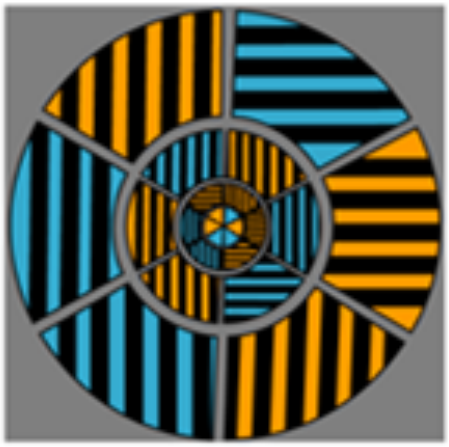
Attention!

1. Definitions and behavioral effects
2. Effects on neural firing rates:
   - Spatial attention
   - Attention to features
3. Directing attention:
   - Posterior parietal cortex
   - Frontal eye fields
   - Top-down and bottom-up attention

1

Spatial attention modulates visual cortex retinotopically



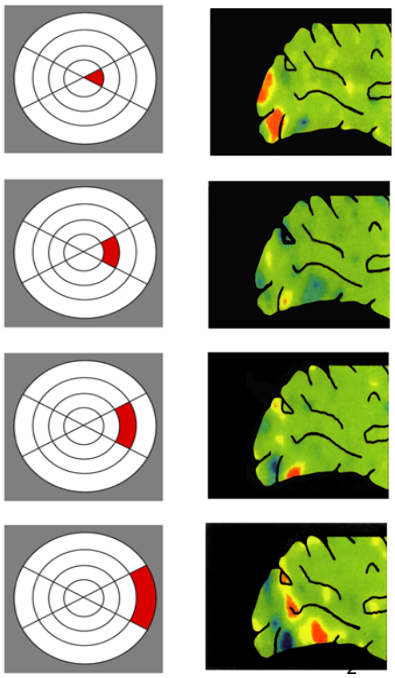


Fig 21.5

Attention!

1. Definitions and behavioral effects
2. Effects on neural firing rates:
   - Spatial attention—SPOTLIGHT
   - Attention to features
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3

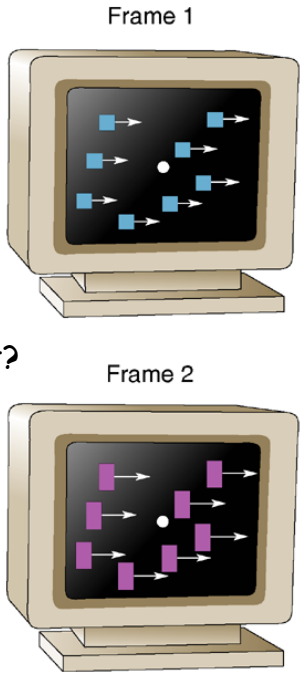
Attention to features:

Shape, color, speed

Same-different task

A) Selective attention condition
- Was a specific feature different?

B) Divided attention condition
- Was any feature different?



