

The quest for consciousness

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<http://ramonycajal.mit.edu/kreiman/academia/classes/ncc/quest.htm>

Fridays 11-12 am (Jan. 06, 13, 20, 27)

46-5165

Summary of previous class

How can a physical system show consciousness?

Several alternative explanations for the origin and mechanisms of consciousness

1. Dualist view
2. Science cannot understand consciousness. New principles are needed
2. Consciousness is an illusion. Consciousness is an epiphenomenon

Consciousness is of the brain, for the brain and by the brain

Overview of neuroscience

1. The brain is not homogeneous
2. Neurons communicate through electrical impulses
3. Several techniques to study the brain at different spatiotemporal resolutions

Can download PDF from:

http://ramonycajal.mit.edu/kreiman/academia/classes/ncc/quest_schedule.htm

A framework for consciousness

Crick, F. and C. Koch (2003). A framework for consciousness
Nat Neurosci **6**:119-126

Koch C. The Quest for Consciousness. Ch. 19

1. The frontal cortex homunculus

The frontal cortex “looking” and “interpreting” the information from the sensory systems.

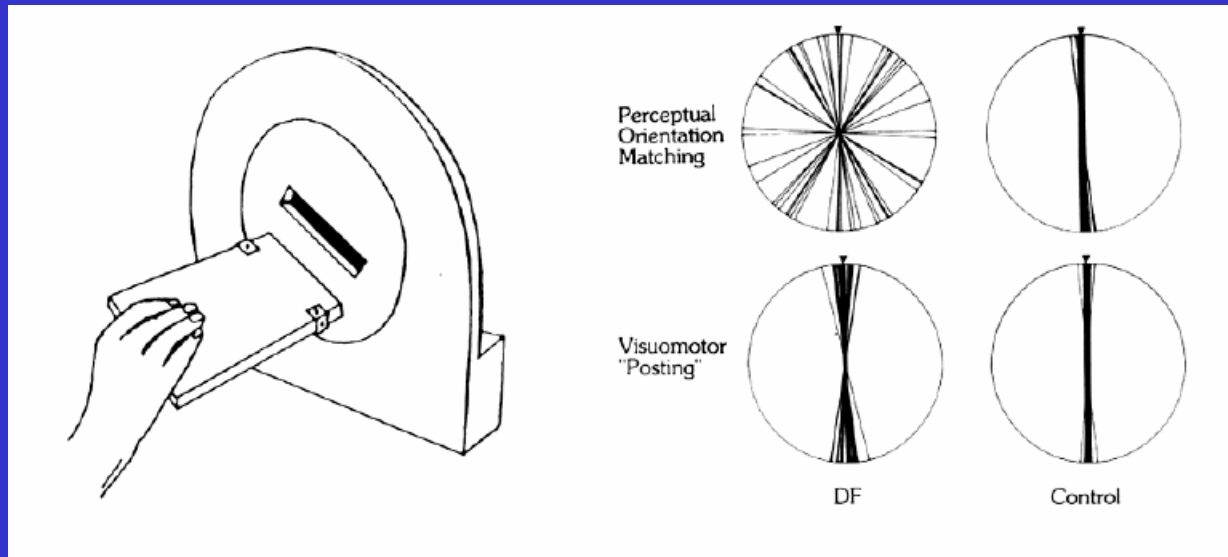
2. Zombie modes

Rapid, transient, stereotyped and unconscious responses

In a zombie mode the main flow of information is feed-forward

Zombie modes are very fast and useful

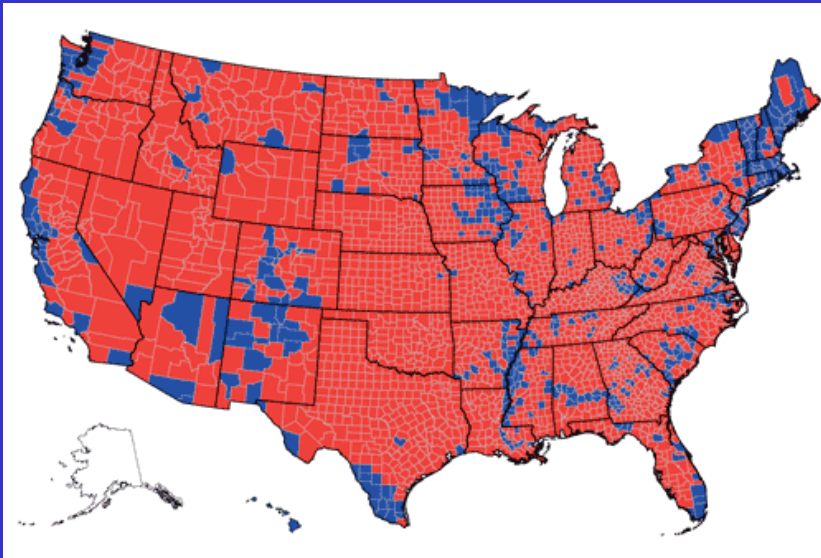
2. Zombie modes



3. Neuronal coalitions

Assemblies of neurons competing against each other

A crude analogy: elections



3. Neuronal coalitions

Motion aftereffects

[Link 1](#) (waterfall)

[Link 2](#) (scrolling text)

[Link 3](#)

