# Pre-load these (perception)

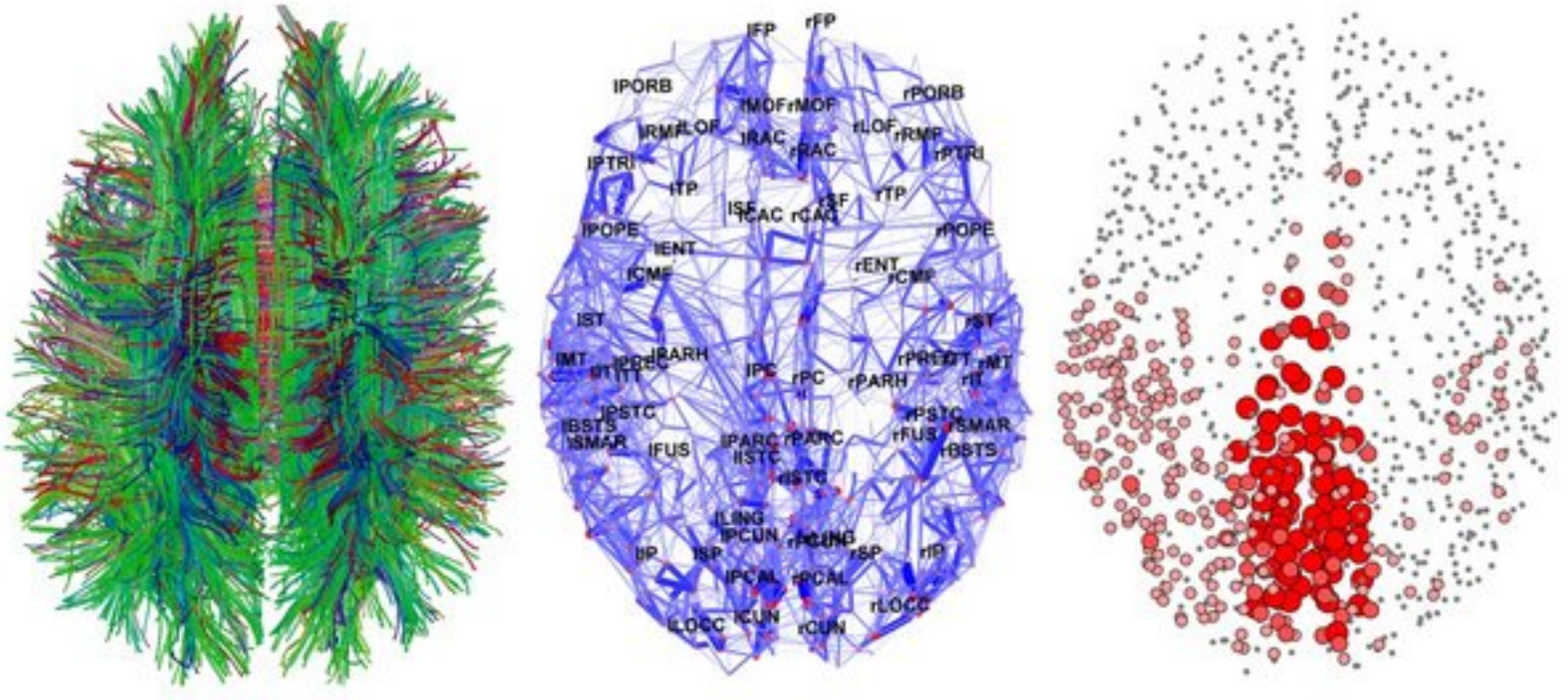
- http://www.youtube.com/watch?v=vJG698U2Mvo&feature=player_embedded
- http://www.youtube.com/watch?v=IGQmdoK_ZfY&list=UUoUA-CpKaFCCV2Uz__qNJZw&index=6
- http://www2.psych.ubc.ca/~rensink/flicker/download
- http://www.youtube.com/watch?v=vBPG_OBgTWg&feature=related

# Pre-load these (memory)

http://www.youtube.com/watch?v=qy_mIEnnlF4

http://www.youtube.com/watch?v=PQtDTdDr8vs

# Cognitive Neuroscience



# What is cognitive neuroscience?

- **Cognition** – from Latin: **Con** (with) + **Gnosco** (to know)
- Cognitive neuroscience is the study of how our brains allow us to think, perceive, and reason.
- Cognitive neuroscientists study things such as attention, learning, memory, perception, and decision making.

