Learning About the World around us
Visual System

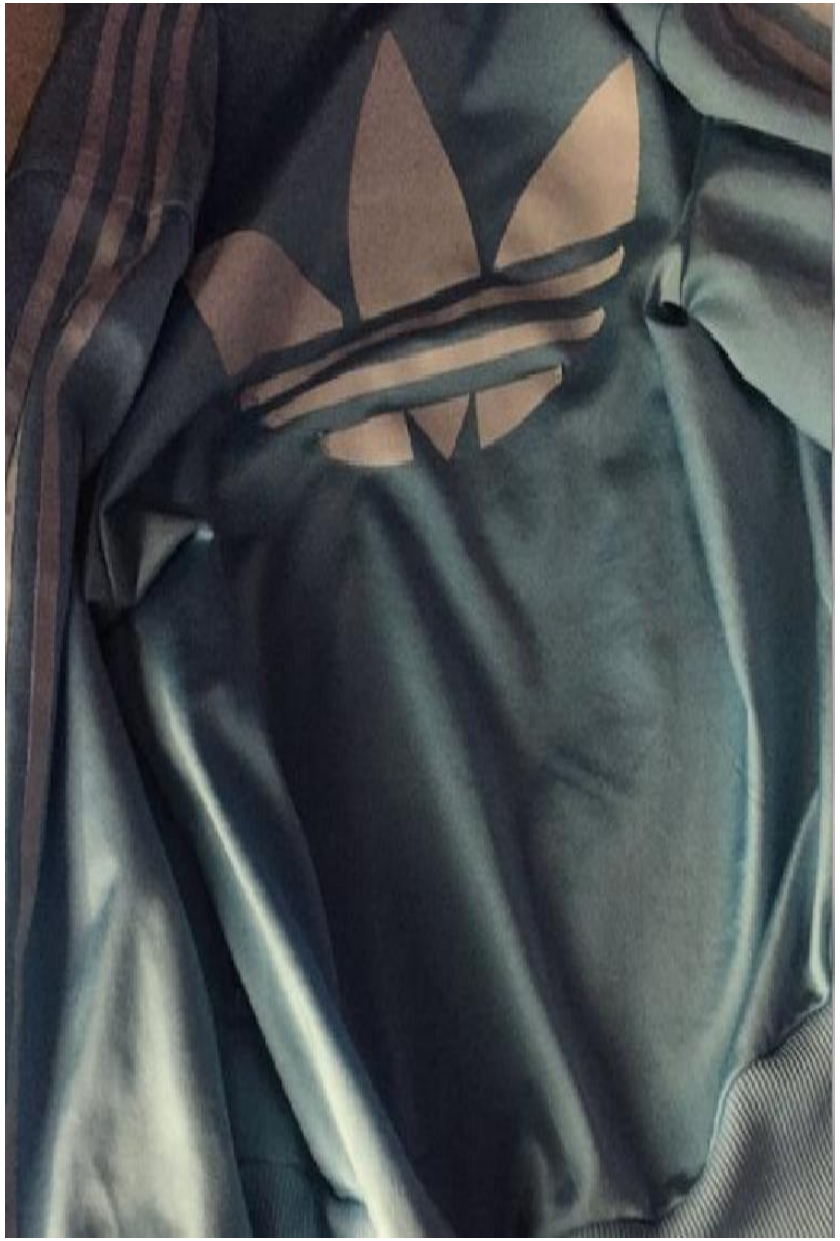
Part 2 of the book

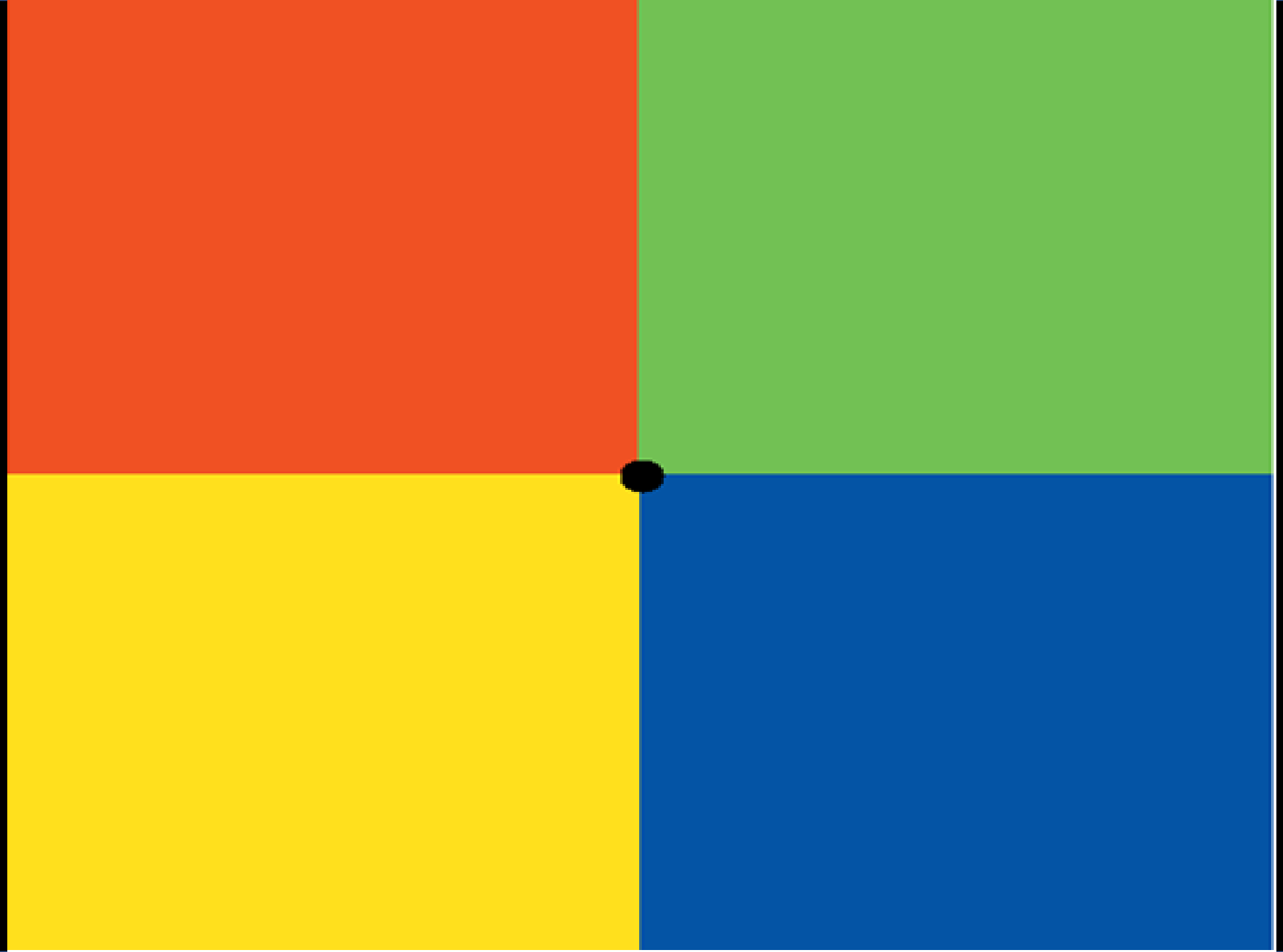
Kavita Vemuri

The Eye and Light

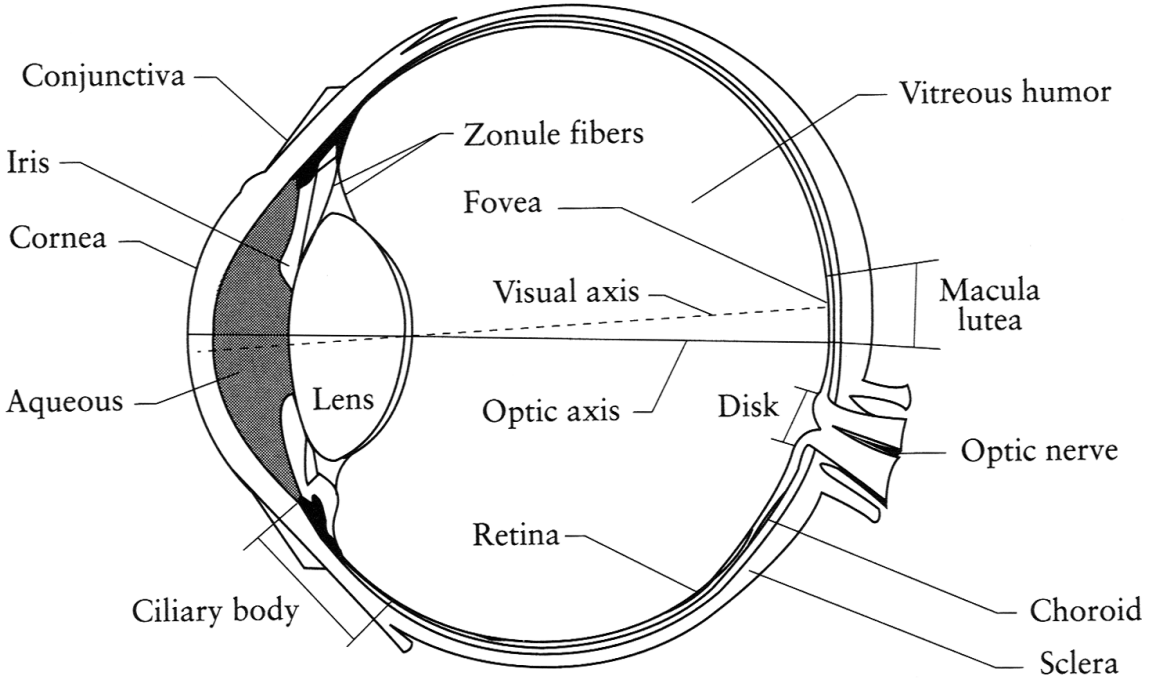
The visual system

- Color
- Shapes
- Depth
- Motion
- Texture
- ??





The Eye is a camera?

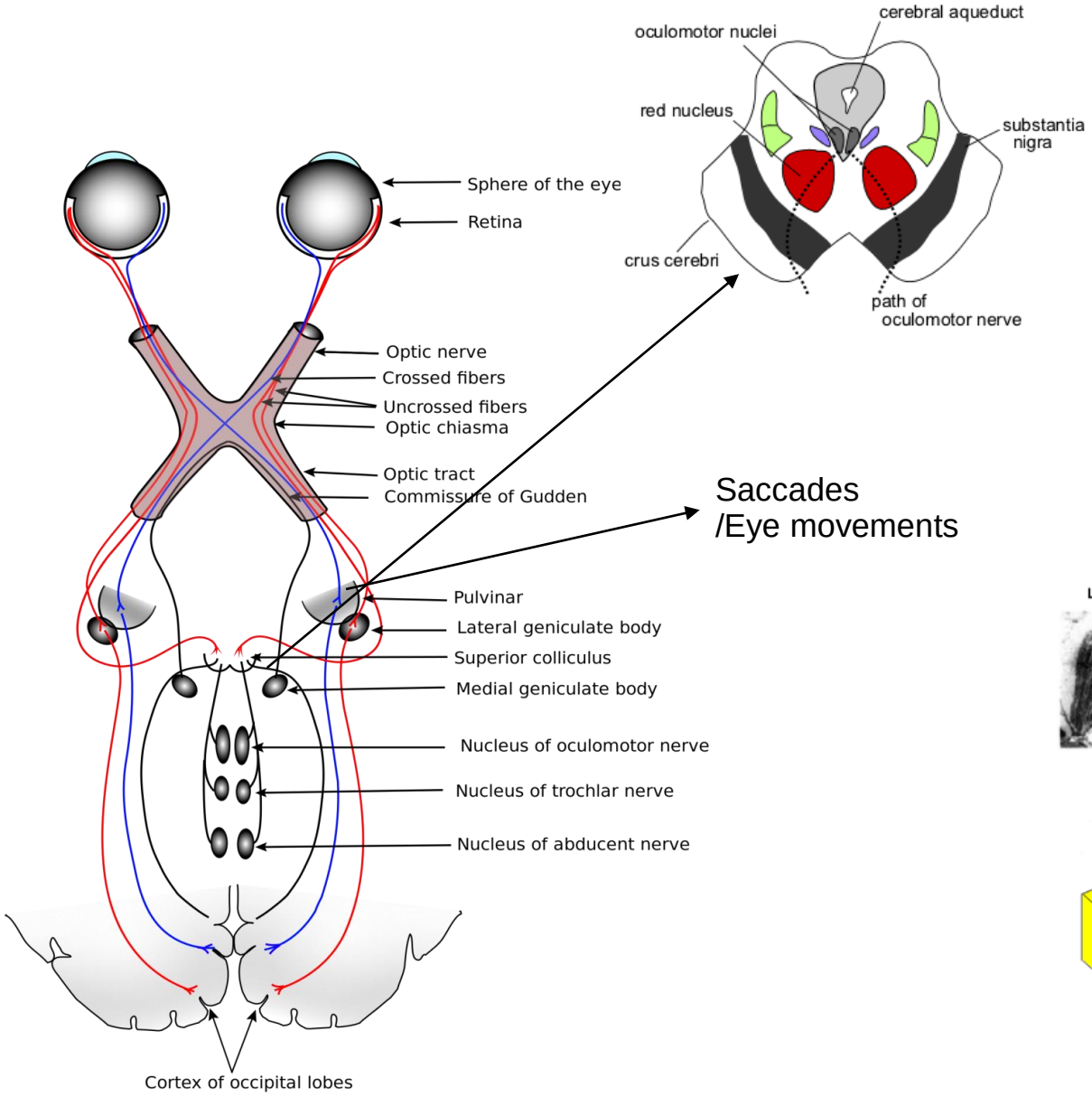


The camera is designed as the eye!

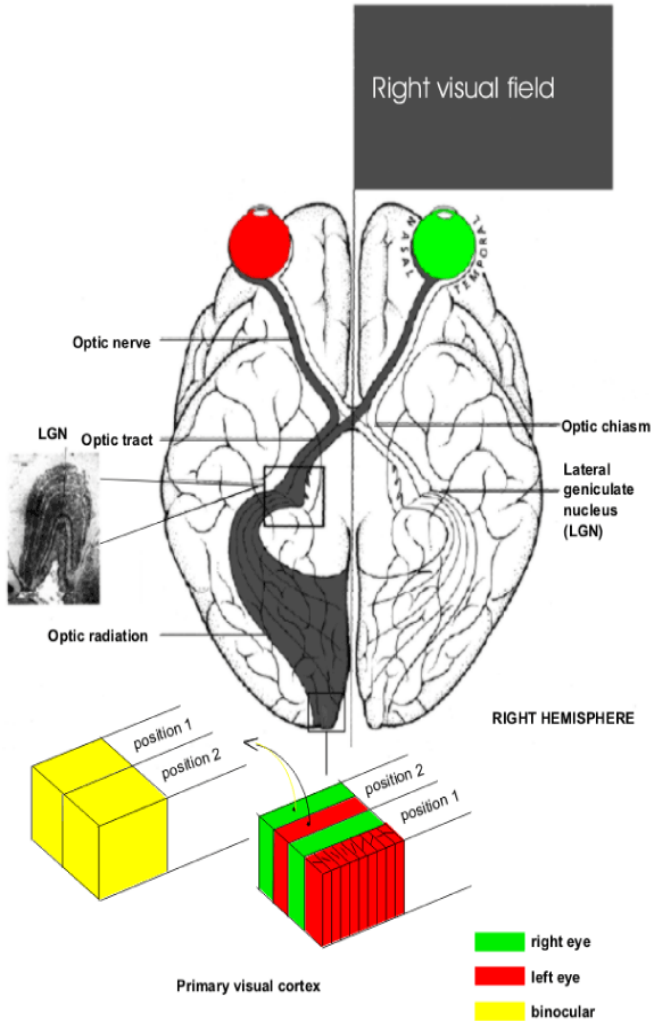
- **Iris** - colored annulus with radial muscles
- **Pupil** - the hole (aperture) whose size is controlled by the iris
- What's the "film"?

  –photoreceptor cells (rods and cones) in the **retina**

Pathway to Visual Cortex

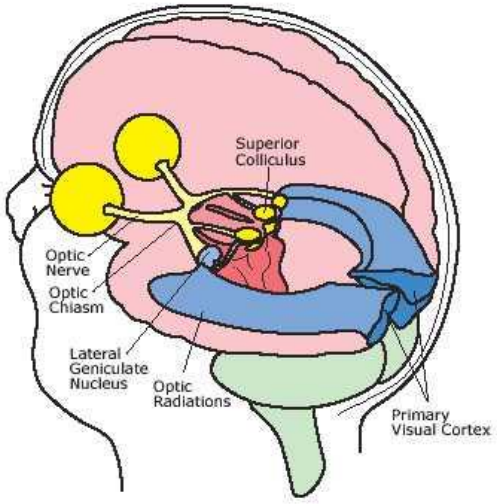


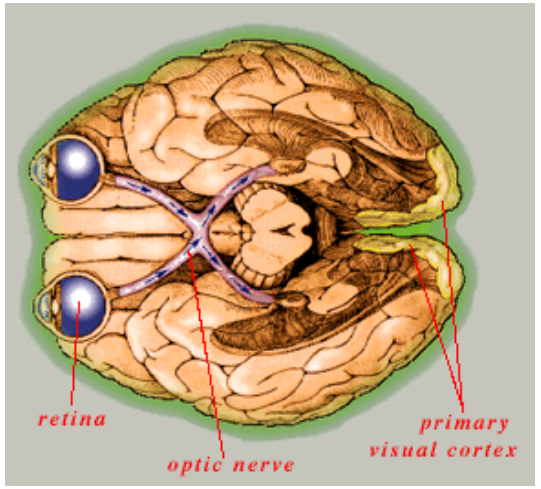
Saccades
/Eye movements



The Visual System

Both eye and brain are required for functional vision

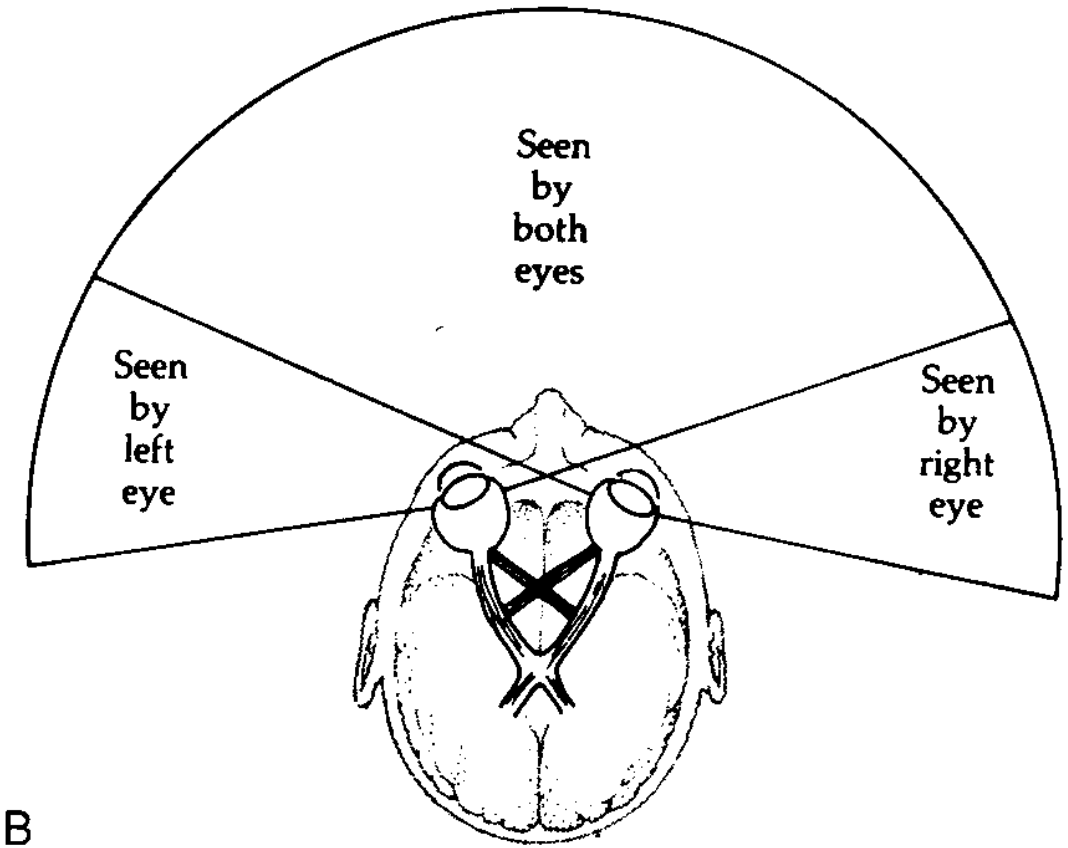




Two kinds of blindness:

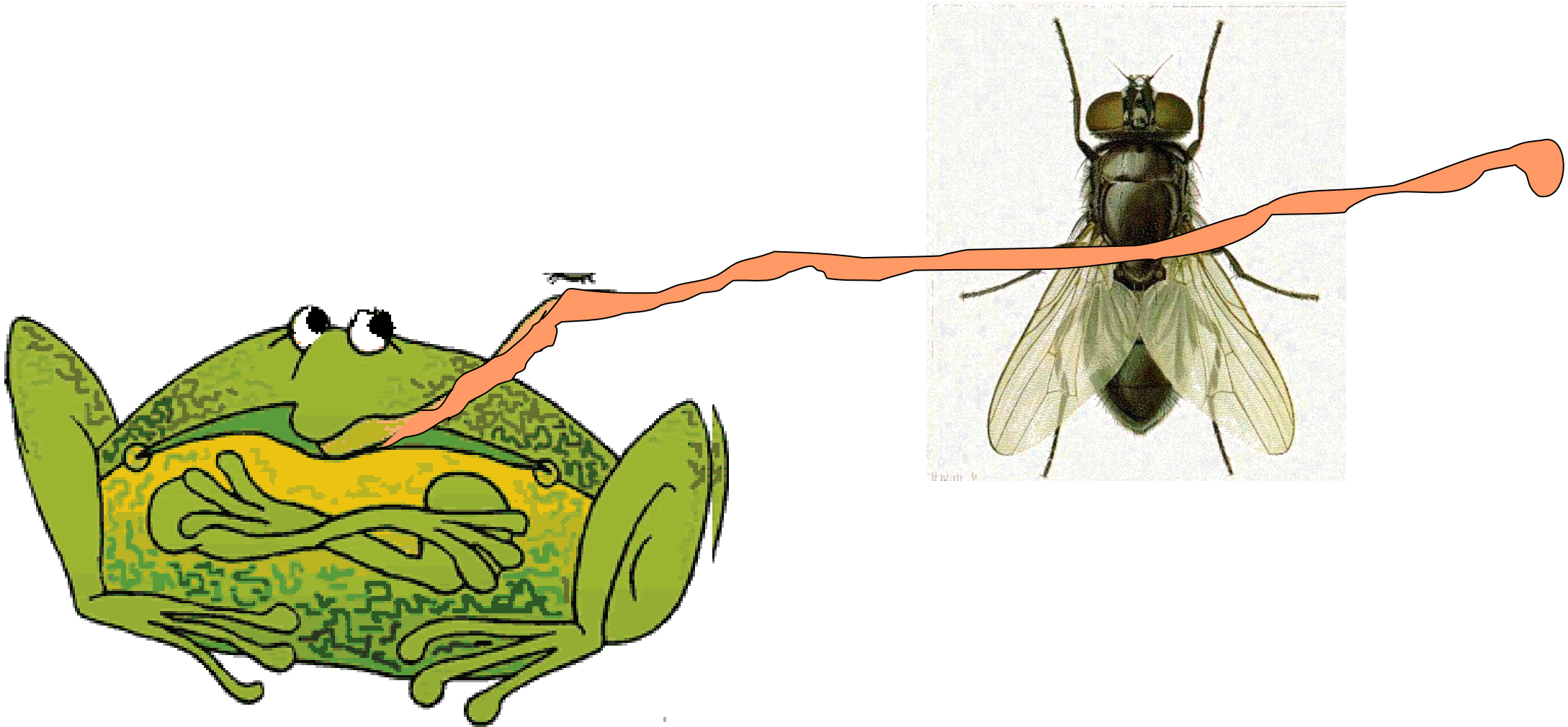
- Normal blindness (eye dysfunction)
- Cortical blindness (brain dysfunction)

Monocular Visual Field: 160 deg (w) X 135 deg (h)
Binocular Visual Field: 200 deg (w) X 135 deg (h)

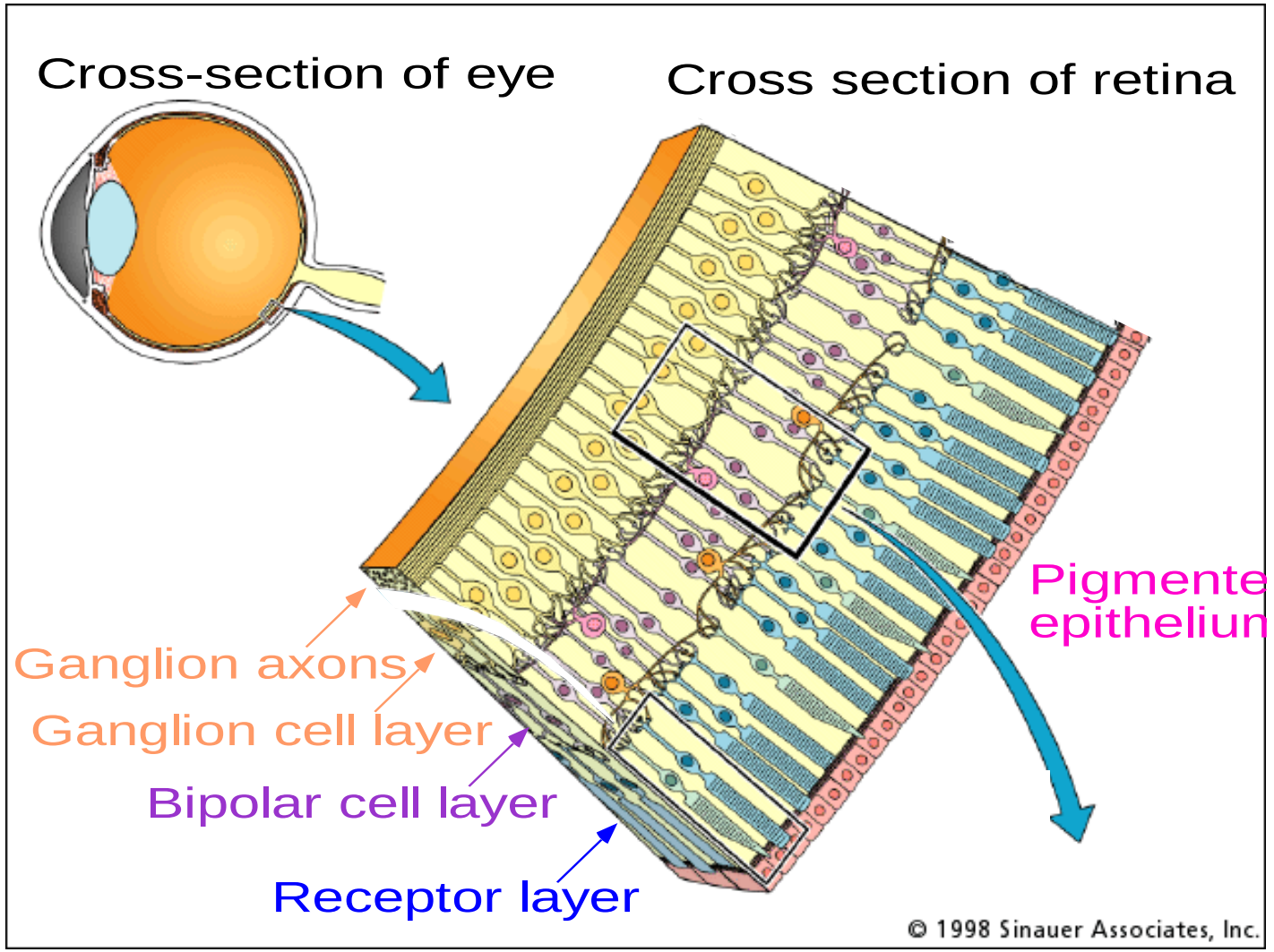


B

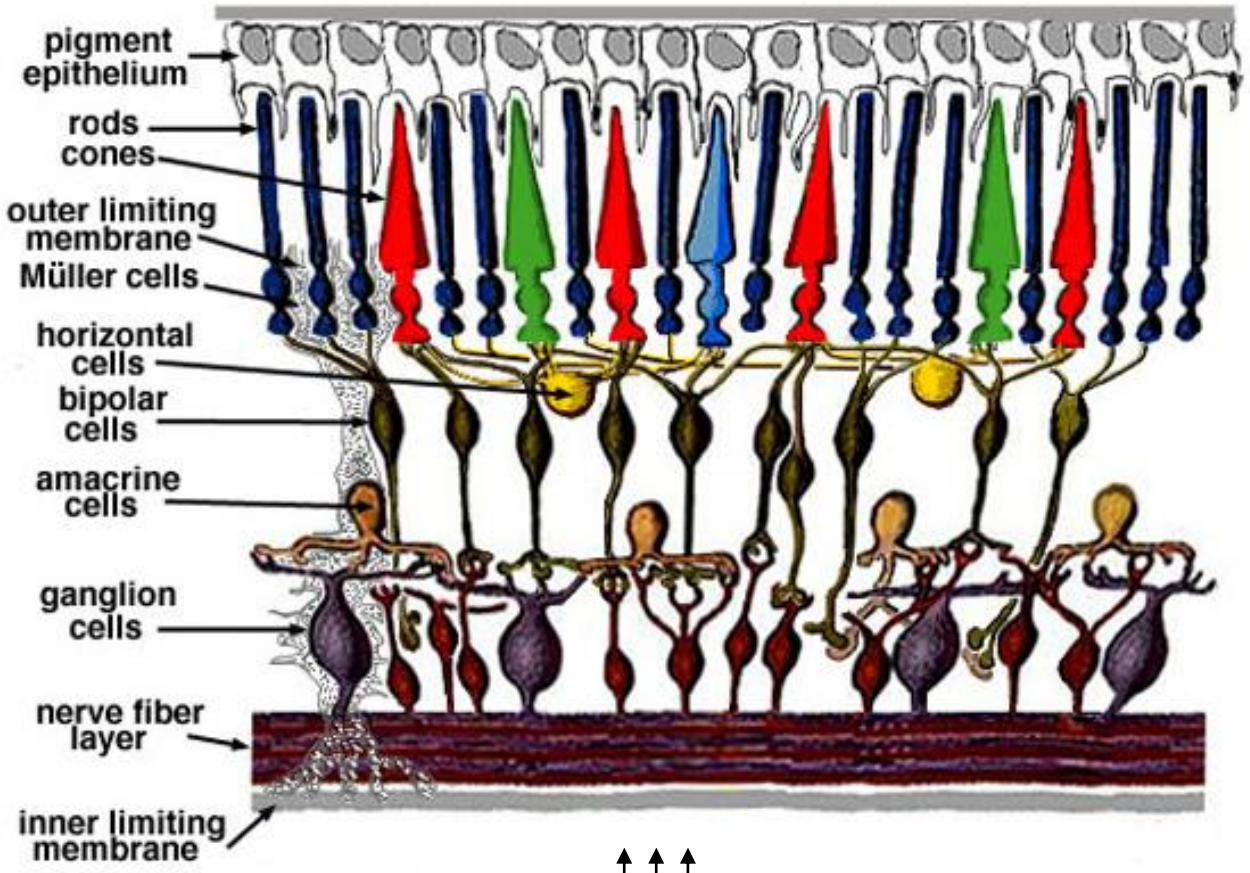
The Visual Grasp Reflex moves the eyes towards a suddenly appearing peripheral signal



The Retina


Cross-section of eye
Cross section of retina
Pigmente
epitheliun
Ganglion axons
Ganglion cell layer
Bipolar cell layer
Receptor layer
© 1998 Sinauer Associates, Inc.

