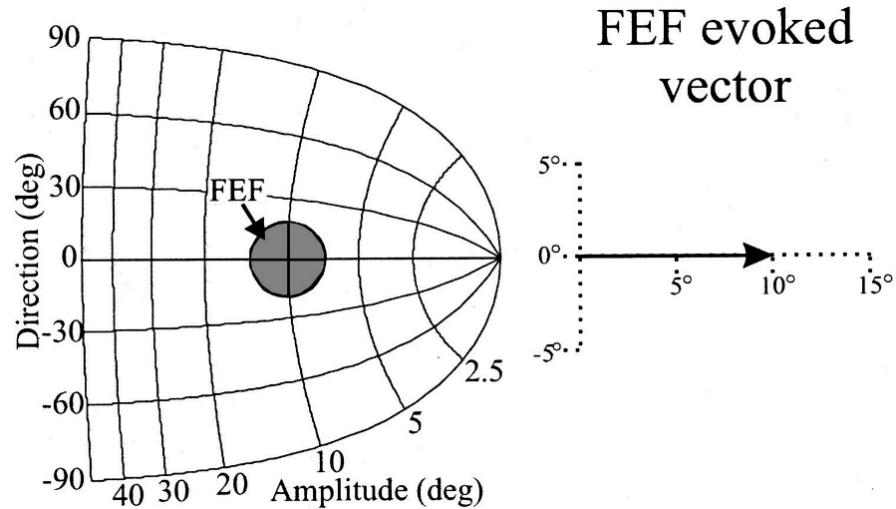
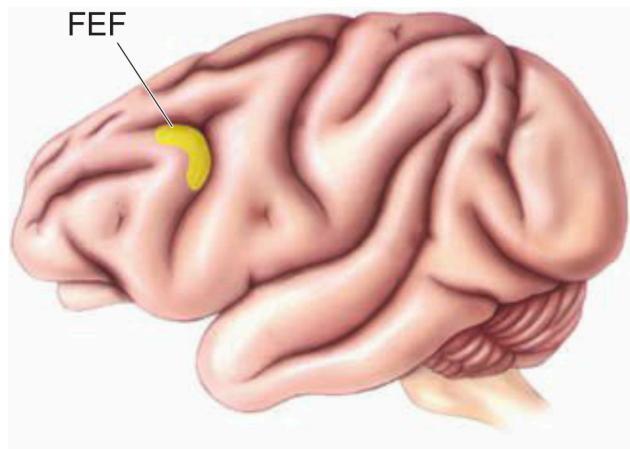
FEF site 1	FEF site 2
Threshold	Threshold
Current used	Current used



Eye-movement center in frontal cortex

Electrical stimulation at a given location in the FEF generates an eye movement with a specific amplitude and direction (a saccade)

Frontal eye fields (FEF)



Eye-movement center in frontal cortex

Electrical stimulation at a given location in the FEF generates an eye movement with a specific amplitude and direction (in other words, a vector)

FEF has a topographic map of stimulation-driven eye movements

Why is FEF control of eye movements important for attention?

Attention and gaze location are often coupled. We usually look at the things we are attending to (overt attention).