# Introducing Memory

Memory can be divided into two broad categories:

- Short-term memory
- Long-term memory

These memory systems rely on different brain systems.

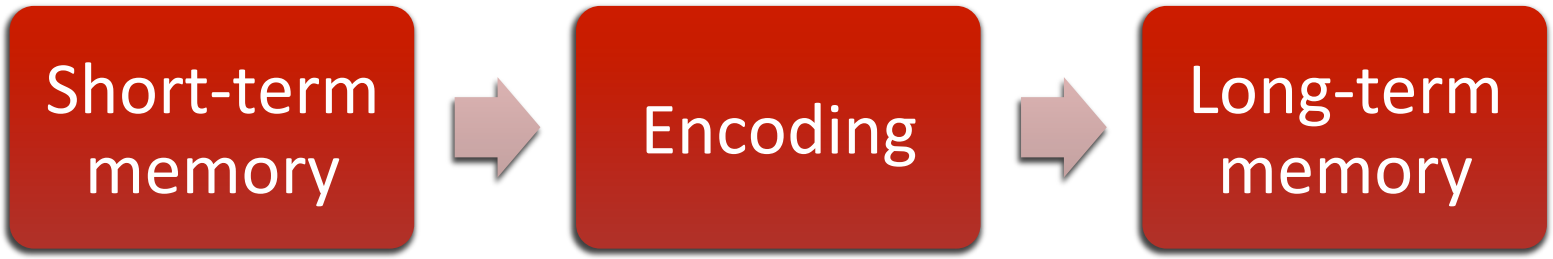
# Short-term memory

- The ‘magic number’ for short-term memory is 7±2 items.
  - “**Chunking**”: a technique we use to overcome this limitation.
  - We “chunk” phone numbers. 9023246745 is not too easy to remember, but 902-324-6745 is manageable.
- Short-term memory normally lasts only a few seconds.
  - But if we keep repeating what we’re trying to remember, we can hold it longer. This is called “**rehearsal**”.

# Long-term memory

- Information stored in short-term memory can be transferred to long-term memory. This is called "**encoding**"
- This process involves rehearsal, emotional impact, and fitting the new memory into your network of associations.
- Unfortunately not a process we have much control over.