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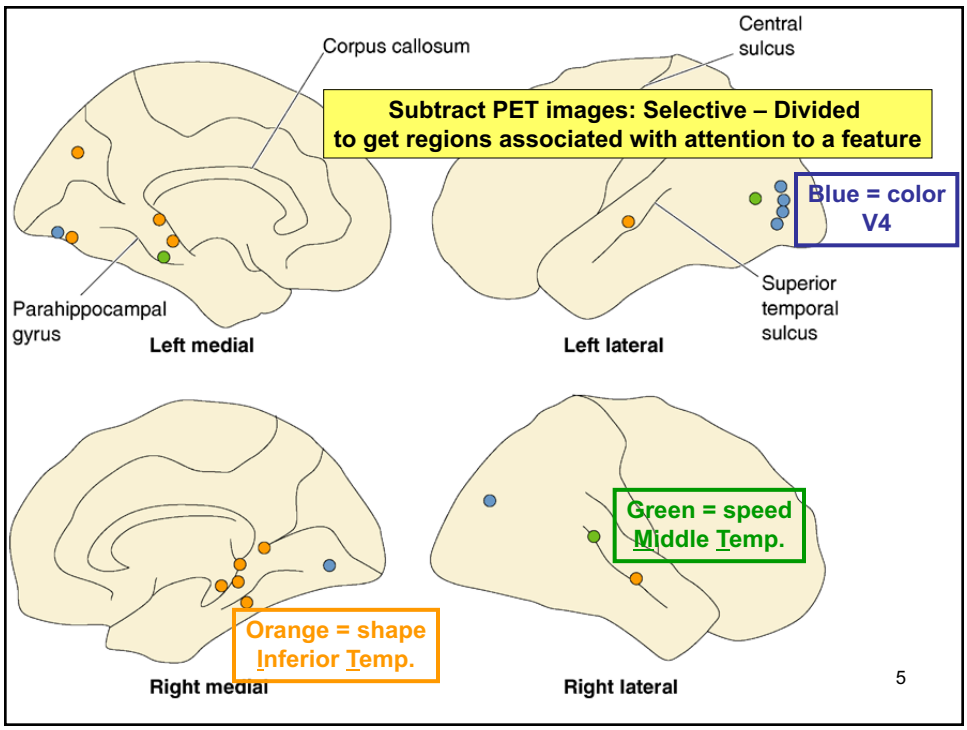
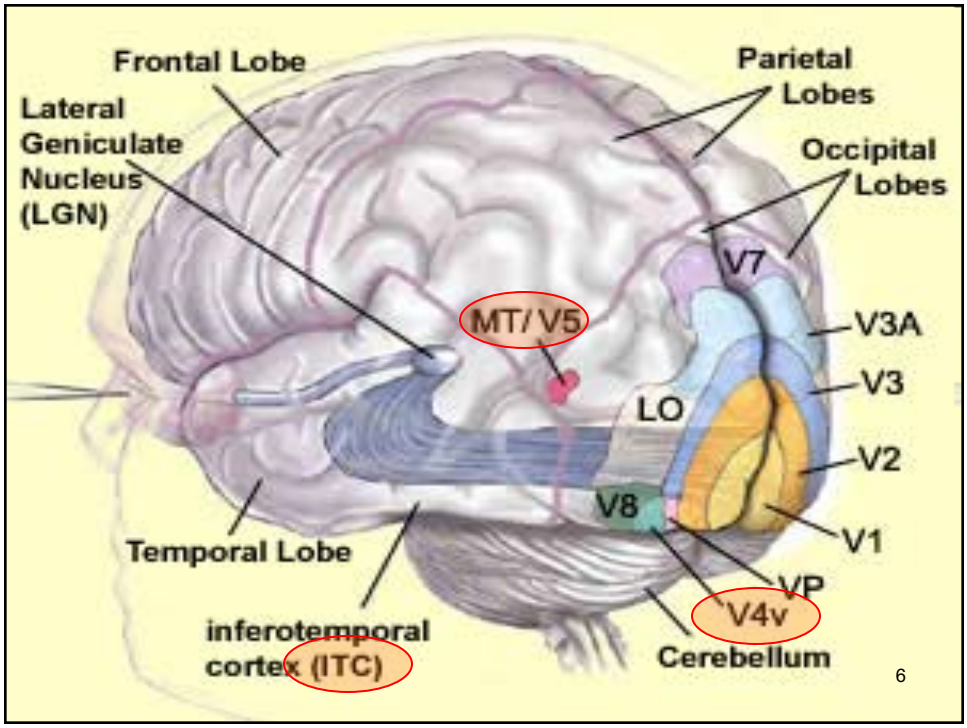

Corpus callosum
Central sulcus
Subtract PET images: Selective – Divided to get regions associated with attention to a feature
Blue = color V4
Parahippocampal gyrus
Left medial
Left lateral
Superior temporal sulcus
Green = speed Middle Temp.
Orange = shape Inferior Temp.
Right medial
Right lateral
5


Frontal Lobe
Parietal Lobes
Lateral Geniculate Nucleus (LGN)
Occipital Lobes
V7
MT/ V5
V3A
V3
LO
V2
V8
V1
VP
V4v
Temporal Lobe
inferotemporal cortex (ITC)
Cerebellum
6

How is attention directed?

Who modulates V4, IT, MT…?

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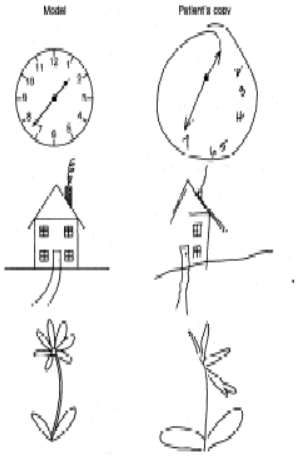
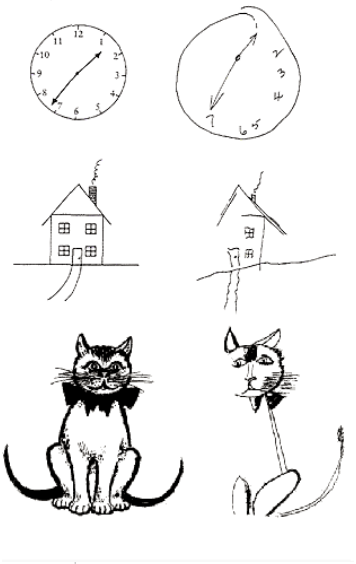
Unilateral posterior parietal lesions cause unilateral neglect

Copying:





9

Spontaneous drawing:

10

Attention!