Retina up-close



↑↑↑

Light

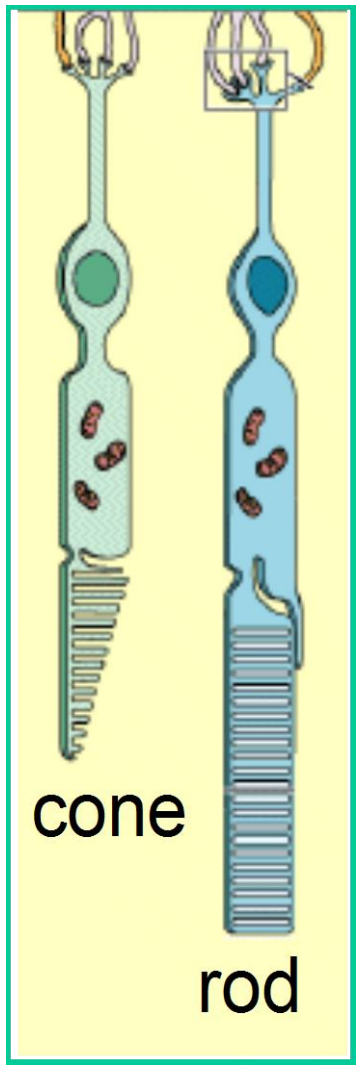
Two types of light-sensitive receptors

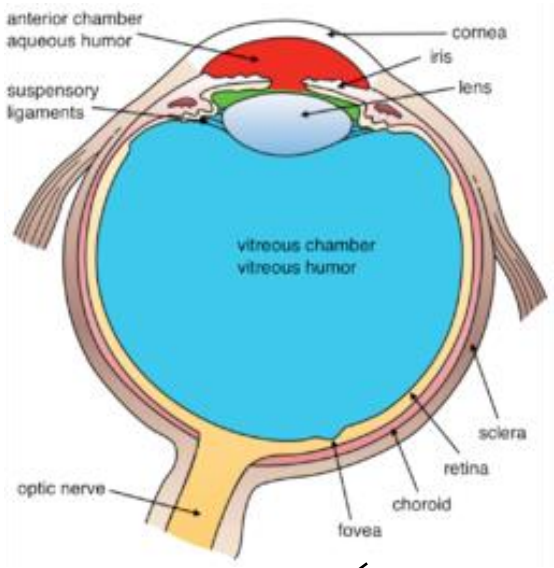
Cones

- cone-shaped
- less sensitive
- operate in high light
- color vision

Rods

- rod-shaped
- highly sensitive
- operate at night
- gray-scale vision



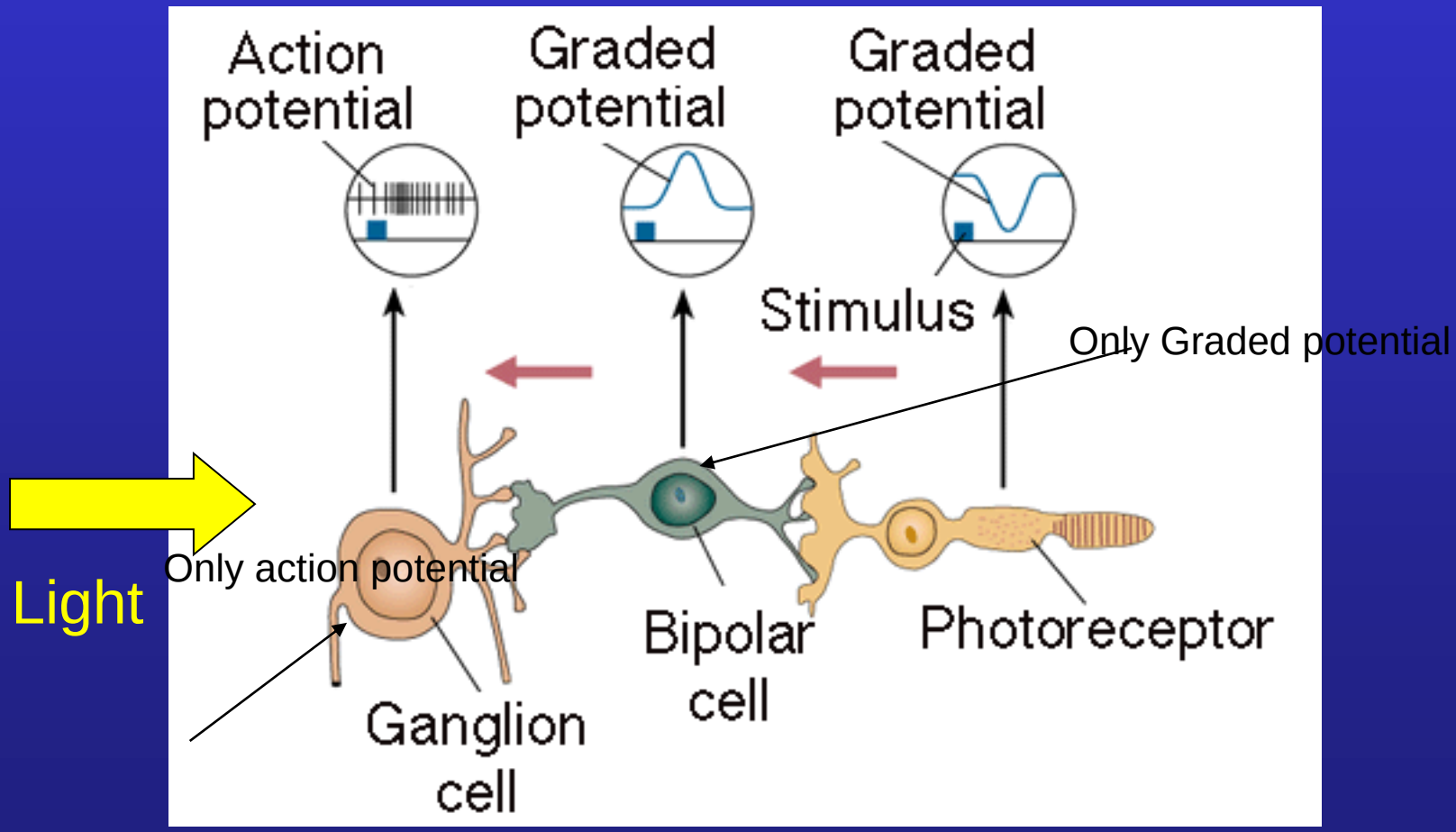


0.3 mm diameter rod-free area

Retina is organized into macula, optic disc, fovea and peripheral retina

Retinal Receptive Fields

Receptive field structure in bipolar cells



Transmission from the eye.

- Light or darkness cause changes in neurotransmitter release

in photoreceptors.

- Bipolar cells become either hyperpolarized or depolarized by light.

- Changes in glutamate release by the bipolar cells cause changes in the membrane potential of ganglion cells.

- If the ganglion cell is depolarized to threshold, it produces action potentials that are then conducted to the brain via axons that run in the optic nerve

Retinal ganglion cells respond to edges

Input image
(cornea)

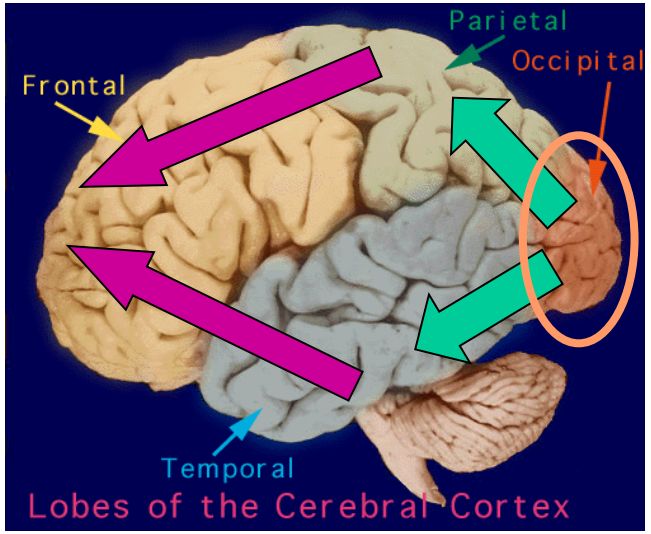
"Neural image"
(retinal ganglion cells)

Center-surround receptive fields: emphasize edges.

http://www.cns.nyu.edu/~david/courses/perception/lecturenotes/ganglion/ganglion.html

The pathways in the brain

Eyes register optical information

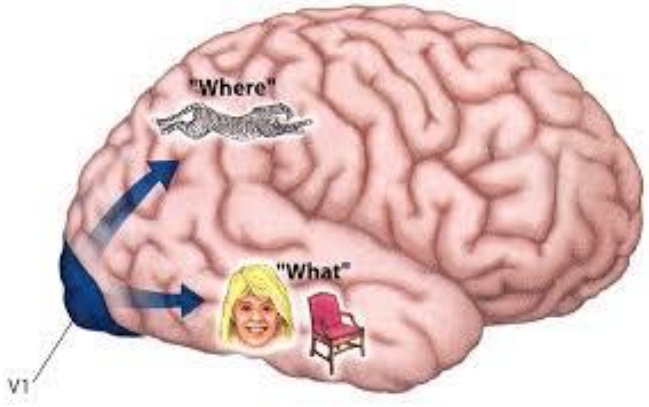


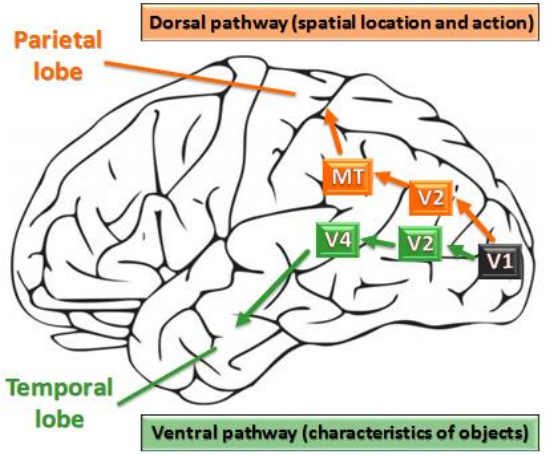
Two pathways from V1

"What" pathway to temporal cortex

"Where" pathway to parietal cortex

Convergence on frontal cortex





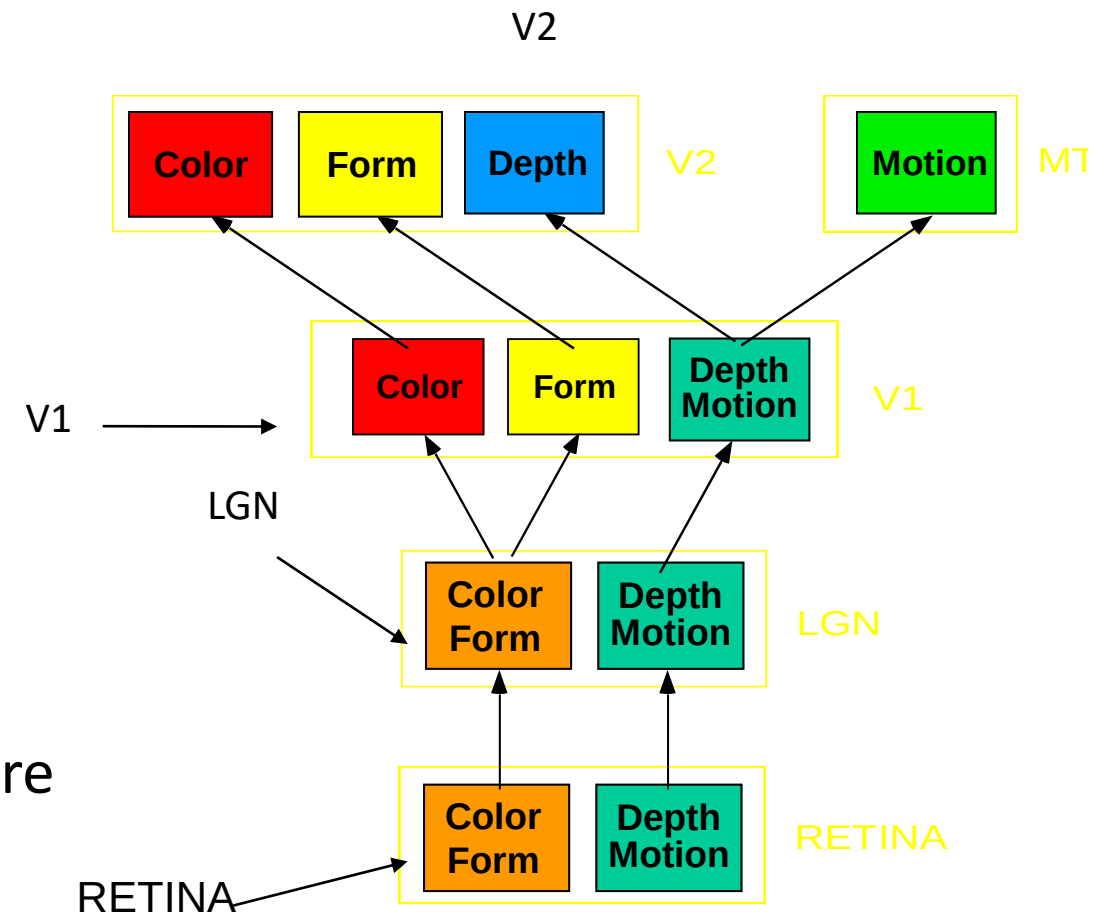
Feature-based Pathways Hypothesis

Visual Features

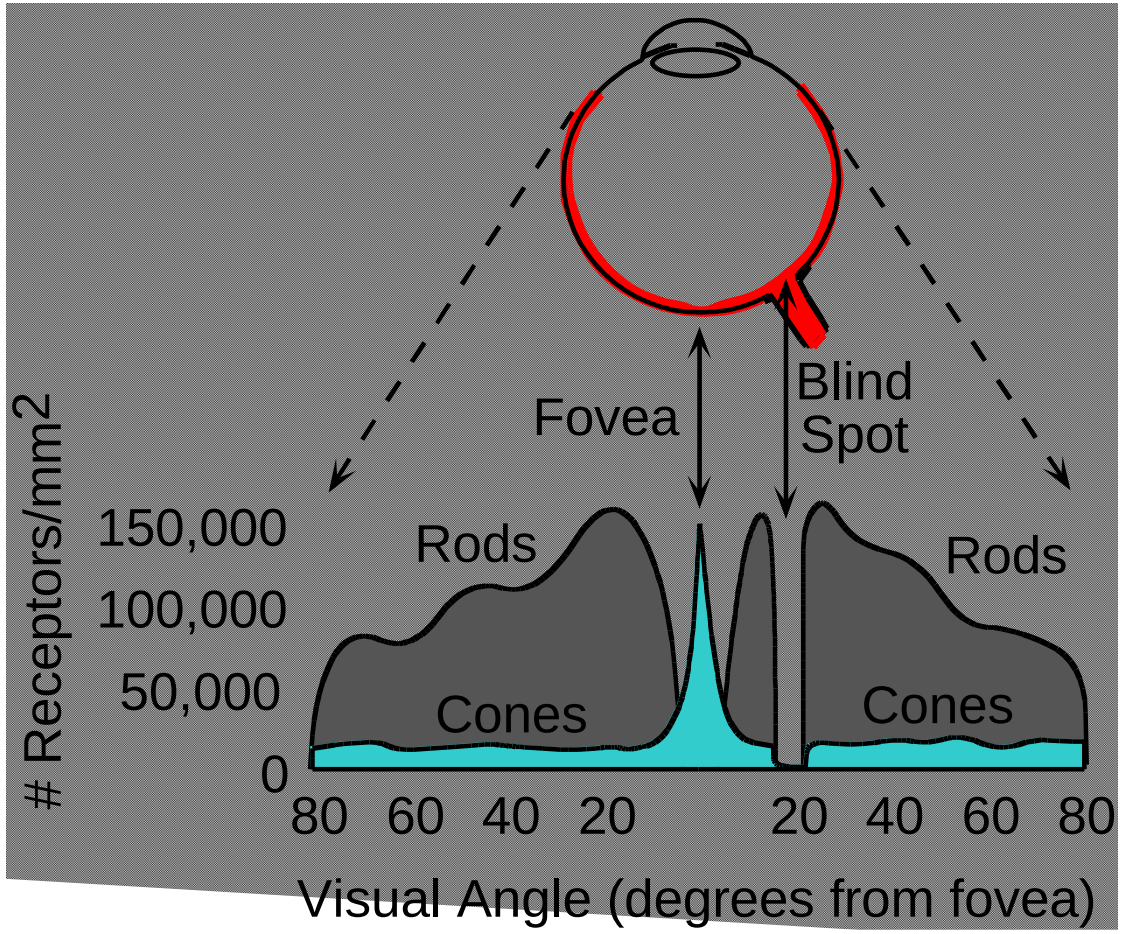
Color
Shape
Depth
Motion

Featural Pathways

Separate neural pathways in which different features are processed.



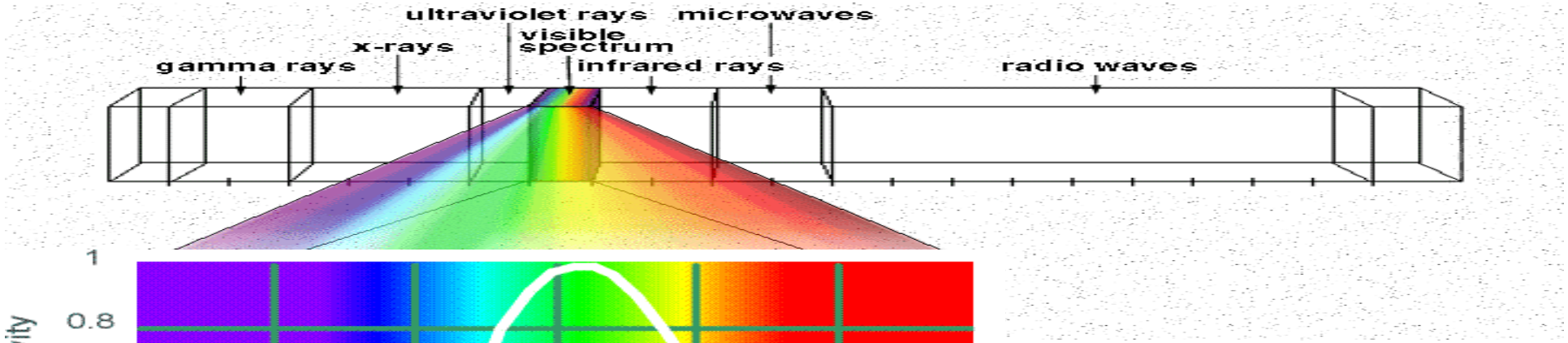
Distribution of Rods and Cones

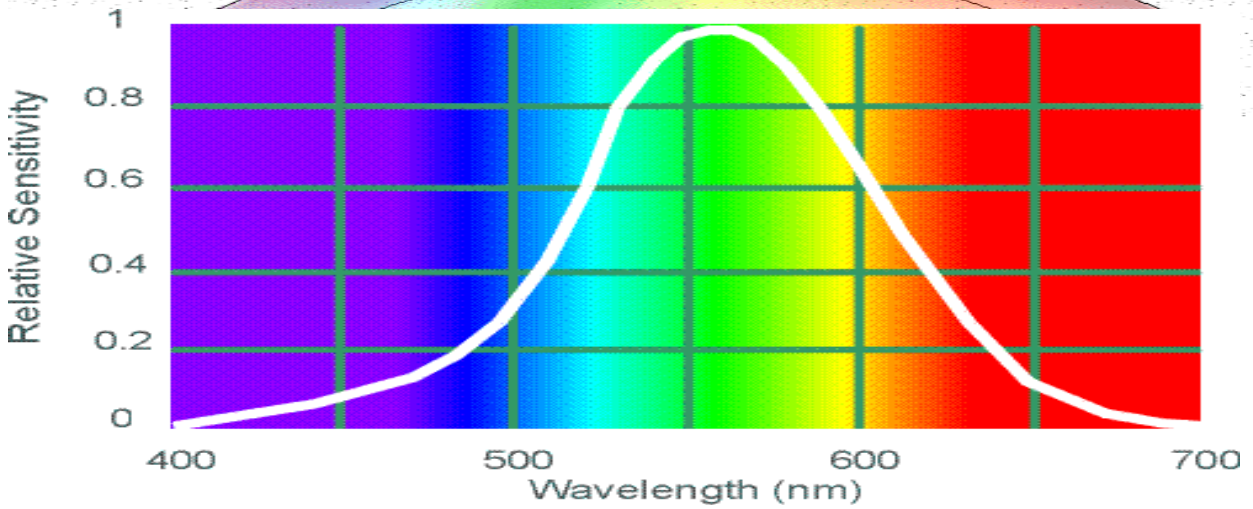


Night Sky: why are there more stars off-center?

Color Perception

Electromagnetic Spectrum

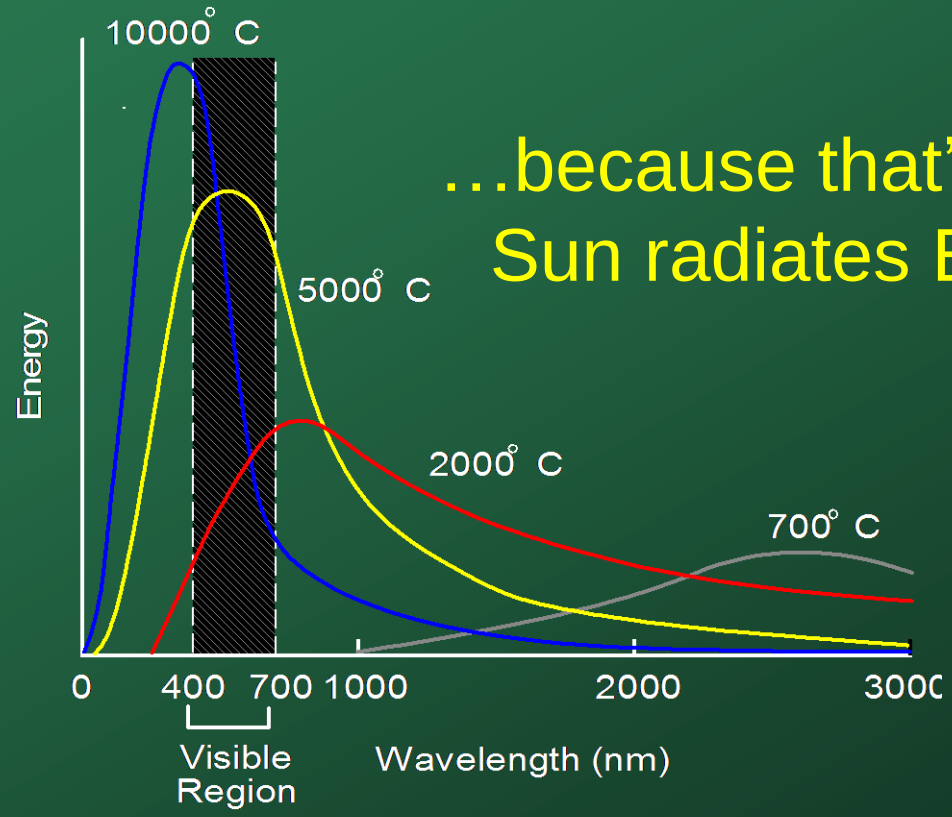




Human Luminance Sensitivity Function

Visible Light

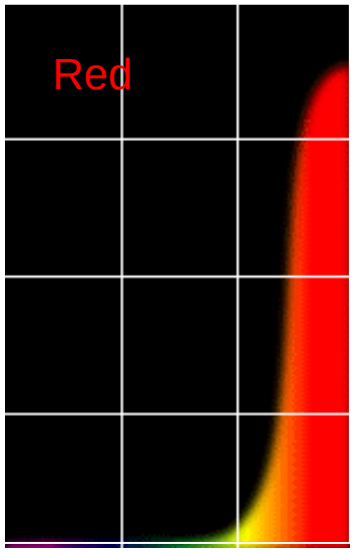
Why do we see light of these wavelengths?

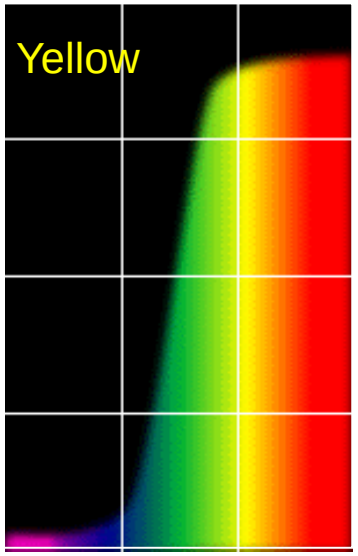


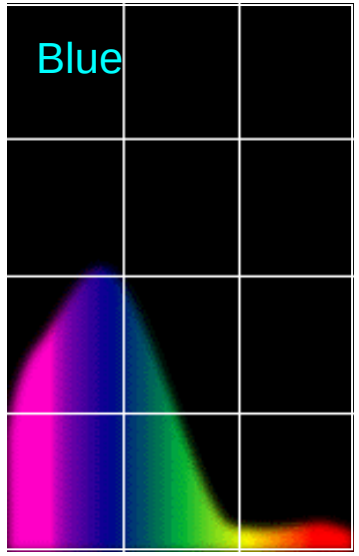
…because that's where the Sun radiates EM energy

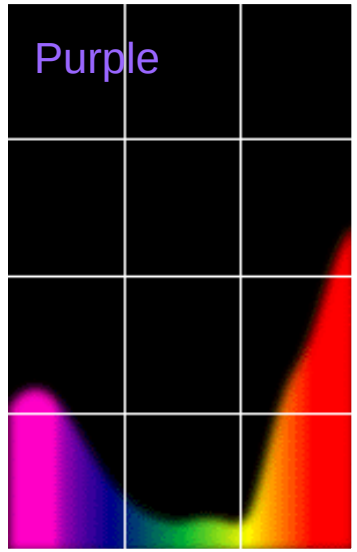
The Physics of Light

Some examples of the reflectance spectra of surfaces



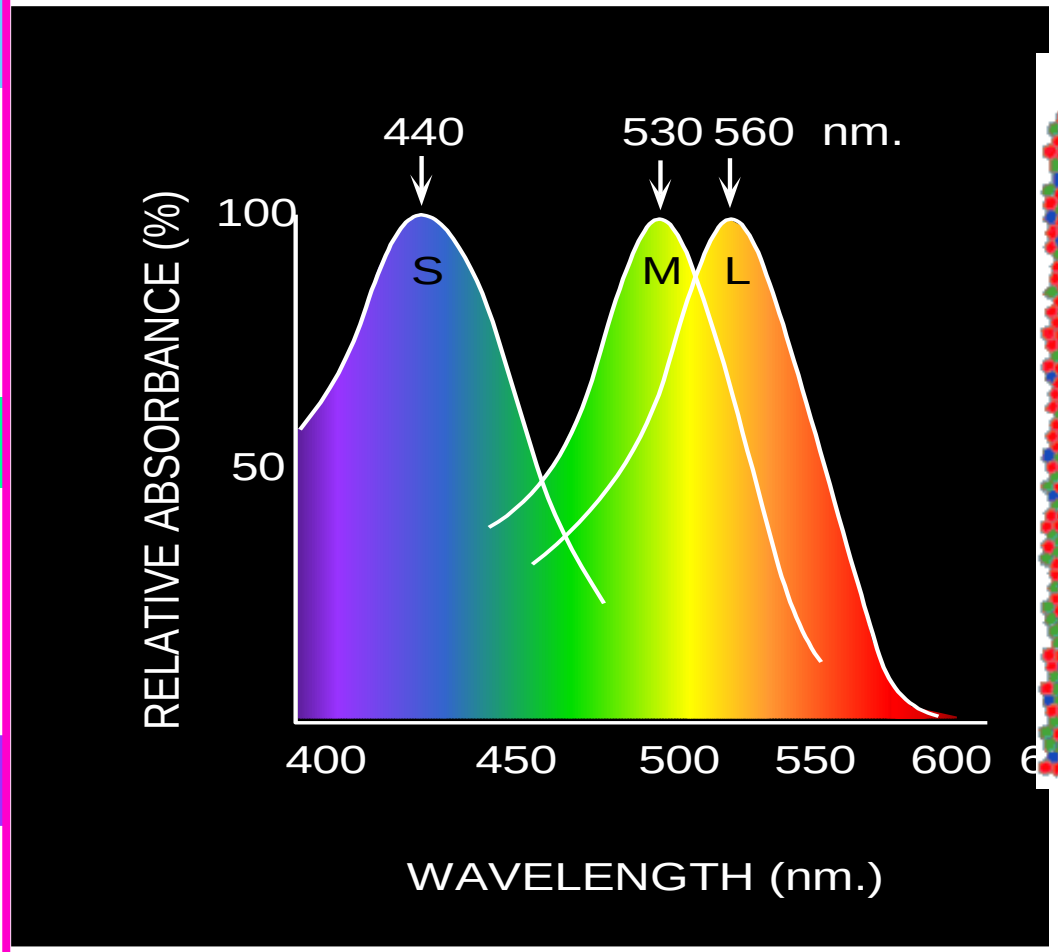


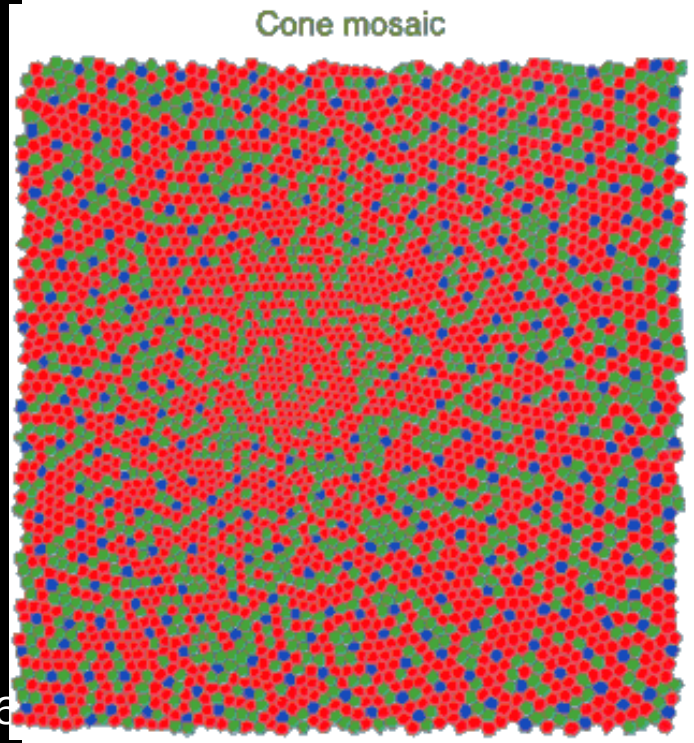




Physiology of Color Vision

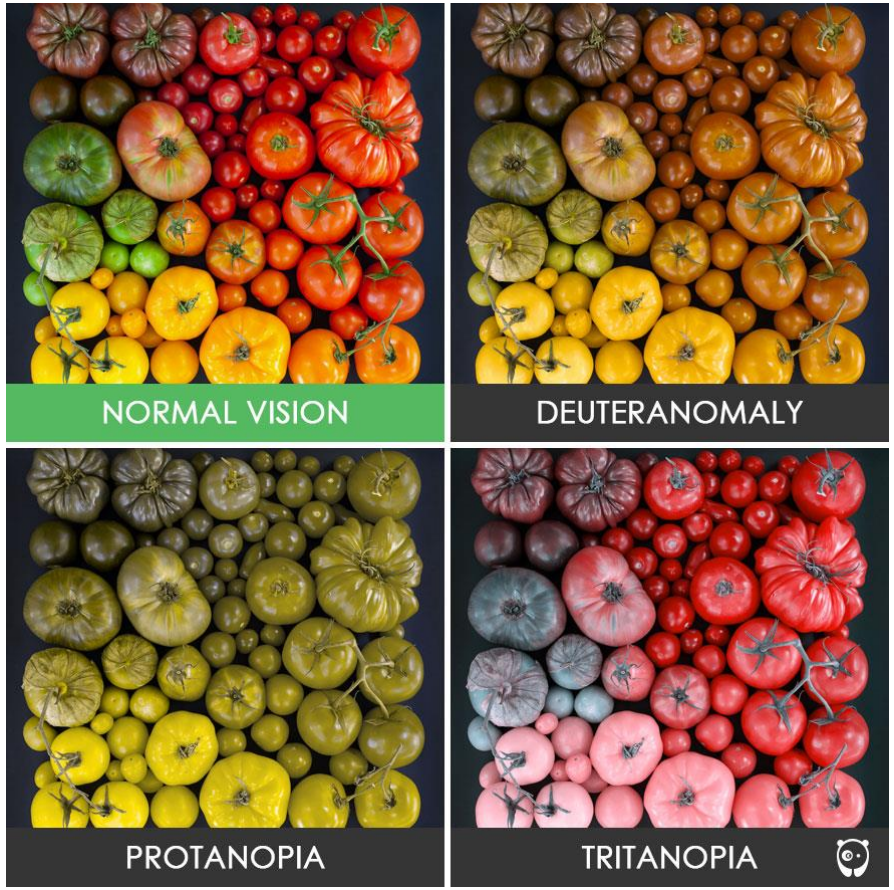
Three kinds of cones:

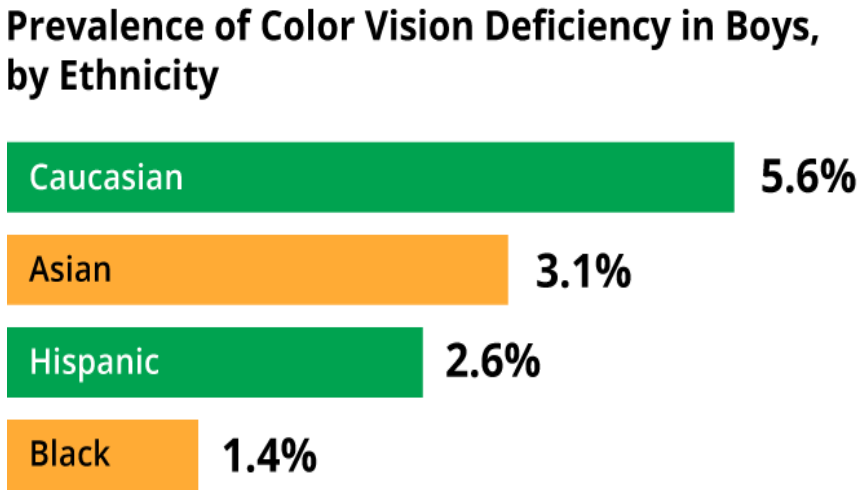




?