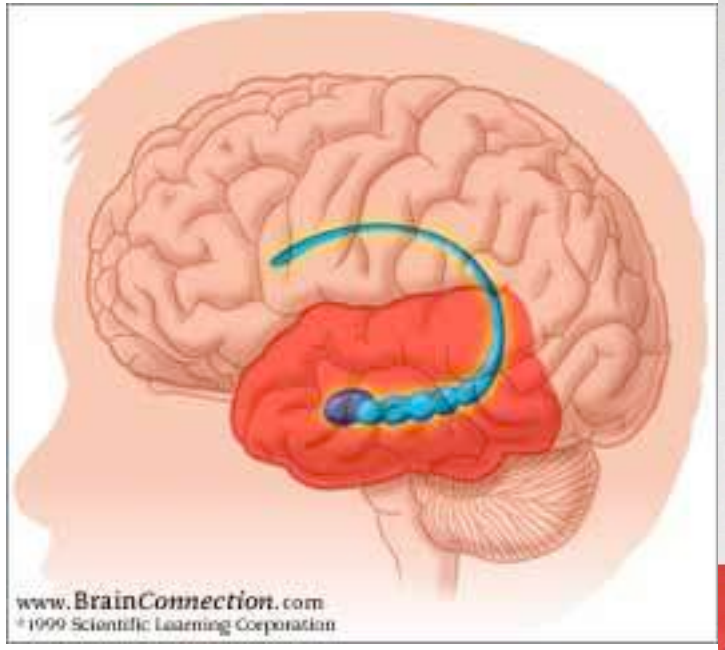
# Memory storage

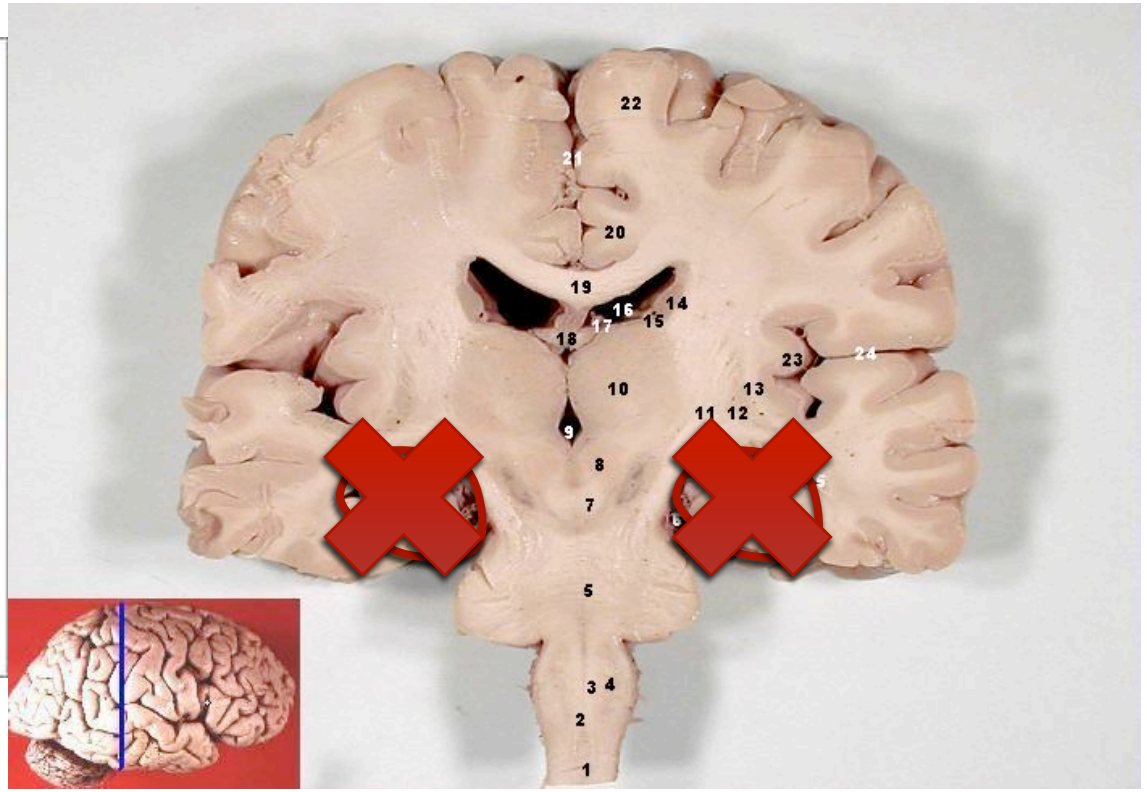


# How is long-term memory stored?

- Case study: HM
  - In order to cure intractable seizures, surgeons tried a new operation called a "**medial temporal lobectomy**".
  - This resulted in the removal of the hippocampus.