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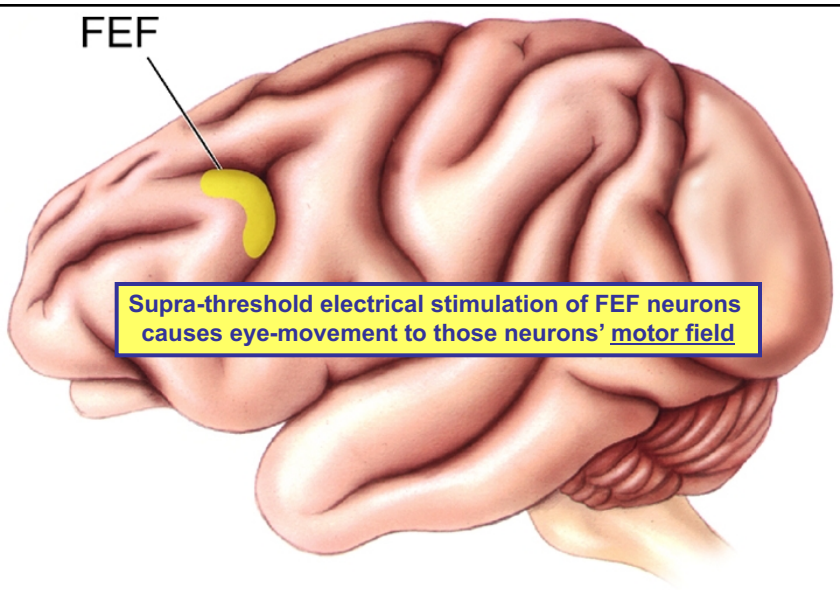

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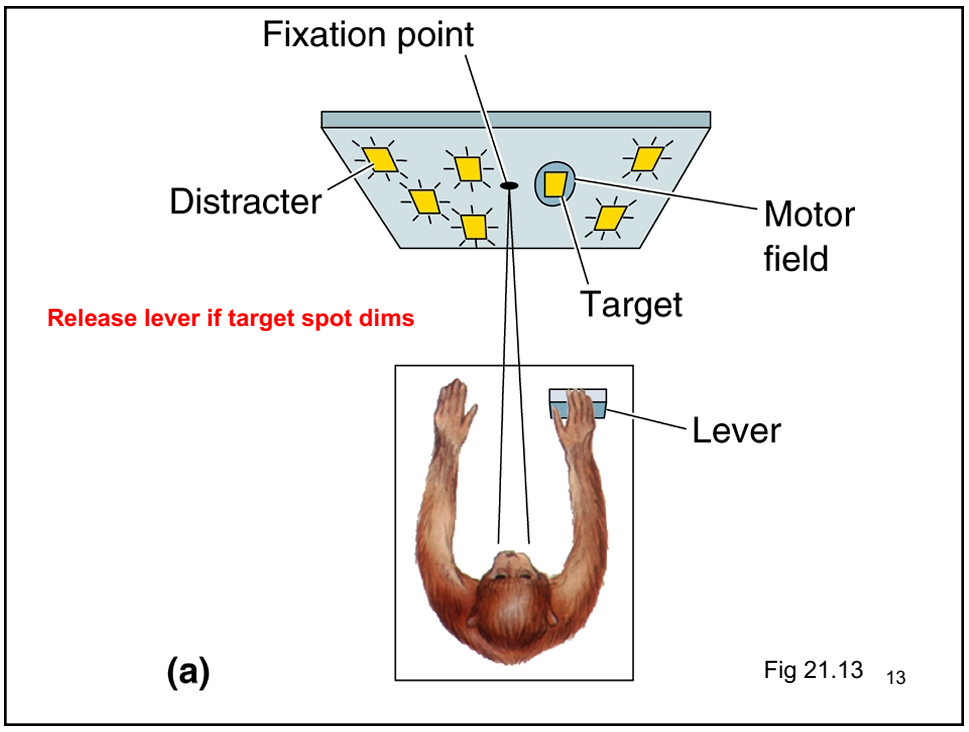
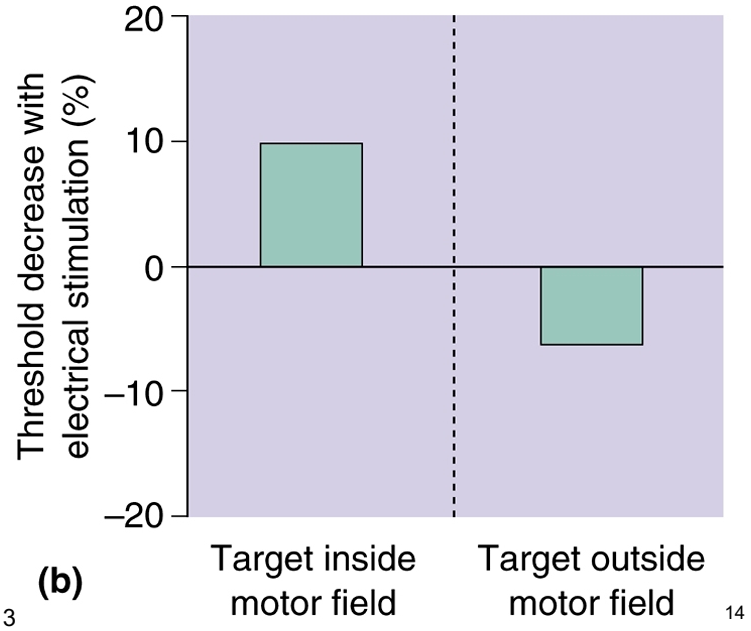


