

# Key questions about attention

How does attention affect behavioral performance?

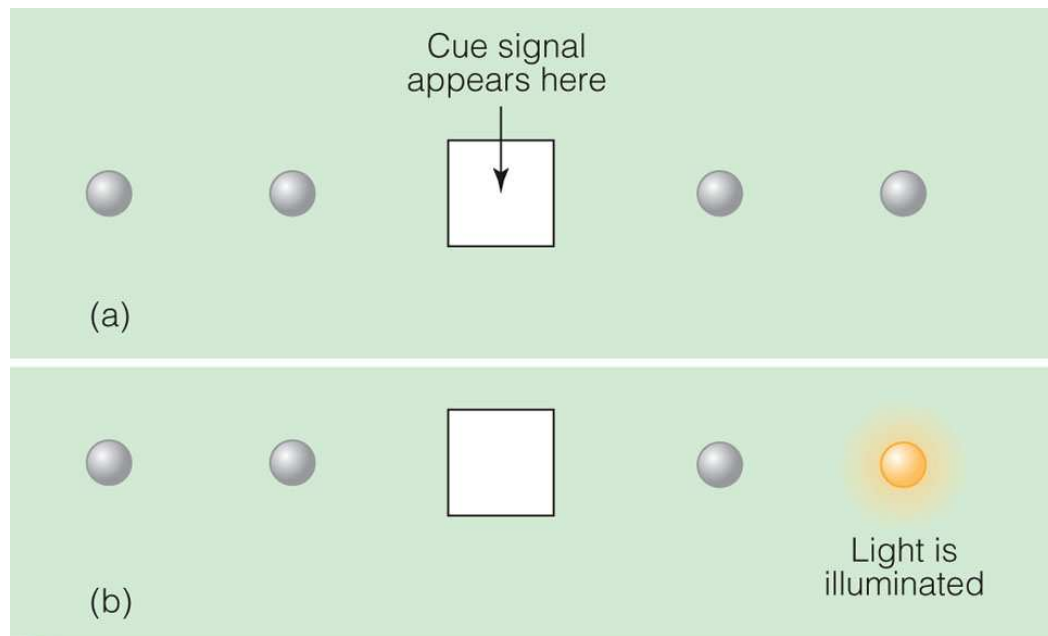
Can attention affect the appearance of things?

How does spatial and feature-based attention affect neuronal responses in the visual cortex?

Where in the brain are these top-down influences coming from?

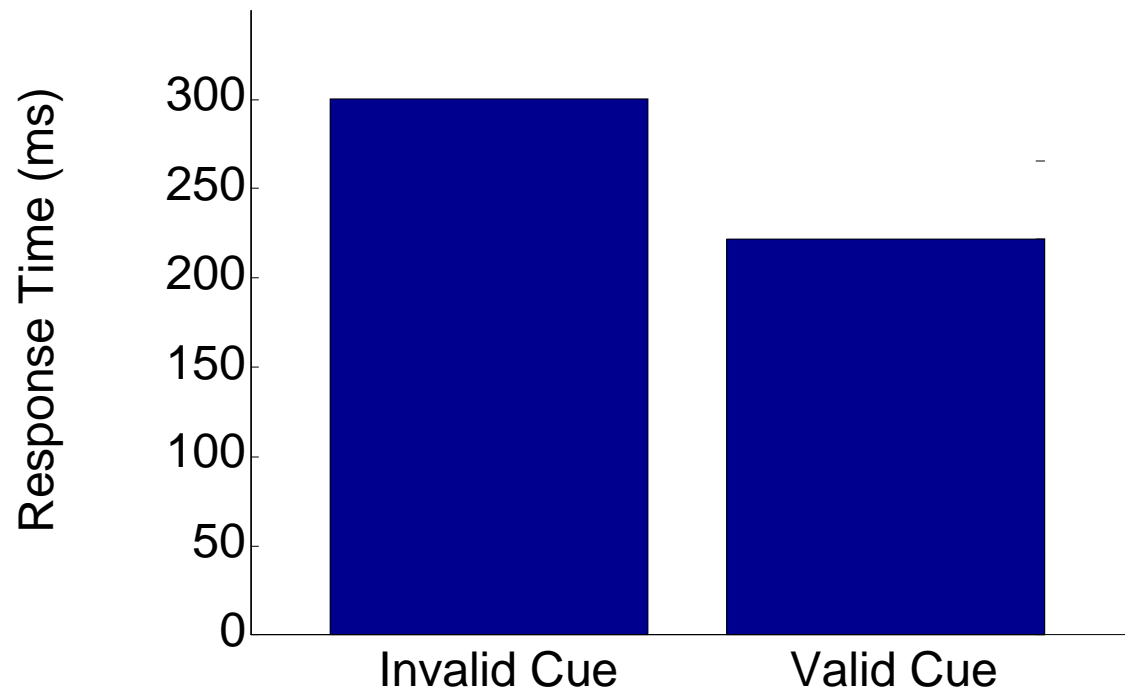
# How does attention help performance?

- Experiment by Posner et al.
  - Observers saw a square with two lights on each side
  - Precueing was used to indicate on which side the light would turn on (**endogenous** cue to attention)
  - Lights turned on consistent or inconsistent with the cue
  - Task was to push button when light was seen



## Experiment by Posner et al.

- Results showed that observers responded fastest when cue was consistent with light
- Information processing is most efficient where attention is directed



# Effects of Attention on Perception

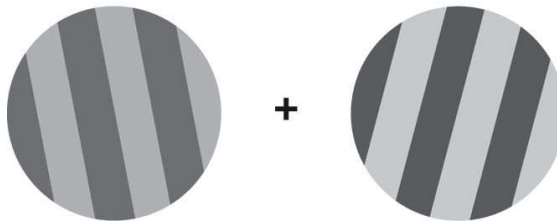
- Experiment by Carrasco et al.
  - Observers saw two grating stimuli with either similar or different contrast between the bars
  - Task was to fixate on center point between gratings and indicate orientation of bars with higher contrast
  - Small dot was flashed very quickly on one side before gratings appeared (**exogenous** cue to attention)