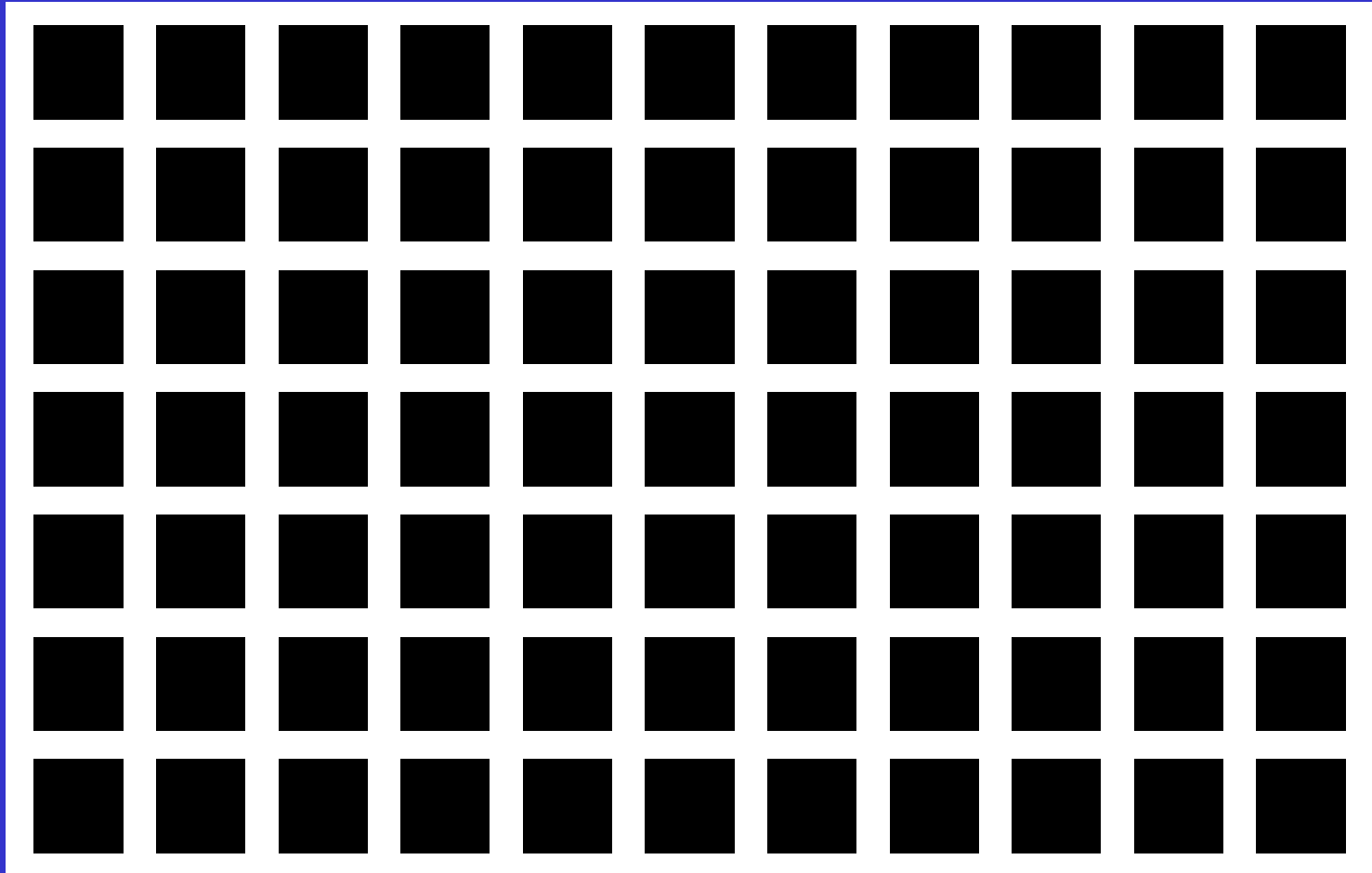
4. The representation is explicit

A single layer of neurons can deliver the answer

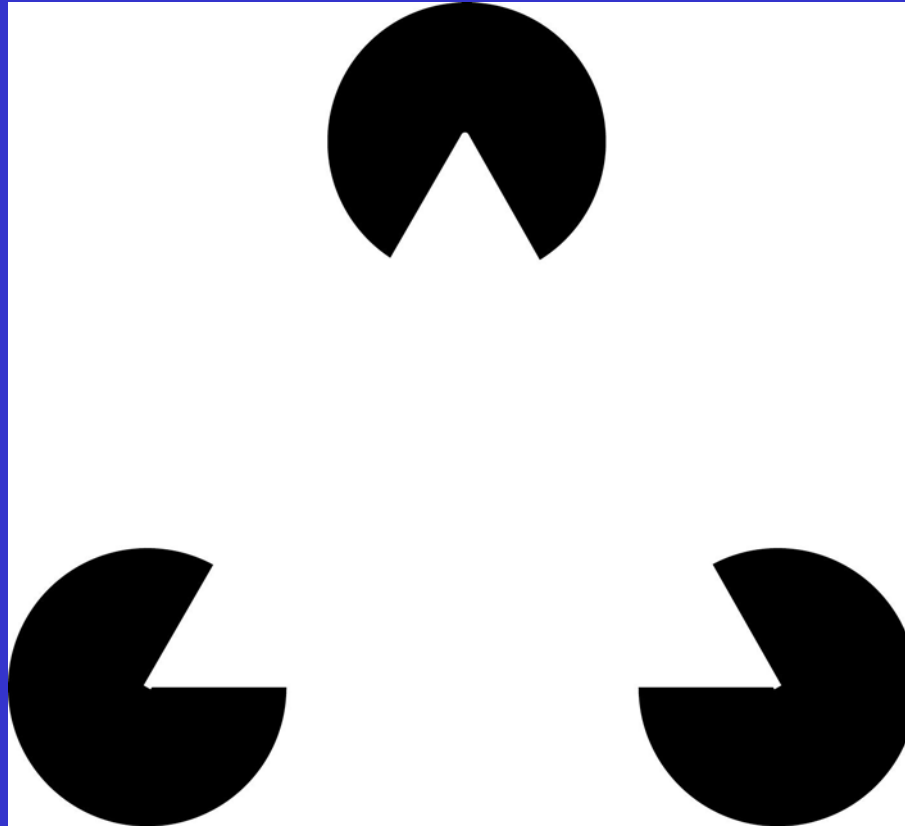
Prosopagnosia, achromatopsia, akinetopsia. Lesions in monkeys