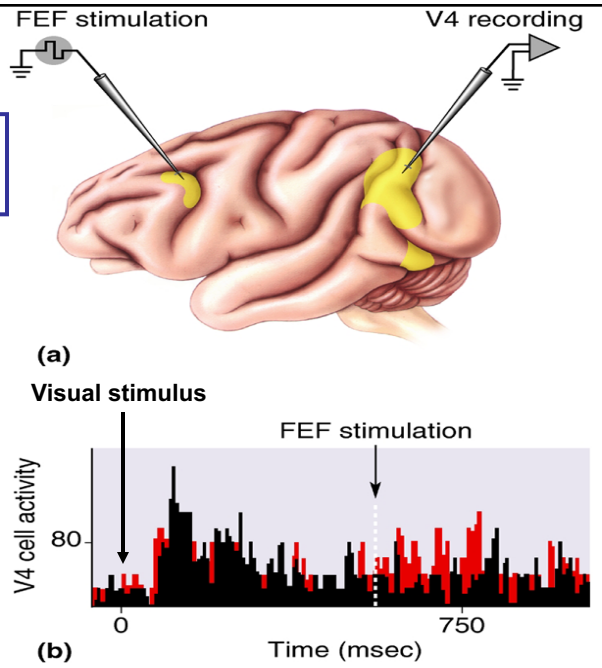
Fig 21.13 13

Sub-threshold FEF microstimulation mimics behavioral effects of attention



Bear Fig 21.13 14

FEF stimulation mimics physiological effects of attention



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Attention conclusions so far

- Attention enhances detection and reaction times
- Spatial attention turns up brain activation topographically
- Feature attention turns up feature-specific areas
- Frontal and posterior parietal areas are involved in directing attention

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Attention!

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Bottom-up	Top-down
• Stimulus-driven: salience, automatic	• Goal-driven: voluntary, effortful
• Feed-forward neural projections	• Feed-back neural projections
• Faster	• Slower
• e.g. Loud noise, flash of light	• e.g. Looking for keys
POPOUT!	CONJUNCTION SEARCH

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Top-Down Versus Bottom-Up Control of Attention in the Prefrontal and Posterior Parietal Cortices

Timothy J. Buschman and Earl K. Miller*

Attention can be focused volitionally by "top-down" signals derived from task demands and automatically by "bottom-up" signals from salient stimuli. The frontal and parietal cortices are involved, but their neural activity has not been directly compared. Therefore, we recorded from them simultaneously in monkeys. Prefrontal neurons reflected the target location first during top-down attention, whereas parietal neurons signaled it earlier during bottom-up attention. Synchrony between frontal and parietal areas was stronger in lower frequencies during top-down attention and in higher frequencies during bottom-up attention. This result indicates that top-down and bottom-up signals arise from the frontal and sensory cortex, respectively, and different modes of attention may emphasize synchrony at different frequencies.