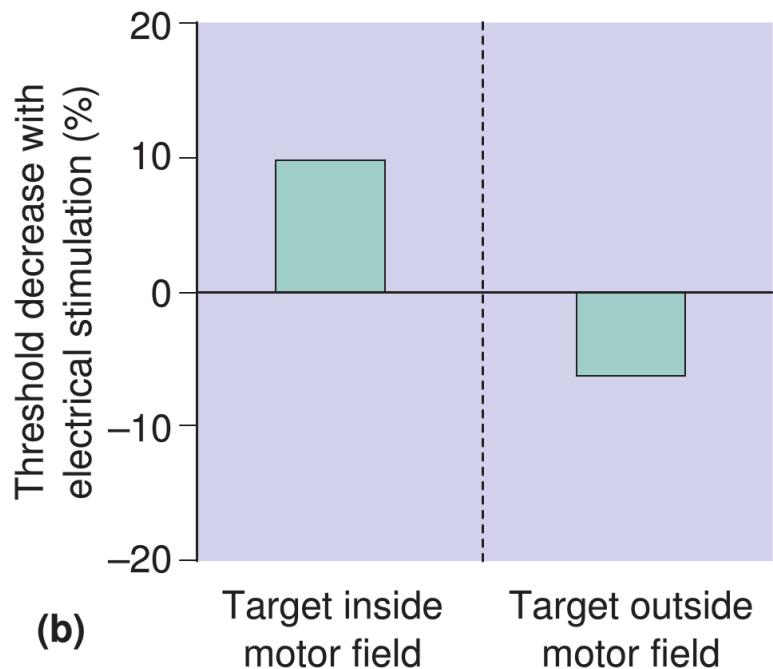
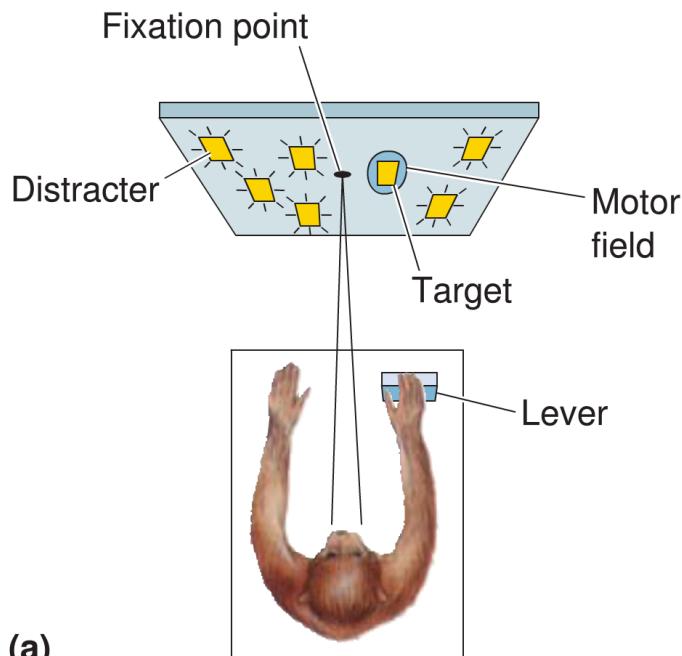
Sometimes attention is covert, and gaze doesn't reveal what we are attending to. This is called *covert attention*.

Whether attention is overt or covert, attention enhances visual processing at that location.

Strong stimulation (above threshold) of frontal eye fields directs gaze location

Weak stimulation (below threshold) of frontal eye fields directs attention but not gaze location

Frontal eye field stimulation alters perceptual thresholds



Subthreshold stimulation of FEF makes you attend to a spatial location!

Consciousness



anger

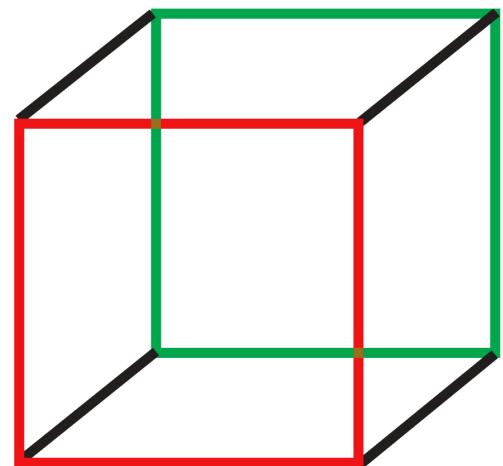
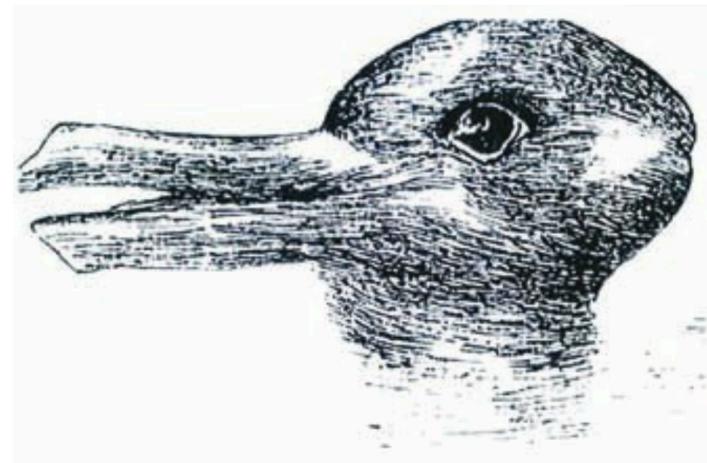