Color deficiency





4,005 California children ages 3 to 6 in Los Angeles and Riverside Counties

Xie et al.,
April 2014 in the journal *Ophthalmology*.

Deuteranomaly: reduced sensitivity to green light and is the most common form of colour blindness
Protanopia: reduced sensitivity to red light
Tritanopia: reduced sensitivity to blue light – extremely rae.

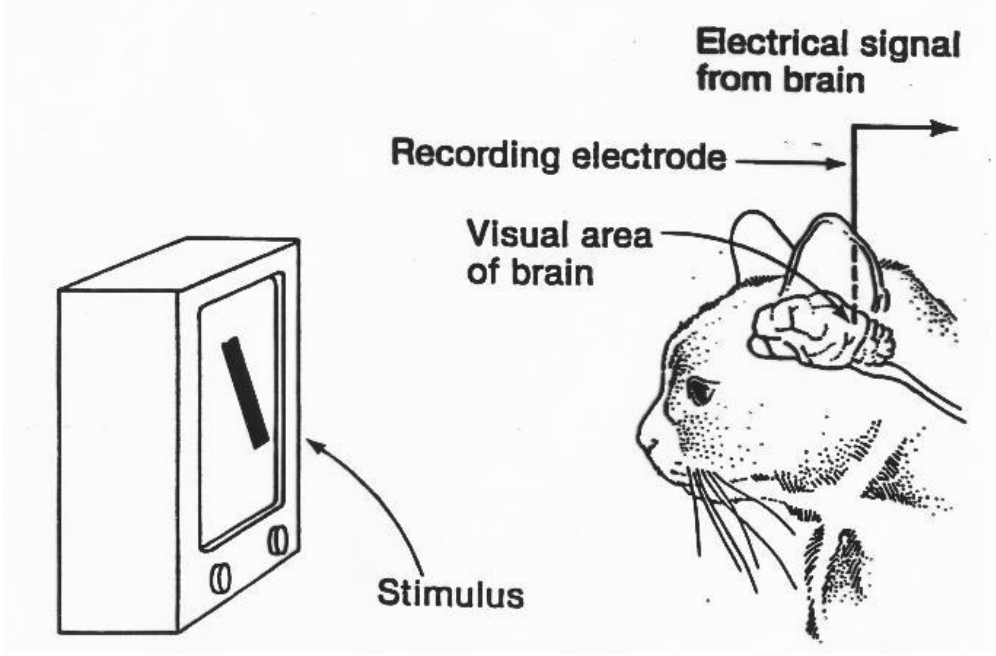
From rods and Cones to LGN and V1

Cortical Receptive Fields

Single-cell recording from visual cortex

David Hubel & Thorston Wiesel

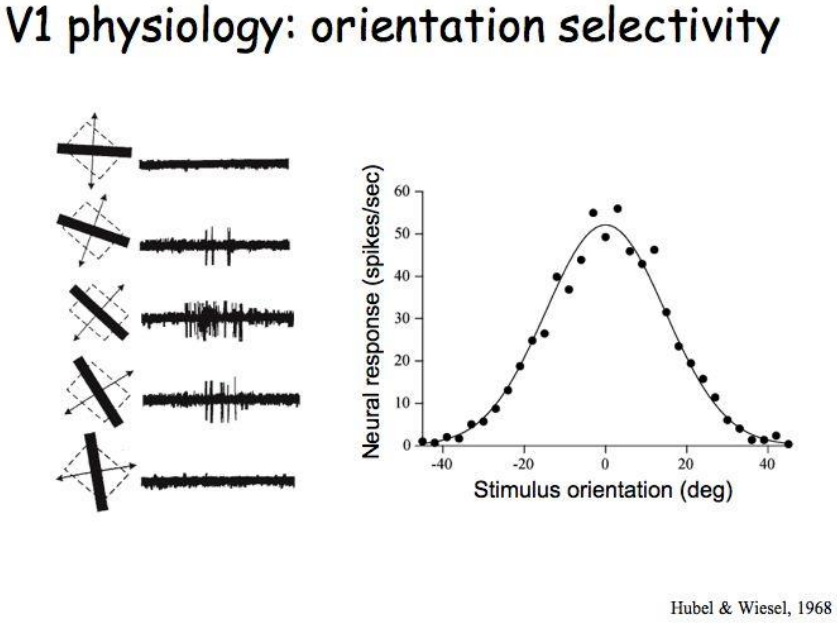
Hubel and Wiesel



http://www.cns.nyu.edu/~david/courses/perception/lecturenotes/V1/LGN-V1-slides/hw-2-cortical-rfs-640x480.mov

Function of the V1

- David Hubel and Torsten Wiesel discovered the functional organization and basic physiology of neurons in V1.
- They discovered three different types of neurons that can be distinguished based on how they respond to visual stimuli that they called: *simple cells*, *complex cells*, and *hypercomplex cells*.
- V1 neurons transform information (unlike LGN cells whose receptive fields look just like those of ganglion cells) so that they are *orientation selective* and *direction selective*.



summary

The visual system is composed of many interactive functional parts:

Eye (optics of image formation)

Retina (light transduction)

LGN (waystation?)

Area V1 (hypercolumns)

Higher cortical areas (features)

Cortical pathways (what/where)

Object recognition

Gestalt principles of perceptual organization

- The Gestaltists argued that the organization is contributed by the perceiver; this is why, they claimed, the perceptual whole is often different from the sum of its parts.

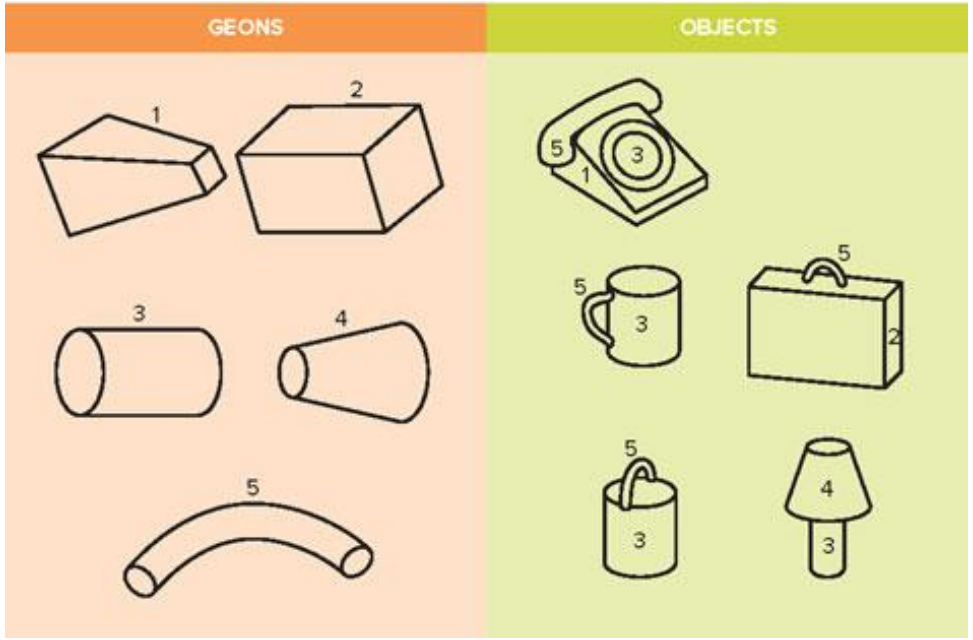
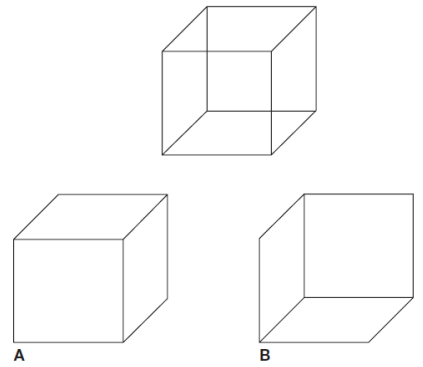
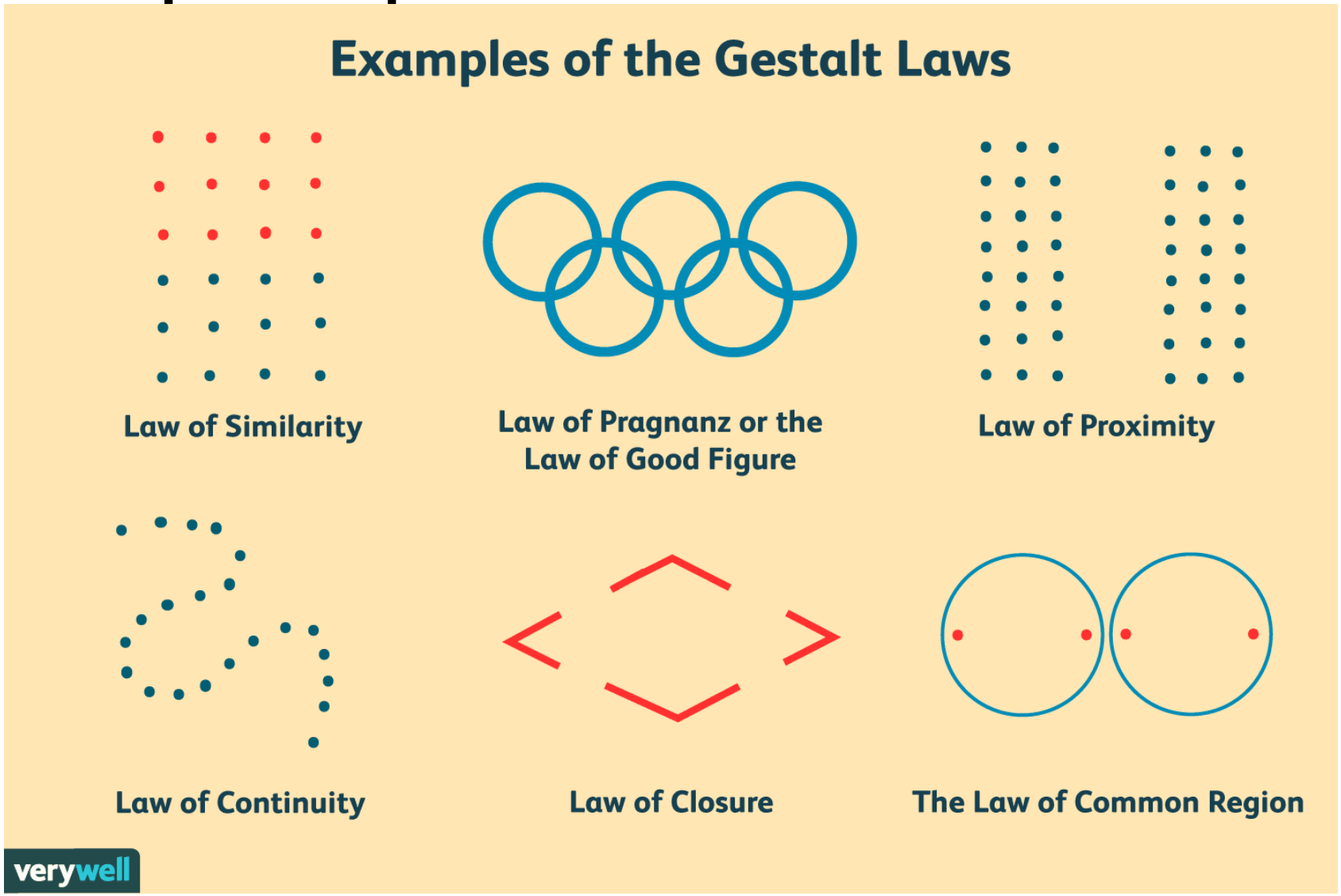


FIGURE 3.11 THE NECKER CUBE



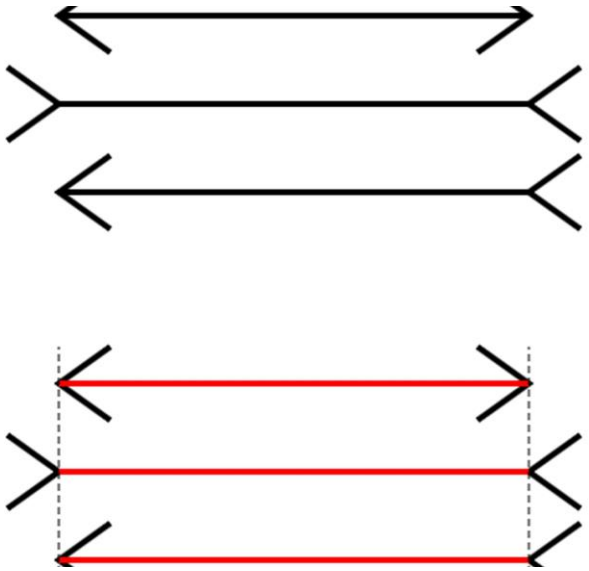
The top cube can be perceived as if viewed from above (in which case it is a transparent version of Cube A) or as if viewed from below (in which case it is a transparent version of Cube B).

Gestalt principles



Helmholtz’s theory of unconscious inference(1867)

- It states that some of our perceptions are a result of unconscious assumptions we make about the environment.
- Includes the **Likelihood principle** – we perceive an object that is most likely to have caused the pattern.



Object Recognition

How Humans Recognize Objects: Segmentation, Categorization and Individual Identification

Object agnosia (see only the faces)

How Do We Recognize Objects From Different Viewpoints?

- Two competing theories:

- Structural description models

- Image description models

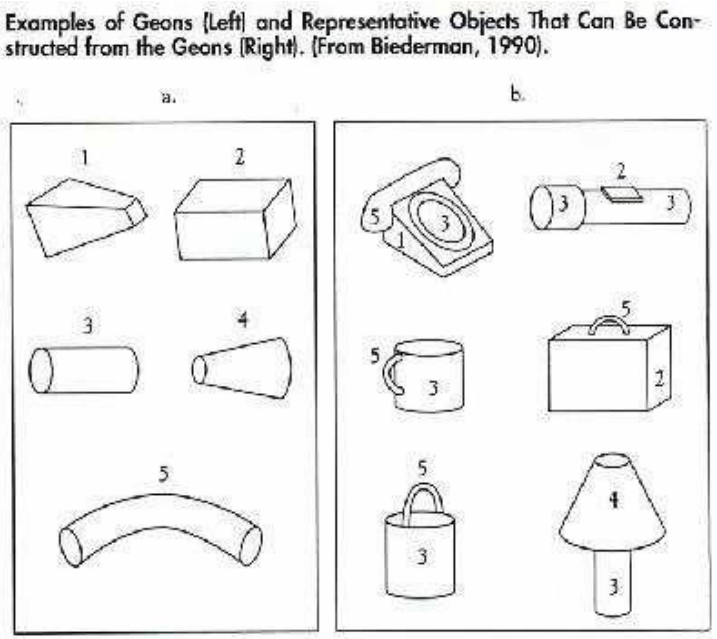
Structural-Description Models:

- Recognition by Components (RBC) {Biederman (1985)}
- Geons (“Geometric Ions”)
- Each geon is uniquely identifiable from most viewpoints *(viewpoint invariant).*
- Only 36 geons needed to make thousands of objects.
- Objects can be identified if the geons can be identified:
- which geons are present?
- what is the spatial relation among geons?

(a)

(b)

Figure 5.35 (a) It is difficult to identify the object behind the mask because its geons have been obscured.
(b) Now that it is possible to identify geons, the object can be identified as a flashlight.



Recognition by Components

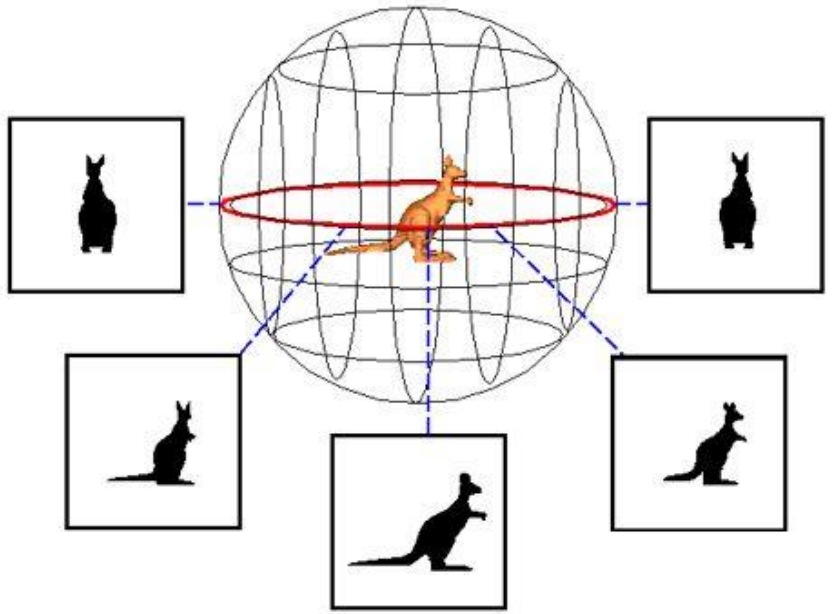
Strengths

- – Viewpoint invariant
- – Parts-based
- – May be able to deal with partial occlusion via feedback
- – Represent 3-D structure

Weaknesses

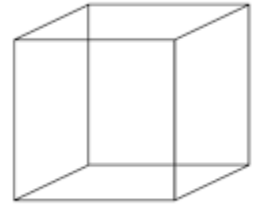
- – Complexity of representation
- – Doesn’t easily represent subtle metric differences (e.g.,distance between eyes)
- – Recognition is at the level of categories (chair vs. table) rather than individuals (my office chair vs. my kitchen chair)

Viewpoint-dependent theory of recognition



- This is an alternative theory. You store in your head a bunch of characteristic views (mental images) of objects. You recognize a new image by finding the closest match. That is, you don't use 3D shape to recognize objects. Only the 2D views of the objects

Image-Description Models



- Ability to identify 3-D objects comes from stored 2-D viewpoints from different perspectives
- – For a familiar object, view invariance occurs
- – For a novel object, view invariance does not occur

This shows that an observer needs to have the different viewpoints encoded before recognition can occur from all viewpoints

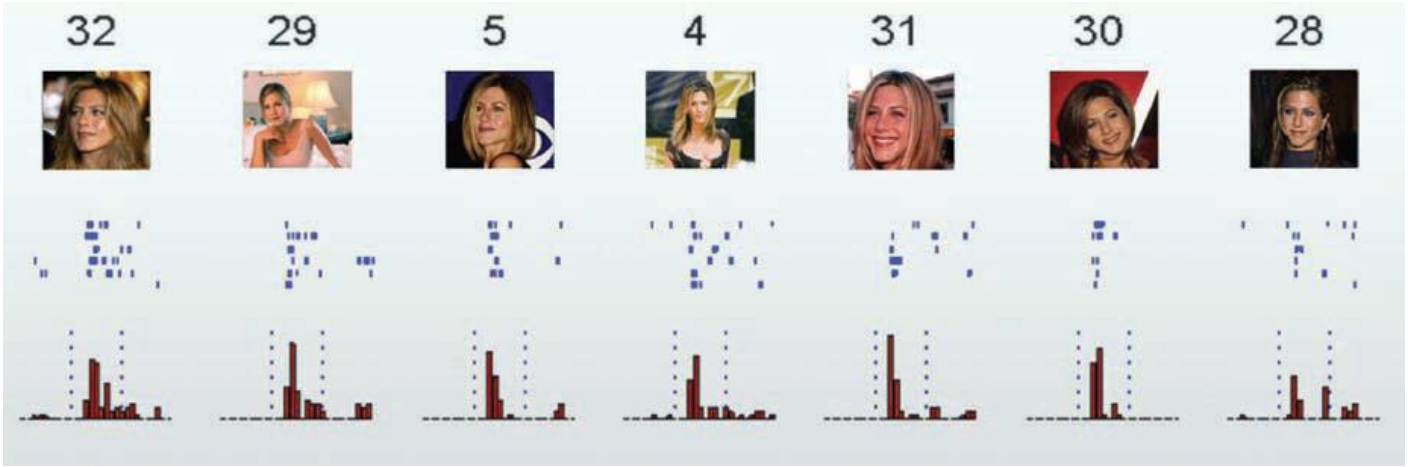
Object recognition

- Schneider's (1969) suggestion that two distinct pathways support visual orientation toward object features.
- Research stemming from this idea has inextricably linked object recognition to the experiences of space, time, and persistence over time, i.e., individual identity (Scholl, 2007; Fields, 2012).
- Without a spacetime "container" and individual, time-persistent objects, motion and causation cannot be defined; hence object recognition underlies these experiences as well.
- **Will object recognition be possible without memory?**

https://www.frontiersin.org/articles/10.3389/fpsyg.2016.00400/full

Object Recognition

- Researchers in one study were able to do single-cell recording within the brains of people who were undergoing surgical treatment for epilepsy. The researchers located cells that fired strongly whenever a picture of Jennifer
- Aniston was in view — whether the picture showed her close up (picture 32) or far away (picture 29), with long hair (picture 32) or shorter (picture 5). These cells are largely viewpoint-independent; other cells, though, are viewpoint-dependent.



Pattern Recognition

Face,Speech/music,text, art

Theories of pattern recognition:

1. Template-matching theory.
2. Feature detection theories
3. Prototype theories

Prototype theory is preferred, because (a) it appears to be amore flexible approach (since prototypes can be updated continuously with new experiences), and (b) fewer representations need to be stored.

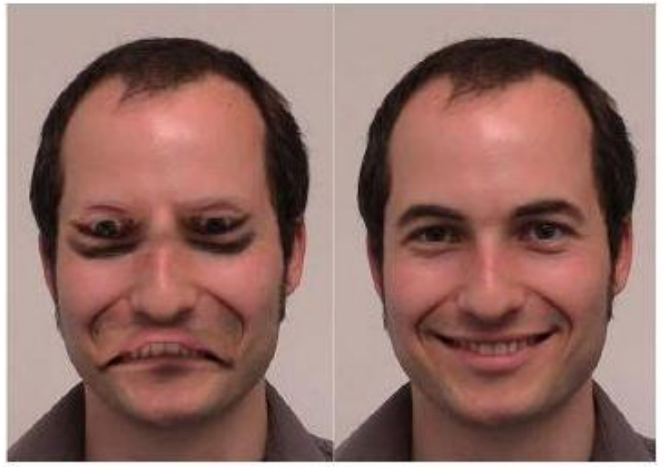
Extreme cases:

Apophenia (early stages of schizophrenia).

Pareidolia: ringing phone while taking a shower.

Gambler's fallacy: school oneself to see patterns

Pattern Invariance- Pattern recognition



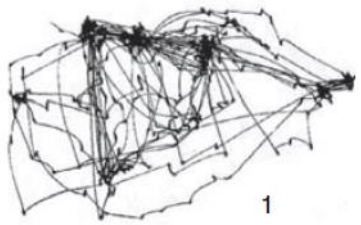
Attention

FIGURE 5.1 THE INVISIBLE GORILLA

In this procedure, participants are instructed to keep track of the ballplayers in the white shirts. Intent on their task, participants are oblivious to what the black-shirted players are doing, and—remarkably—they fail to see the person in the gorilla suit strolling through the scene. (FIGURE PROVIDED BY DANIEL J. SIMONS.)

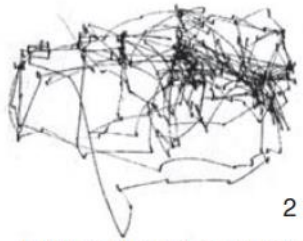
Change Blindness

Eye movements and vision



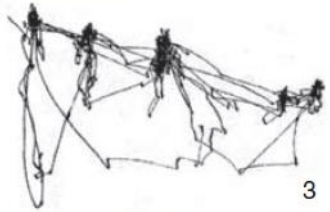
1

Free examination.



2

Estimate material circumstances of the family.

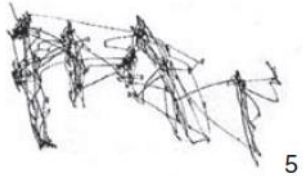


3

Give the ages of the people.

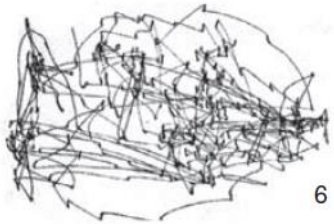
4

Surmise what the family had been doing before the arrival of the unexpected visitor.



5

Remember the clothes worn by the people.



6

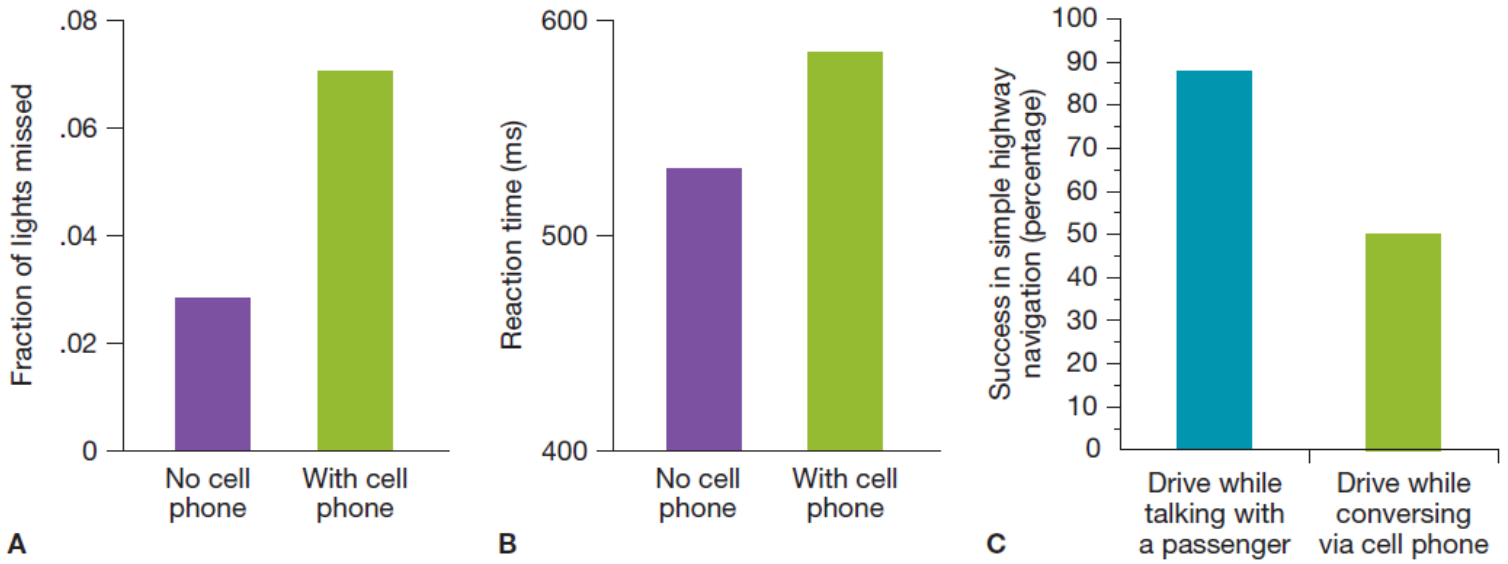
Remember positions of people and objects in the room.

7

Estimate how long the visitor had been away from the family.

Multitasking & Attention

FIGURE 5.19 CELL PHONE USE AND DRIVING



Many studies show that driving performance is impaired when the driver is on the phone (whether hand-held or hands-free). While on the phone, drivers are more likely to miss a red light (Panel A) and are slower in responding to a red light (Panel B). Disruption is not observed, however, if the driver is conversing with a passenger rather than on the phone (Panel C). That's because the passenger is likely to adjust her conversation to accommodate changes in driving—such as not speaking while the driver is navigating an obstruction.

(AFTER STRAYER & JOHNSTON, 2001)

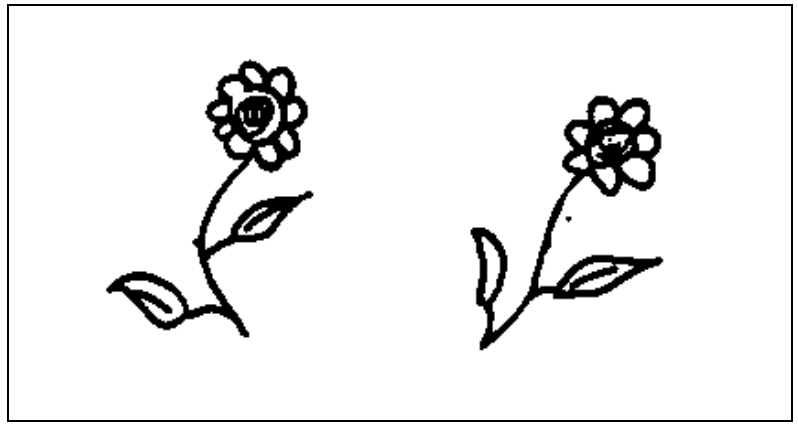
FIGURE 5.21 STROOP INTERFERENCE

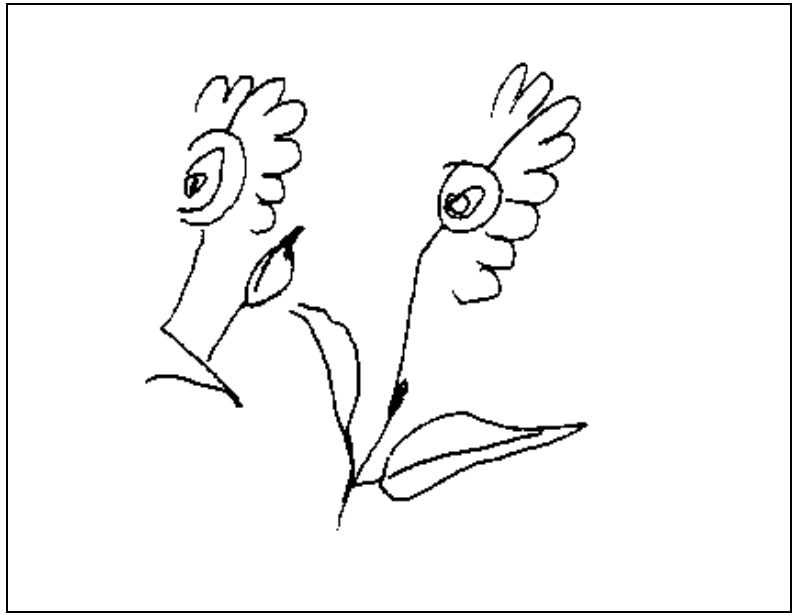
As rapidly as you can, name out loud the colors of the *ink* in Column A. (You'll say, "black, green" and so on.) Next, do the same for Column B — again, naming out loud the colors of the ink. You'll probably find it much easier to do this for Column A, because in Column B you experience interference from the automatic habit of reading the words.

Alan Burgess

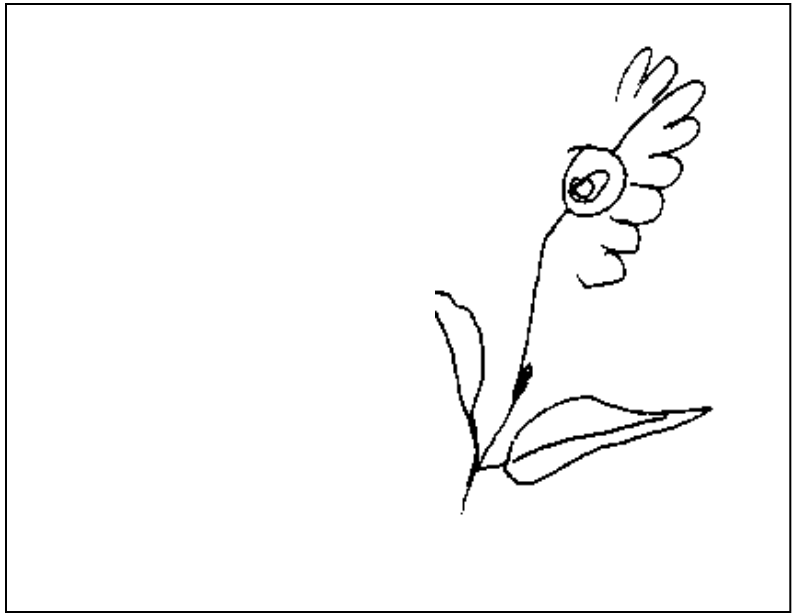
- hemispatial neglect – an inability to pay attention to sensory stimuli on his left side .
- Stroke damaged the parietal lobe on the right side of his brain, the part that deals with the higher processing of attention. The damage causes him to ignore people, sounds, and objects on his left.
- research suggests that people with normal vision perform better at visual attention tasks when they are rewarded for good performance and Dr Malhotra and his team have found the same thing in neglect patients.