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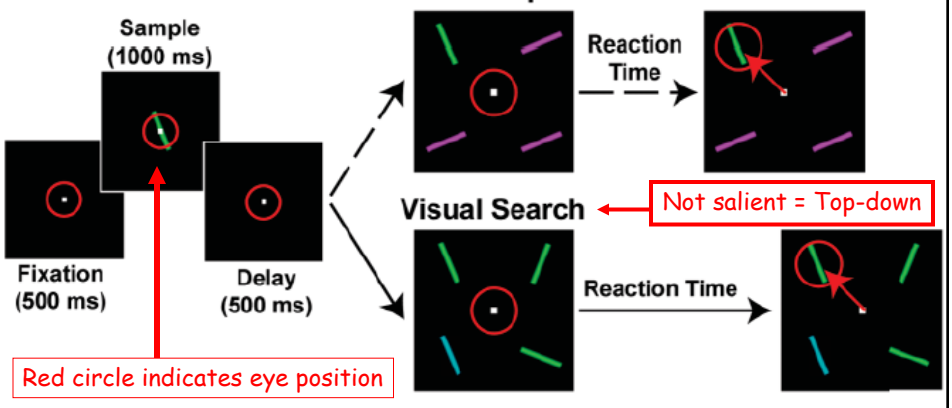
Task: saccade to target after delay

Salient, automatic = Bottom-up



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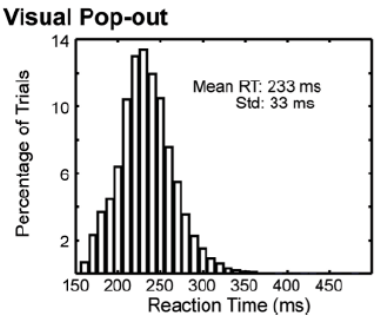
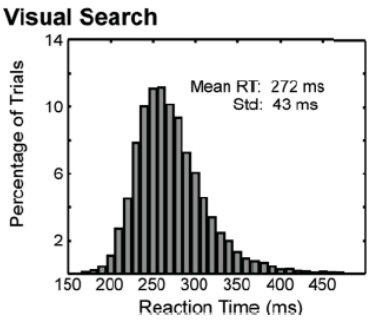
Behavioral hallmarks of top-down vs. bottom-up attention



Bottom-up faster
and less sensitive to distractors
(6 ms per additional)



Top-down slower
and more sensitive to distractors
(22 ms per additional)

21

Top-Down Versus Bottom-Up Control of Attention in the Prefrontal and Posterior Parietal Cortices

Timothy J. Buschman and Earl K. Miller*

Attention can be focused volitionally by "top-down" signals derived from task demands and automatically by "bottom-up" signals from salient stimuli. The frontal and parietal cortices are involved, but their neural activity has not been directly compared. Therefore, we recorded from them simultaneously in monkeys. Prefrontal neurons reflected the target location first during top-down attention, whereas parietal neurons signaled it earlier during bottom-up attention. Synchrony between frontal and parietal areas was stronger in lower frequencies during top-down attention and in higher frequencies during bottom-up attention. This result indicates that top-down and bottom-up signals arise from the frontal and sensory cortex, respectively, and different modes of attention may emphasize synchrony at different frequencies.

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Attention conclusions

- Attention enhances detection and reaction times
- Spatial or feature attention can turn up the firing rates of relevant neurons or their synchronization
- Top-down attention (search) engages frontal areas first, and emphasizes synchronization at lower frequencies (22-34 Hz)
- Bottom-up attention (pop-out) engages posterior parietal cortex first, and emphasizes synchronization at higher frequencies (35-55 Hz)

Attention, Binding, and Consciousness

1. Perceptual binding, dynamic binding
2. Neural Correlates of Consciousness: Binocular rivalry
3. Attention vs. consciousness
4. Binding revisited: Split-brain, split-consciousness

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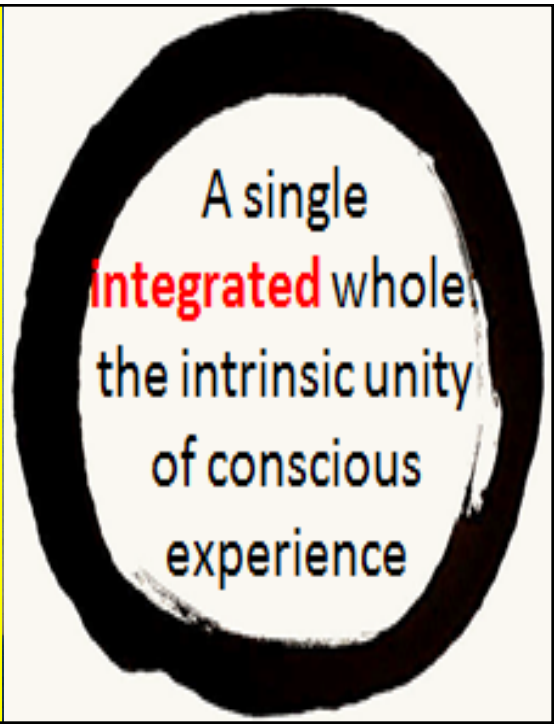
The Binding Problem

"Exactly how the parallel streams of sensory data are melded into perception, images, and ideas remains the Holy Grail of neuroscience."