An explicit representation is necessary but not sufficient for the NCC

4. The representation is explicit



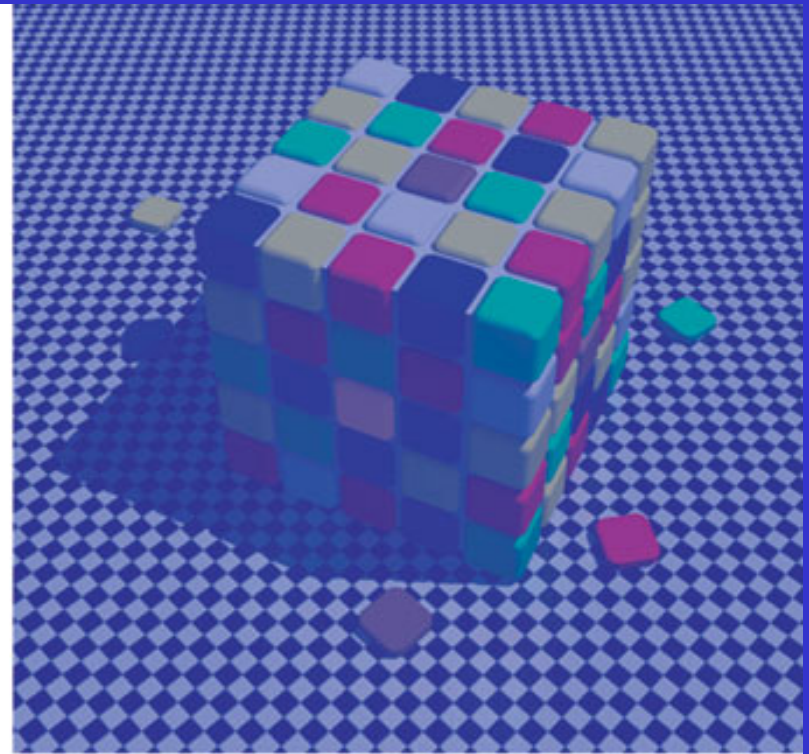
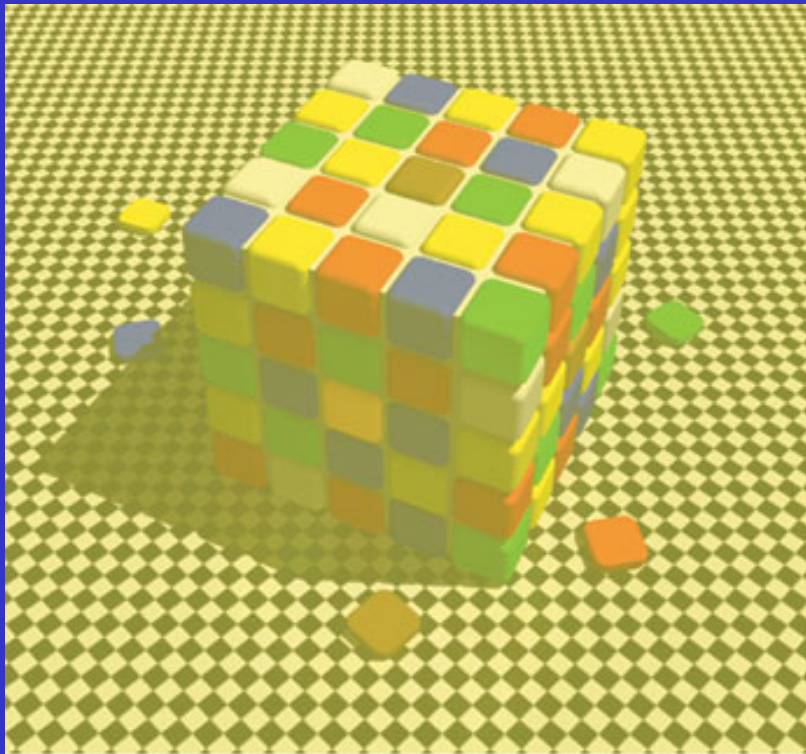
4. The representation is explicit