fear



happiness

Ambiguous stimuli and perceptual rivalry



THE DRESS



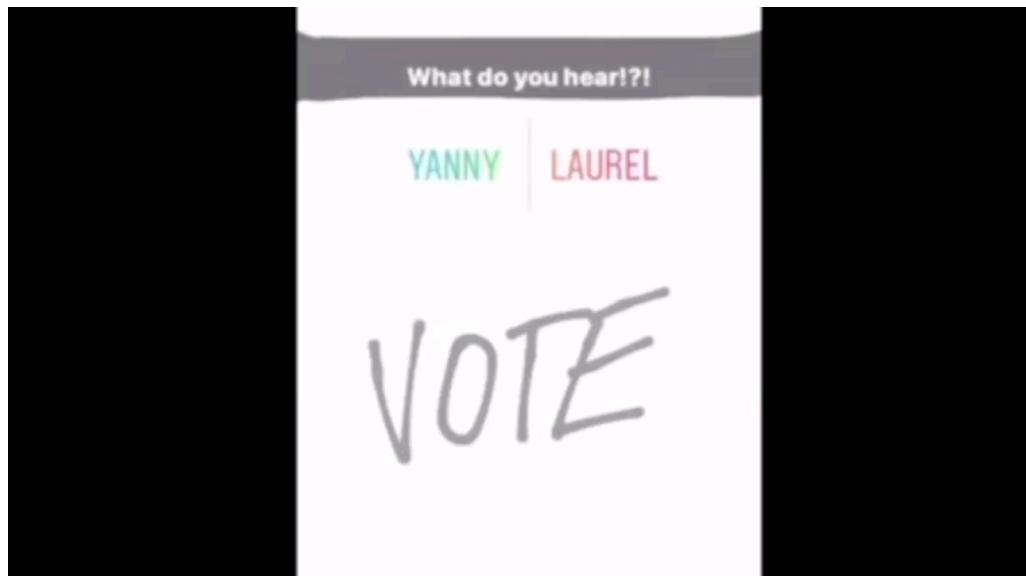
CLICKER QUESTION

Is this dress:

- A. White and gold?
- B. Blue and black?



Laurel vs Yanny – CLICKER QUESTION



Do you hear
A. Laurel
B. Yanny

Area IT and the fusiform face area in ventral stream complex receptive fields: orientation/color; faces



Does neural activity in inferotemporal cortex change when conscious perception changes?

Binocular Rivalry

Merge me!



Merge me!



Merge me!

Merge me!