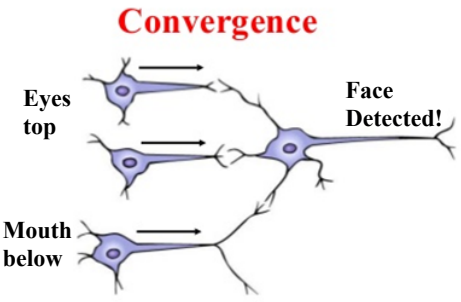
—Bear p. 421



Perceptual Binding

Static

- Learned or innate
- Dedicated neurons i.e. anatomical neural



Dynamic

- In order to be able to perceive and represent (remember) **new** feature combinations, new objects or new situations
- Distributed neurons

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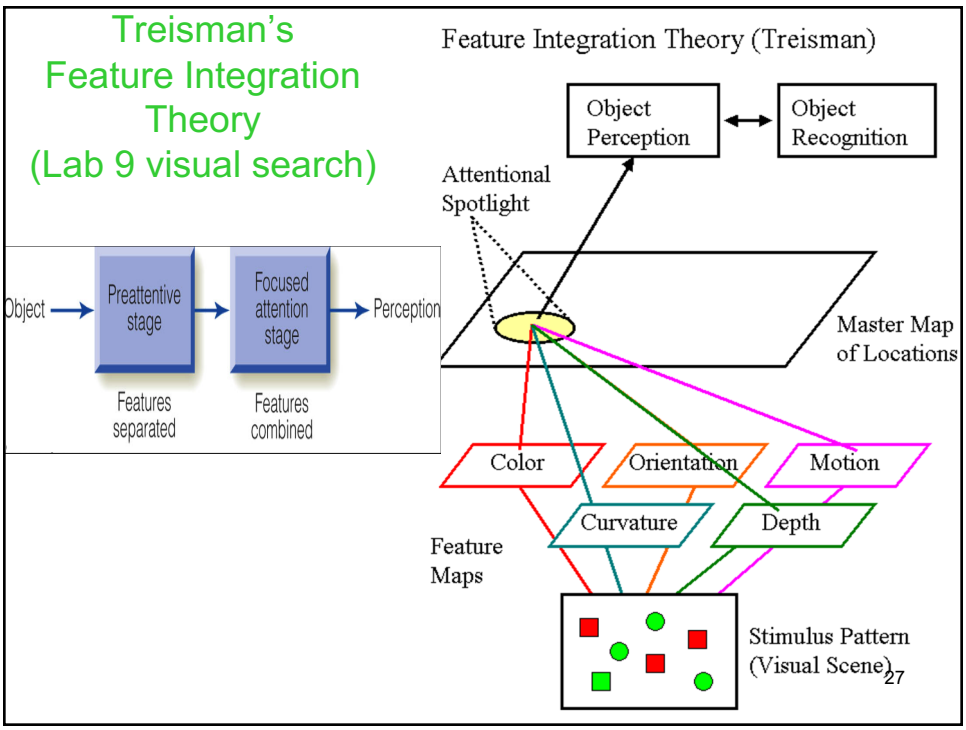
Treisman's Feature Integration Theory (Lab 9 visual search)



Dynamic binding by neural synchronization?

"By momentarily **synchronizing the fast oscillations** generated by different regions of cortex, perhaps the brain **binds** together various neural components into a **single perceptual construction**.

The evidence for this idea is indirect, far from proven, and understandably controversial."

—Bear p.592

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Attention, Binding, and Consciousness

1. Perceptual binding, dynamic binding
2. Neural Correlates of Consciousness: Binocular rivalry
3. Attention vs. consciousness
4. Binding revisited: Split-brain, split-consciousness

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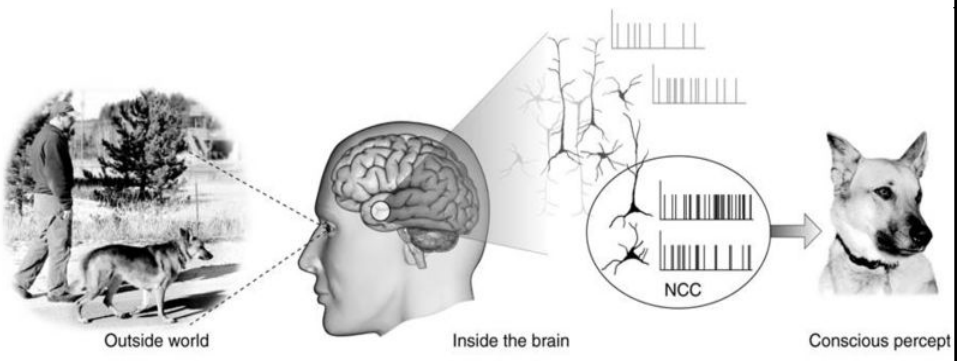
Neural Correlates of Consciousness (NCC)

The minimal neural activity sufficient for any one specific conscious percept.