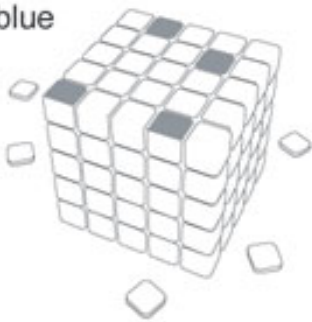
4. The representation is explicit



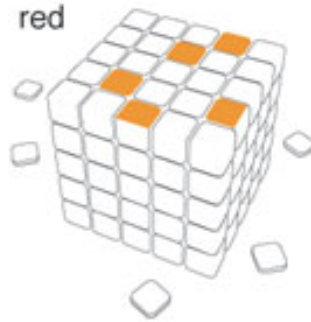
4. The representation is explicit



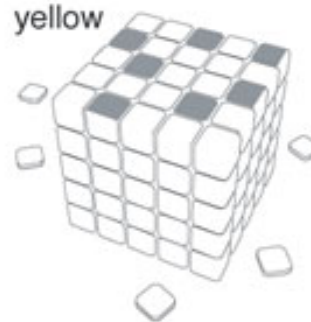
blue



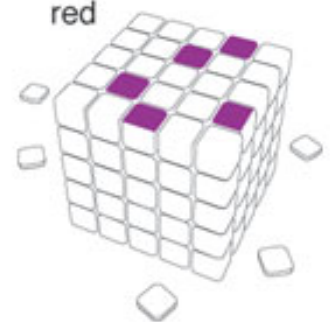
red



yellow

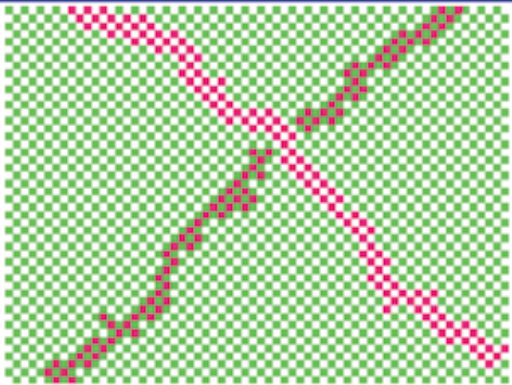


red



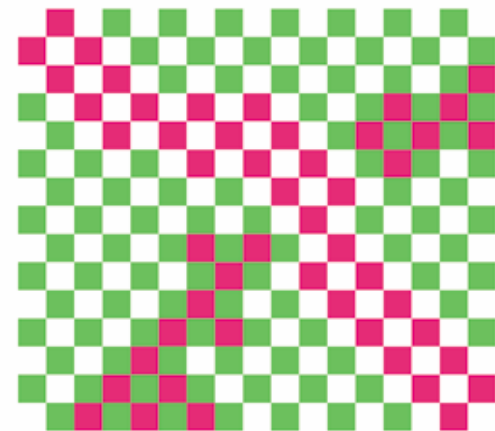
4. The representation is explicit

See the Pink and Red
Colors?

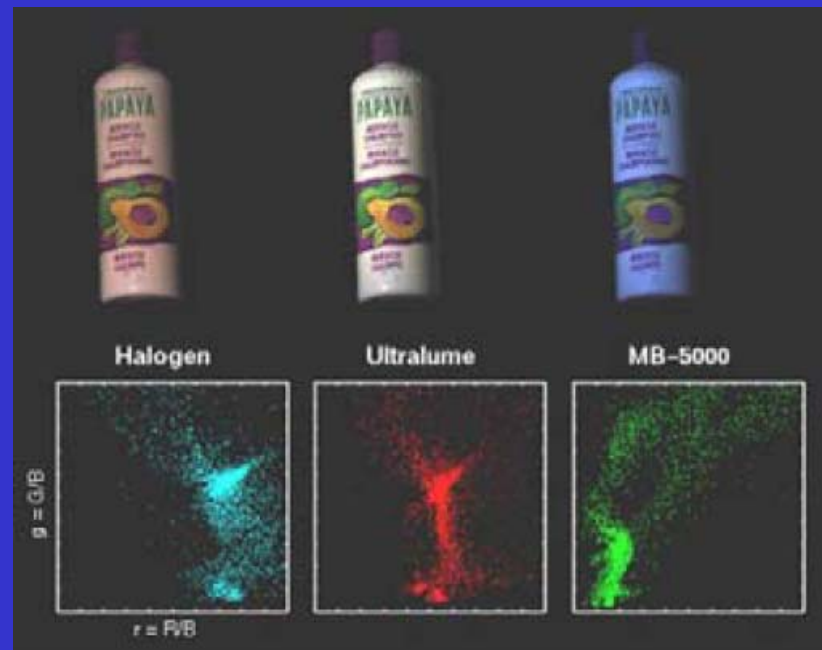


They are actually the same color.