Neural correlates of binocular rivalry

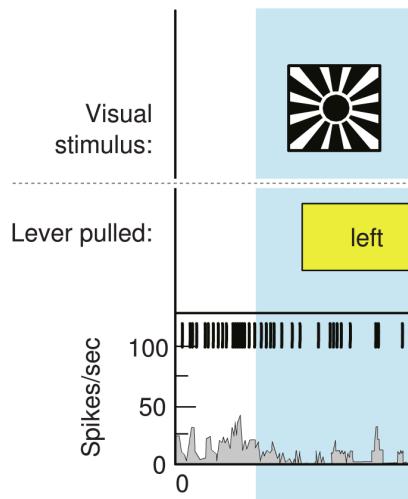


Monkey presses left lever



Monkey presses right lever

Responses of a monkey inferotemporal (IT) neuron during binocular rivalry



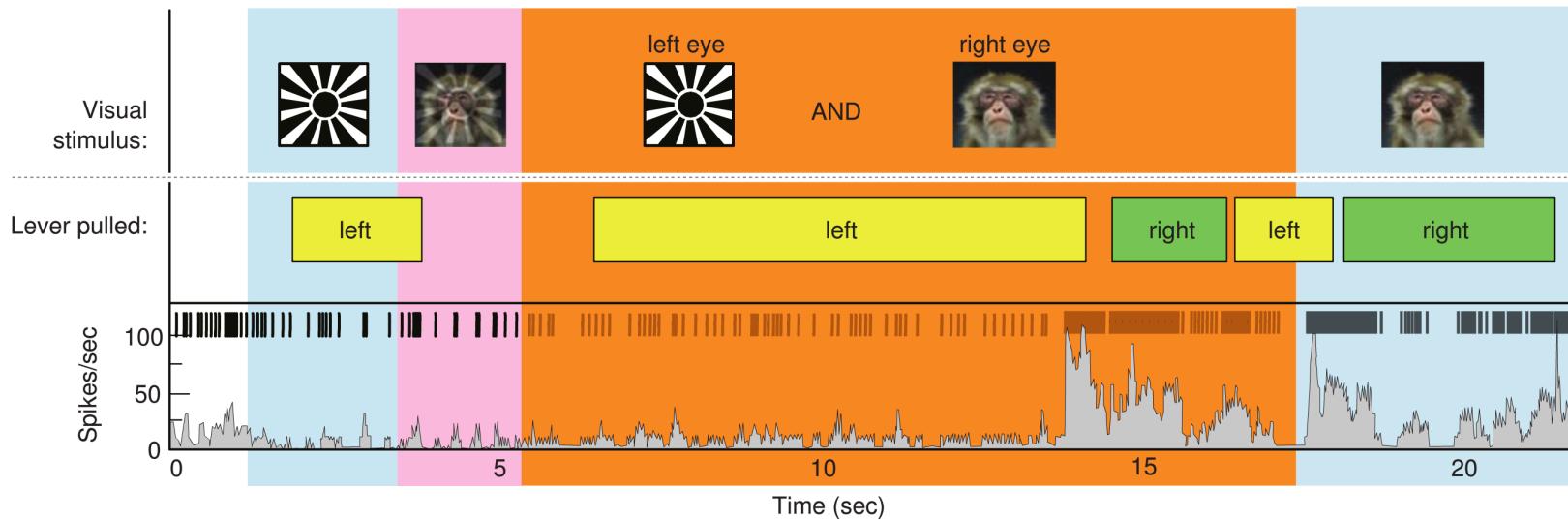
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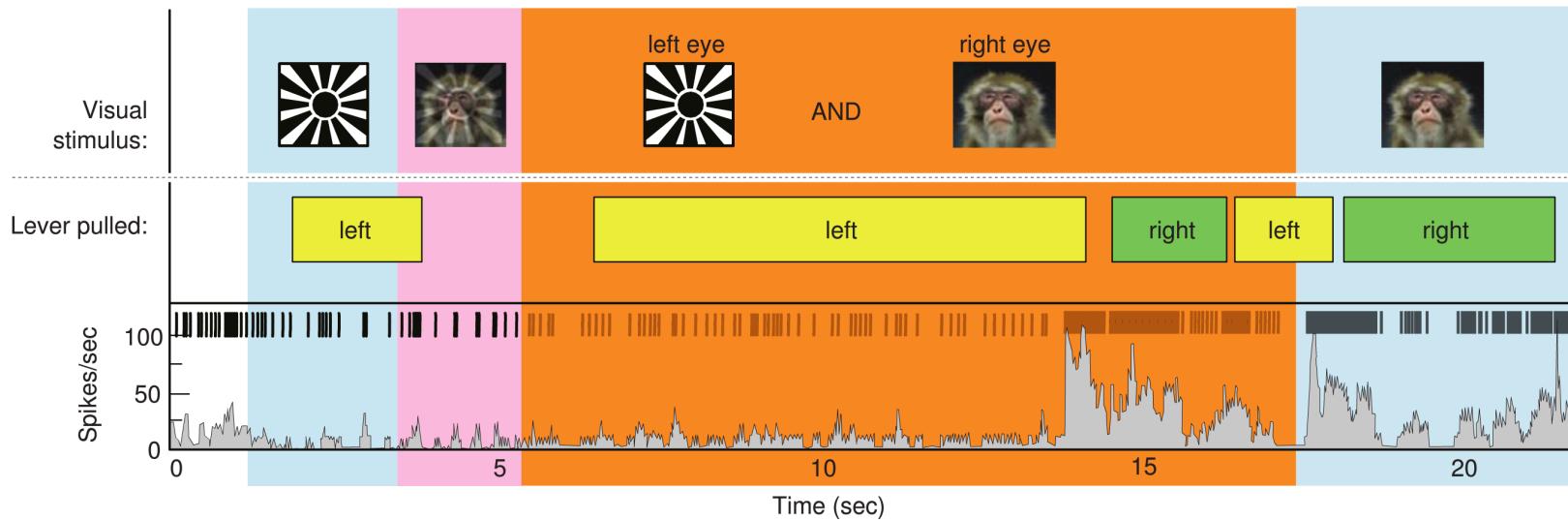
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What do these data suggest about this neuron?