# Experiment by Carrasco et al.

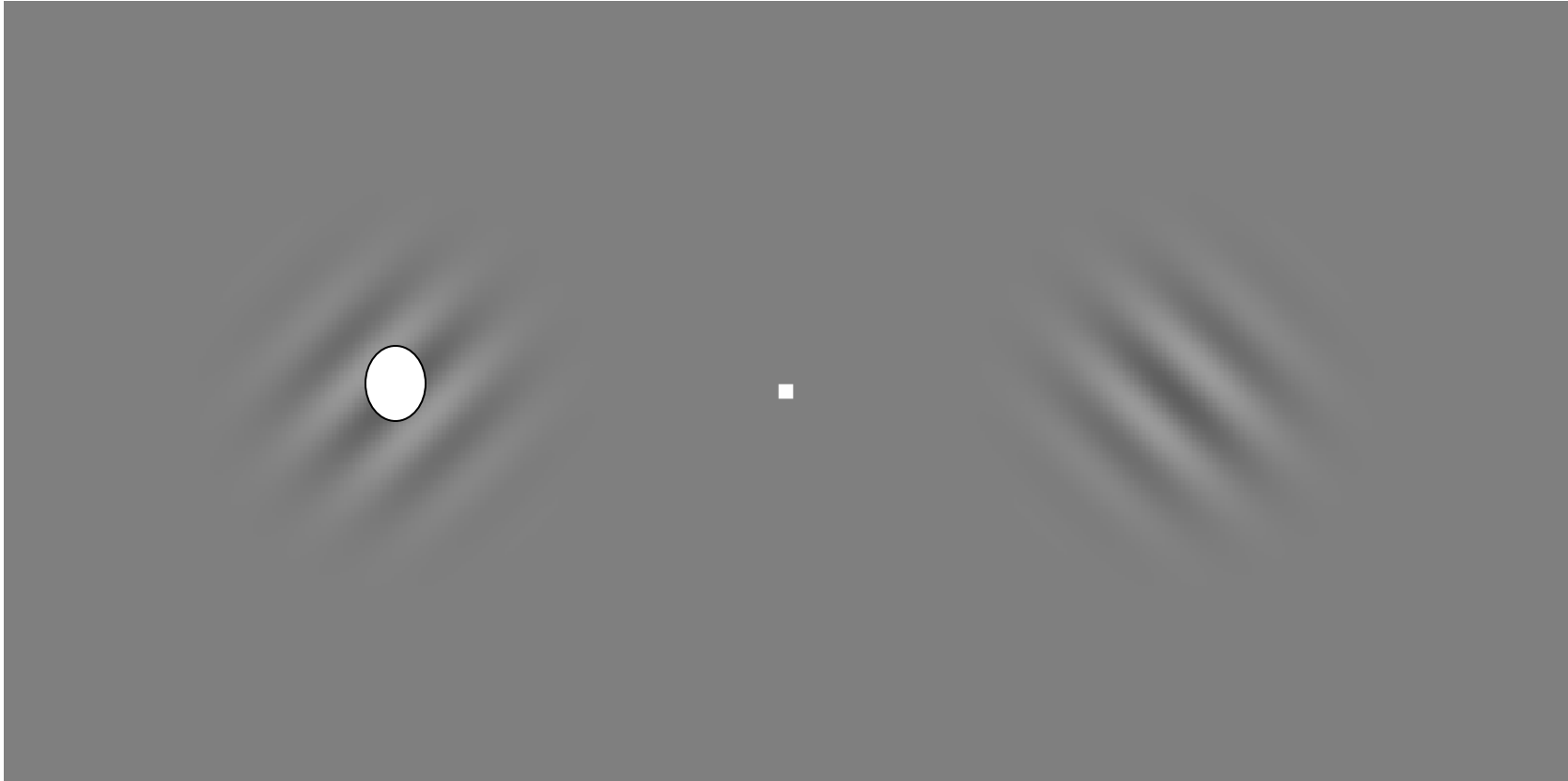
- Results showed that:
  - When there was a large difference in contrast, the dot had no effect
  - When the contrast was the same, observers were more likely to report that the grating preceded by the dot had higher contrast
  - Thus the shift of attention led to an effect on the perception



(a)



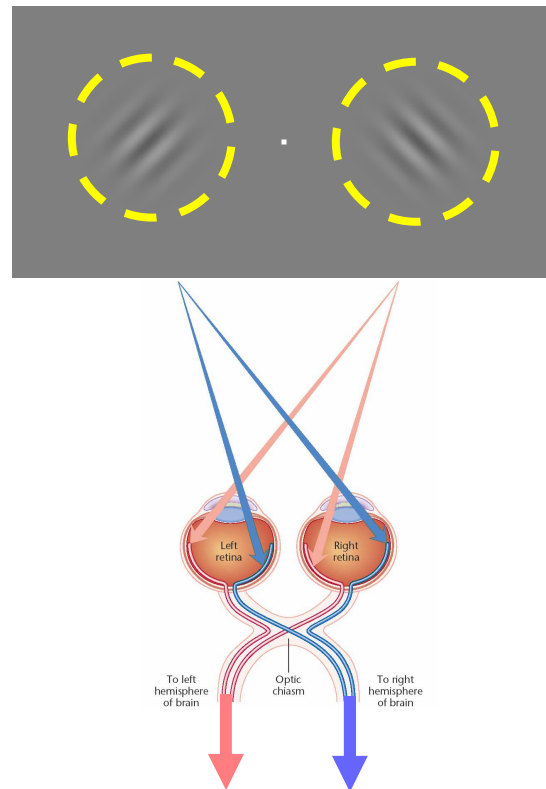
(b)