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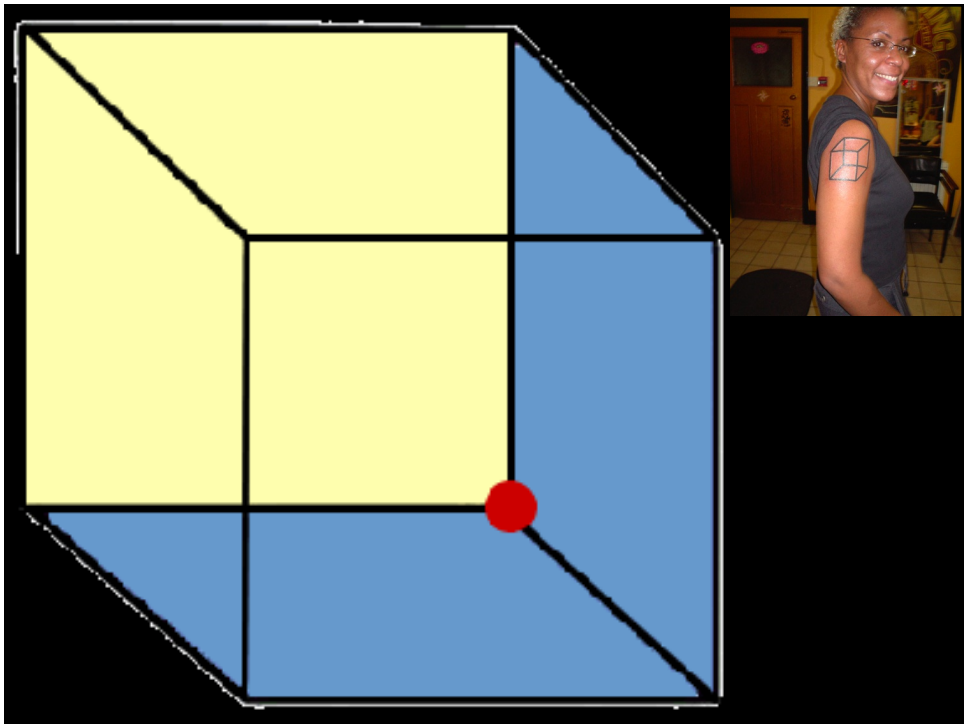
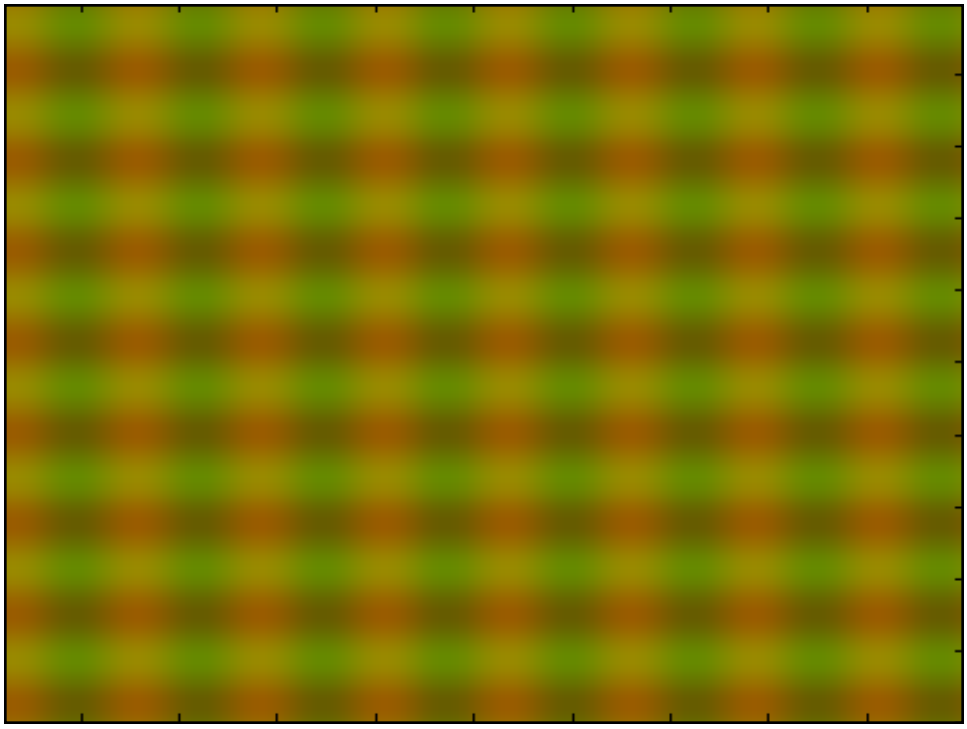
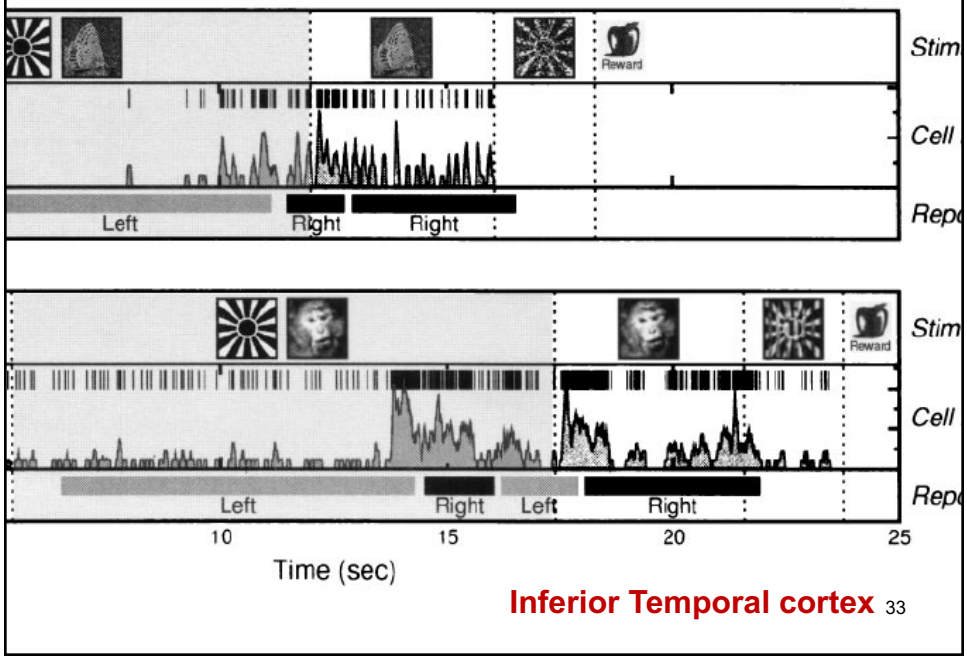