- A. Firing rate increases each time the starburst is shown
- B. Firing rate increases each time the monkey face is shown
- C. Firing rate increases each time the starburst is perceived
- D. Firing rate increases each time the monkey face is perceived

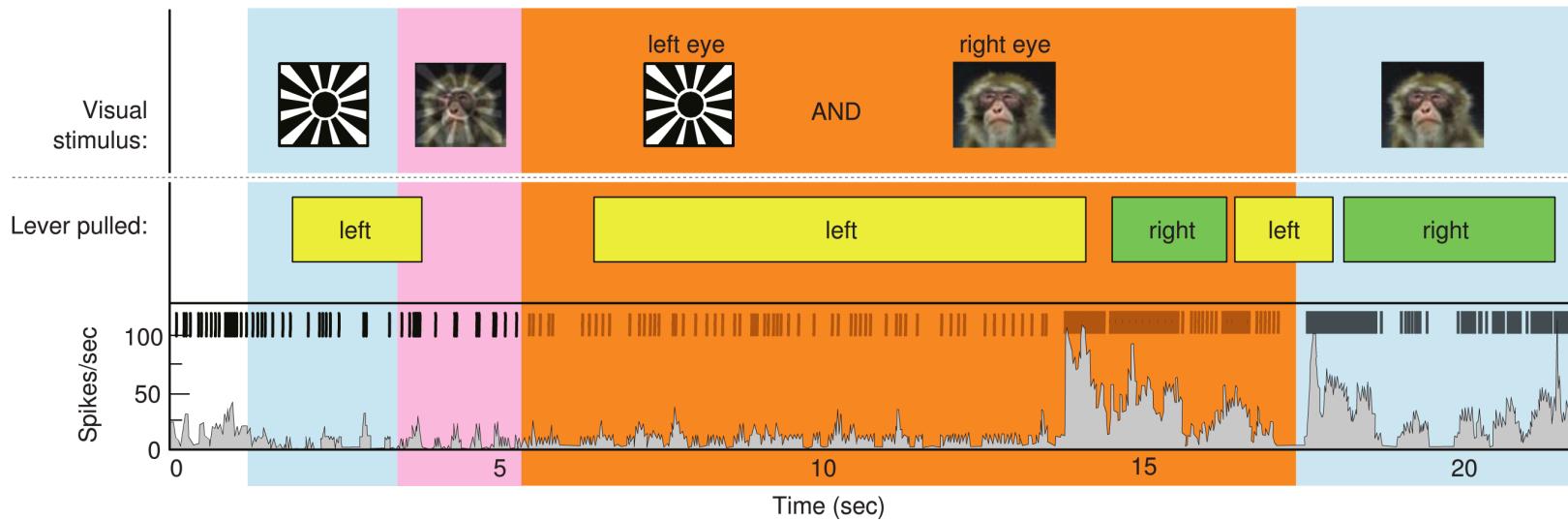
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Responses of a monkey inferotemporal (IT) neuron during binocular rivalry



The firing rate of this neuron reflects the image that is dominating conscious awareness!