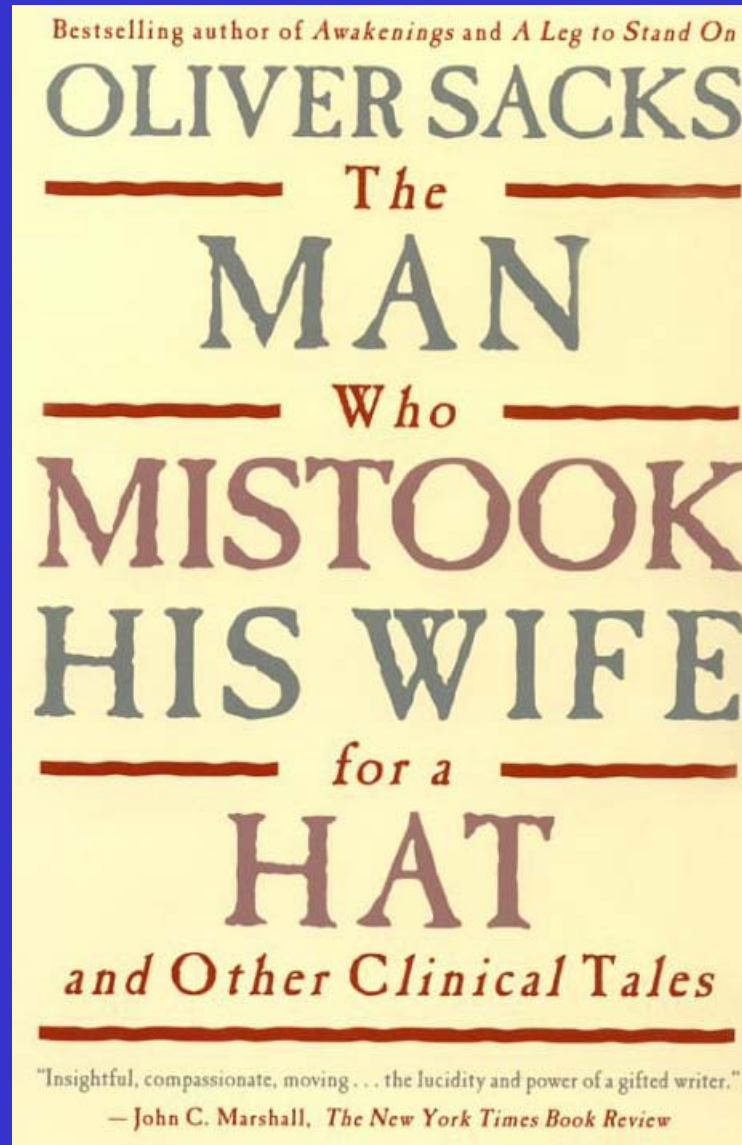
See it Better in Closeup:



4. The representation is explicit

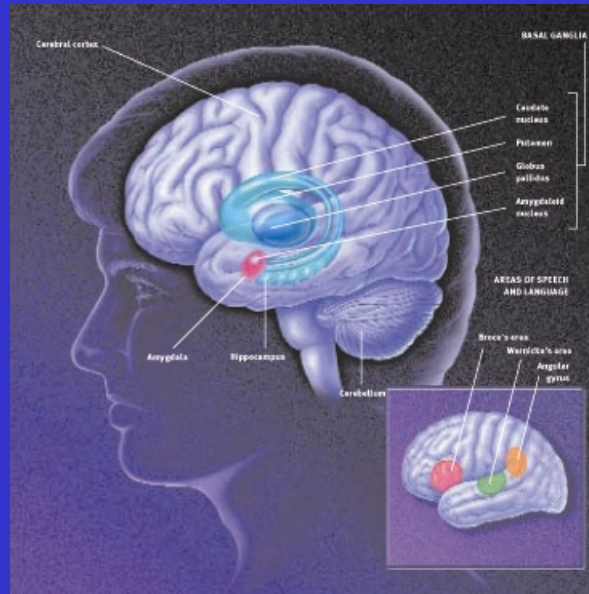
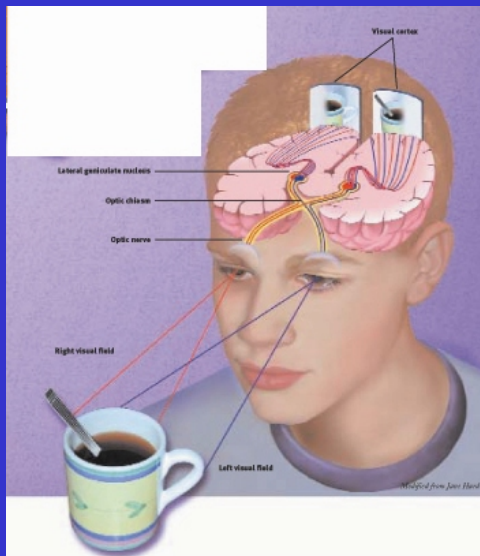


4. The representation is explicit



5. Higher levels first

As a first approach, information travels “upward” from the retina to higher cortical areas and then there is feedback