Dr Paresh Malhotra, senior lecturer in neurology at Imperial College London



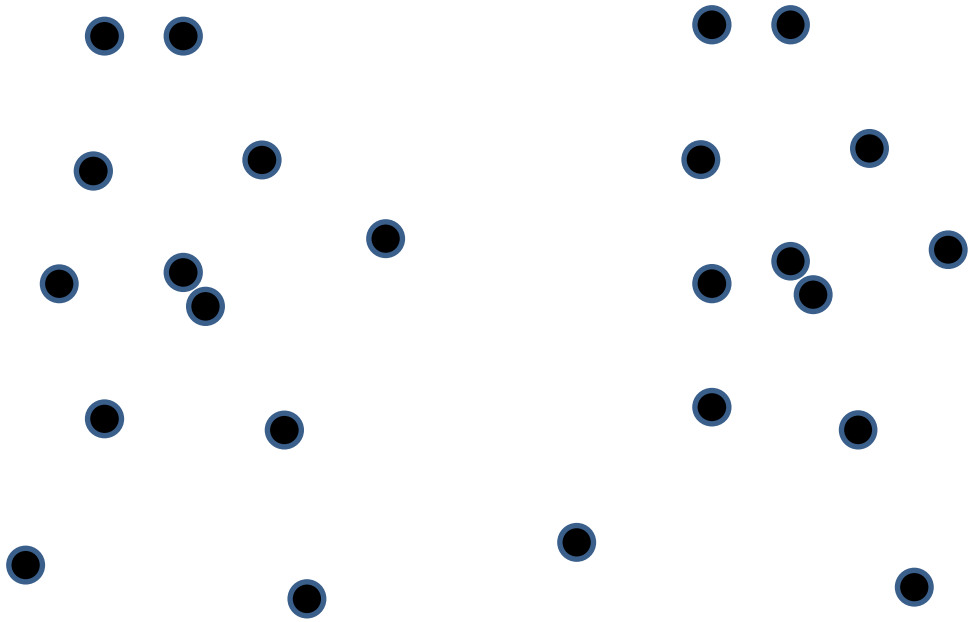


Object-centred Neglect



Object and Location-based Neglect

Reconstructing shape from movement



Johansson (1973)

https://www.youtube.com/watch?v=rEVB6kW9p6k

What/Where Pathways
Evidence from Neuropsychology

Visual agnosia: apperceptive agnosia (features) and associative agnosia (meaning).

Inability to identify objects and/or people

Caused by damage to inferior (lower) temporal lobe

Disruption of the "what" pathway

https://www.youtube.com/watch?v=ze8VVtBgK7A

Face recognition – prosopagnosia.

2006 study revealed that about one in 50 Americans is affected by Prosopagnosia.

https://www.youtube.com/watch?v=-vQGPcYfIAo

https://www.youtube.com/watch?v=vwCrxomPbtY

Memory - I

IBC, Spring 2022

Agenda

- Introductory lecture, broad overview
- Modal model
- Serial position curves and what we can infer about short term memory, long-term memory, etc

Clive Wearing

- The man with the 7 second memory
- http://www.youtube.com/watch?v=Vwigmktix2Y

What is memory?

- *THE ABILITY TO STORE AND RETRIEVE INFORMATION OVER TIME*

Memory Test


Bed
Sheets
Xylophone
Pillow
Dream
Rest
Tired
Snore
Yawn
Darkness
Blanket
Couch
RESTY

Memory Test

Sheets?

Sleep?

Dream?

Mattress?

Snore?

<u>Memory Illusion</u>:

False but subjectively compelling memory

We view memory like this:

It’s more like this

Reconstructive View of Memory

- Memories are not **reproduced** like a tape playing
- Memories are actively constructed and **reconstructed**

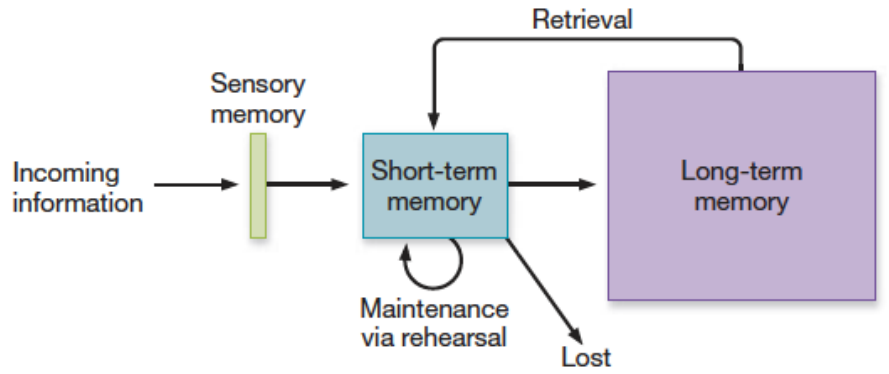
Memory

- **Memory**: the ability to store and retrieve information over time
- There are three key components of memory:
  - **Acquisition/Encoding**: the process by which we transform what we perceive, think, or feel into a memory.
  - **Storage**: the process of maintaining information in memory over time
  - **Retrieval**: the process of bringing to mind information that has been previously encoded and stored

How is information acquired?

- Atkinson and Shiffrin (1968): The modal model

FIGURE 6.1 AN INFORMATION-PROCESSING VIEW OF MEMORY



Diagrams like this one depict the flow of information hypothesized by the modal model. The model captures many important truths but must be updated in important ways. Current theorizing, for example, emphasizes that short-term memory (now called "working memory") is not a place serving as a "loading dock" outside of long-term memory. Instead, working memory is best understood as an activity, in ways described in the chapter.

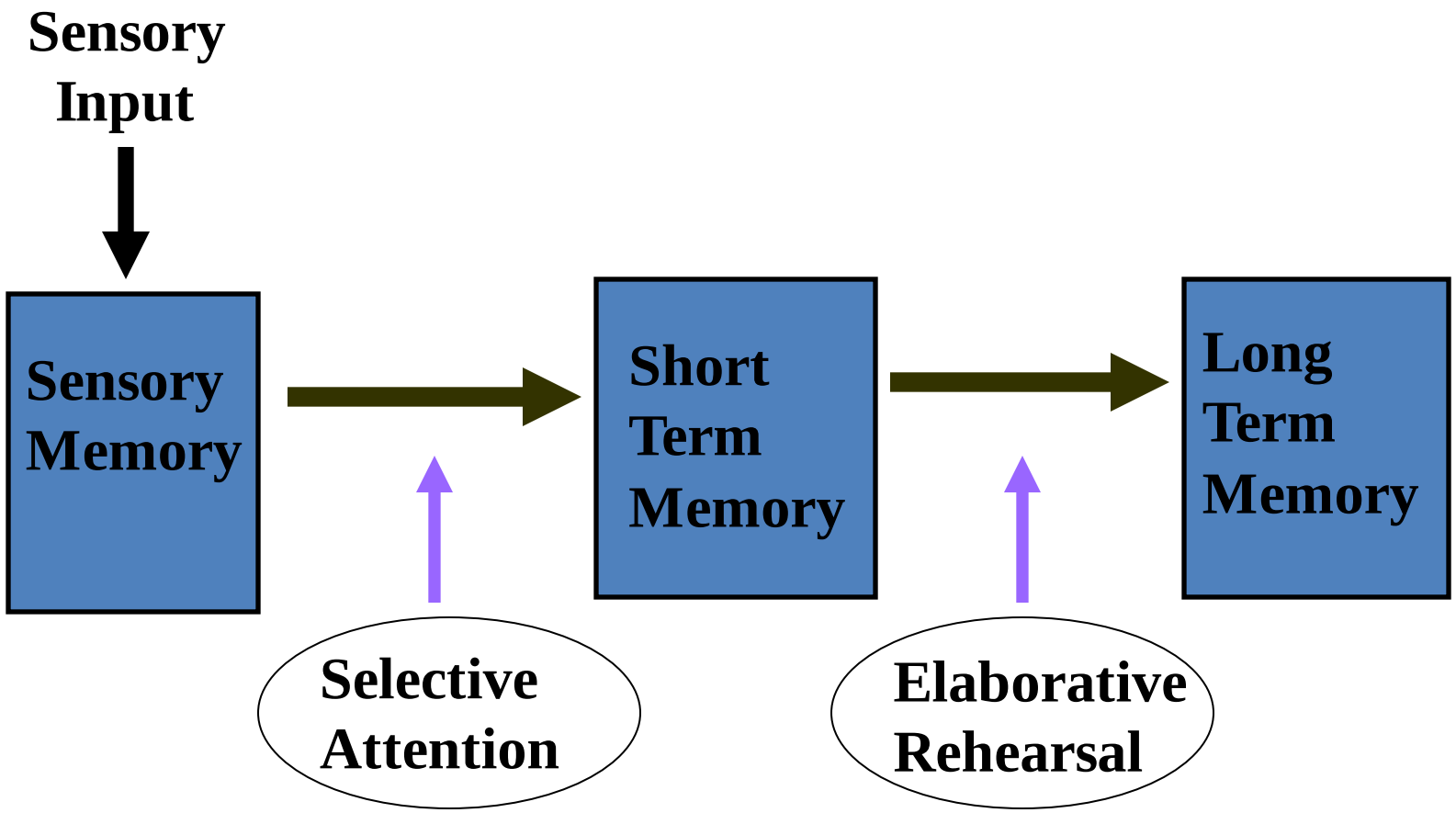
Storage

- There are three major kinds of memory storage:
  - **Sensory memory**: storage that holds sensory information for a few seconds or less
    - **Iconic memory**: a fast-decaying store of visual information
    - **Echoic memory**: a fast-decaying store of auditory information
  - Short-term memory (STM)
  - Long-term memory (LTM)

Three System Memory

	Sensory Memory	Short-term Memory	Long-term Memory
Function			
Span			
Duration			

Three Systems of Memory



Three Systems of Memory

- Each stage is different in terms of
  - **Span**: How much information
  - **Duration**: How long
  - **Function**: What is done with the stored info

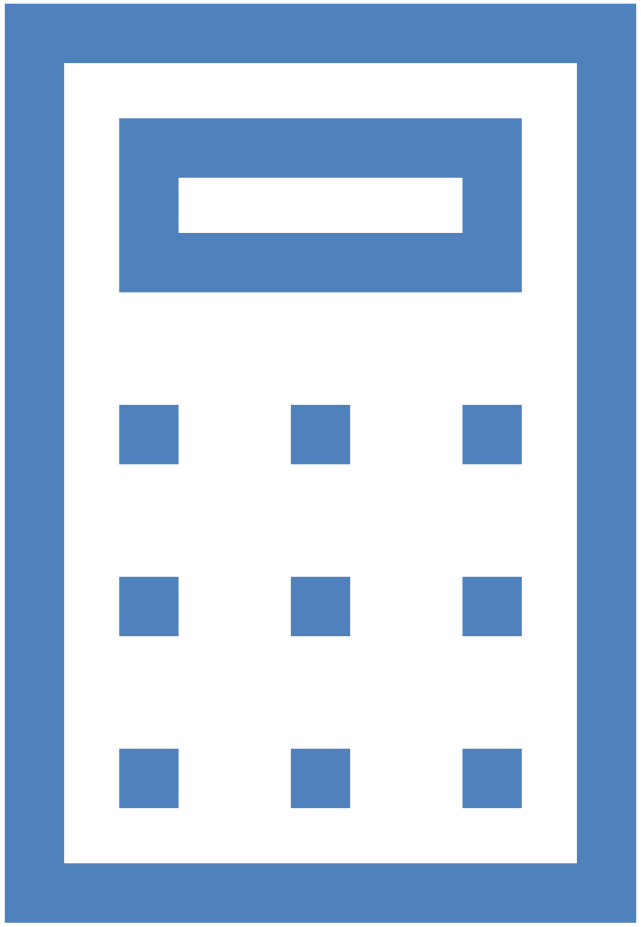
Sensory Memory

- Sensory registers: temporary storage of sensory information
- Registers a great deal of information from the environment
- Separate sensory memory exists for each sense
- Quickly fades: less than 1 sec (visual) or a few sec (auditory)

Sensory Memory

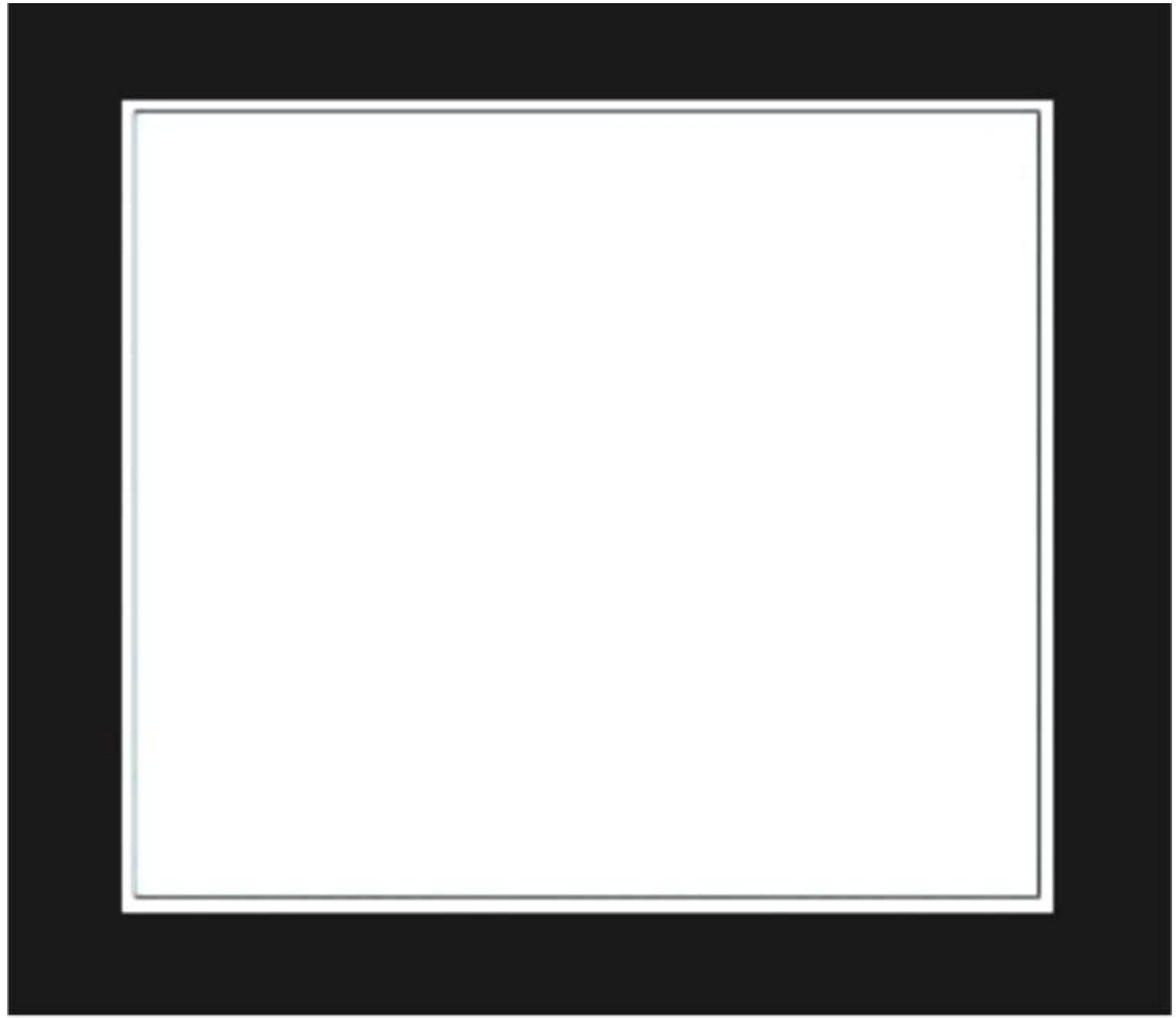
- Selective attention
  - With limited mental resources, only part of the stimulus field is being focused
  - Control what information is processed further
  - Information that passes through an attentional gate is transferred to short-term memory

- Sperling task (1960)



Sperling Task

- Sperling (1960)
  - Presented matrix of letters for 1/20th second
  - Report as many letters as possible



Sperling Task

- Sperling (1960)
  - Presented matrix of letters for 1/20th second
  - Report as many letters as possible

Sperling Task

- Sperling (1960)
  - Presented matrix of letters for 1/20th second
  - Followed by low, medium, or high tone
  - Tone signaled which row to report

HIGH

MEDIUM

LOW

Sperling Task

- Sperling (1960)
  - Presented matrix of letters for 1/20th second
  - Followed by low, medium, or high tone
  - Tone signaled which row to report
  - Recall was almost perfect

How’d they do that?

- **Visual sensory memory** (iconic memory)
  - Holds an image for about a second

- **Auditory sensory memory** (echoic memory)
  - Holds sound info from a few to several seconds

Three System Memory

	Sensory Memory	Short-term Memory	Long-term Memory
Function	Temporary storage		
Span	High		
Duration	Less than 1 sec or a few sec		

Storage: Maintaining Memories Over Time

- There are three major kinds of memory storage:
  - Sensory memory
  - **Short-term memory (STM)** or working memory: storage that holds non-sensory information for more than a few seconds but less than a minute; can hold about 7 items
    - **Rehearsal**: the process of keeping information in STM by mentally repeating it
    - **Chunking**: combining small pieces of information into larger clusters that are more easily held in STM
    - **Working memory**: active maintenance of information in STM.
  - Long-term memory (LTM)

Short-term Memory

- Working memory
  - Helps to work with info held in short-term memory
  - Maintenance
    - Hold info in short-term memory
  - Manipulation
    - Work on that information

Short-term Memory

- Span
  - Immediate memory span: Max # of items you can recall perfectly after seeing once
  - Magic number: 7±2 (?) **meaningful** items
  - With new information coming, displacement or bumping out will happen
    - Interference – loss of info due to incoming, competing information
    - Decay – fading of info from memory over time
  - Enlarge Span?
    - Chunking and organization

Short-term Memory

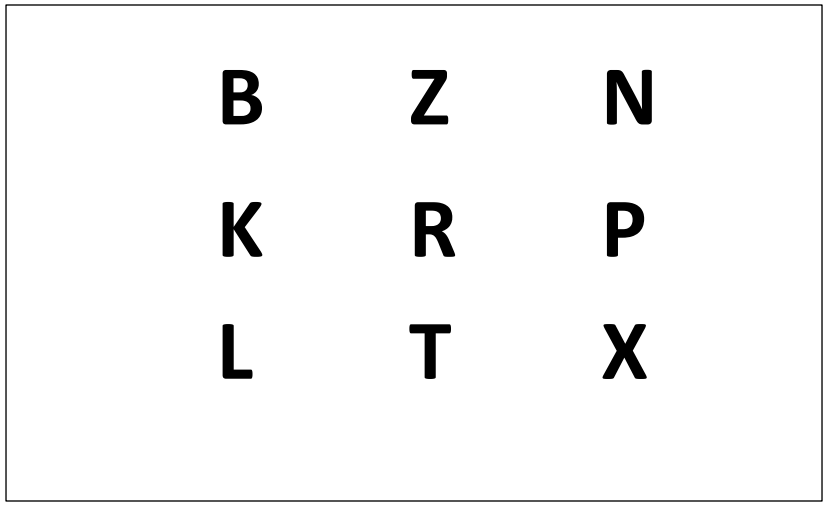
- Chunking and organization
  - GROUPINGBYMEANINGFULUNIT
    (Grouping by meaningful unit)
  - Increase the amount of information held in short-term memory

JFKCIAUSANBC

JFKCIAUSANBC

Short-term Memory

- Duration
  - Less than 20 sec without rehearsal
  - *Brown-Peterson task*
    - *A group of 3 letters presentation*
    - *Count backward by 3 from some number*



Short-term Memory

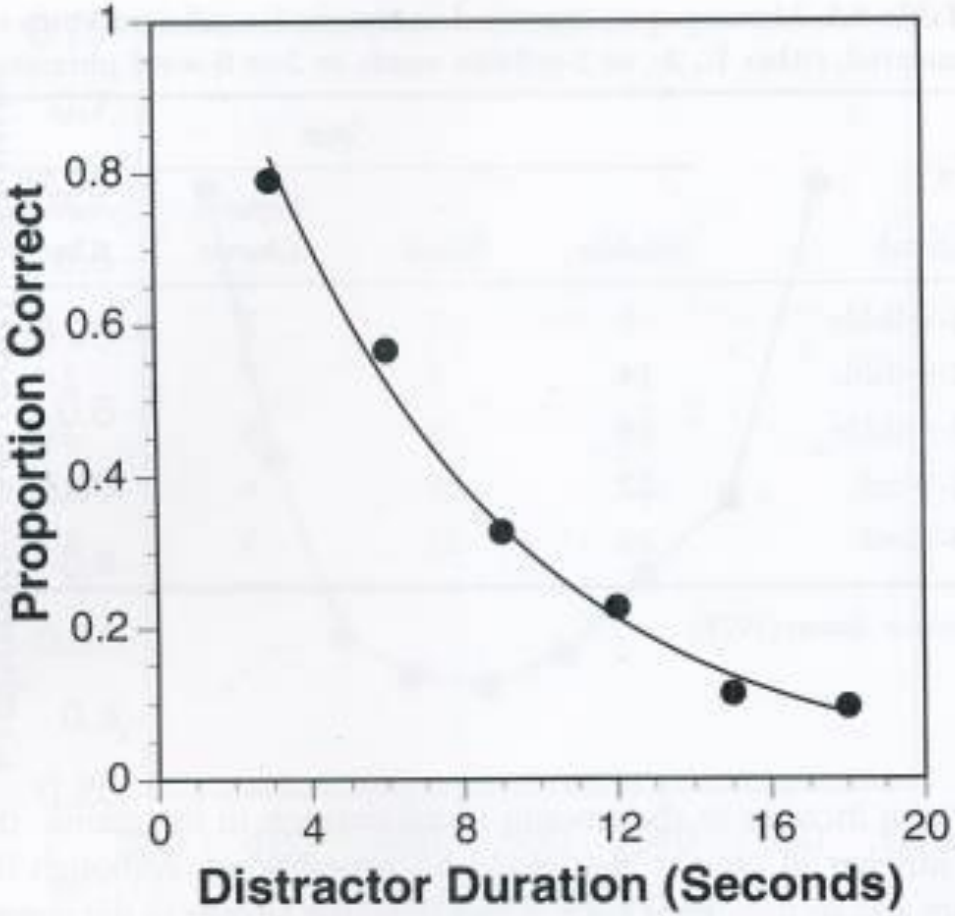


Figure 4.3 Proportion of consonant trigrams correctly recalled as a function of the distractor task duration. Source: Peterson & Peterson (1959).

Short-term Memory

- Brief storage of information currently being used
- Stores limited amount of info for limited time
- Duration: less than 20 sec

Three System Memory

	Sensory Memory	Short-term Memory	Long-term Memory
Function	Temporary storage of sensory info	Storage of info currently being used	
Span	High	Limited (*Chunking)	
Duration	Less than 1 sec or a few sec	Less than 20 sec	

Storage: Maintaining Memories Over Time

- There are three major kinds of memory storage:
  - Sensory memory
  - Short-term memory (STM)
  - **Long-term memory (LTM)**: storage that holds information for hours, days, weeks, or years; no known capacity

Long-term Memory

- The transfer of information between short-term and long-term memory
- Store information indefinitely
  - Maybe for a life time
- Permastore
  - May endure for decades

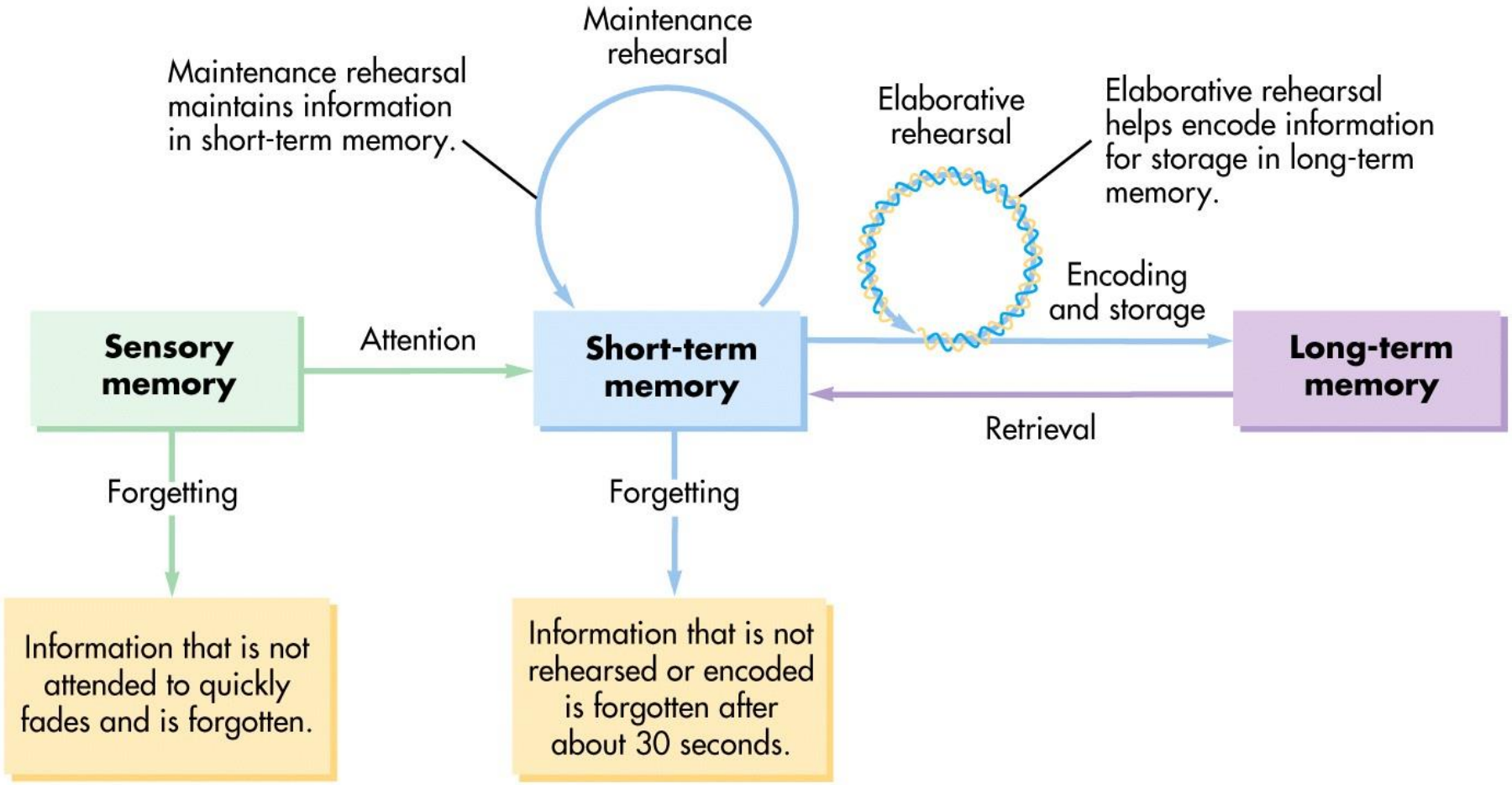
Long-term Memory

- Expectations affect what is recalled
  - Heard: The karate champion *hit* the cinder block
  - Remembered: The karate champion *broke* the cinder block
- Psychology: Science of Exceptions
  - Jill Price (40s) – recalls every daily event in great detail since 1980s
- Prone to distortion
  - Eyewitness testimony

Three System Memory

	Sensory Memory	Short-term Memory	Long-term Memory
Function	Temporary storage of sensory info	Storage of info currently being used	Storage of info indefinitely
Span	High	Limited (*Chunking)	Unlimited
Duration	Less than 1 sec or a few sec	Less than 20 sec	For a lifetime

Three System Memory



Insights from free recall memory performance

Are STM and LTM different systems? Do they contribute differentially to different memory tasks?

Study the following words

BRICK

COFFEE

PUPIL

PANTS

TREE

GLASS

SHIRT

BAT

WATCH

SKY

Test

- Recall the words in any order you like.

Primacy and Recency Effects

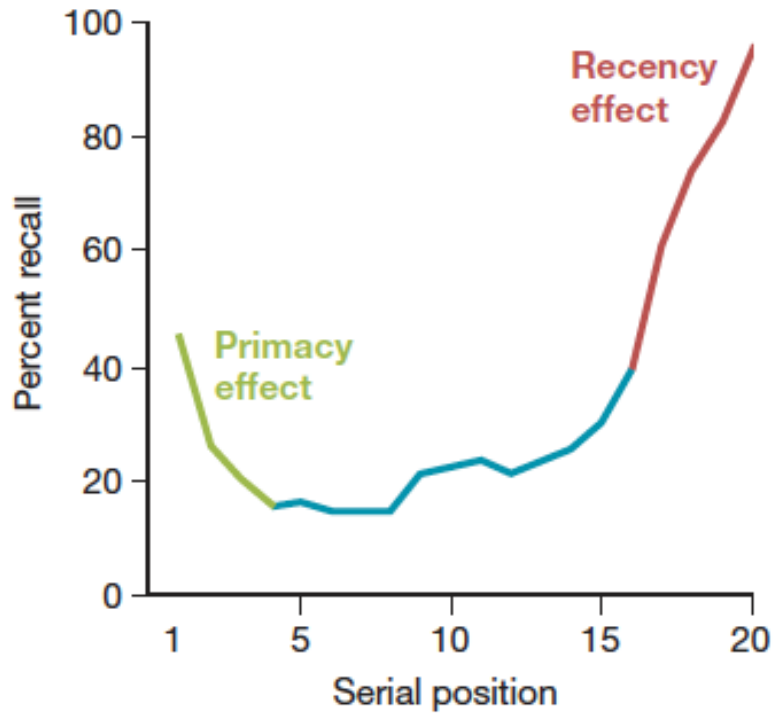


FIGURE 6.2 PRIMACY AND RECENCY EFFECTS IN FREE RECALL

Research participants in this study heard a list of 20 common words presented at a rate of one word per second. Immediately after hearing the list, participants were asked to write down as many of the words on the list as they could recall. The results show that position in the series strongly affected recall—participants had better recall for words at the beginning of the list (the primacy effect) and for words at the end of the list (the recency effect), compared to words in the middle of the list.

How do we explain primacy and recency effects?

- Recency – output from working memory
- Primacy – more attention, rehearsal time

If primacy and recency are driven by two different memory "systems", it should be possible to manipulate them independently

Add a distractor task at the end of the study list = "delayed free recall" with a "filled delay".