# The hippocampus



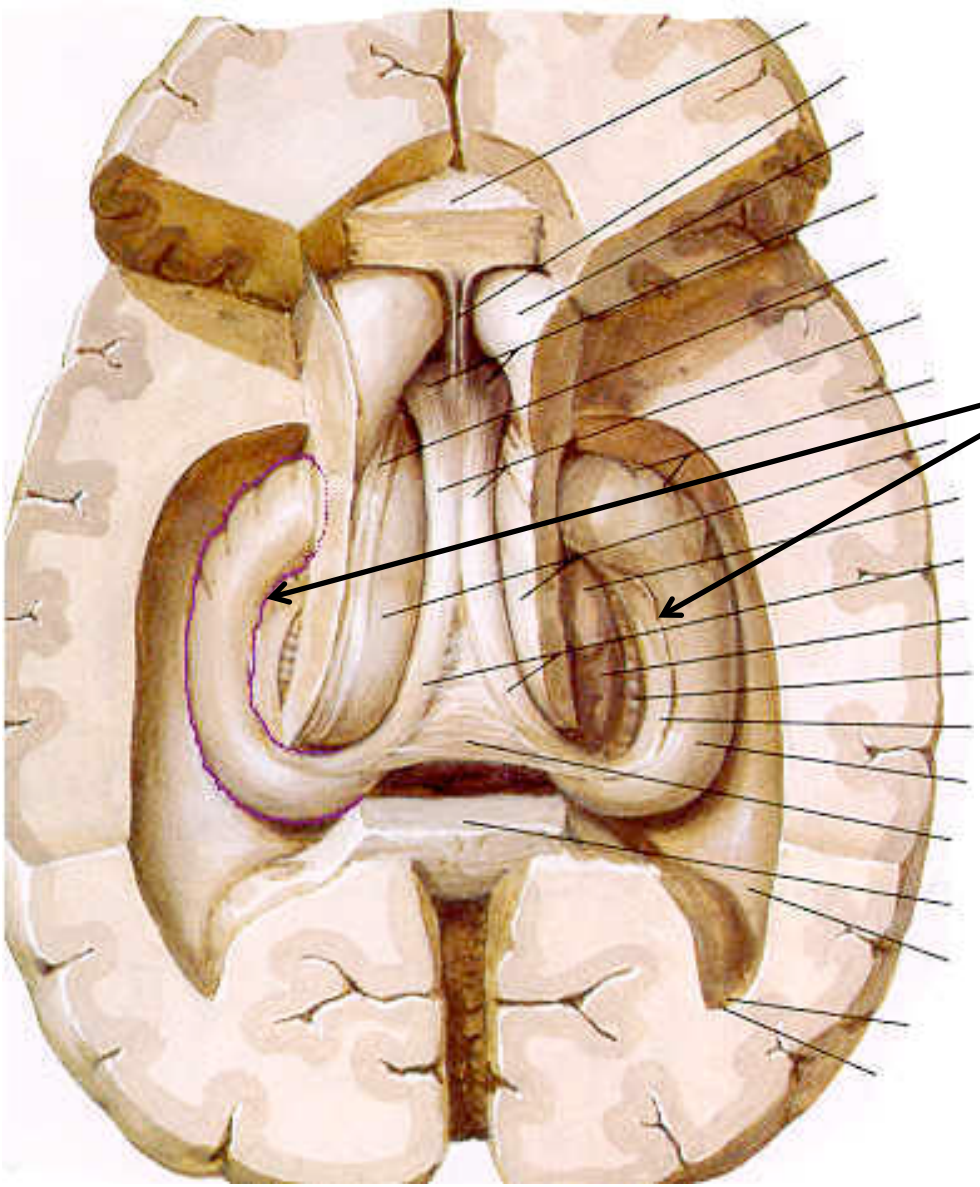

Hippocampus

Plate 19

# What happens without a hippocampus?

- HM recovered from surgery and was ostensibly healthy.  But he had serious memory problems.
- HM had good short-term memory, and he could remember everything before the surgery, *but he was completely incapable of forming new long-term memories.*

## Anterograde amnesia

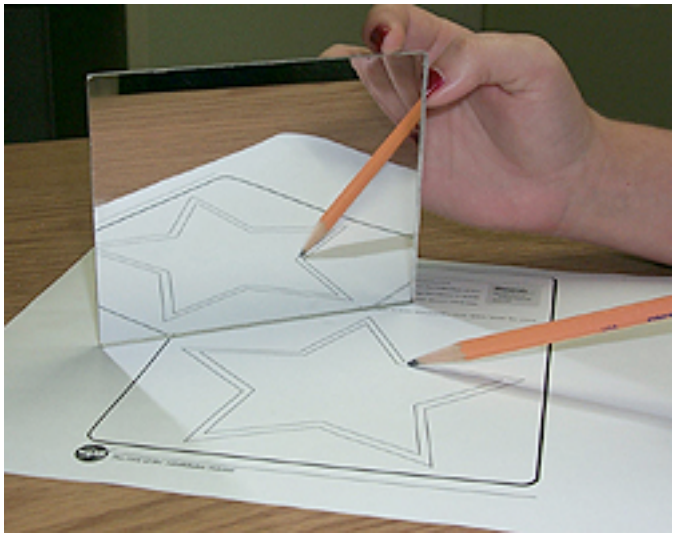
# What does the hippocampus do?