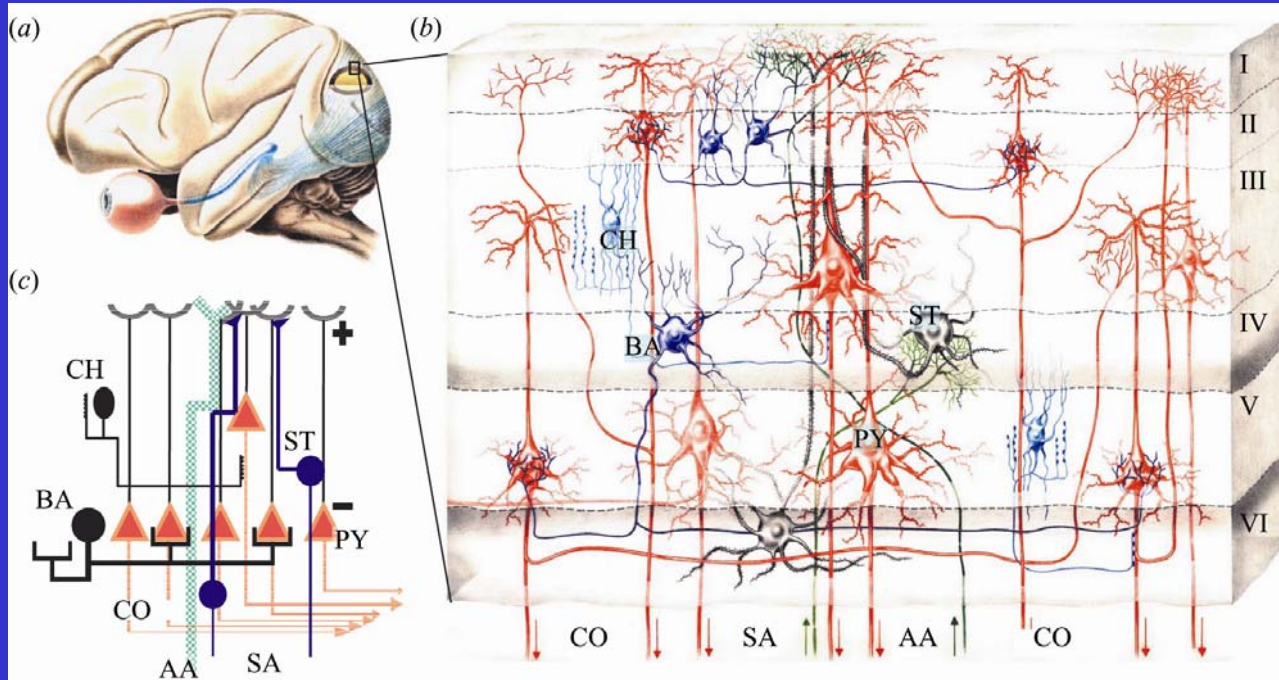


6. Driving and modulating connections

Two broad classes of inputs: modulating input and driving input

Different layers in cortex show different connectivity properties

6. Driving and modulating connections



7. Time and consciousness: Snapshots

Consciousness is composed of a series of snapshots

Snapshots durations are not constant

A threshold is involved in reaching consciousness

8. Attention and binding

We have the illusion that we “see” the whole visual field.
But recall inattention blindness illusion!

Attention filters information¹

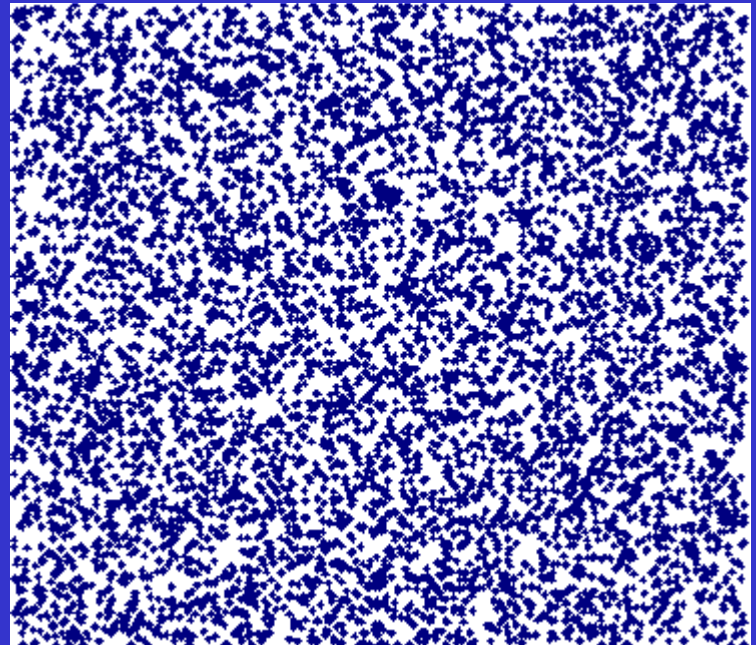
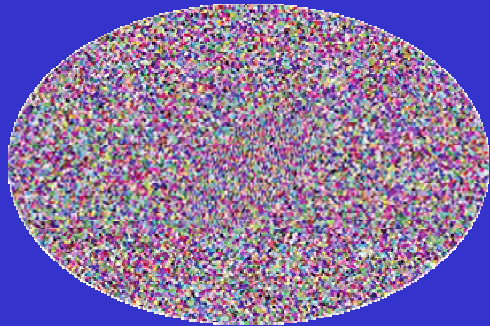
Consciousness may generally require attention
But consciousness may happen in the absence of attention²

Two mechanisms for attention: bottom-up (saliency) and top-down
(cognitive)

¹Desimone, R. and J. Duncan (1995). Neural mechanisms of selective visual attention *Annual Review of Neuroscience* **18**: 193-222

²Li, F. F., R. VanRullen, et al. (2002) Rapid natural scene categorization in the near absence of attention *Proc Natl Acad Sci USA* **99**:9596-9601