Serial position curve of a distractor-filled delayed free recall task compared to immediate free recall or unfilled delay period

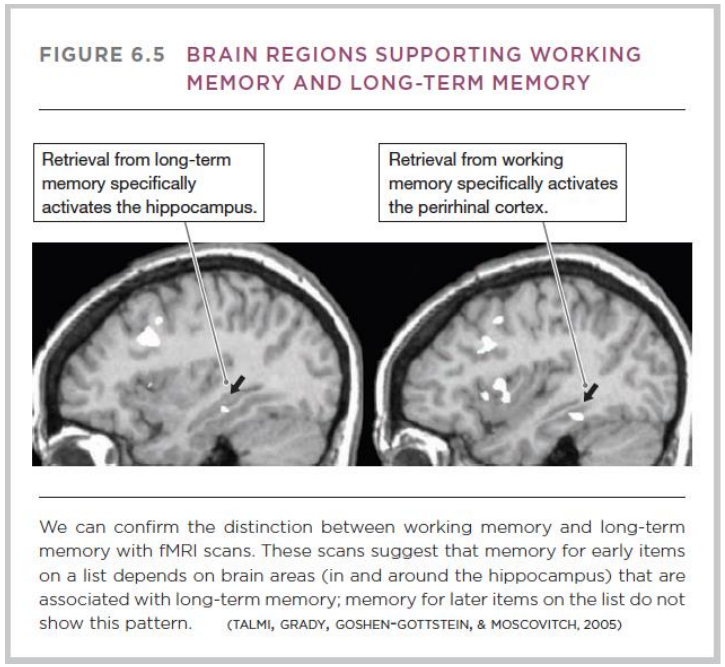


FIGURE 6.5 BRAIN REGIONS SUPPORTING WORKING MEMORY AND LONG-TERM MEMORY

We can confirm the distinction between working memory and long-term memory with fMRI scans. These scans suggest that memory for early items on a list depends on brain areas (in and around the hippocampus) that are associated with long-term memory; memory for later items on the list do not show this pattern. (TALMI, GRADY, GOSHEN-GOTTSTEIN, & MOSCOVITCH, 2005)

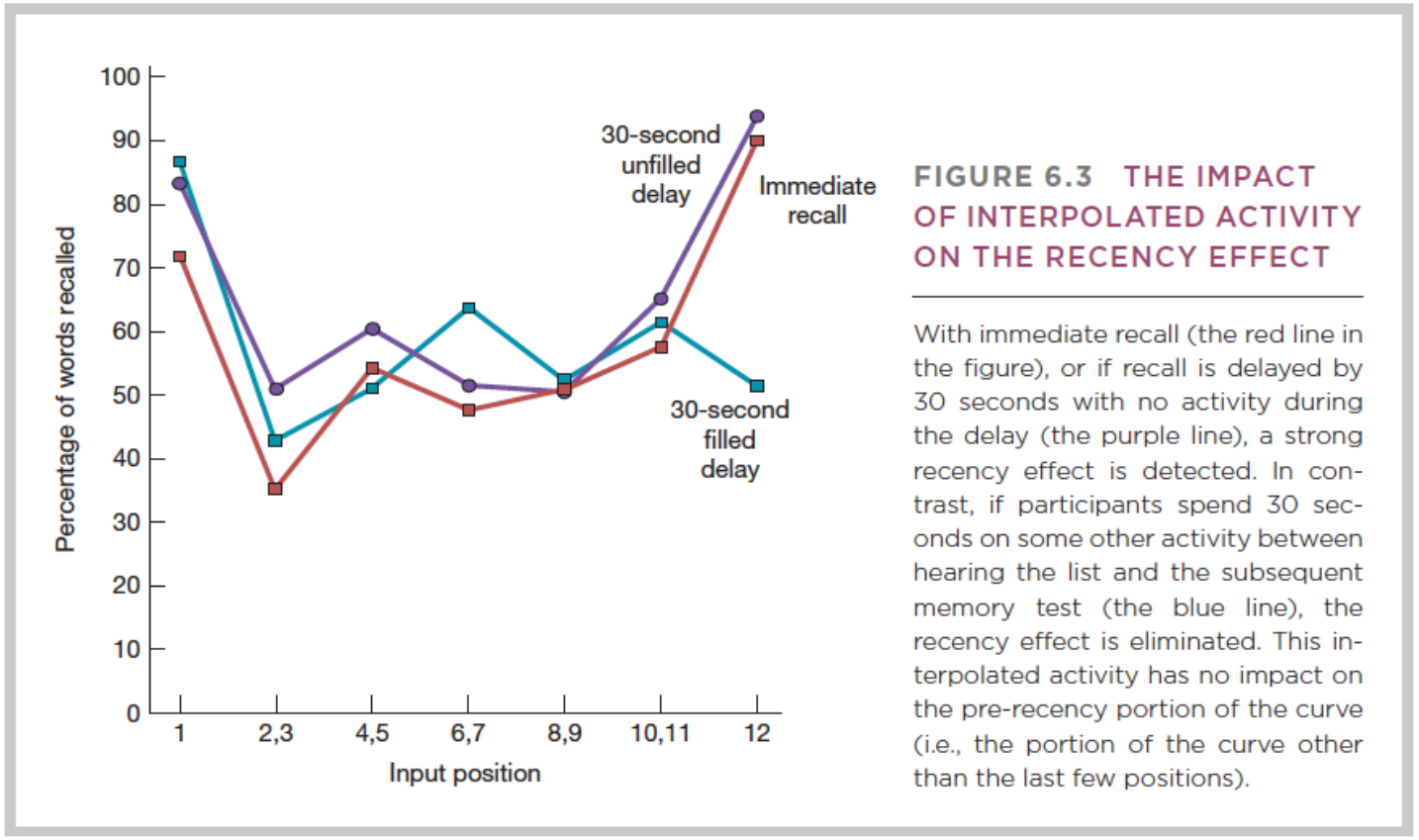


FIGURE 6.3 THE IMPACT OF INTERPOLATED ACTIVITY ON THE RECENCY EFFECT

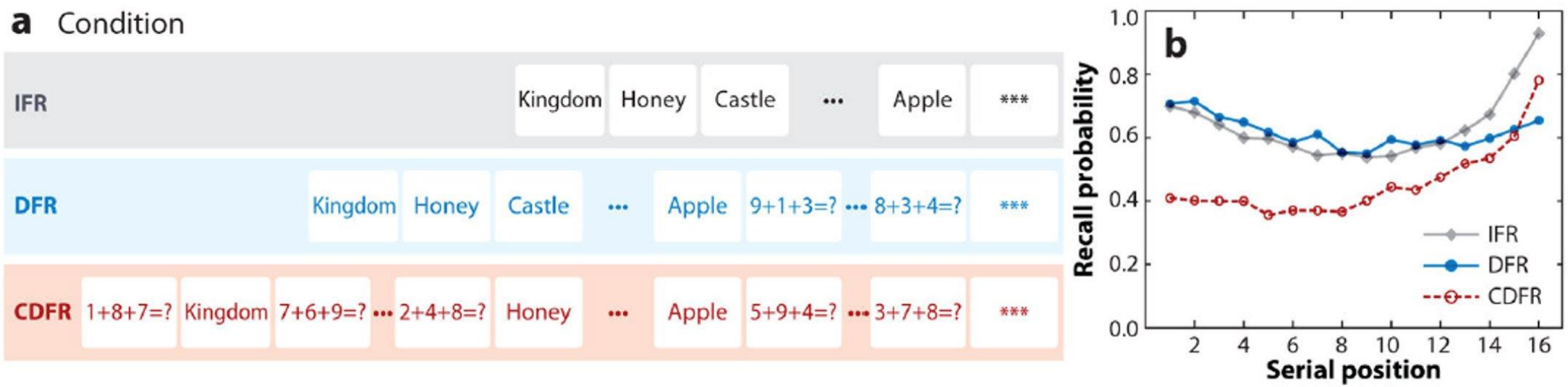
With immediate recall (the red line in the figure), or if recall is delayed by 30 seconds with no activity during the delay (the purple line), a strong recency effect is detected. In contrast, if participants spend 30 seconds on some other activity between hearing the list and the subsequent memory test (the blue line), the recency effect is eliminated. This interpolated activity has no impact on the pre-recency portion of the curve (i.e., the portion of the curve other than the last few positions).

Interim conclusions from recency effects

- Recency --> driven by items held in working memory which are easier to access, so they get recalled first.
- Disappears when you introduce a filled delay period.
- Open and shut case?

Think again: long-term recency effects!

- Why do we get recency effects in a continuous-distractor free-recall task?! Not covered in the text book.

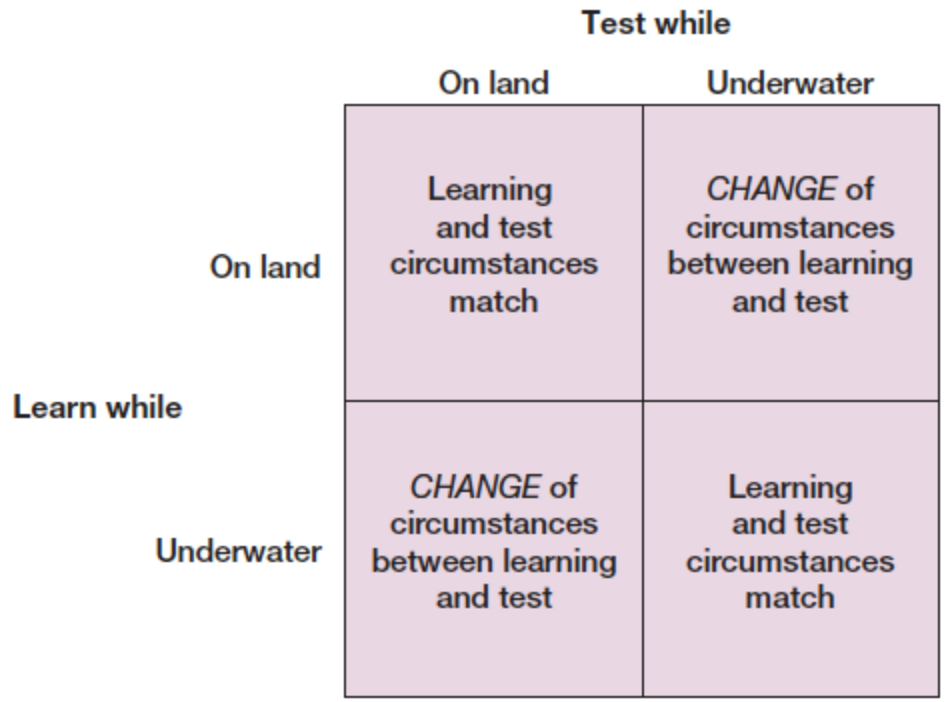


The role of context

Godden & Baddeley, 1975

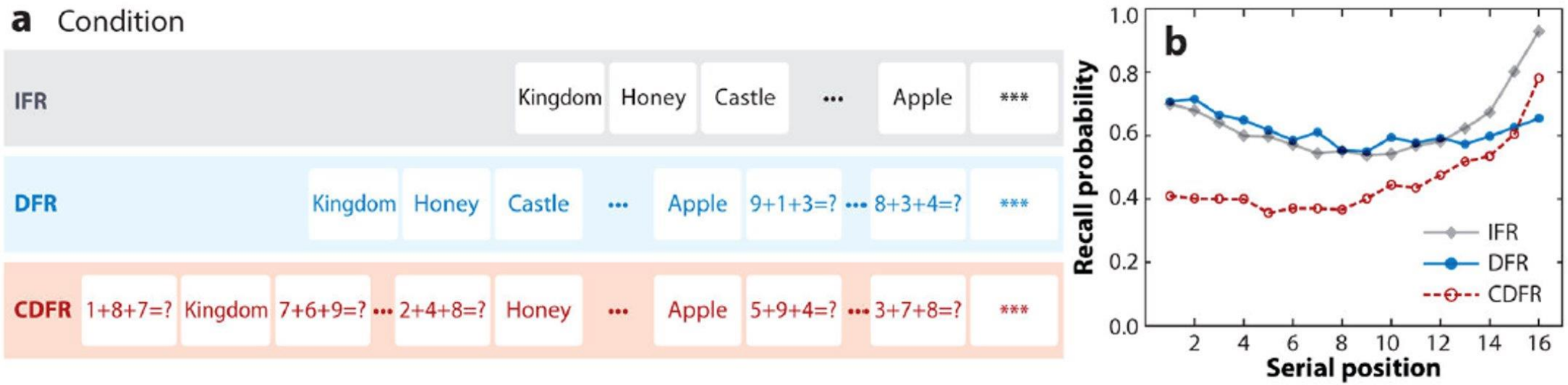
FIGURE 7.2 THE DESIGN OF A CONTEXT-DEPENDENT LEARNING EXPERIMENT

Half of the participants (deep-sea divers) learned the test material while underwater; half learned while on land. Then, within each group, half were tested while underwater; half were tested on land. We expect a retrieval advantage if the learning and test circumstances match. Therefore, we expect better performance in the top left and bottom right cells.



Similarity of testing context to study context matters

- Now, think again about long-term recency effects



The testing context is most similar to the study context at the end of the list, if you assume that context is something that changes very gradually

Temporal Context Model (TCM)

Gradually changing temporal context during experience

A

B

C

D

***

ABC

Recovery of temporal context during re-experience

E

F

C

ABC

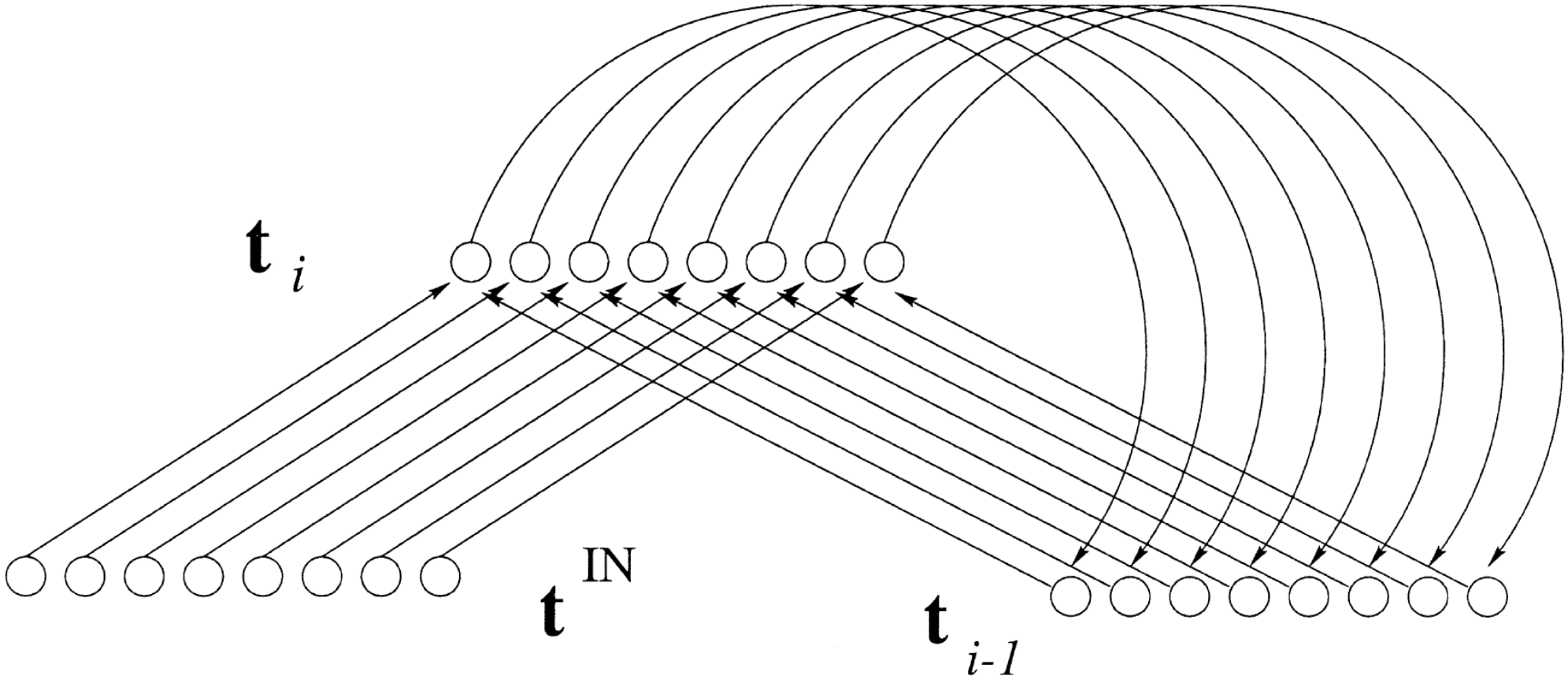
Retrieved temporal context

Current temporal context

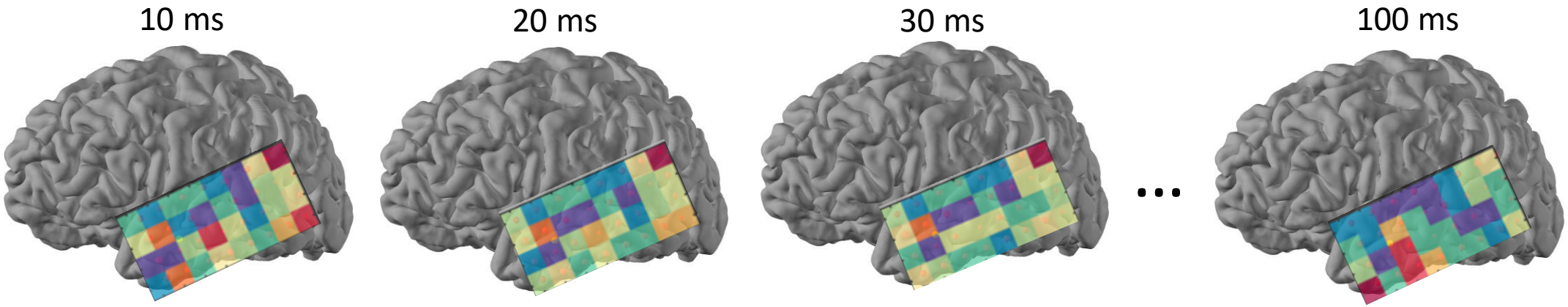
EFC

Oh no! Man get fruit NOW or man die!

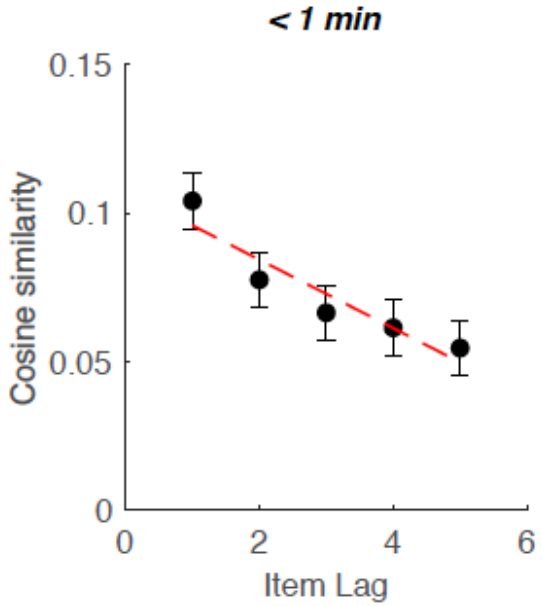
Slowly varying temporal context as a RNN

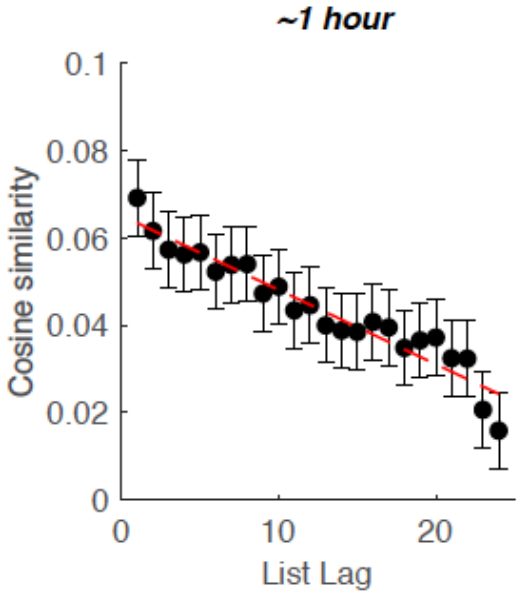


Context representations changing over time



N = 31





Sreekumar, Swift, Kaplan, El-Kalliny, Inati, & Zaghloul, *In Prep*

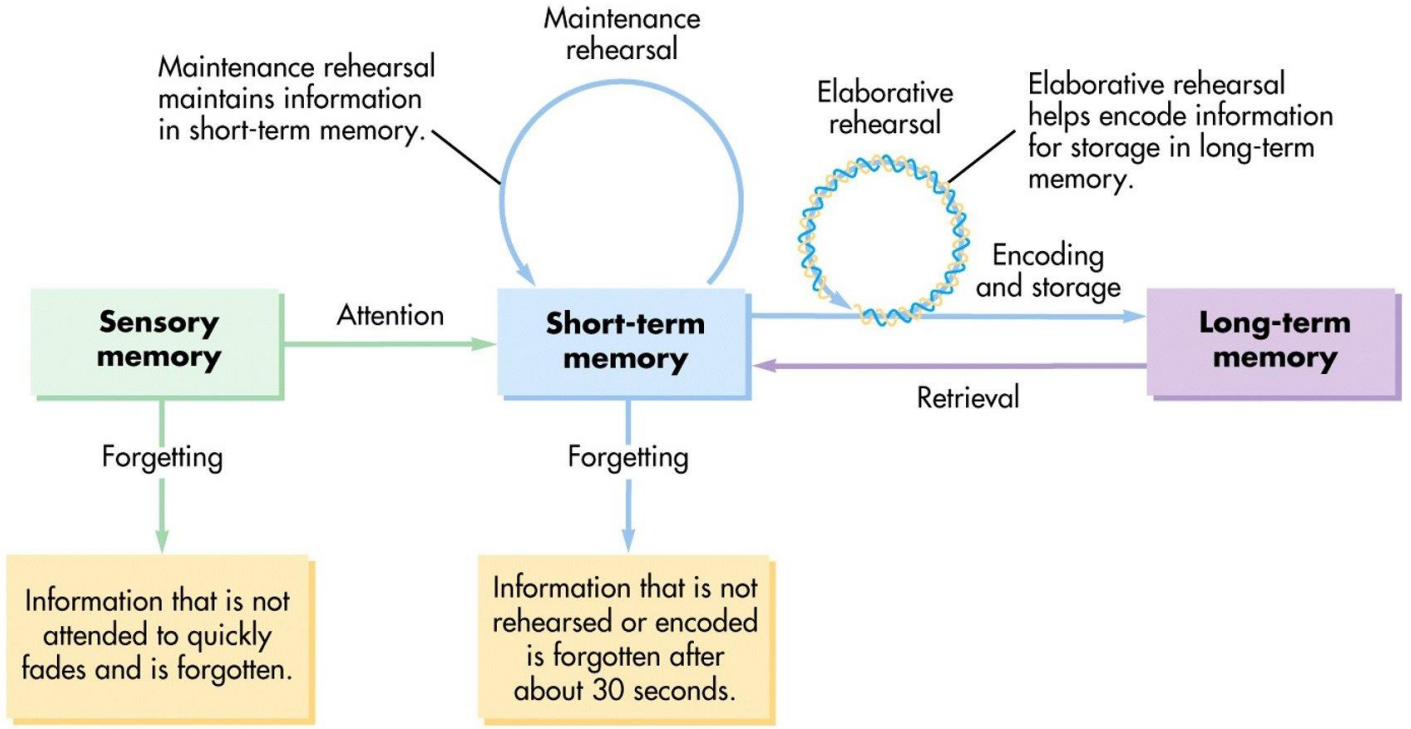
If context similarity is the explanation, why is recency attenuated in delayed free recall but not continuous distractor free recall?

- Both tasks have the same delay after the last item
- A potential answer: free recall retrieval is a competitive retrieval: competition amongst items. So the more distinctive the items are, the better they can be recalled. Continuous distractors make the last items (most recent) distinctive. So, there is an added benefit of distinctiveness, explaining recency effects in CDFR but not in DFR.
- Compare test context match with last item and test context match with other items: a greater difference for CDFR, explaining long-term recency effects.
- So a short term memory buffer by itself cannot explain all recency effects in free recall because it cannot explain this difference in recency between DFR and CDFR.

So is our dual store model of memory correct?

- Is there really such a big difference between STM and LTM or should we instead focus on common principles (such as distinctiveness, context-based retrieval) that can explain phenomena across different tasks and conditions?
- This is an open debate..

A few quick notes about how information might move from working memory to more long-term storage

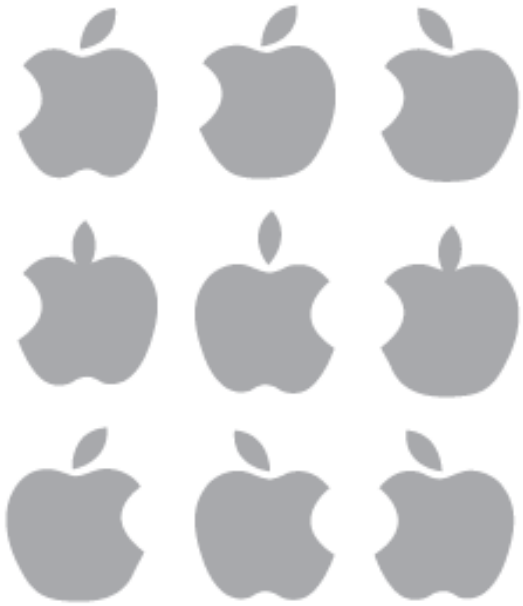


Multiple passive exposures are insufficient

FIGURE 6.10 MEMORY FOR AN OFTEN-VIEWED LOGO

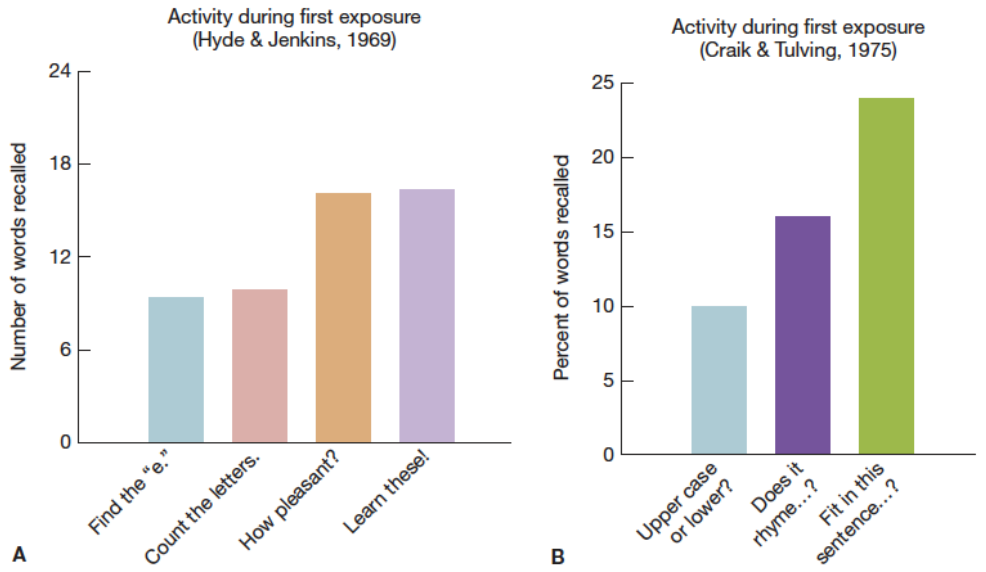
Most people have seen the Apple logo countless times, but they've had no reason to pay attention to its features. As a result, they have poor memories for the features. Test yourself. Can you find the correct version among the options displayed here?

(THE ANSWER IS AT THE END OF THE CHAPTER.)



The need for active and deep encoding

FIGURE 6.12 THE IMPACT OF DEEPER PROCESSING



The two sets of results shown here derive from studies described in the text, but they are part of an avalanche of data confirming the broad pattern: Shallow processing leads to poor memory. Deeper processing (paying attention to meaning) leads to much better memory. And what matters seems to be the level of engagement; the specific intention to learn (because participants know their memory will be tested later on) contributes little.

Other techniques to improve LTM

SPACED REPETITION

TESTING EFFECT

HOW WOULD YOU APPLY THIS TO PREPARE FOR EXAMS?

Brain activity when you correctly remember

Univariate analysis

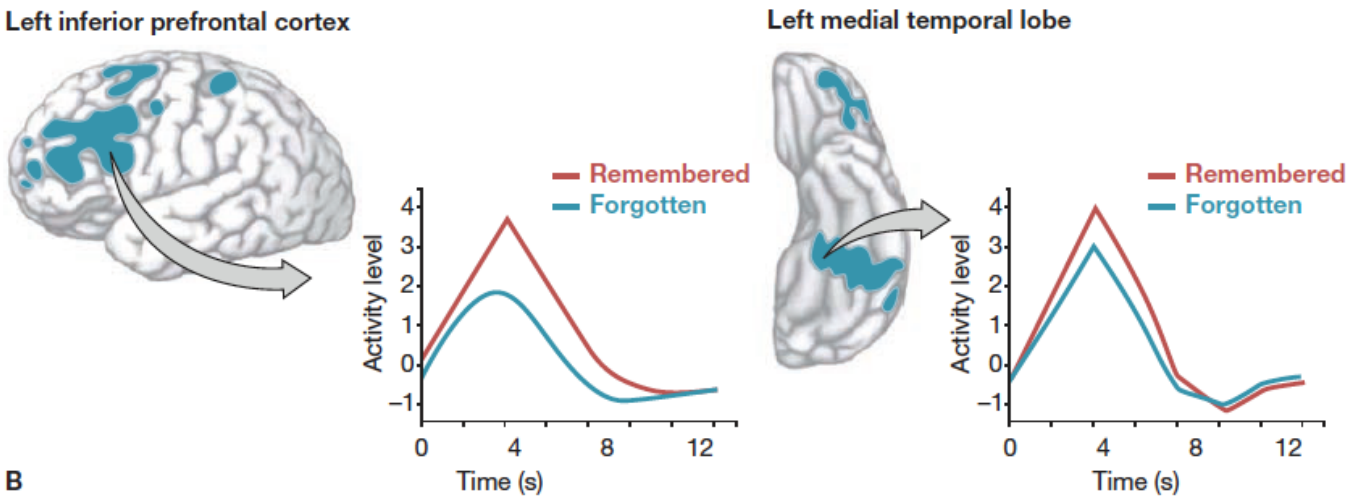
FIGURE 6.11 BRAIN ACTIVITY DURING LEARNING

Learn a series of words, and, during learning, record the neural response to each word.

Test memory for the words.

Based on what happened at Time 2, go back and examine the data from Time 1, looking separately at what happened during learning for words that were later remembered, and what happened during learning for words that were later forgotten.

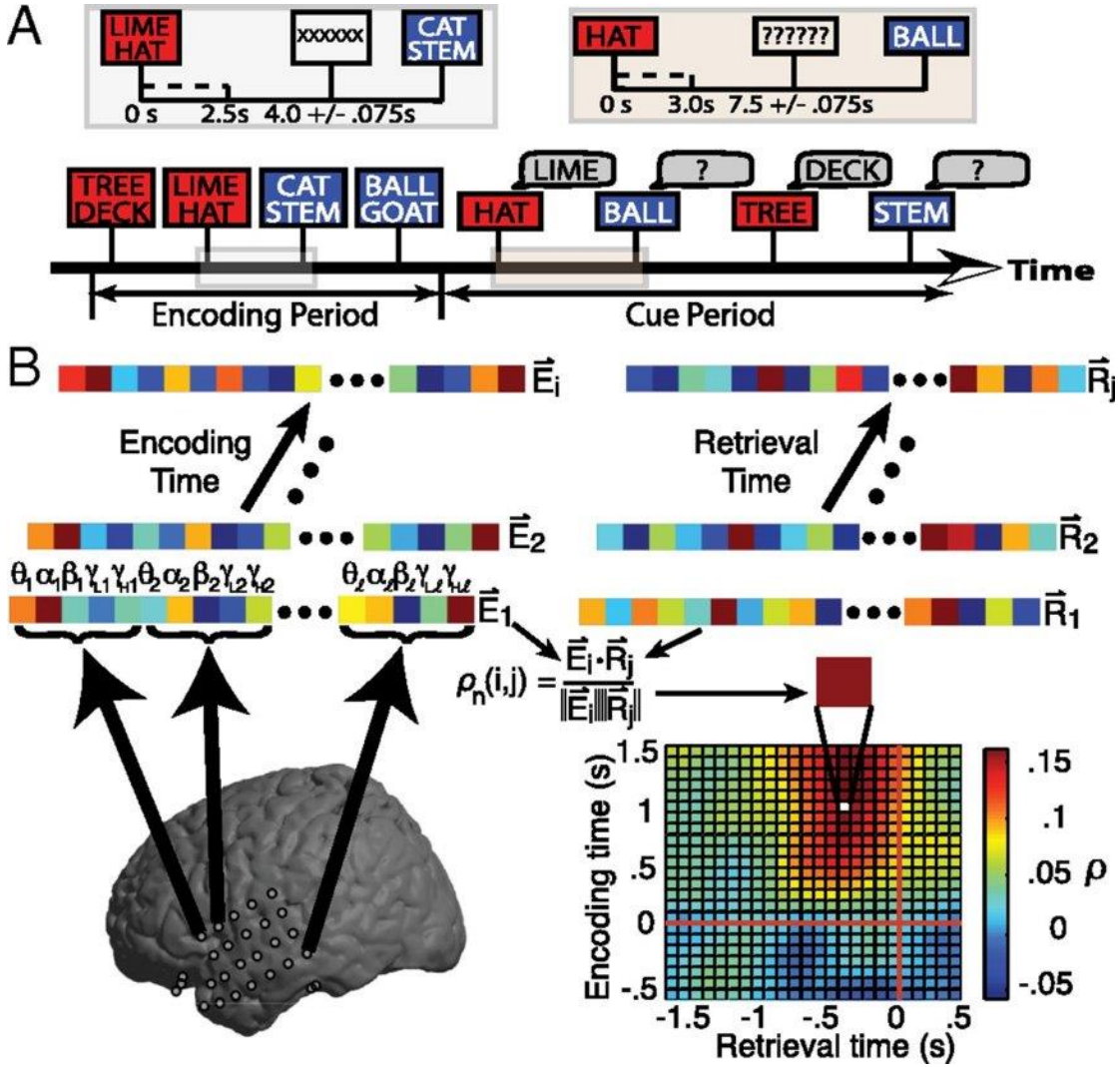
A



B

Brain activity when you correctly remember

Multivariate analysis

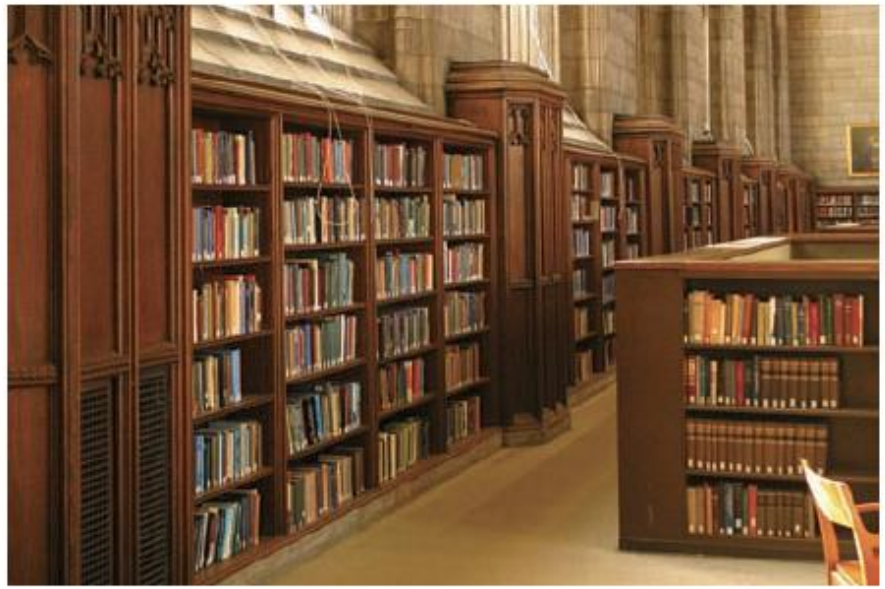


Robert B. Yaffe et al. PNAS 2014;111:52:18727-18732

The role of "connections" - memory cues

Why does spaced repetition enhance LTM?