- Judging from HM's condition, it seems that the hippocampus is critical for forming new memories.

- It's not, however, where memories are stored, otherwise HM would have also forgotten everything he already knew.

# What doesn't the hippocampus do?

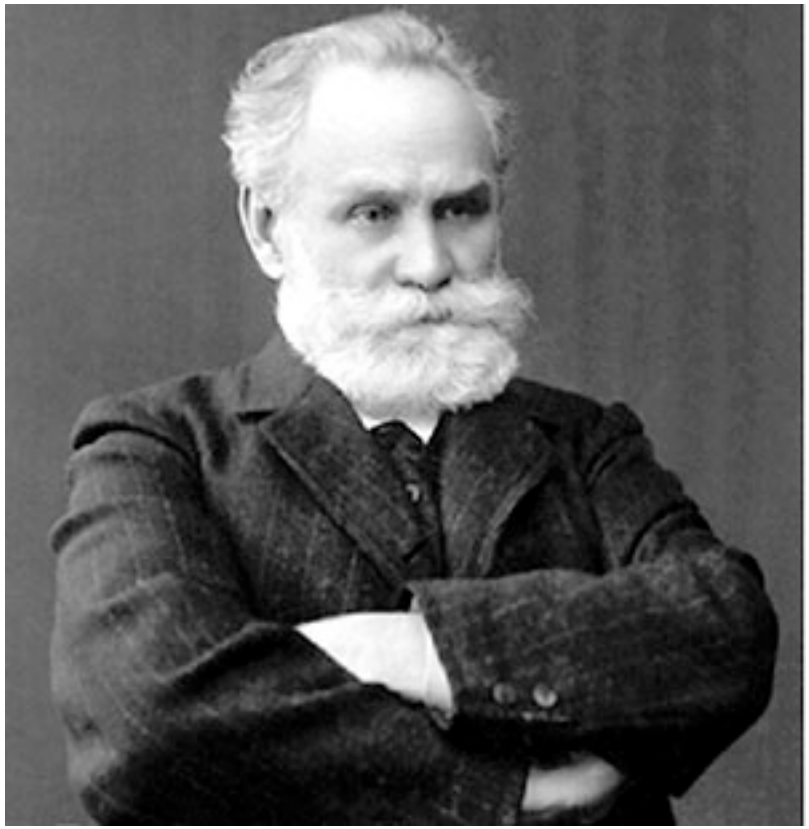
- HM couldn't remember events, at least not explicitly. But he was capable of getting better at tasks through practice.



After daily practice, HM was able to get very good at mirror tracing tasks, even though he never remembered having done them.