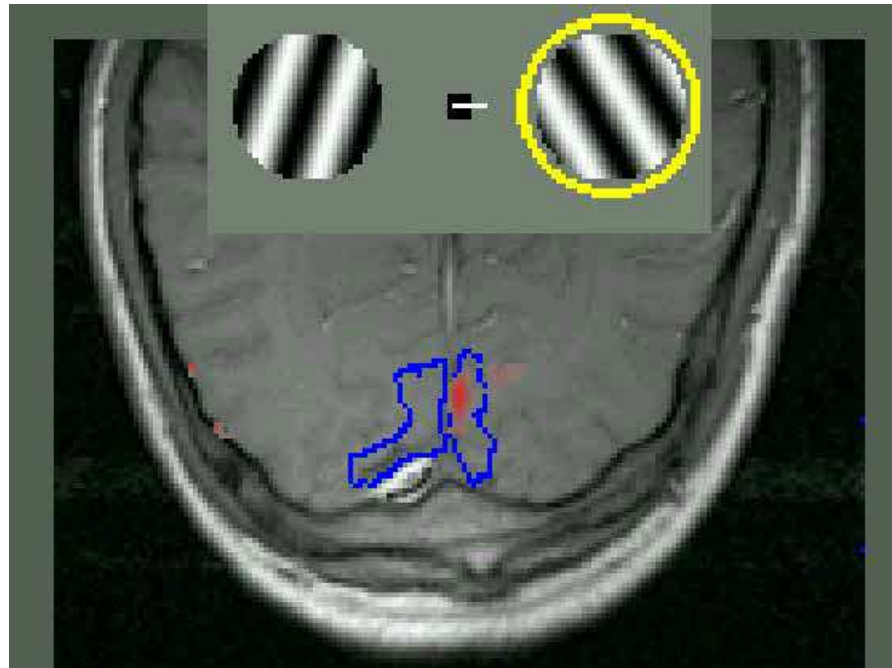
# How does **spatial attention** affect neuronal responses in the visual cortex?

fMRI experiment: present stimuli to left and right side of visual field at the same time.

Have subjects attend to one stimulus at a time (endogenous cue to spatial attention)



How does **spatial attention** affect neuronal responses in the visual cortex?