Context cues and making different ones?



WHY DO MEMORY CONNECTIONS HELP?

When books arrive in a library, the librarians must catalogue them. This doesn't facilitate the "entry" of books into the library, because the books are in the building whether they're catalogued or not. But cataloguing makes the books much easier to find later on. Memory connections may serve the same function: The connections don't "bring" material into memory, but they do make the material "findable" in long-term storage later.

Using "connections" as a memory strategy

FIGURE 6.14 MNEMONIC STRATEGIES

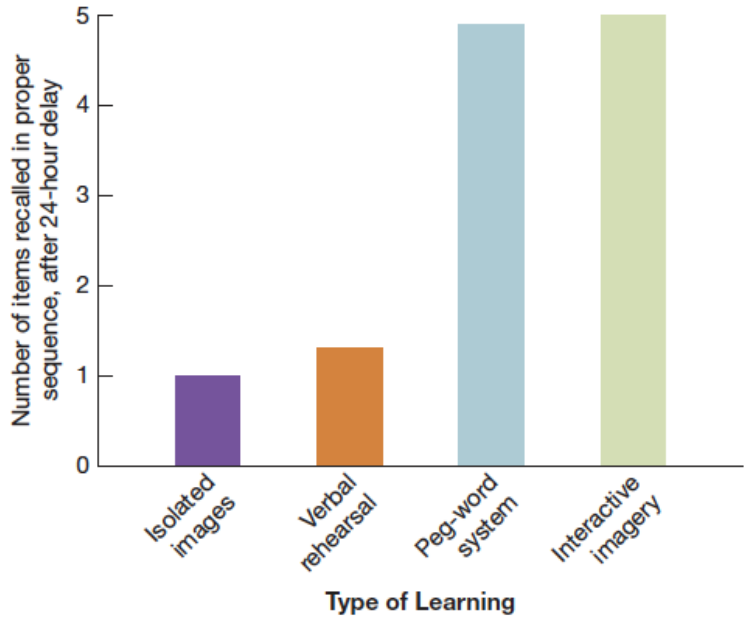
With a bit of creativity, you can make up mnemonics for memorizing all sorts of things. For example, can you name all ten of the Canadian provinces? Perhaps there is a great mnemonic available, but in the meantime, this will do. It's a complicated mnemonic but unified by the theme of the early-morning meal: "**B**reakfast **C**ooks **A**lways **S**ell **M**ore **O**melets. **Q**uiche **N**ever **B**ought; **N**ever **S**old. **P**erhaps **E**ggs **I**n **N**ew **F**orms?" (You're on your own for remembering the three northern territories.)

"Peg words"

One is a bun.
Two is a shoe.
Three is a tree.
Four is a door.
Five is a hive.
Six are sticks.
Seven is heaven.
Eight is a gate.
Nine is a line.
Ten is a hen.

Mnemonics are powerful memory aids

FIGURE 6.15 THE POWER OF MNEMONICS



Mnemonics can be enormously effective. In this study, students who had relied on peg words or interactive imagery vastly outperformed students who'd used other memorizing strategies. (AFTER ROEDIGER, 1980)

Memorization vs Understanding

- All the prior discussion was only about what improves memory.
- Rote memory however does not imply you will be able to use the information you learned in novel situations.
- Understanding is not the same as memorization.
- Understanding comes also from using connections! You have to be actively engaged, constantly trying to make connections to your existing knowledge but also to other new information that you get.

So is spaced repetition testing the best way for you to study?

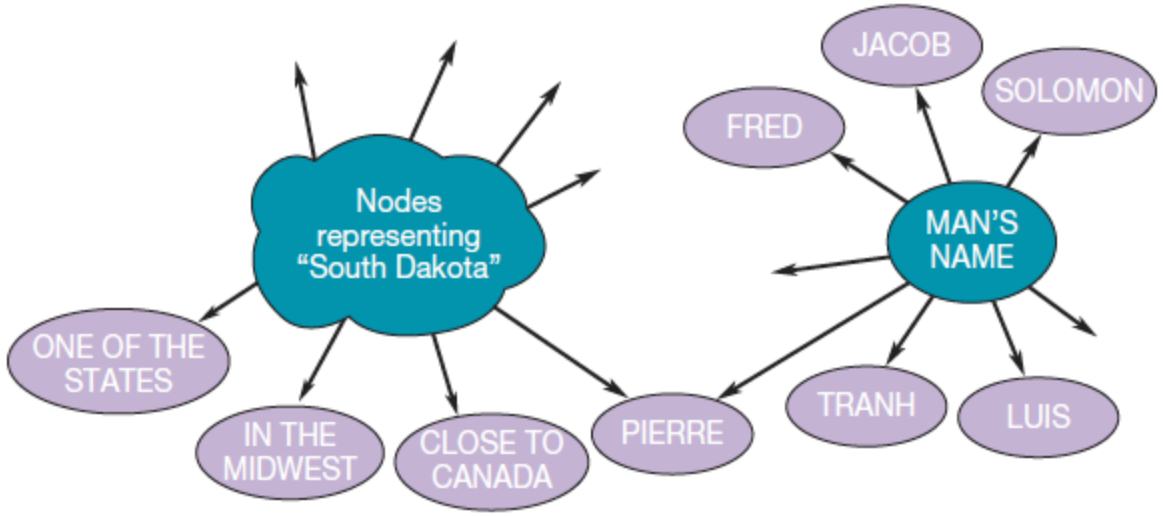
- Well, it will depend on what kind of test it is!
- Going to test your memory?
- Going to test how you can apply the material to novel situations?

Next:

- More on cues, retrieval, etc.
- Remembering complex events: Episodic memory; Autobiographical memory.

Spreading Activation

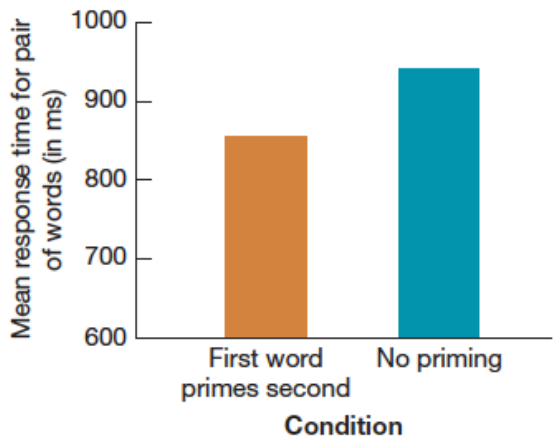
FIGURE 7.5 ACTIVATION OF A NODE FROM TWO SOURCES



Semantic Priming

- Lexical decision-making
- Pair of words
- CAKE SHOE
- BREAD BUTTER

FIGURE 7.6 SEMANTIC PRIMING



Participants were given a lexical-decision task involving pairs of words. In some pairs, the words were semantically related (and so the first word in the pair primed the second); in other pairs, the words were unrelated (and so there was no priming). Responses to the second word were reliably faster if the word had been primed—providing clear evidence of the importance of subthreshold activation.

(AFTER MEYER & SCHVANEVELDT, 1971)

Familiarity vs recollection

"FAMILIAR . . . BUT *WHERE DO I KNOW HIM FROM?!?*"

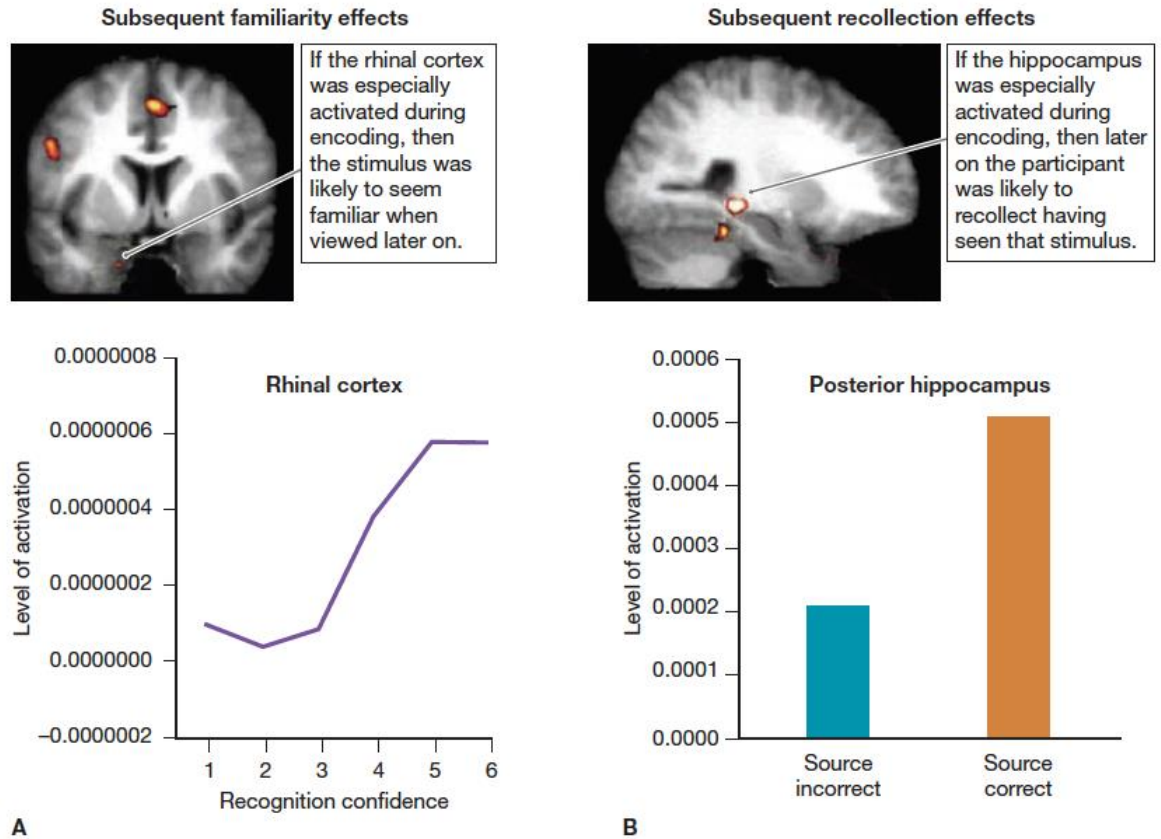
Recognition Memory

- Thought to rely on a memory strength signal
- Signal Detection Theory applies
- Can have familiarity without source memory (Remember/Know judgments)

Can you have source memory without a familiarity signal?!

- Capgras syndrome
- Detailed recollection of when you met your family last, what they look like, etc.
- When they are around however and in view, they feel strangely unfamiliar..

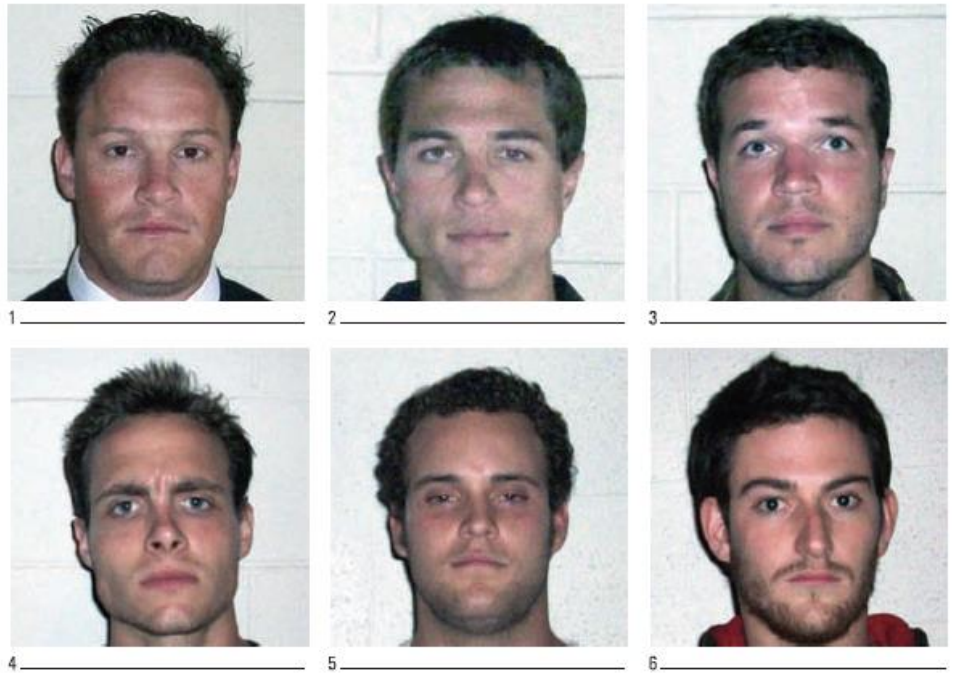
FIGURE 7.7 FAMILIARITY VERSUS SOURCE MEMORY



Familiarity vs source memory

FIGURE 7.8 A PHOTO LINEUP

Middletown Police Department Lineup ID: 24601 20 Mar 2009



1 2 3

4 5 6

FOR OFFICIAL USE ONLY

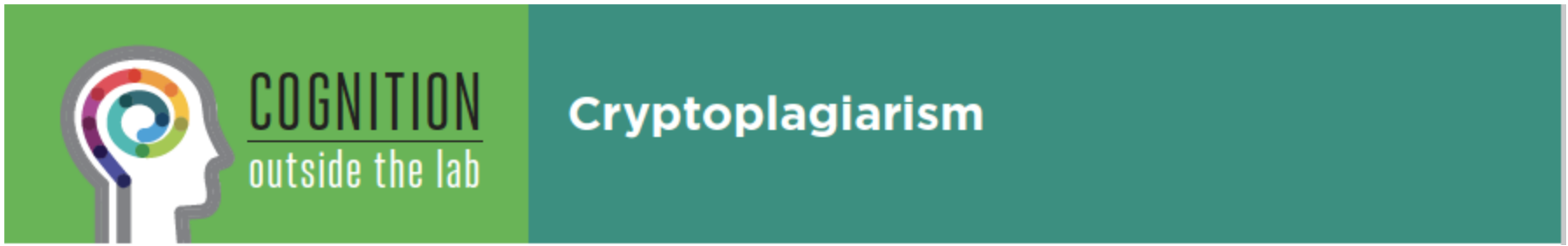
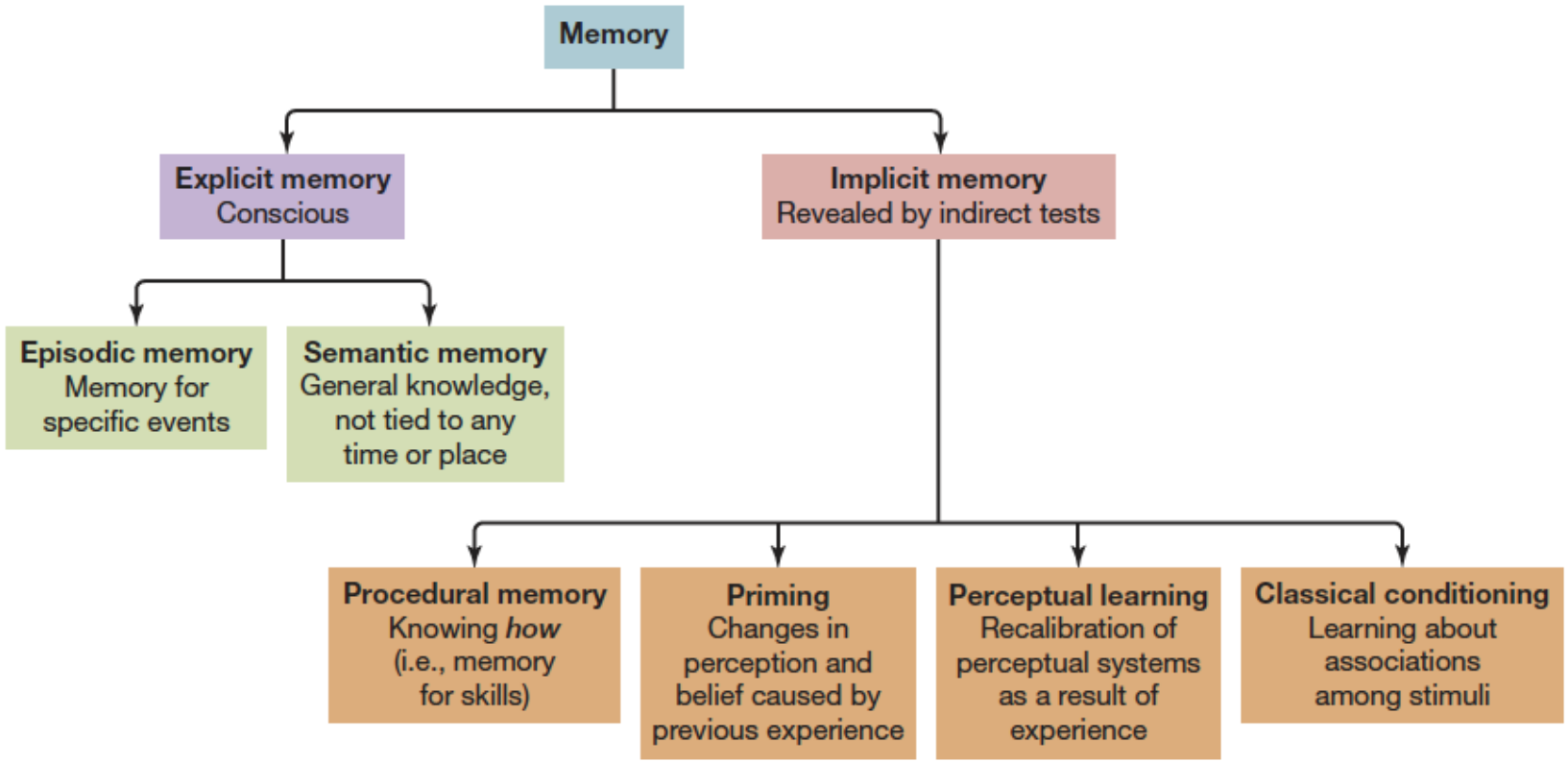

COGNITION
outside the lab
Cryptoplagiarism

FIGURE 7.11 HIERARCHY OF MEMORY TYPES



In our discussion, we've distinguished two types of memory—explicit and implicit. However, there are reasons to believe that each of these categories must be subdivided further, as shown here. Evidence for these subdivisions includes functional evidence (the various types of memory follow different rules) and biological evidence (the types depend on different aspects of brain functioning).

FIGURE 7.13 SEMANTIC MEMORY WITHOUT EPISODIC MEMORY

Kent Cochrane—known for years as "Patient K.C."—died in 2014. In 1981, at age 30, he skidded off the road on his motorcycle and suffered substantial brain damage. The damage caused severe disruption of Cochrane's episodic memory, but it left his semantic memory intact. As a result, he could still report on the events of his life, but these reports were entirely devoid of autobiographical quality. In other words, he could remember the bare facts of, say, what happened at his brother's wedding, but the memory was totally impersonal, with no recall of context or emotion. He also knew that during his childhood his family had fled their home because a train had derailed nearby, spilling toxic chemicals. But, again, he simply knew this as factual material—the sort of information you might pick up from a reference book—and he had no recall of his own experiences during the event.

Hypnosis? Repressed memories?

A Drawings done by hypnotized adult told that he was 6 years old

B Drawings done at age 6

Why do we make memory errors?

FIGURE 8.1 THE OFFICE USED IN THE BREWER AND TREYENS STUDY

No books were in view in this office, but many participants, biased by their expectations of what should be in an academic office, remembered seeing books.

(AFTER BREWER & TREYENS, 1981)

Memory and more

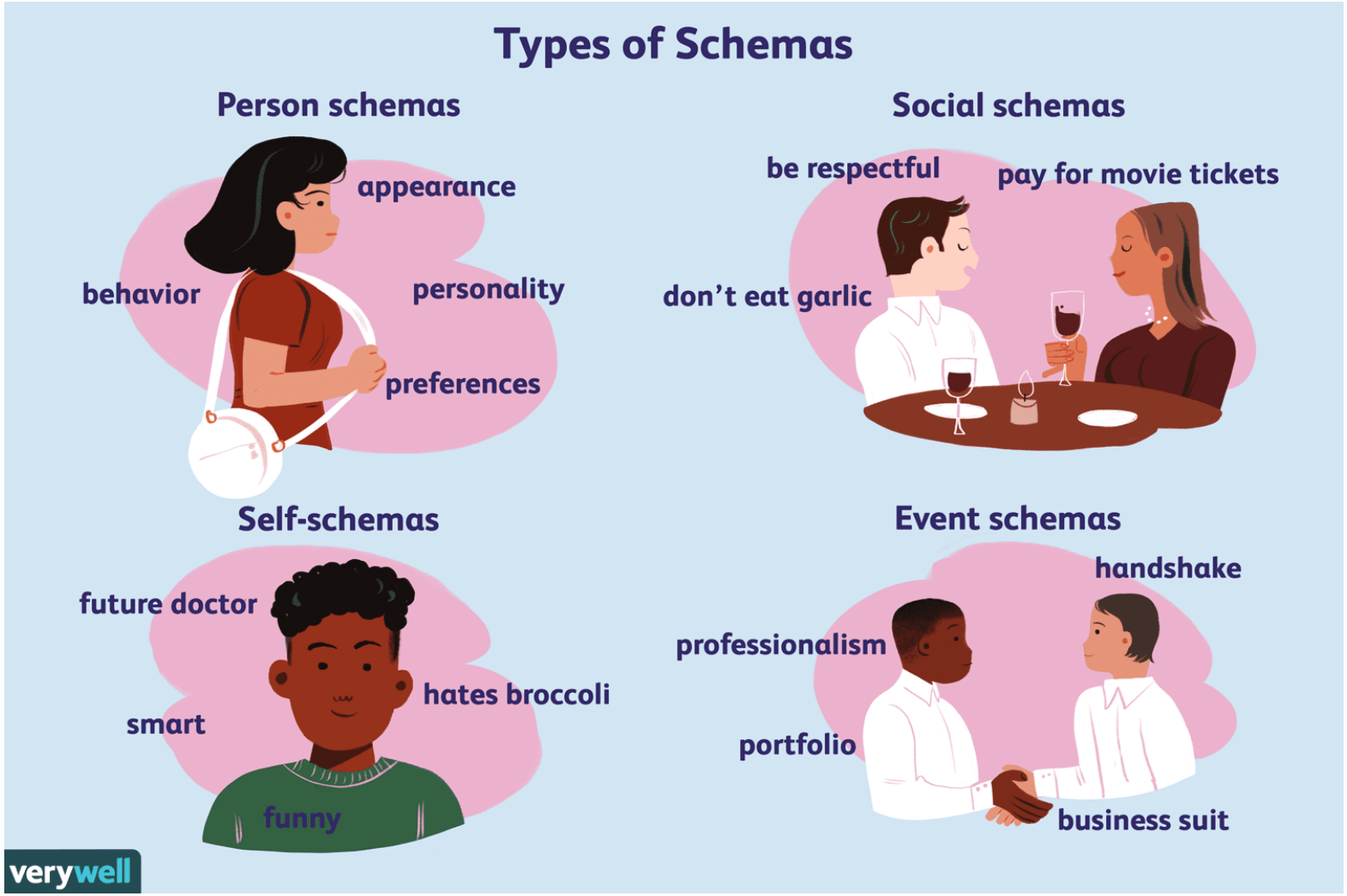
31st March 2022

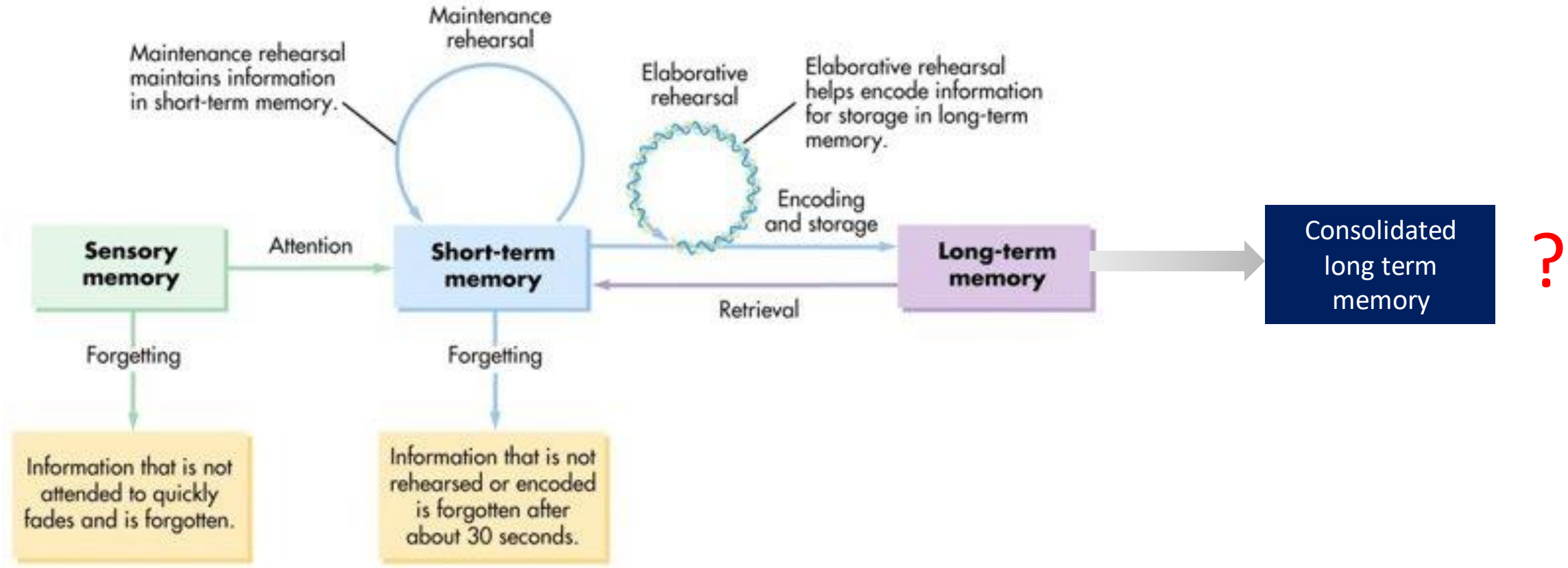
Bhaktee Dongaonkar

What do you typically do when you go to a restaurant?

Schemas

A schema is a cognitive structure that serves as a framework for one's knowledge about people, places, objects, and events.



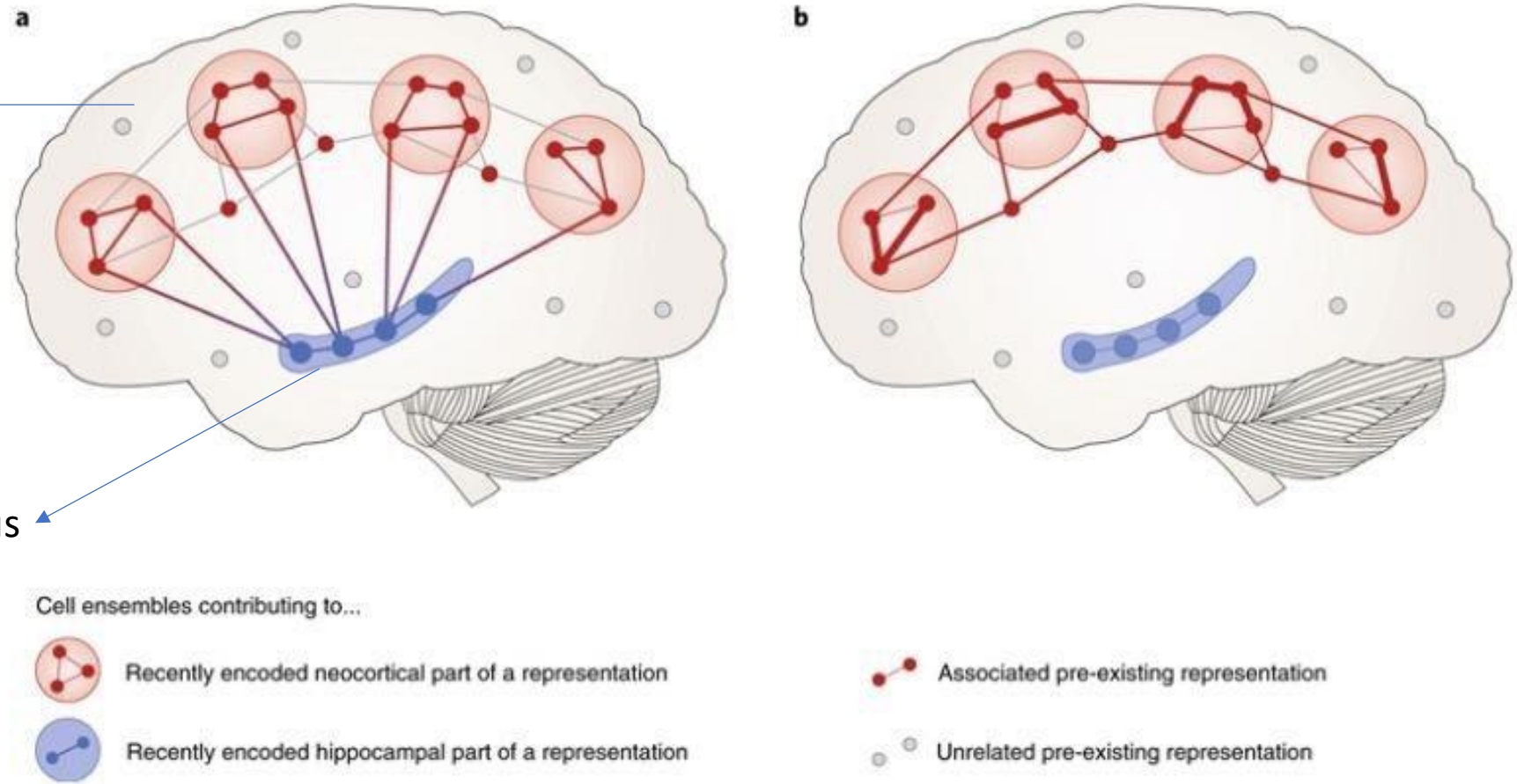


verb
1.make (something) physically stronger or more solid.
"the first phase of the project is to consolidate the outside walls"

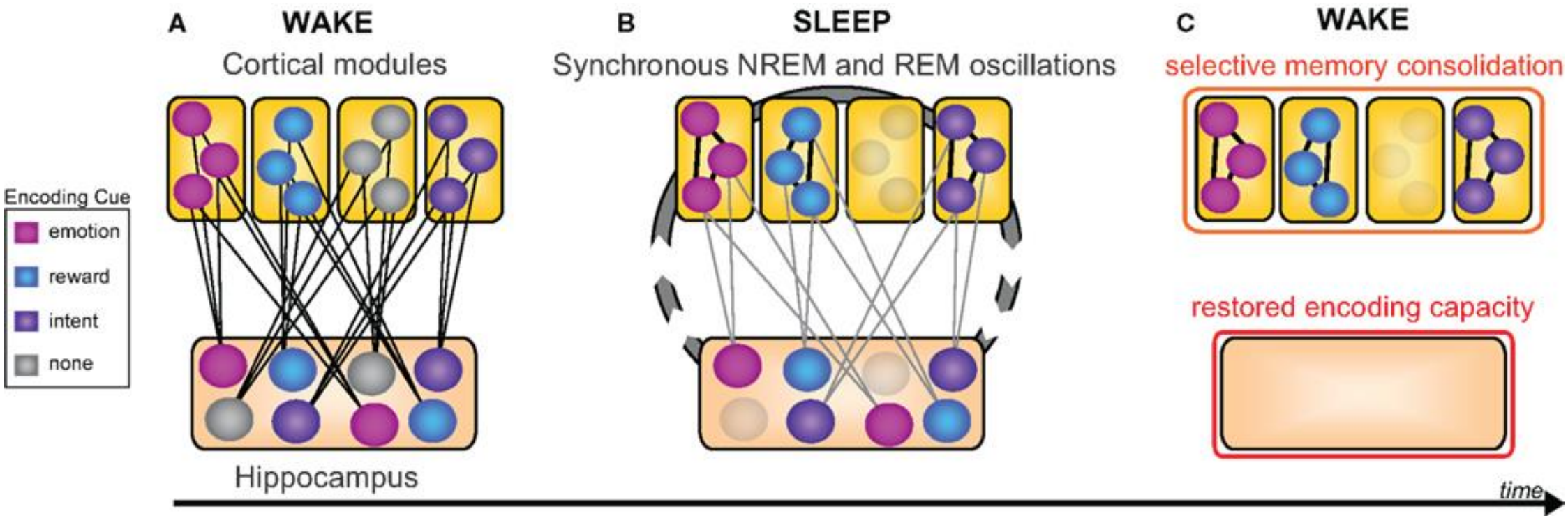
2. combine (a number of things) into a single more effective or coherent whole.
"all manufacturing activities have been consolidated in new premises"