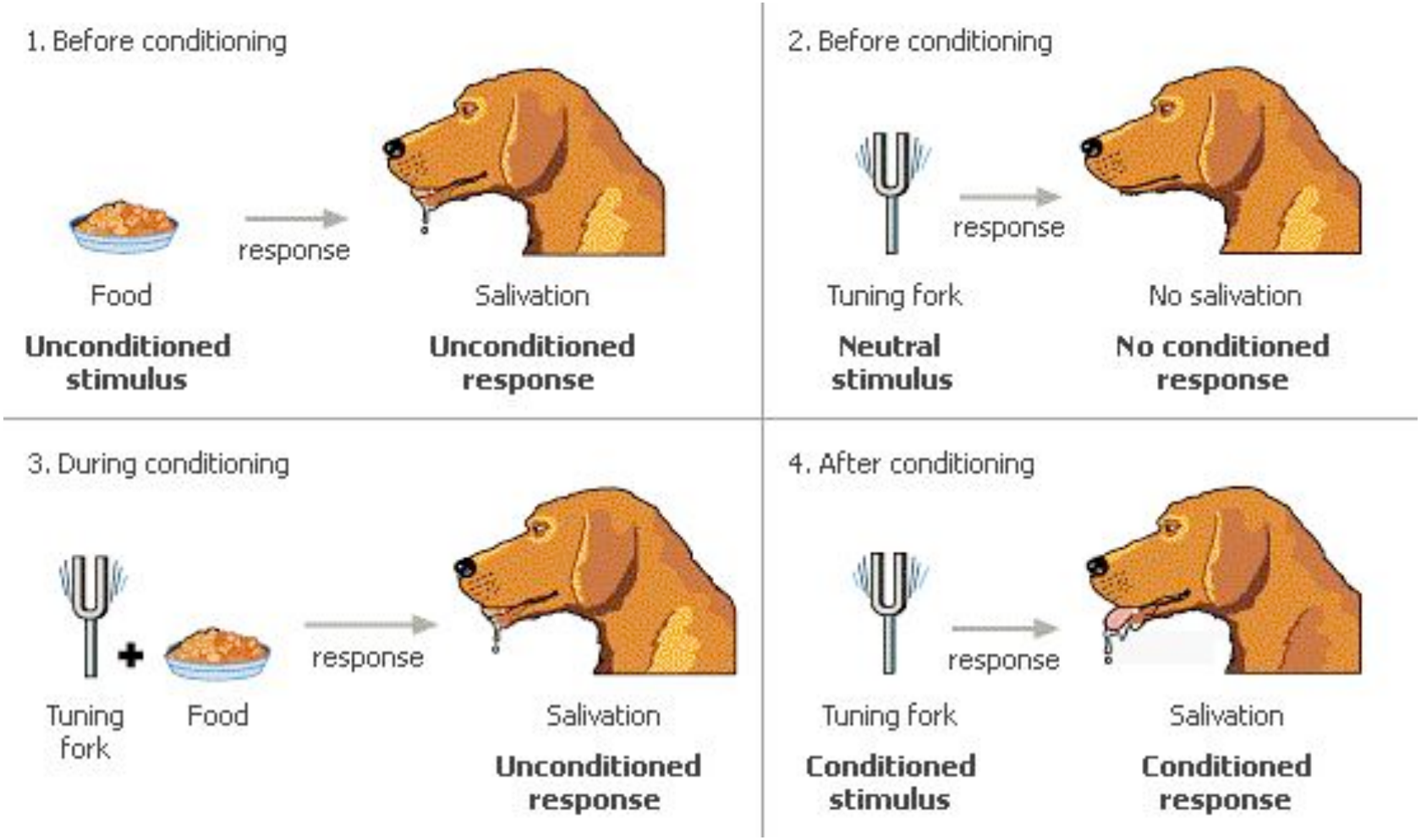
# The Psychology of Learning

# Classical Conditioning

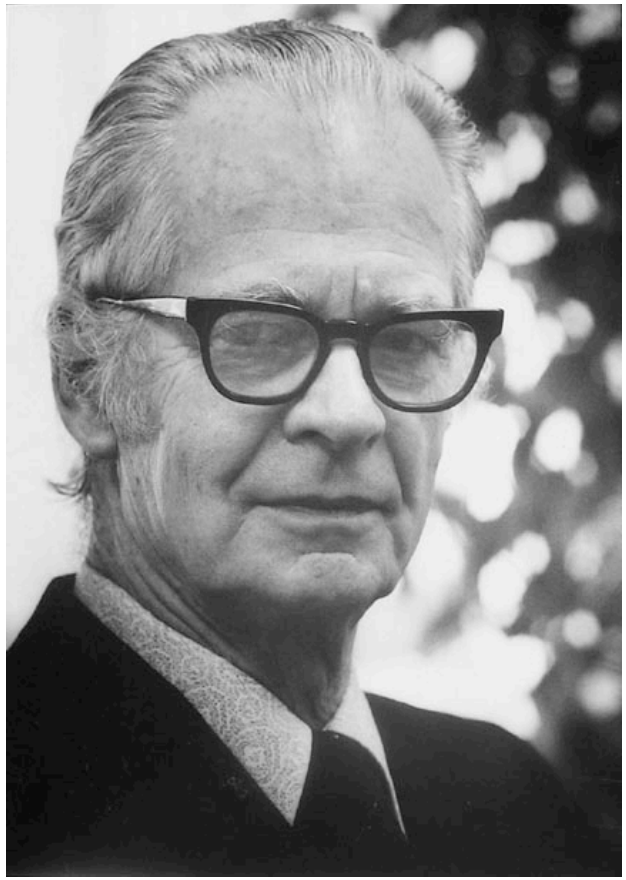


- Ivan Pavlov (1849-1936) first