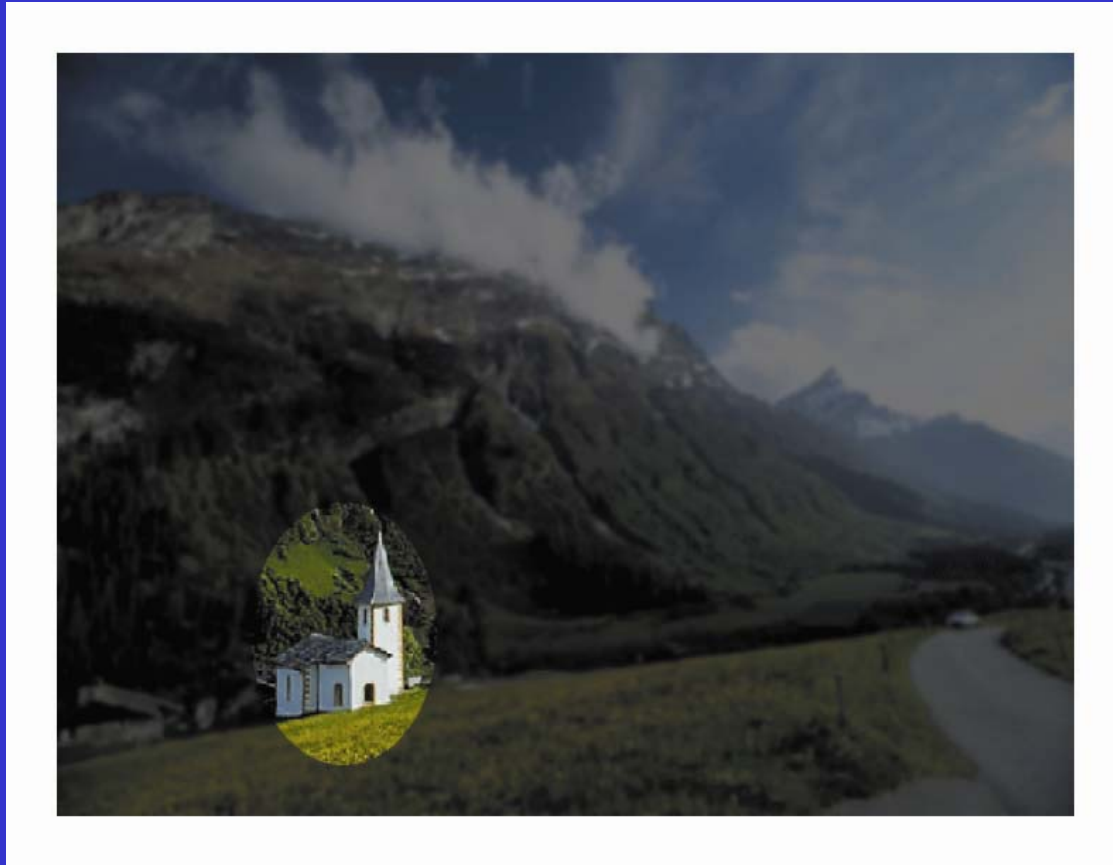
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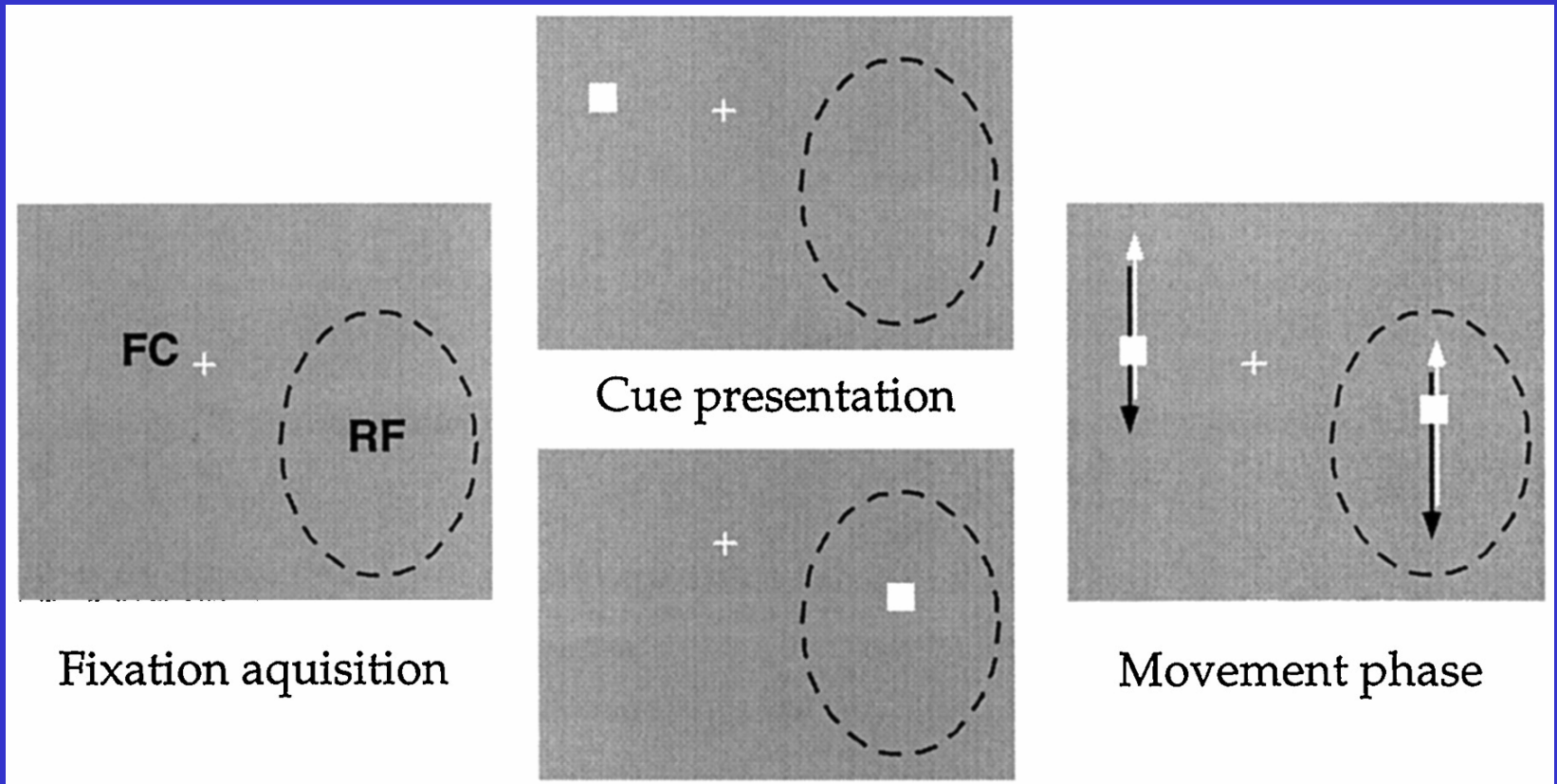