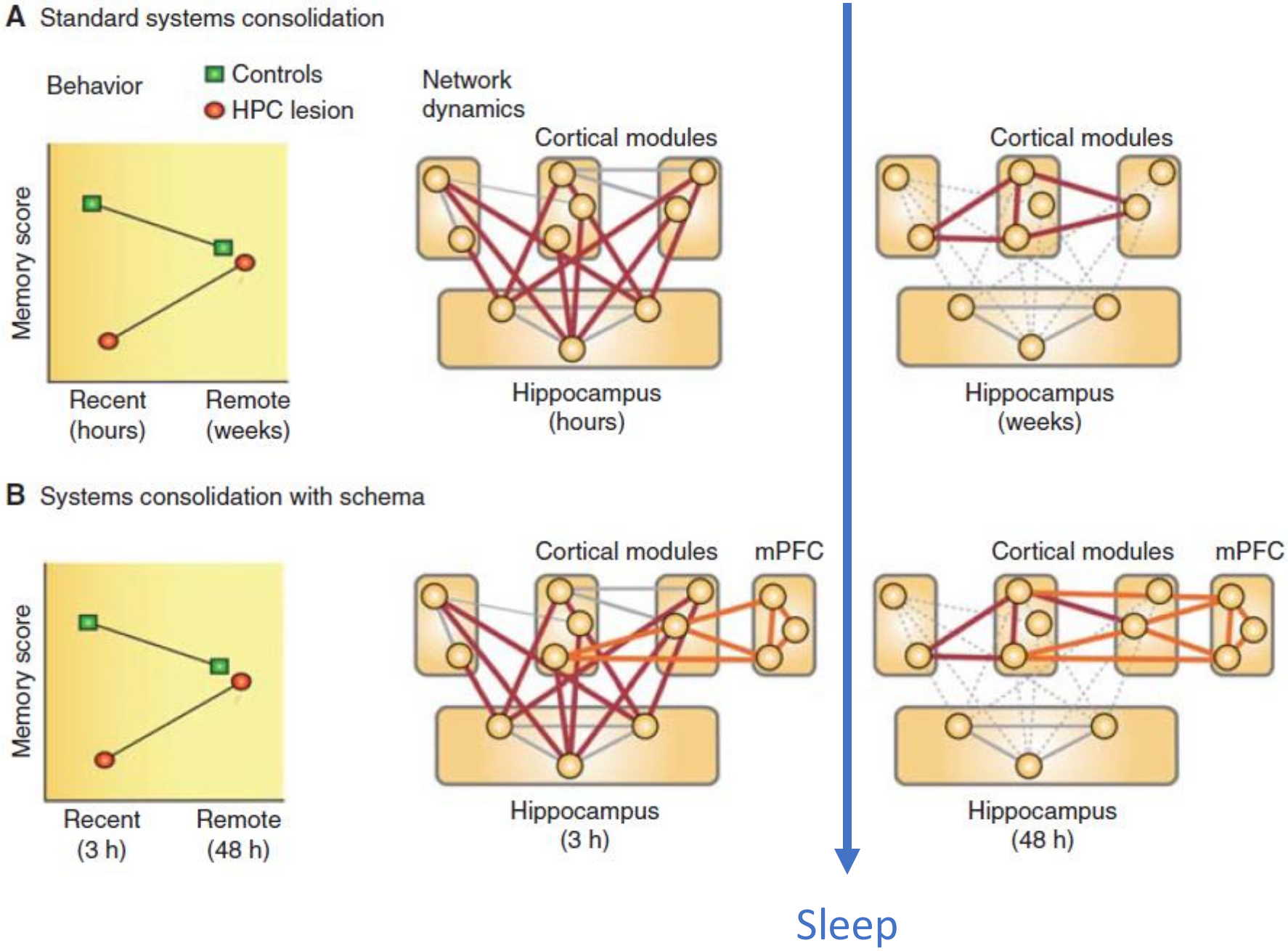
neocortex

hippocampus

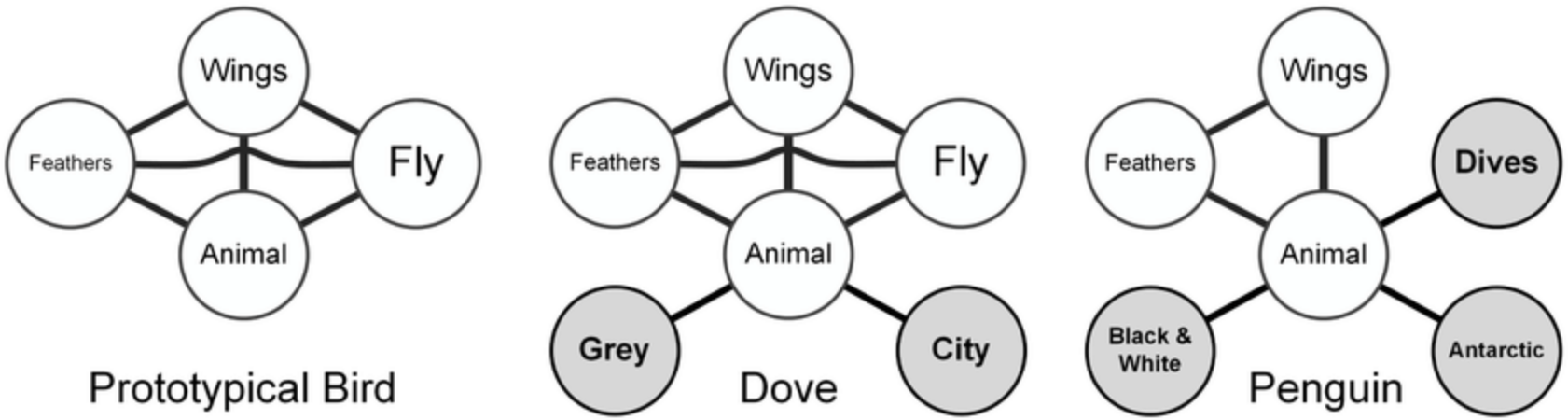


nature neuroscience

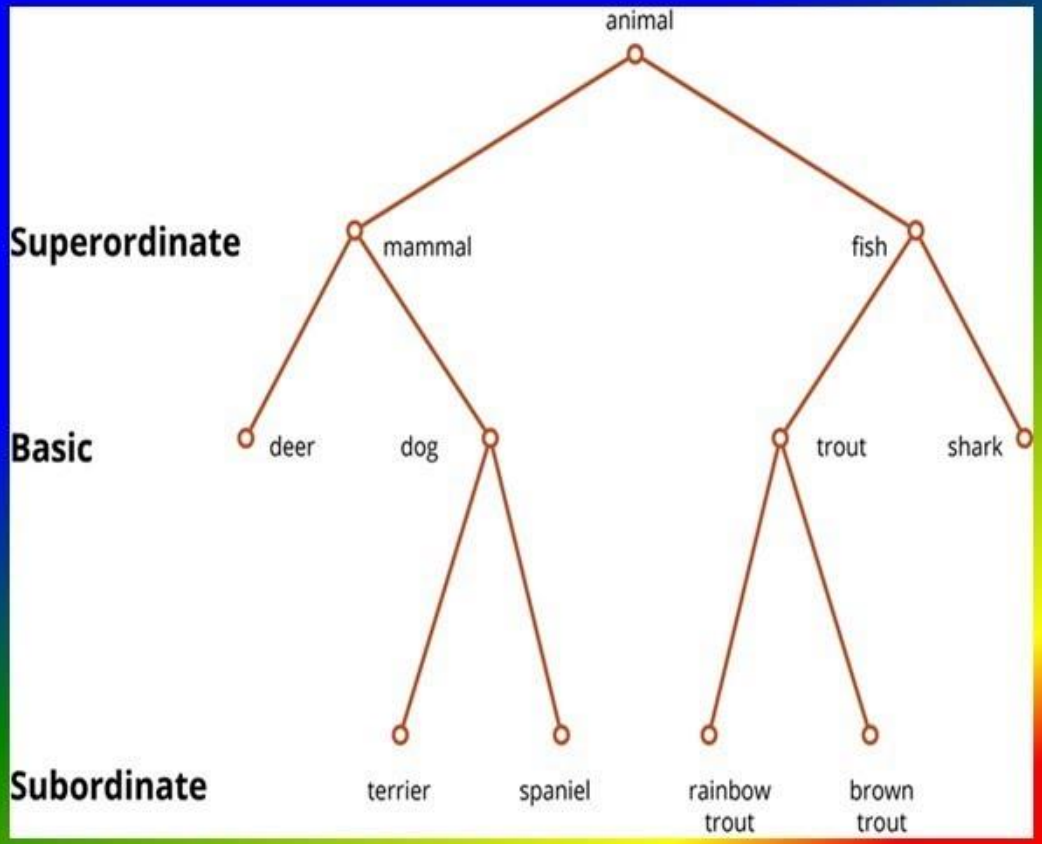

A
WAKE
Cortical modules
B
SLEEP
Synchronous NREM and REM oscillations
C
WAKE
selective memory consolidation
restored encoding capacity
Encoding Cue
emotion
reward
intent
none
Hippocampus
time

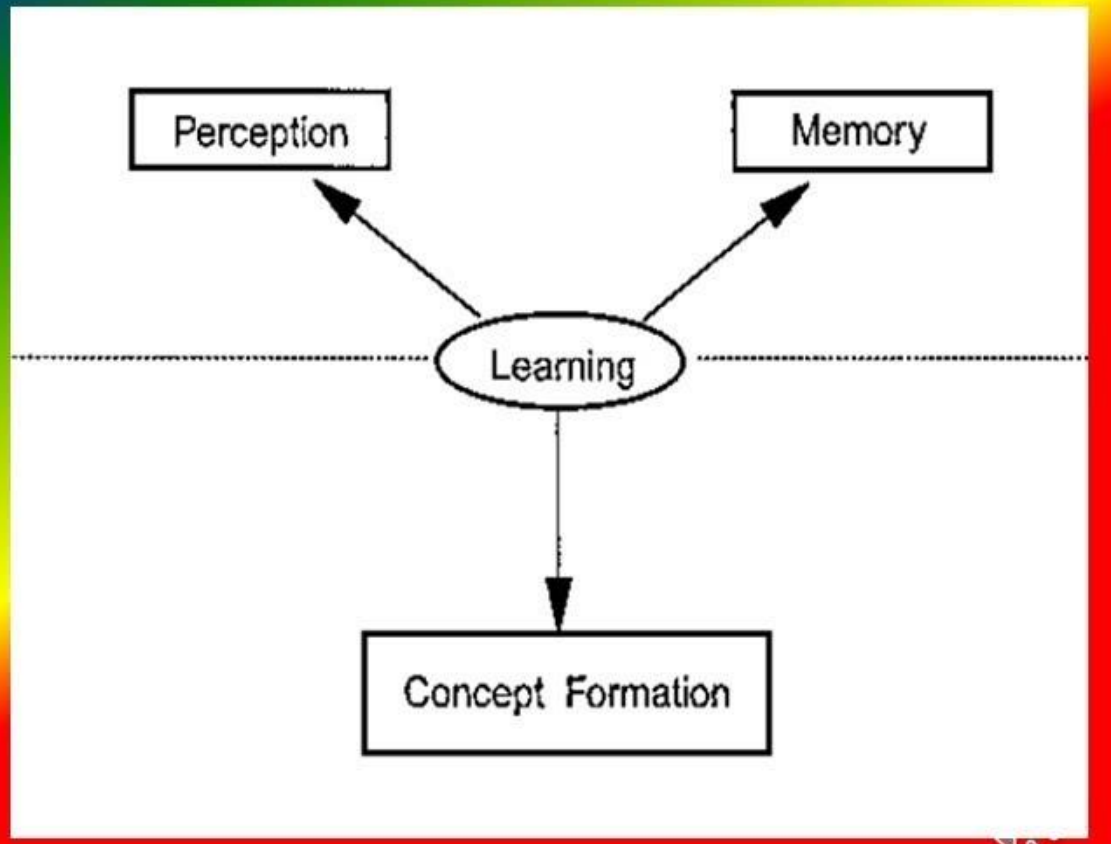

A Standard systems consolidation
Behavior
Controls
HPC lesion
Memory score
Recent
(hours)
Remote
(weeks)
Network
dynamics
Cortical modules
Hippocampus
(hours)
Cortical modules
Hippocampus
(weeks)
B Systems consolidation with schema
Memory score
Recent
(3 h)
Remote
(48 h)
Cortical modules
mPFC
Hippocampus
(3 h)
Cortical modules
mPFC
Hippocampus
(48 h)
Sleep

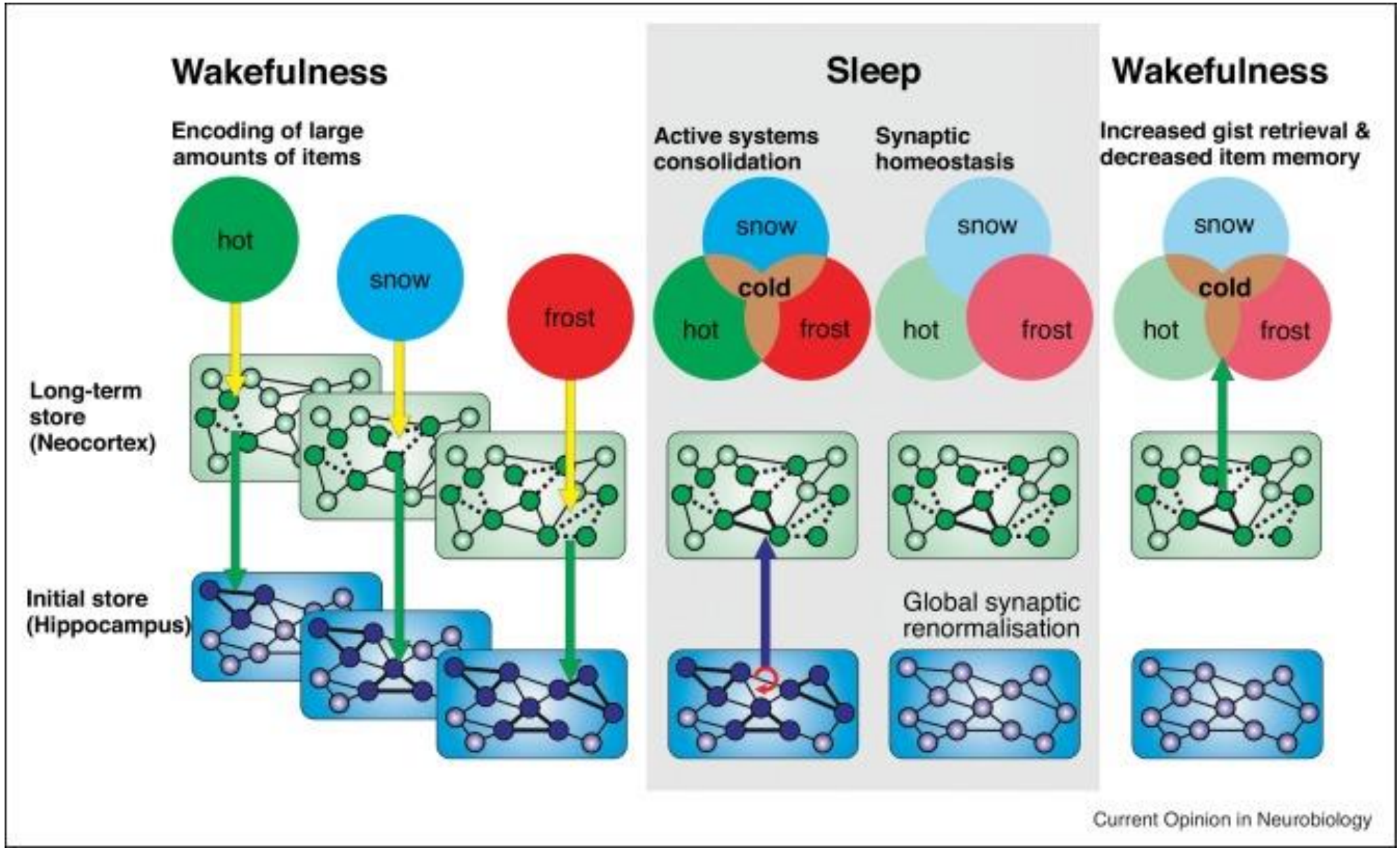
Concept of a Bird

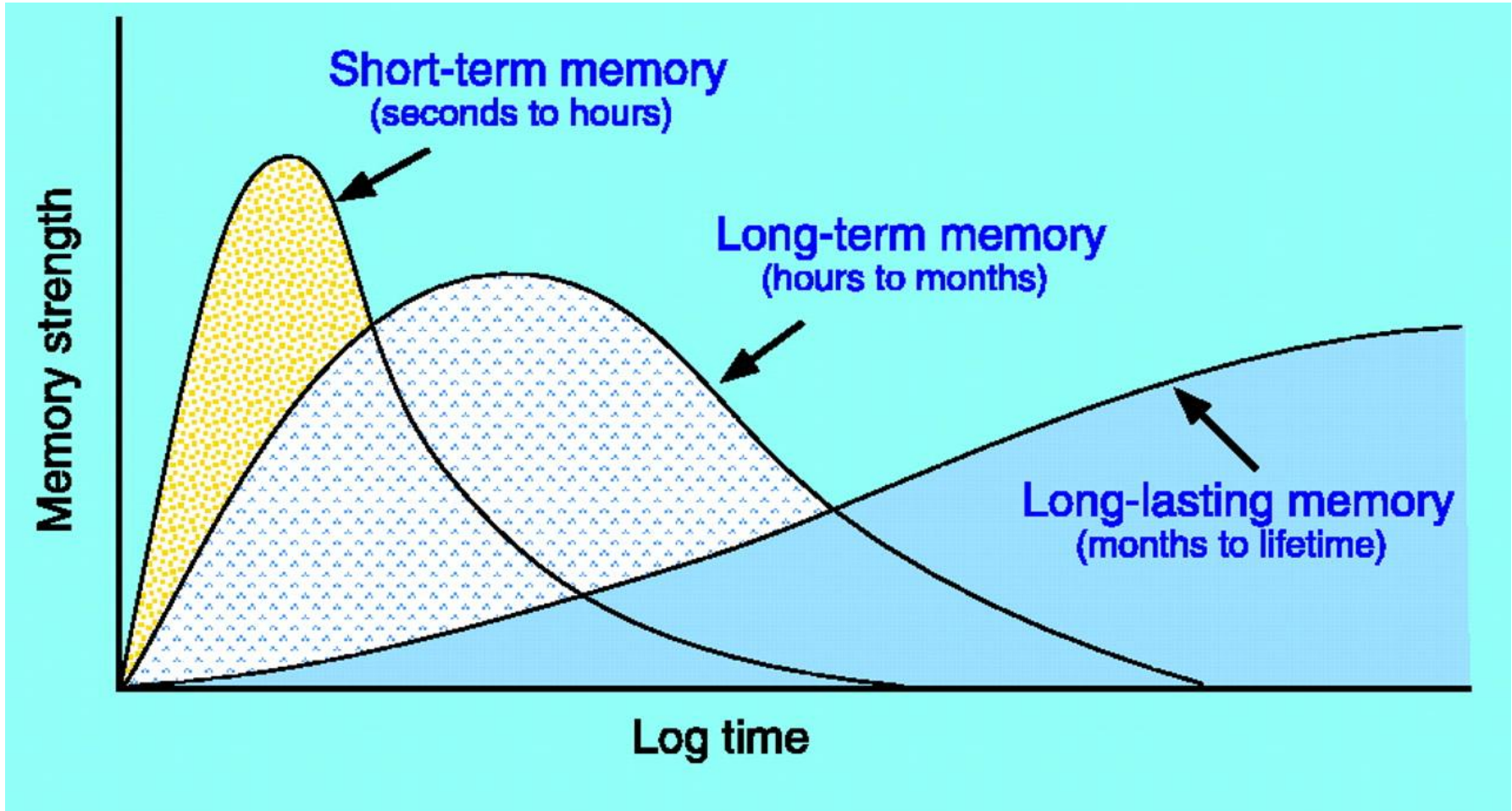


CONCEPT FORMATION

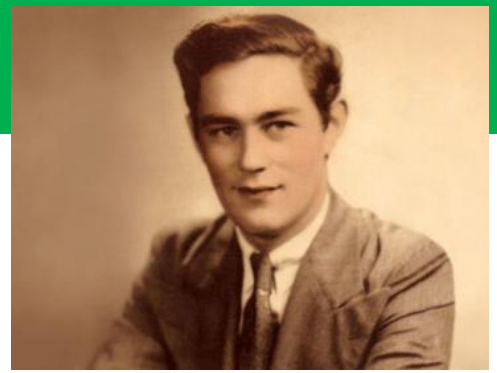


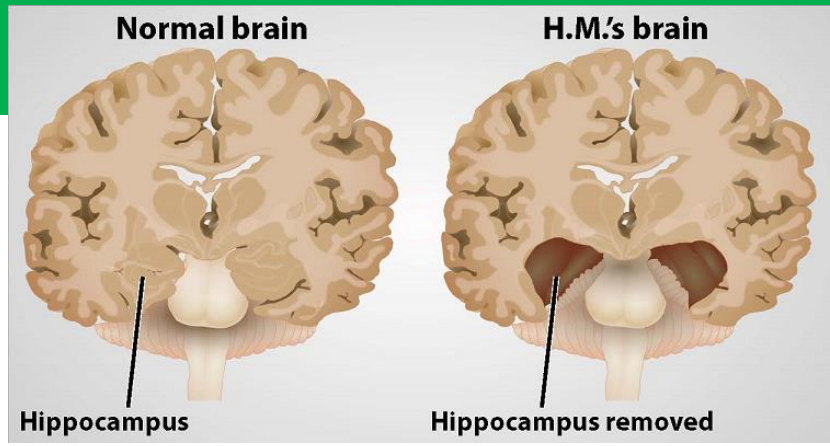



Wakefulness
Sleep
Wakefulness
Encoding of large amounts of items
Active systems consolidation
Synaptic homeostasis
Increased gist retrieval & decreased item memory
hot
snow
frost
cold
Long-term store (Neocortex)
Initial store (Hippocampus)
Global synaptic renormalisation
Current Opinion in Neurobiology


Short-term memory
(seconds to hours)
Long-term memory
(hours to months)
Long-lasting memory
(months to lifetime)
Memory strength
Log time

Patient HM





- Henry Molaison (1926-2008)
- At age 7, HM was knocked down by a bicycle
- Accident resulted in seizures, could not lead a normal life
- At 27, HM's bilateral medial temporal lobes removed to control his seizures.
- After surgery, HM could remember his name, family, and childhood.
- But he could not remember his day- to- day activities, not even his doctor, Dr. Scoville, who visited HM daily.

Patient HM

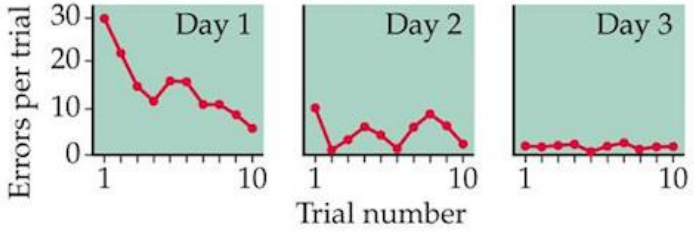
Dr. Brenda Milner
Clinical Neuropsychologist
McGill University
Montreal, Canada

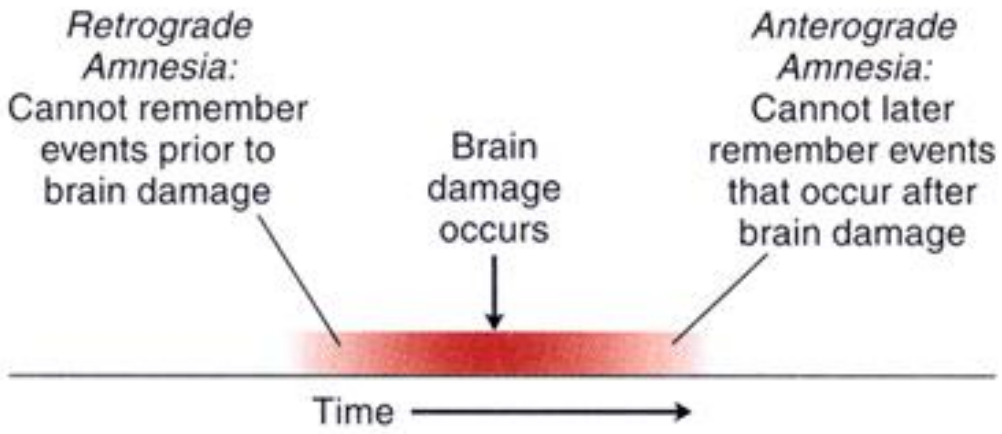
- IQ was intact.
- Could remember facts, schemas, and general knowledge.
- Could learn motor skills (like tracing a star by looking at its mirror reflection) over many practice trials, but was never conscious of these learning sessions.
- Short term memory was intact

- NO LONG TERM MEMORY

(a) The mirror-tracing task

(b) Performance of H.M. on mirror-tracing task

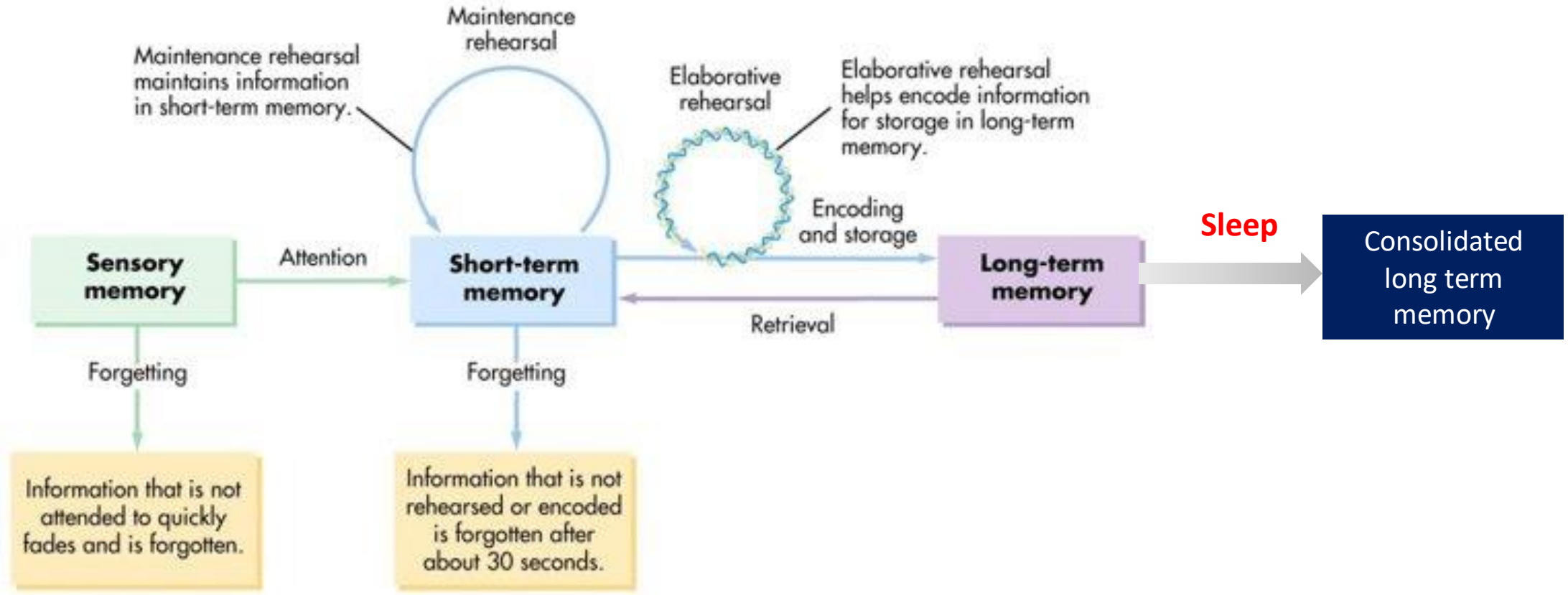




Retrograde amnesia - difficult to remember events from the past few years leading up to his surgery

Antero-grade amnesia – HM could not form new memories

He lived only in the present.


Maintenance rehearsal
Maintenance rehearsal maintains information in short-term memory.
Elaborative rehearsal
Elaborative rehearsal helps encode information for storage in long-term memory.
Encoding and storage
Sensory memory
Attention
Short-term memory
Long-term memory
Retrieval
Forgetting
Forgetting
Information that is not attended to quickly fades and is forgotten.
Information that is not rehearsed or encoded is forgotten after about 30 seconds.
Sleep
Consolidated long term memory

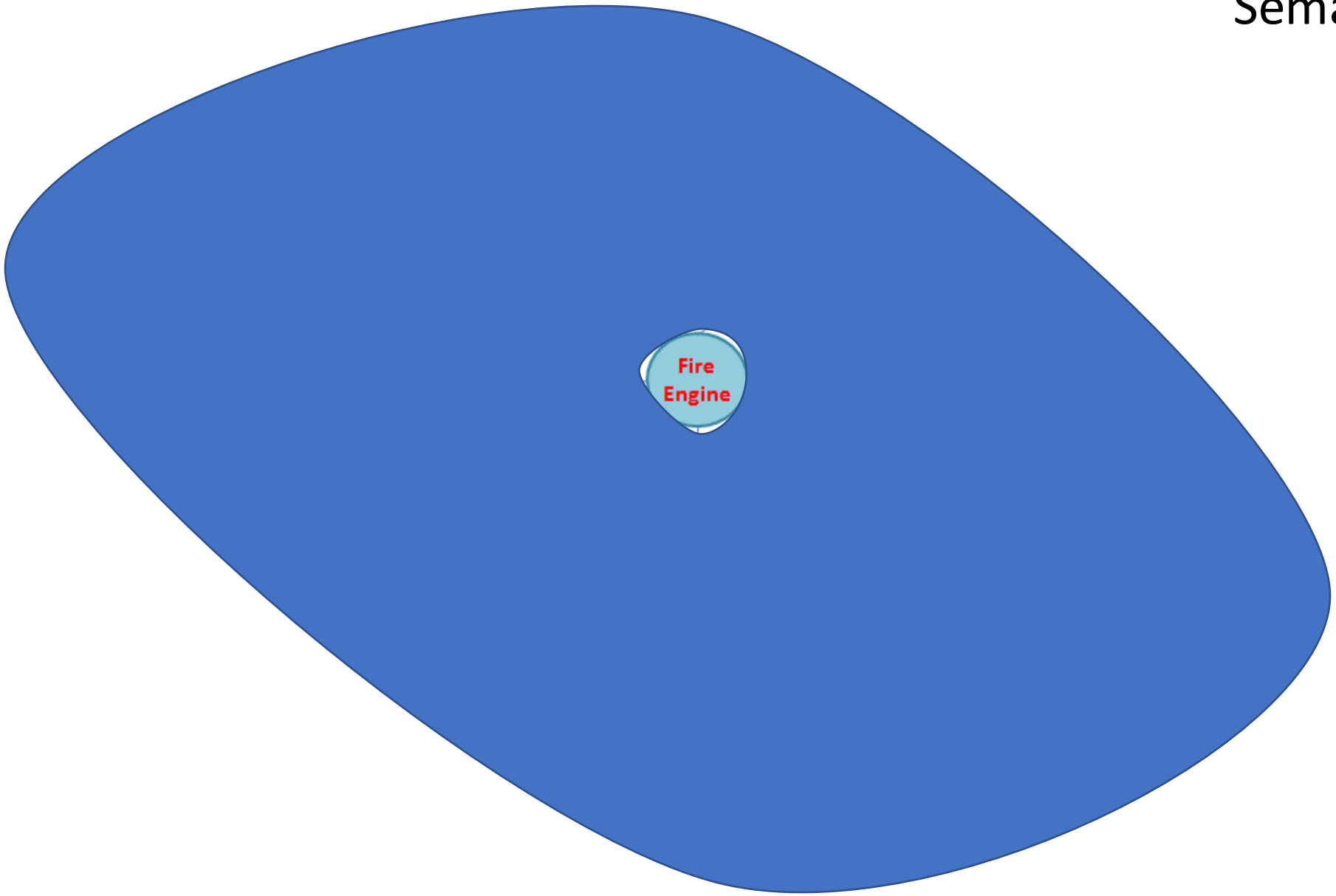
What are memories used for?