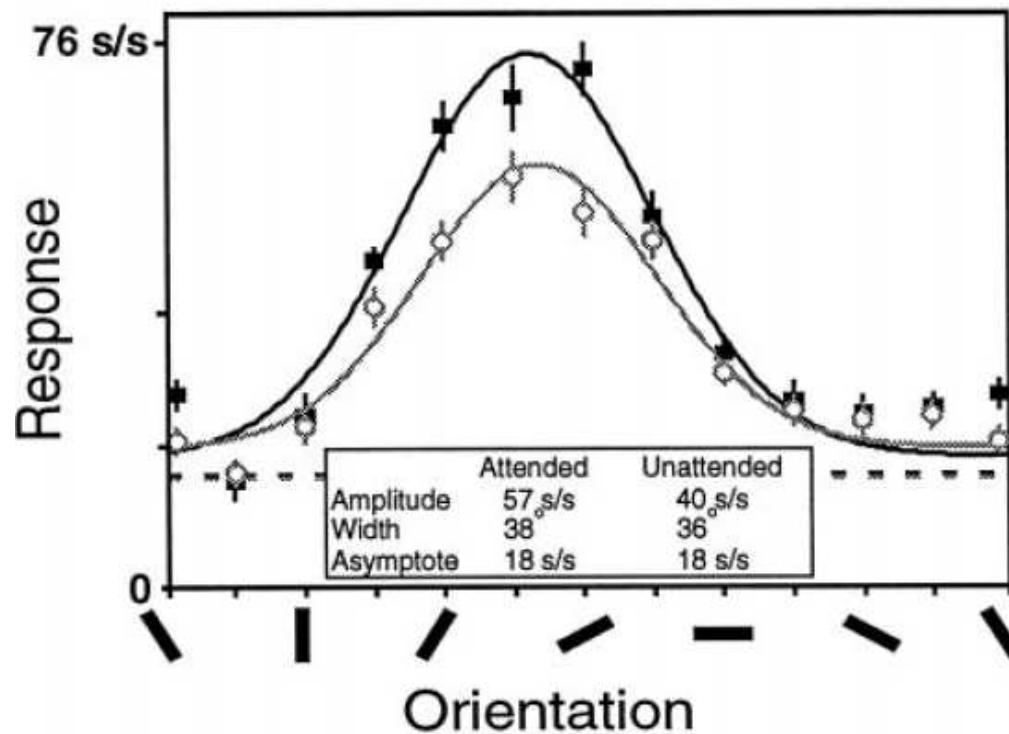


fMRI responses in V1 are increased by spatial attention



# How does **spatial attention** affect neuronal responses in the visual cortex?

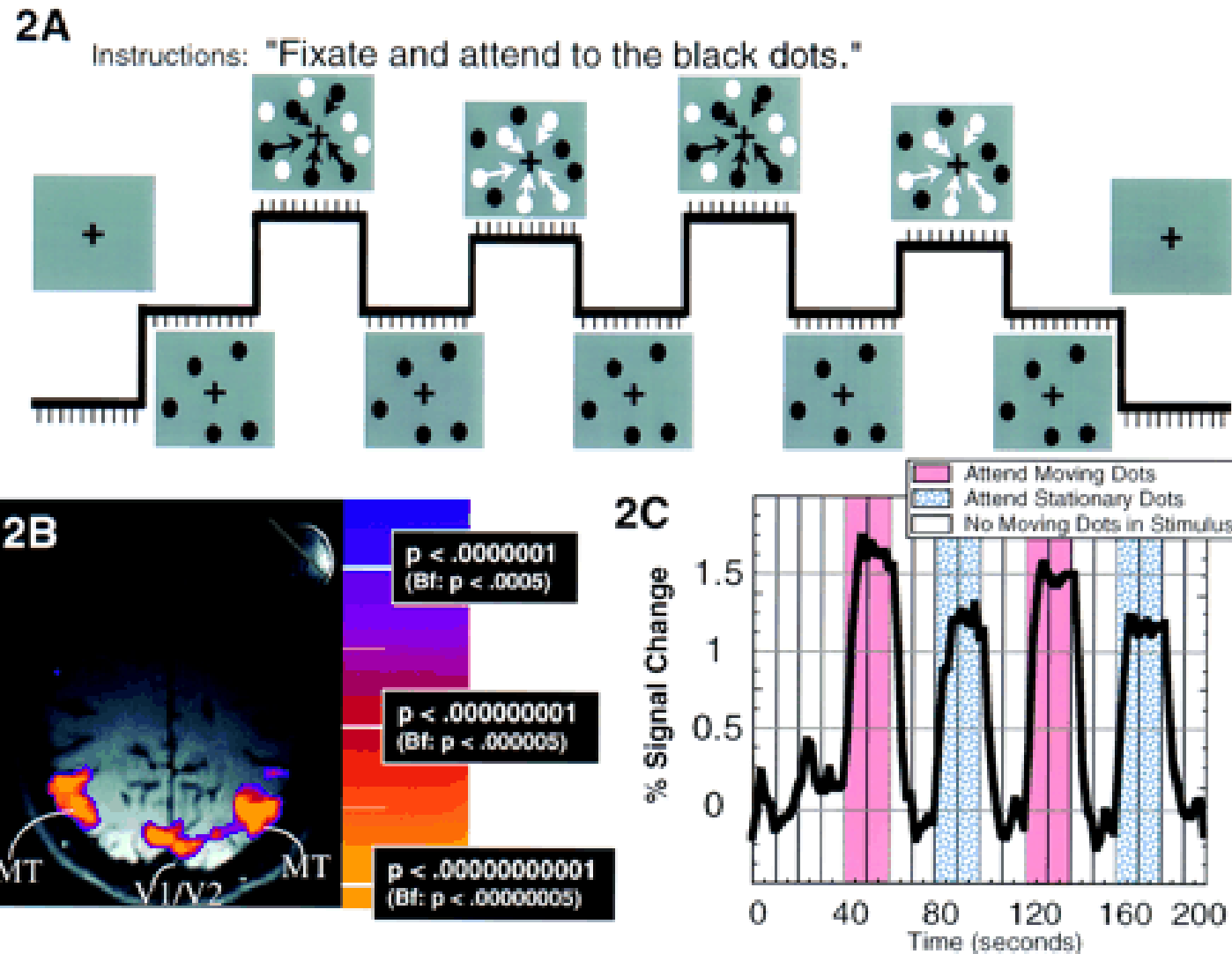
Electrophysiological experiment: have monkeys attend or ignore a stimulus in the receptive field of a neuron.



Electrophysiological responses (spikes) increase with spatial attention in macaque V1 (and area V4) without changing the shape of the orientation tuning

# How does **feature-based attention** affect neuronal responses in the visual cortex?

O'Craven et al. (1997) had subjects attend to moving vs. stationary dots.