8. Attention and binding



8. Attention and binding

An example of an experimental study of visual attention



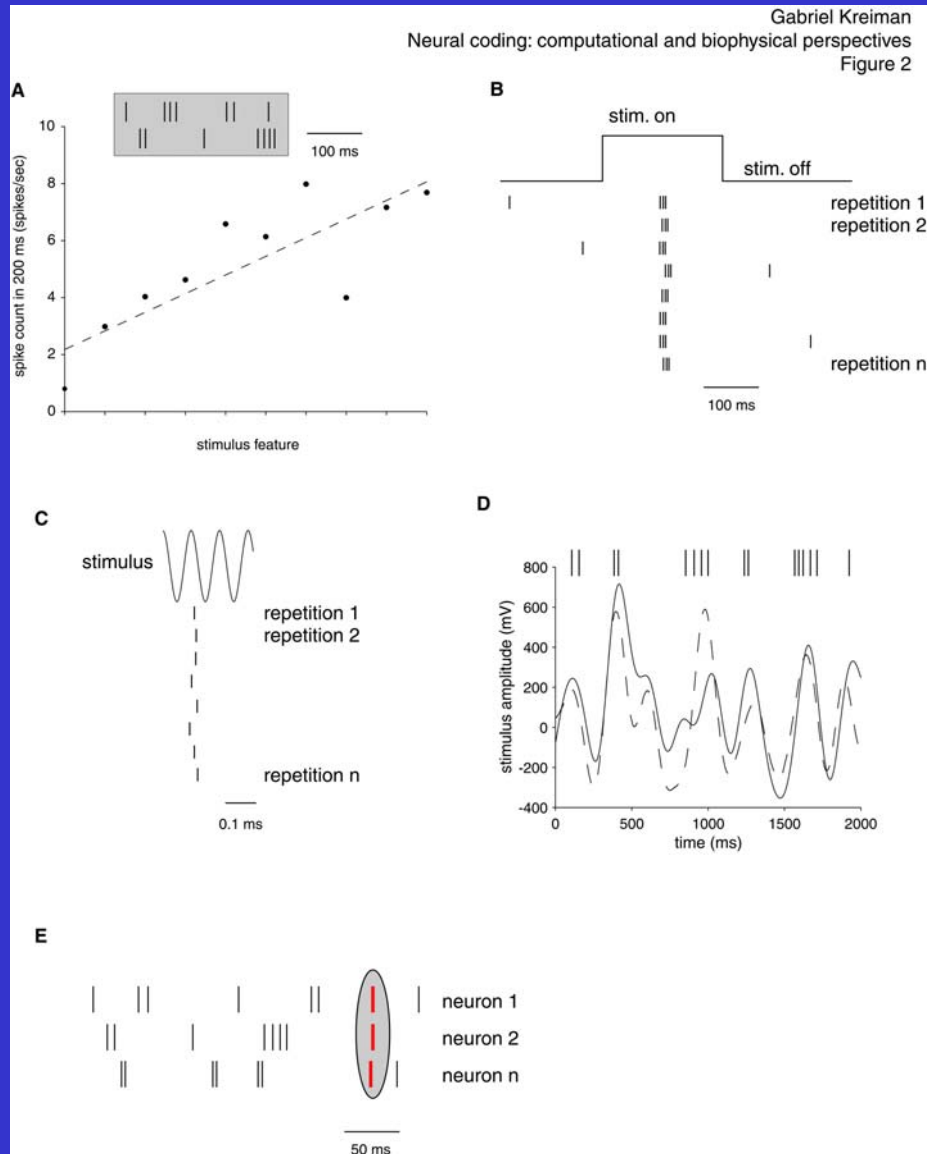
Treue, S. and J. Maunsell (1999). "Effects of attention on the processing of motion in macaque middle temporal and medial superior temporal visual cortical areas." Journal of Neuroscience **19**(17): 7591-7602.

9. Firing modes

A neuronal representation must be read out by other neurons

Specific firing patterns may have a stronger impact on post-synaptic targets

9. Firing modes



10. Penumbra, meaning and qualia

Penumbra: neurons outside the NCC

Qualia are a property of parallel feedback networks in the brain whose activity lasts for a minimal amount of time

Summary

1. The nonconscious *Homunculus*
2. A lot can be done in *zombie mode*
3. The NCC involve *coalitions of neurons*
4. An *explicit* representation is needed
5. Higher levels first
6. The NCC require strong driving projections
7. Consciousness comes in snapshots
8. Attention and binding
9. The NCC may involve specific firing patterns
10. Penumbra, meaning and qualia

Next class

Experimental approaches to search for NCC

Bistable percepts

- binocular rivalry

- flash suppression

- bistable percepts in motion

Visual imagery