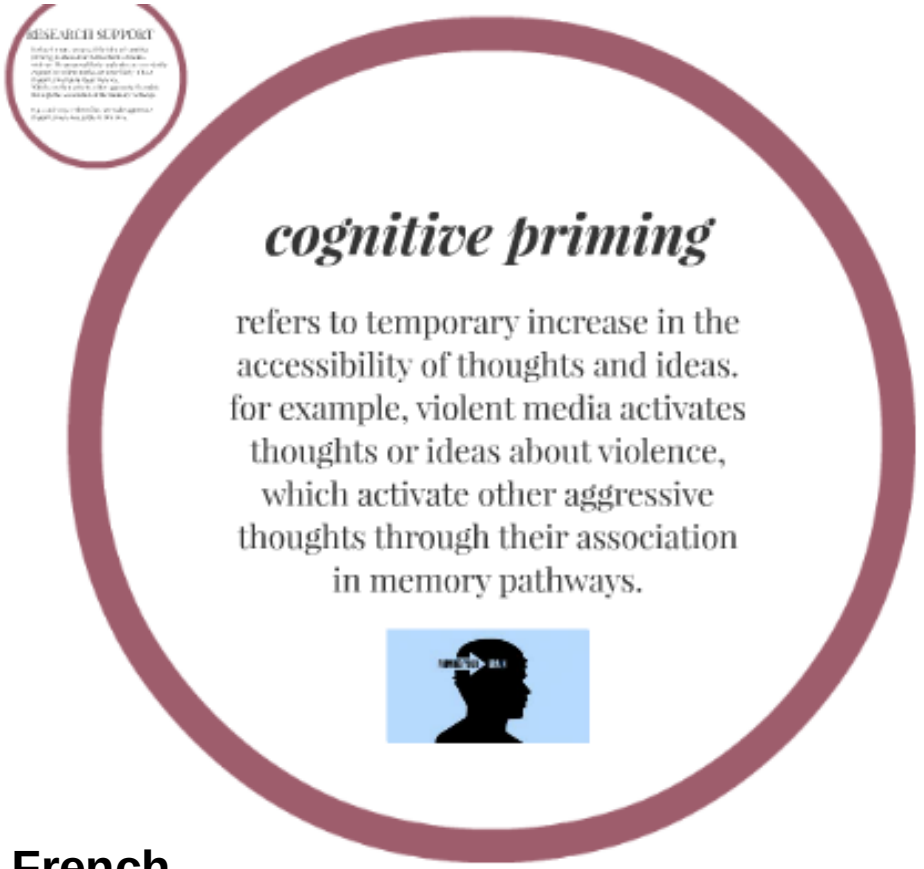
Visual Priming

2

Red
Blue
Orange
Yellow
Gr___

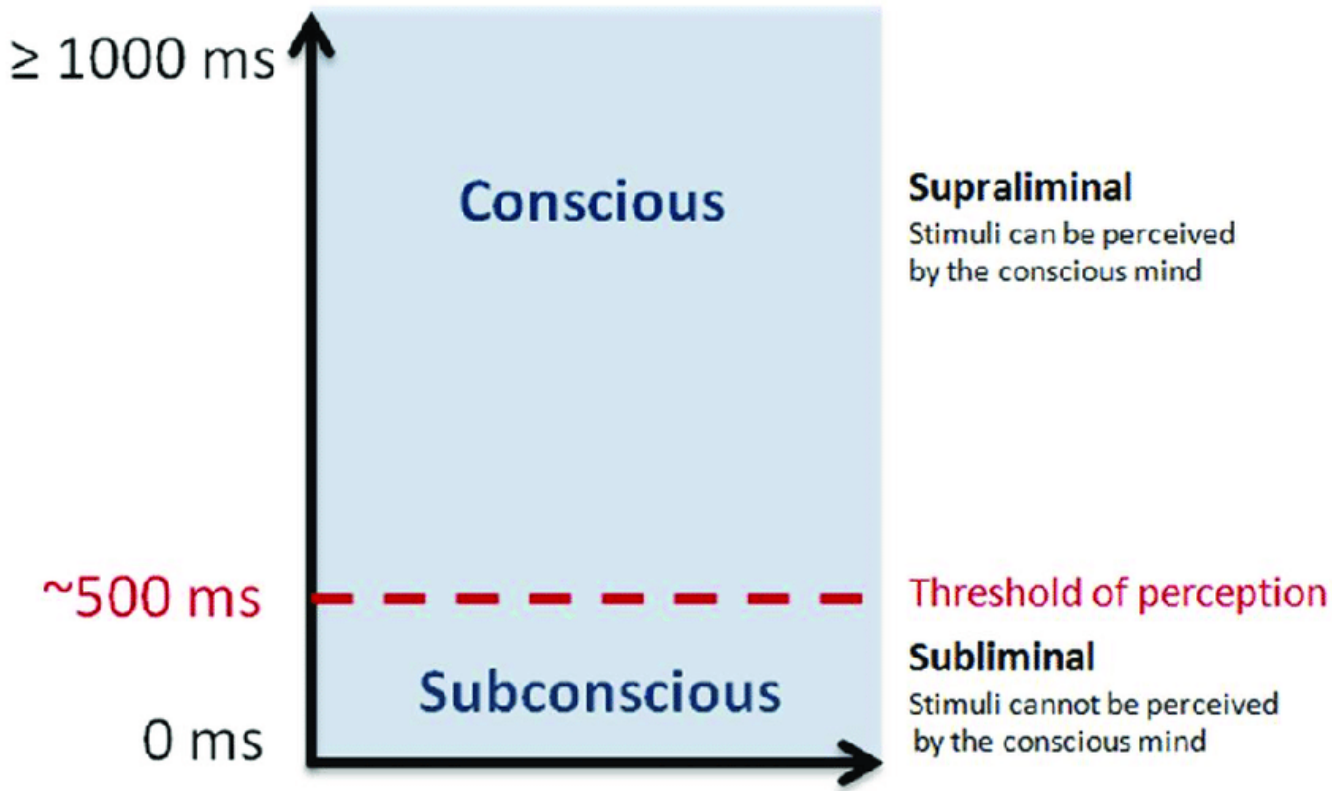
Semantic Priming





You own a restaurant and a ordered too much French wine. A good way to psychologically prime your clients into buying this type of wine is to play French music in the background.

Priming works by using associations made in our subconscious, and are almost always unnoticeable to the subject.


≥ 1000 ms
Conscious
Supraliminal
Stimuli can be perceived
by the conscious mind
~500 ms
Threshold of perception
Subliminal
Subconscious
Stimuli cannot be perceived
by the conscious mind
0 ms

http://karakreative.blogspot.com/2013/02/graphic-designer-of-month-paul-rand.html
http://vimeo.com/putorti

http://tech.fortune.cnn.com/2011/06/27/quoras-designing-woman/
http://topics.nytimes.com/top/reference/timestopics/people/f/shepard_fairey/index.html

Is India a safer place to live in now compared to a decade ago?

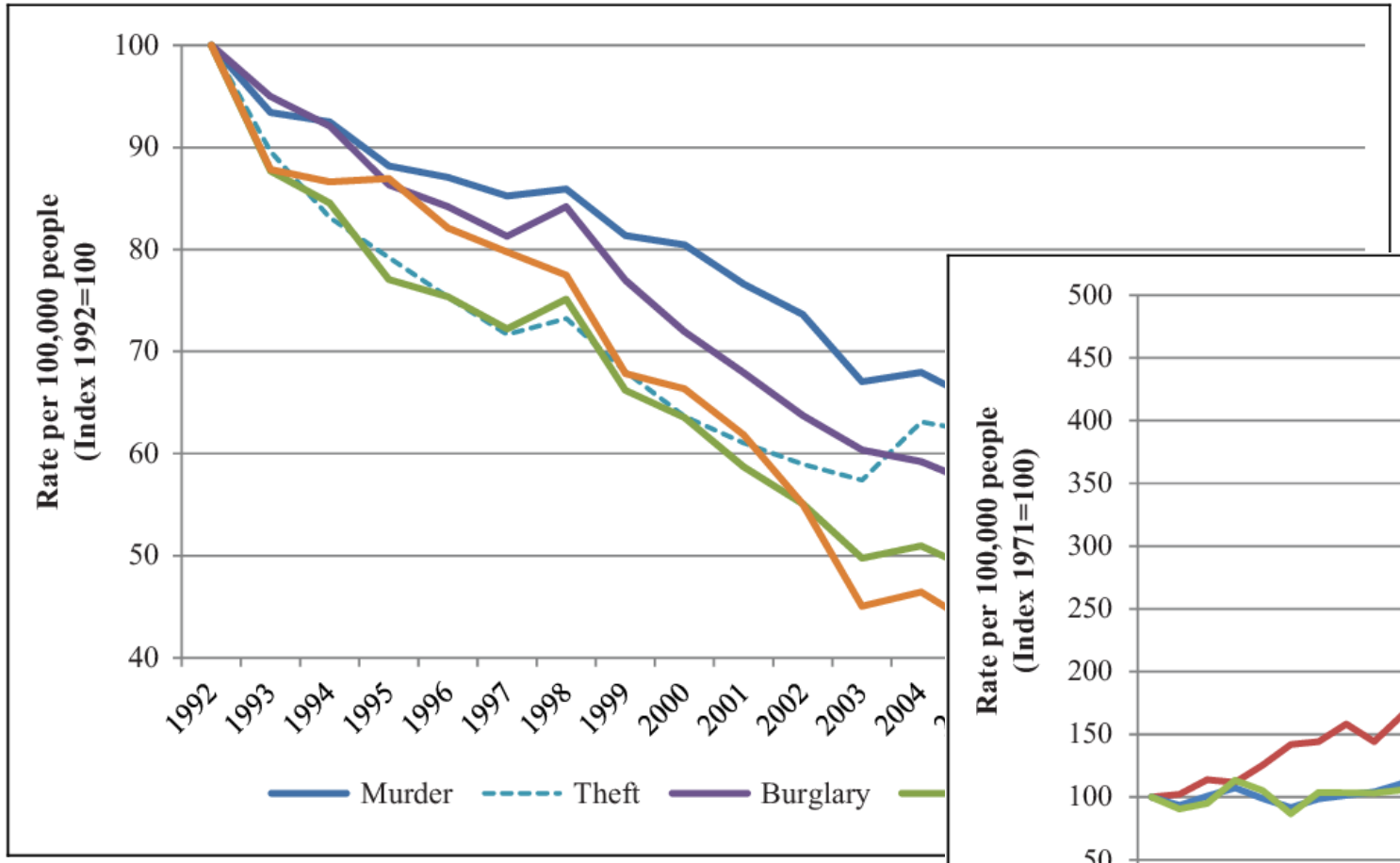
Does the letter *k* occur more often at the beginning of a word or as the third letter?

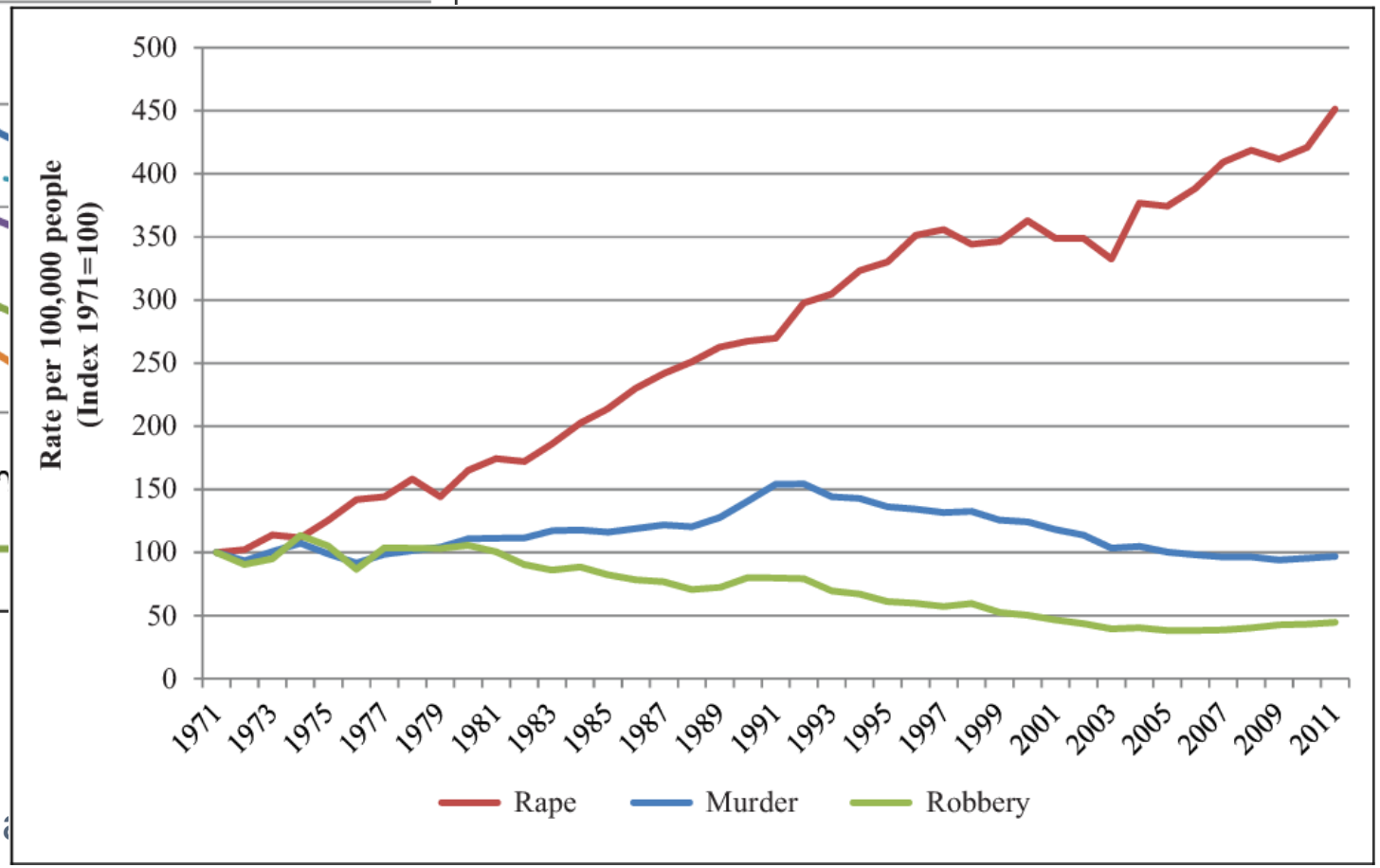
Covid has killed a devastating number of people !

Does the letter *k* occur more often at the beginning of a word or as the third letter?

K in first position	105 (69.1%)
K in third position	47 (30.9%)

Is India a safer place to live in now compared to a decade ago?





Published in 2015

Crime Rates in India S. Ansari, A. Verma, K. Da

1.Frequent is easier to recall than infrequent

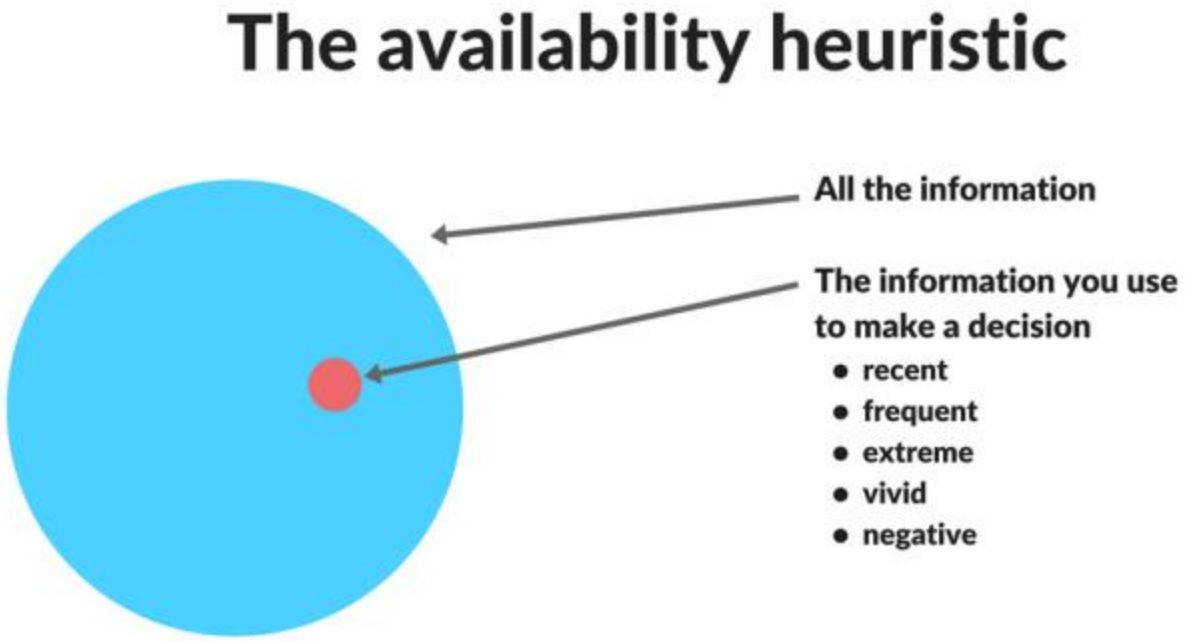
2.Extreme is easier to recall than ordinary

3.Negative is easier to recall than positive

4.Recent is easier to recall than the distant past

5.Vivid is easier to recall than non-vivid

what comes to mind the easiest—what's most available—is true.



Donald J. Trump ✓
@realDonaldTrump

Follow

In the East, it could be the COLDEST New Year's Eve on record. Perhaps we could use a little bit of that good old Global Warming that our Country, but not other countries, was going to pay TRILLIONS OF DOLLARS to protect against. Bundle up!

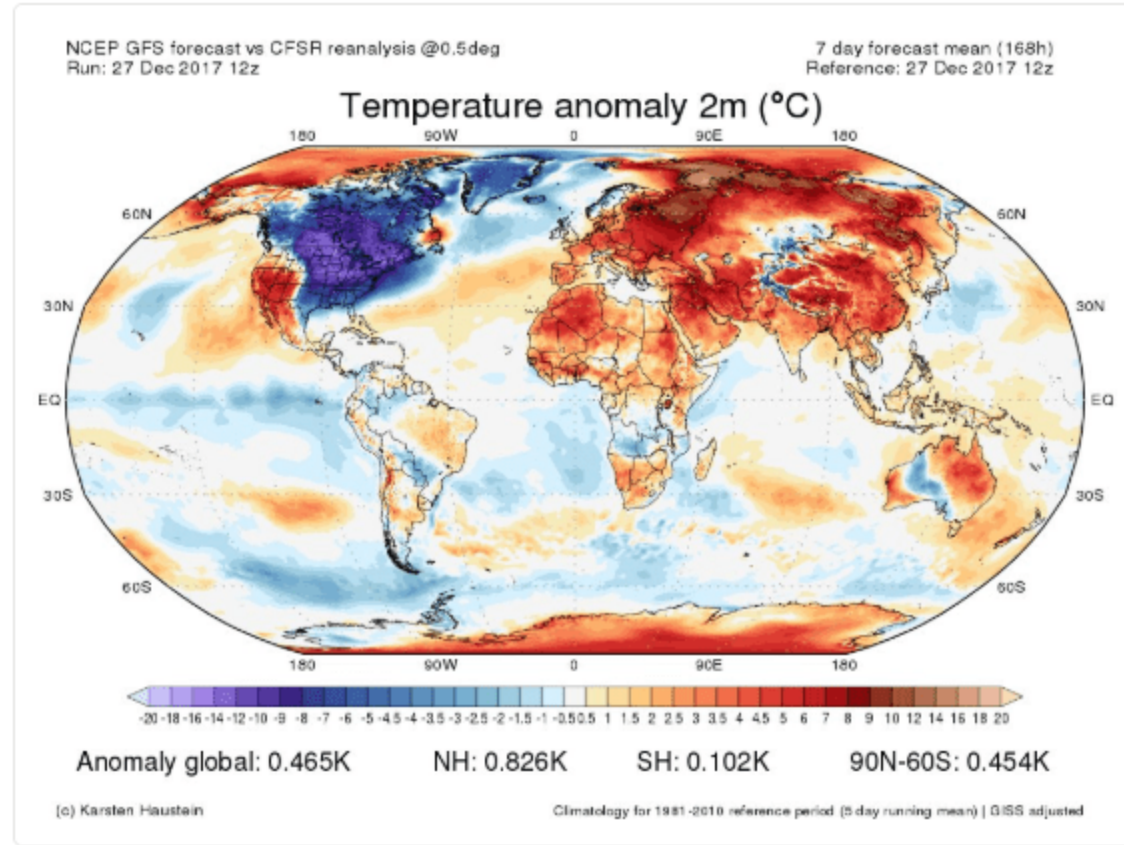
4:01 PM - 28 Dec 2017

Zack Labe ✓
@ZLabe

Follow

The coldest weather (relative to average) will be positioned right over North America through at least the next 7-days...

[Maps: karstenhaustein.com/climate]

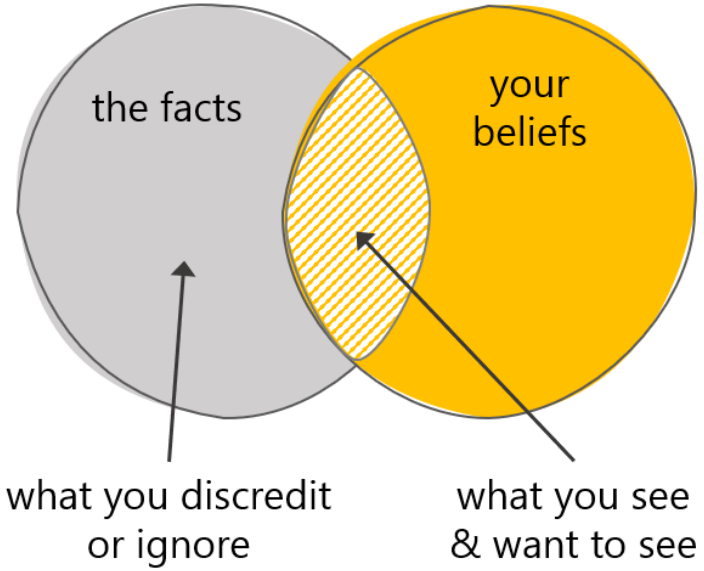


9:15 AM - 27 Dec 2017

A particular university ranks high because it takes high ranking students

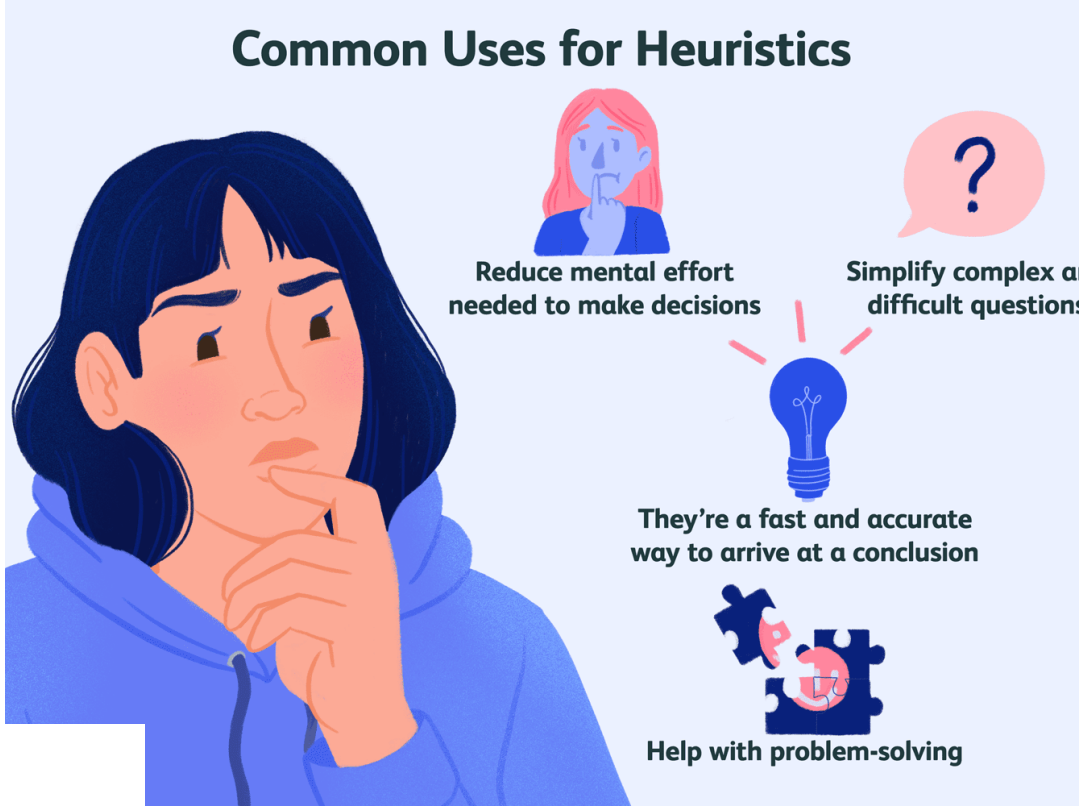
Voters seek info that supports their opinion/beliefs

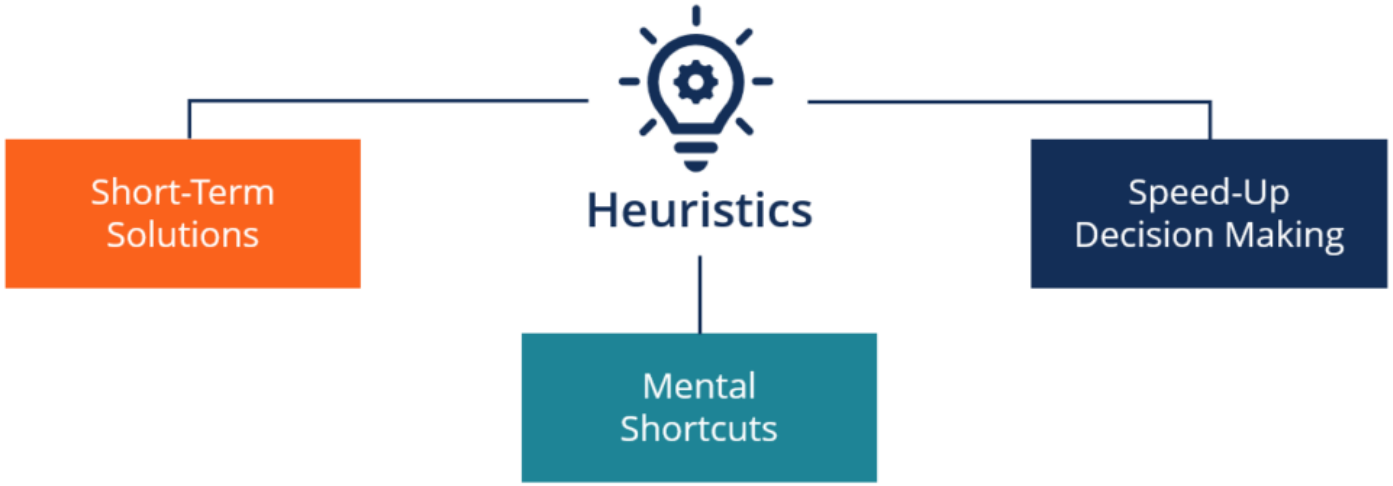
will ignore information from news broadcasters
that contradicts their existing views.

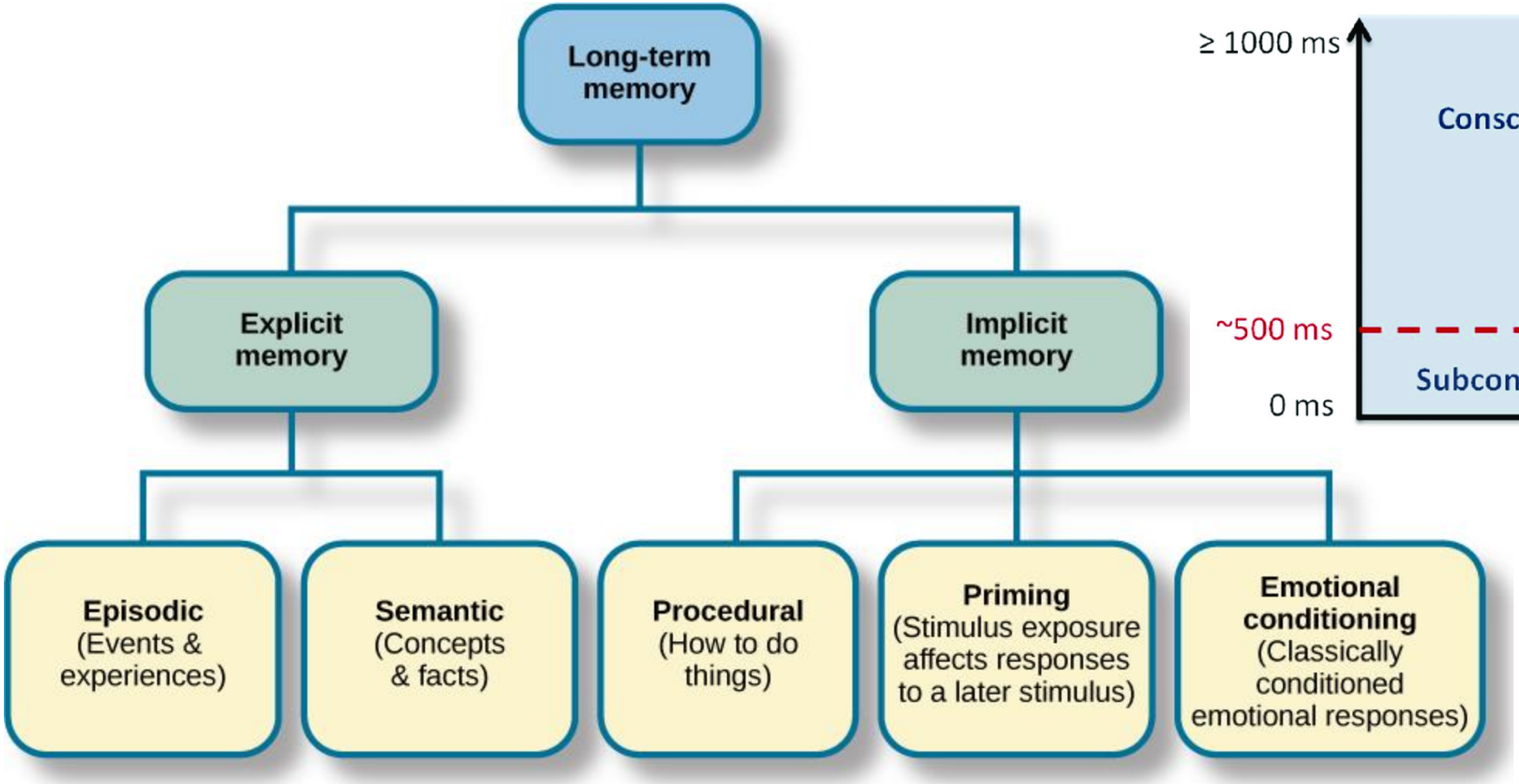


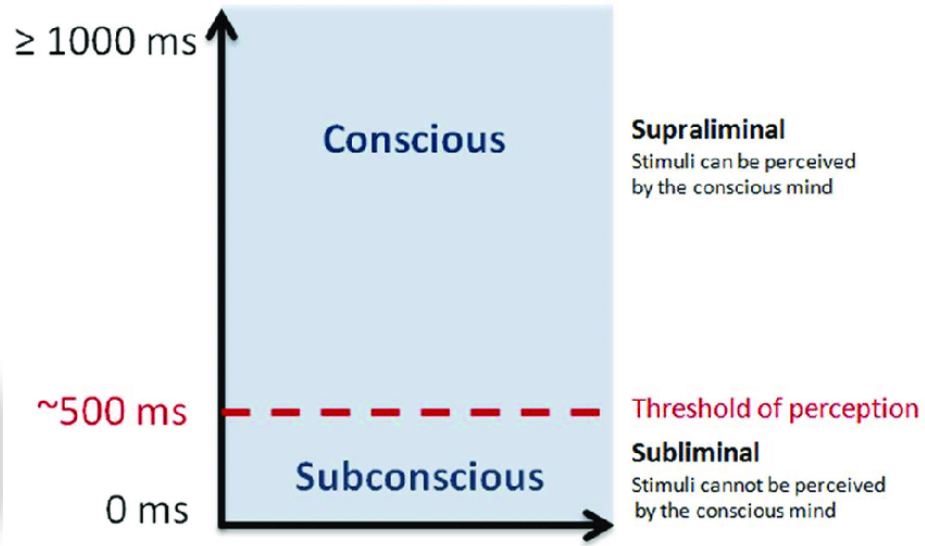
Confirmation bias

Heuristics?


Common Uses for Heuristics
Reduce mental effort needed to make decisions
Simplify complex a difficult question
They're a fast and accurate way to arrive at a conclusion
Help with problem-solving


Short-Term Solutions
Heuristics
Speed-Up Decision Making
Mental Shortcuts


Long-term memory
Explicit memory
Implicit memory
Episodic (Events & experiences)
Semantic (Concepts & facts)
Procedural (How to do things)
Priming (Stimulus exposure affects responses to a later stimulus)
Emotional conditioning (Classically conditioned emotional responses)


≥ 1000 ms
Conscious
Supraliminal
Stimuli can be perceived by the conscious mind
~500 ms
Threshold of perception
Subliminal
Stimuli cannot be perceived by the conscious mind
Subconscious
0 ms

Which factors affect memory?