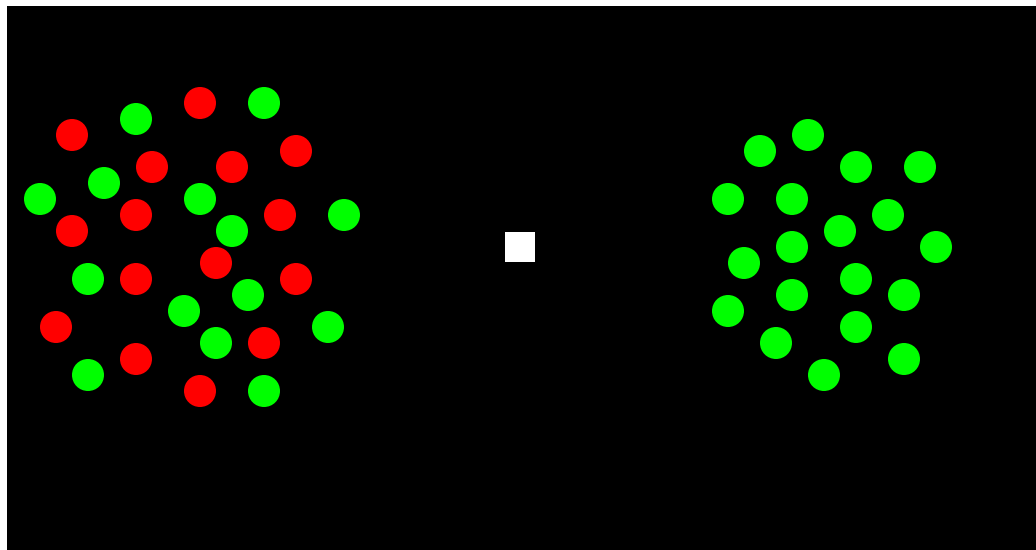


# How does **feature-based attention** affect neuronal responses in the visual cortex?

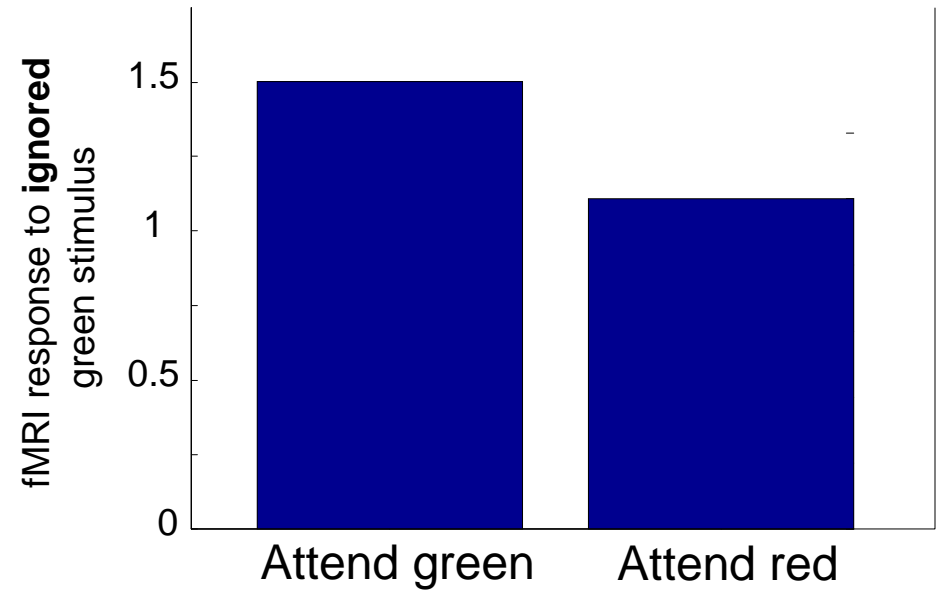
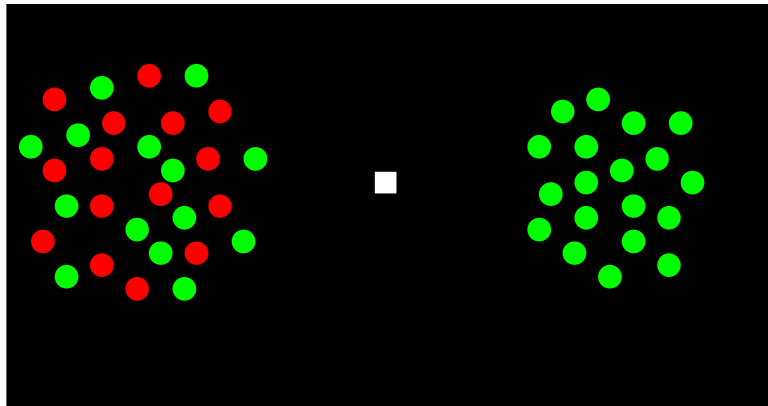
fMRI experiment: present stimuli to left and right side of visual field at the same time.

On one side, have two different overlapping colors on the left side

Have subjects attend to one color at a time on the left (endogenous cue to spatial attention)



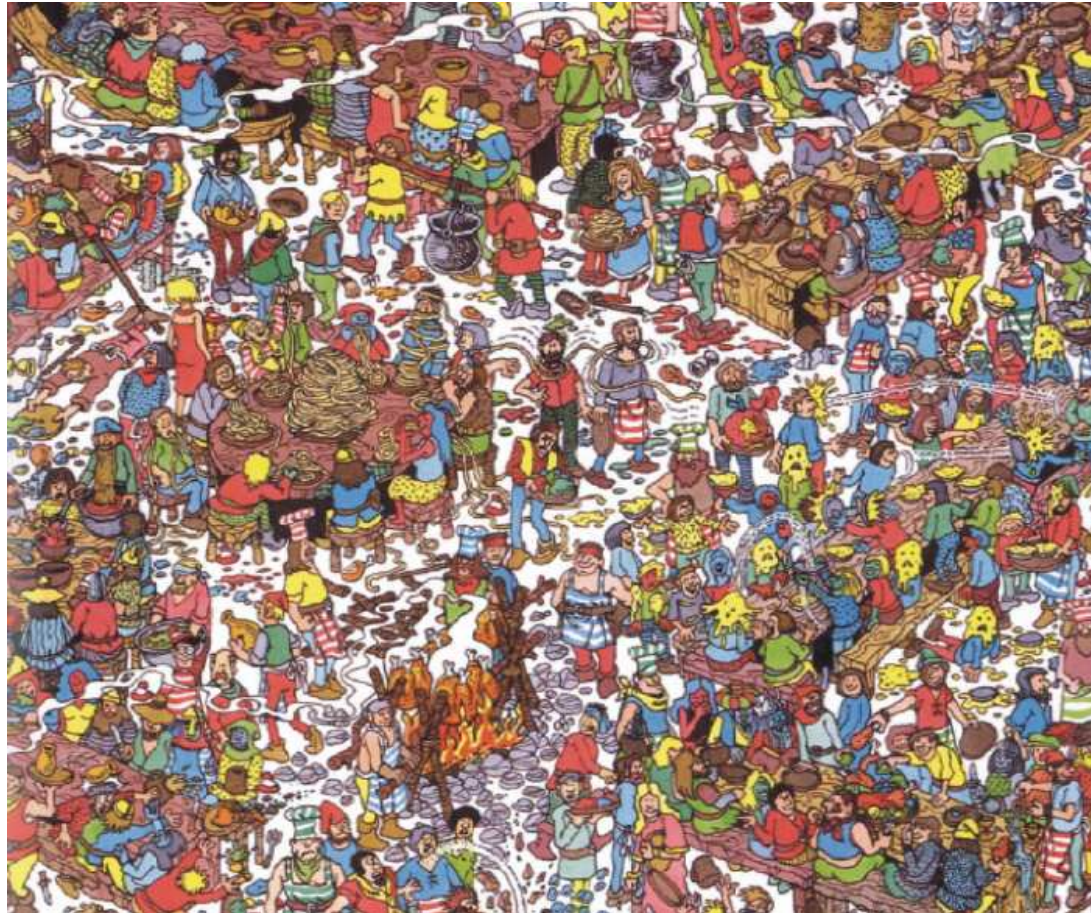
How does **feature-based attention** affect neuronal responses in the visual cortex?



Attending to a color enhances the fMRI response in V1 and other visual areas to all stimuli having the attended color throughout the visual scene.

Attending to a color enhances the fMRI response to all stimuli having the attended color throughout the visual scene.

More recent studies have shown that the same is true for direction of motion and orientation.