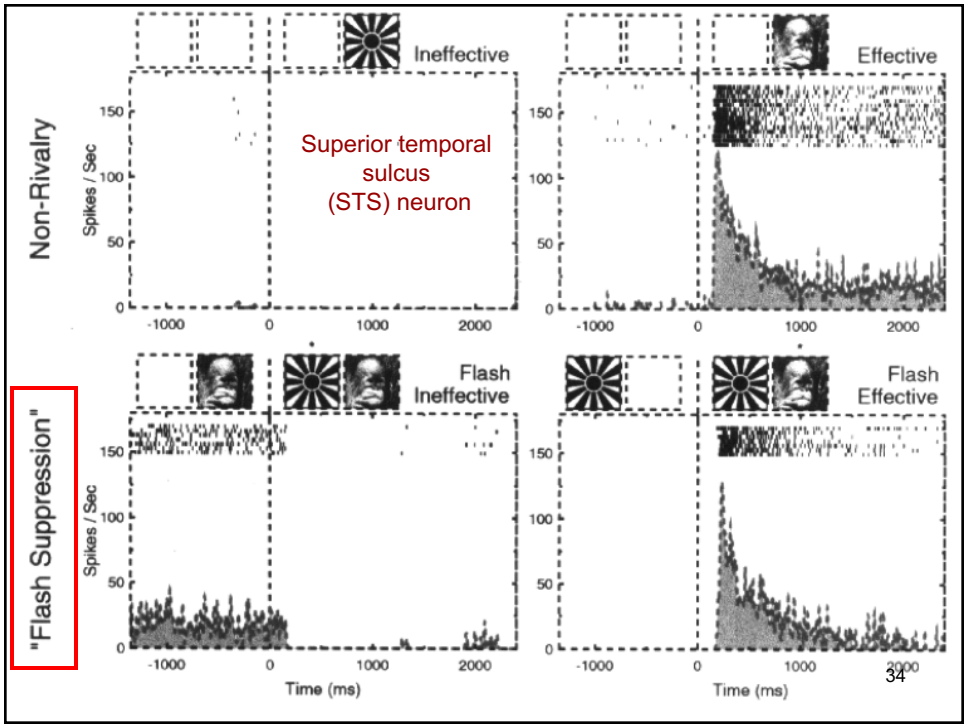




Binocular rivalry



Inferior Temporal cortex 33



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