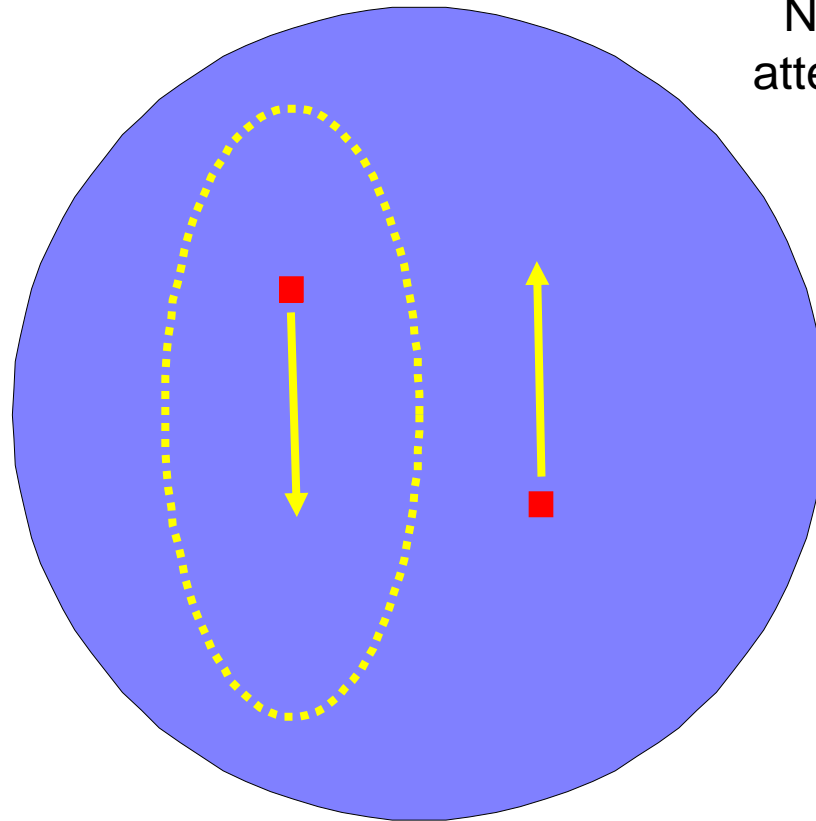
How could this help us search for Waldo?

# How does **feature-based attention** affect neuronal responses in the visual cortex?

Electrophysiological experiment: present two stimuli in the receptive field of a neuron in area MT. (MT has mostly direction selective neurons).

Present dots moving in opposite directions.

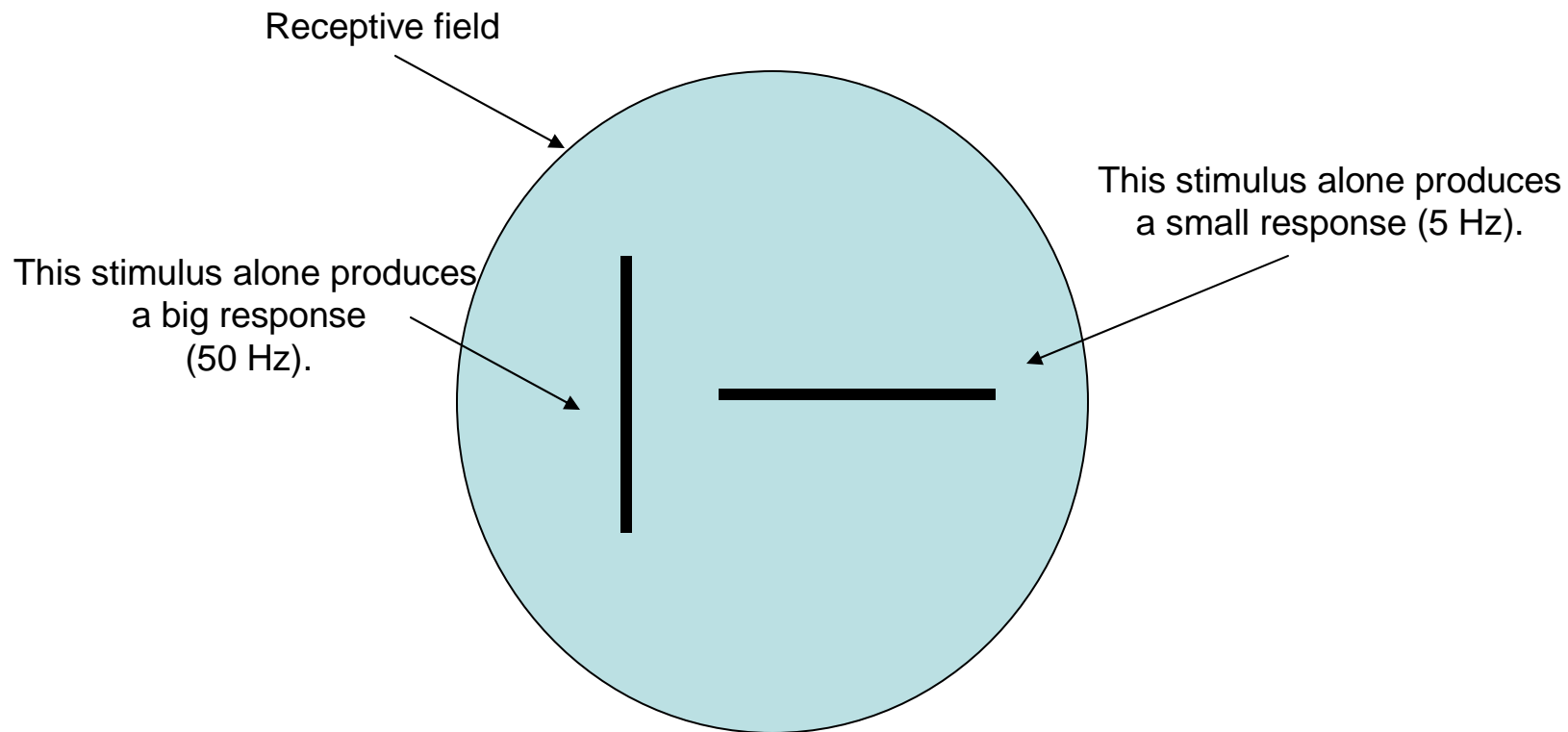
Have monkey attend to only one of the two dots.



Neuron fires only when attended dot moves in the preferred direction!

# How does **feature-based attention** affect neuronal responses in the visual cortex?

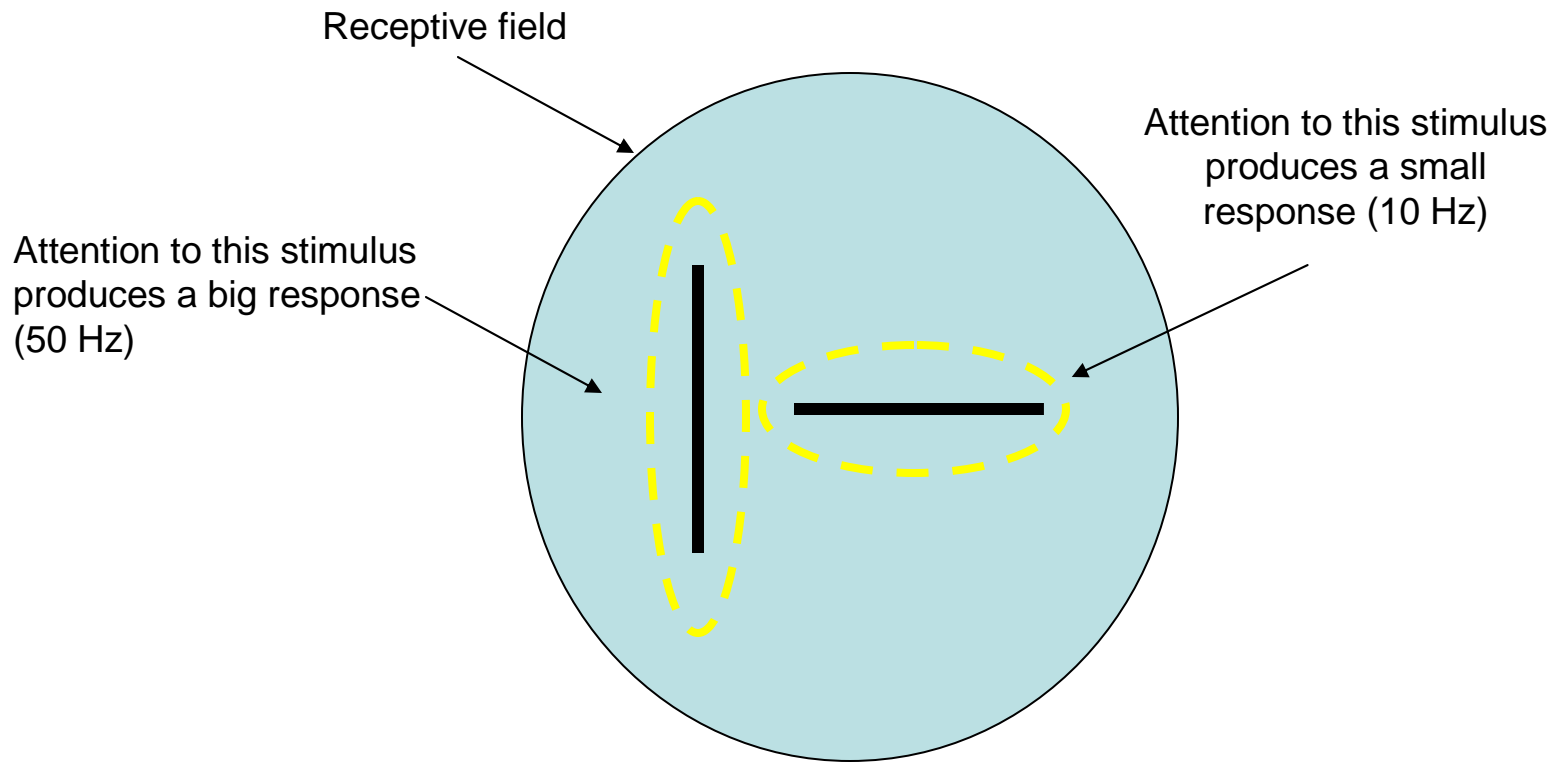
Electrophysiological experiment: present two stimuli in the receptive field of a V4 neuron



Presented together, the stimuli produce an intermediate response (20 Hz).

# How does **feature-based attention** affect neuronal responses in the visual cortex?

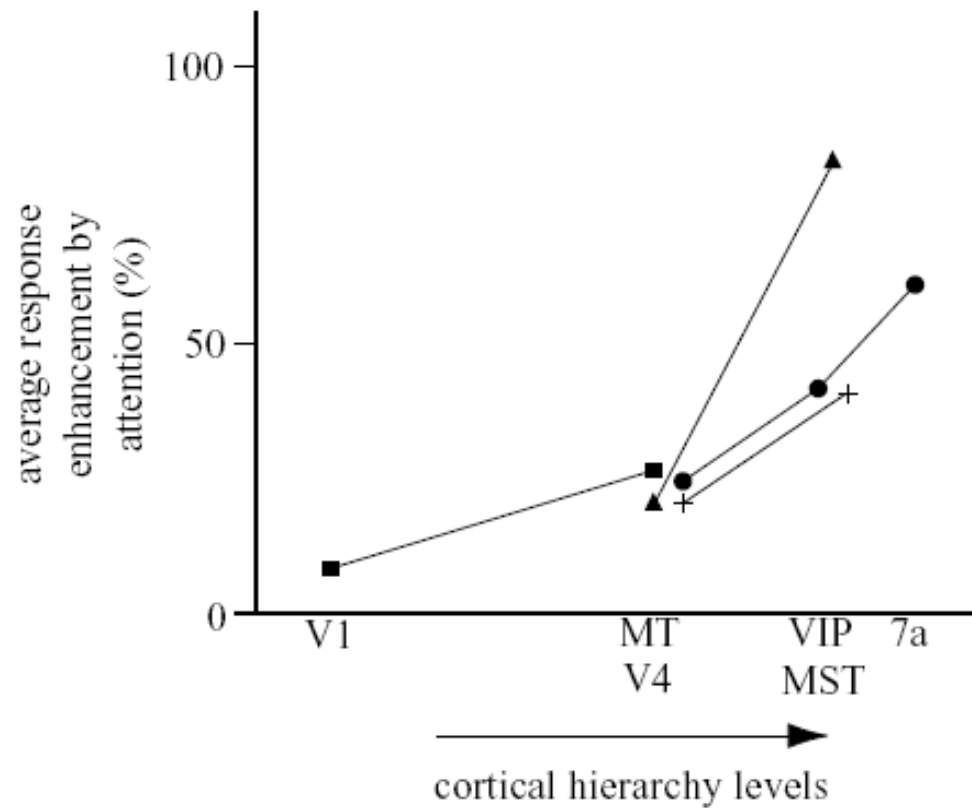
Electrophysiological experiment: now have monkeys attend to one of the two stimuli.



Applying feature-based attention (to orientation) is like removing the unattended stimulus from the receptive field.



## Effects of attention increase along the hierarchy of visual areas



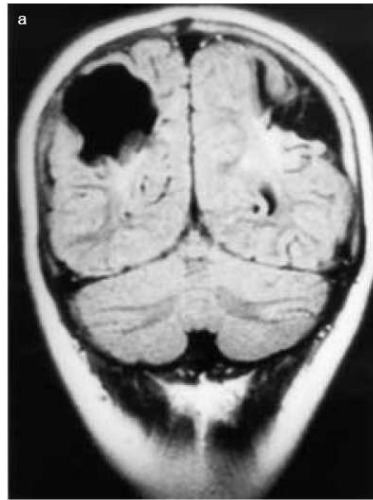
### General rule:

Responses in early visual (LGN, V1) areas depend on the visual stimulus.

Responses in higher areas (V4, MT, Parietal) reflect what you actually experience.

Where in the brain are these top-down influences coming from?

The parietal lobe seems to be important:



**Balint's syndrome:** caused by bilateral damage to parietal lobes

Symptoms include the inability to voluntarily direct or shift spatial attention.

Often includes **simultanagnosia**, where scenes containing multiple objects cannot be interpreted as a whole. Instead, patients with simultanagnosia recognize only portions of the scene at one time, and fail to describe the overall nature of the scene and comprehend its meaning.

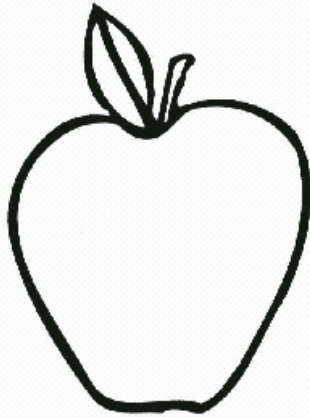
# Visual Awareness

To what extent can it be said that our conscious visual experience fully captures what we perceive?

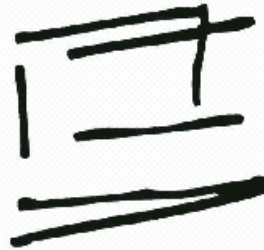
Dissociations between explicit visual awareness and the control of action suggest that our conscious visual awareness is not all that we perceive.

# Patient D.F. is 'blind'

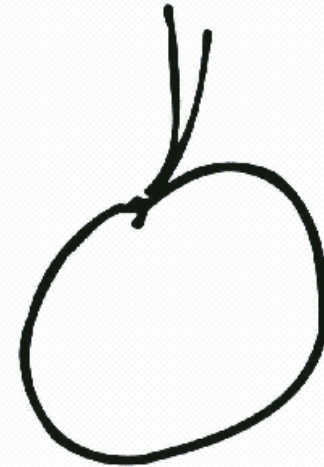
Model



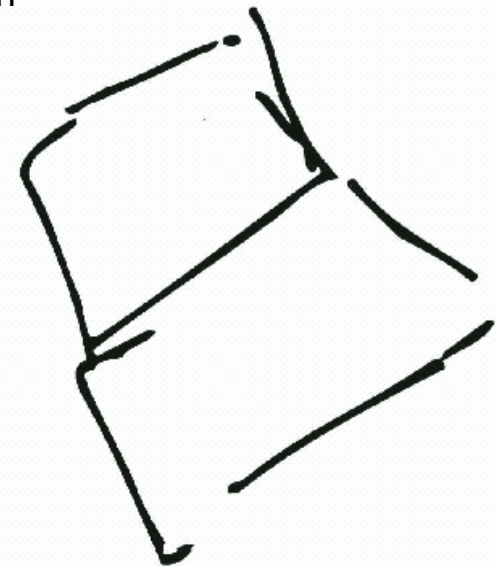
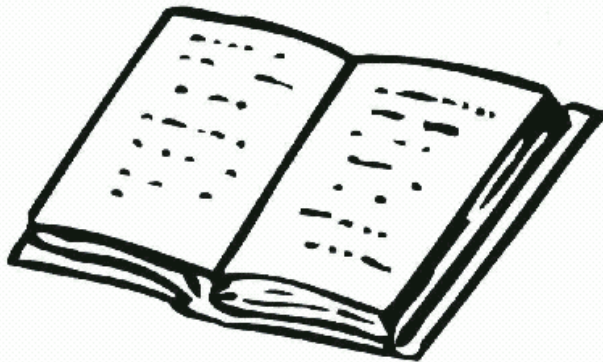
Copy



Memory



•Patient D.F. with **ventral stream damage** cannot identify objects or copy drawings but can draw pictures from memory of these same objects and can recognize them by touch: *visual object agnosia*



•However, D.F. is able to insert a card into a slot ("posting a letter")