described this simple form of learning in dogs.
- "Pavlov's dog"

# Classical Conditioning

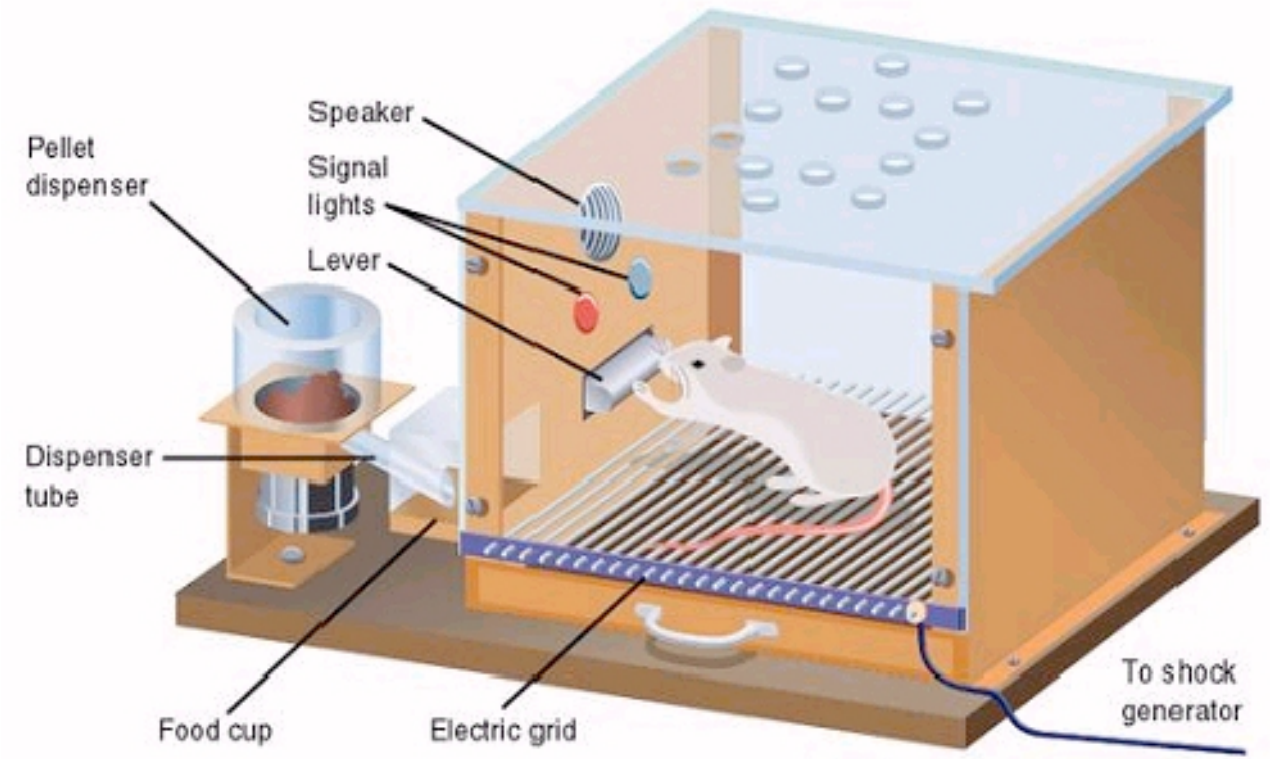


# Operant Conditioning



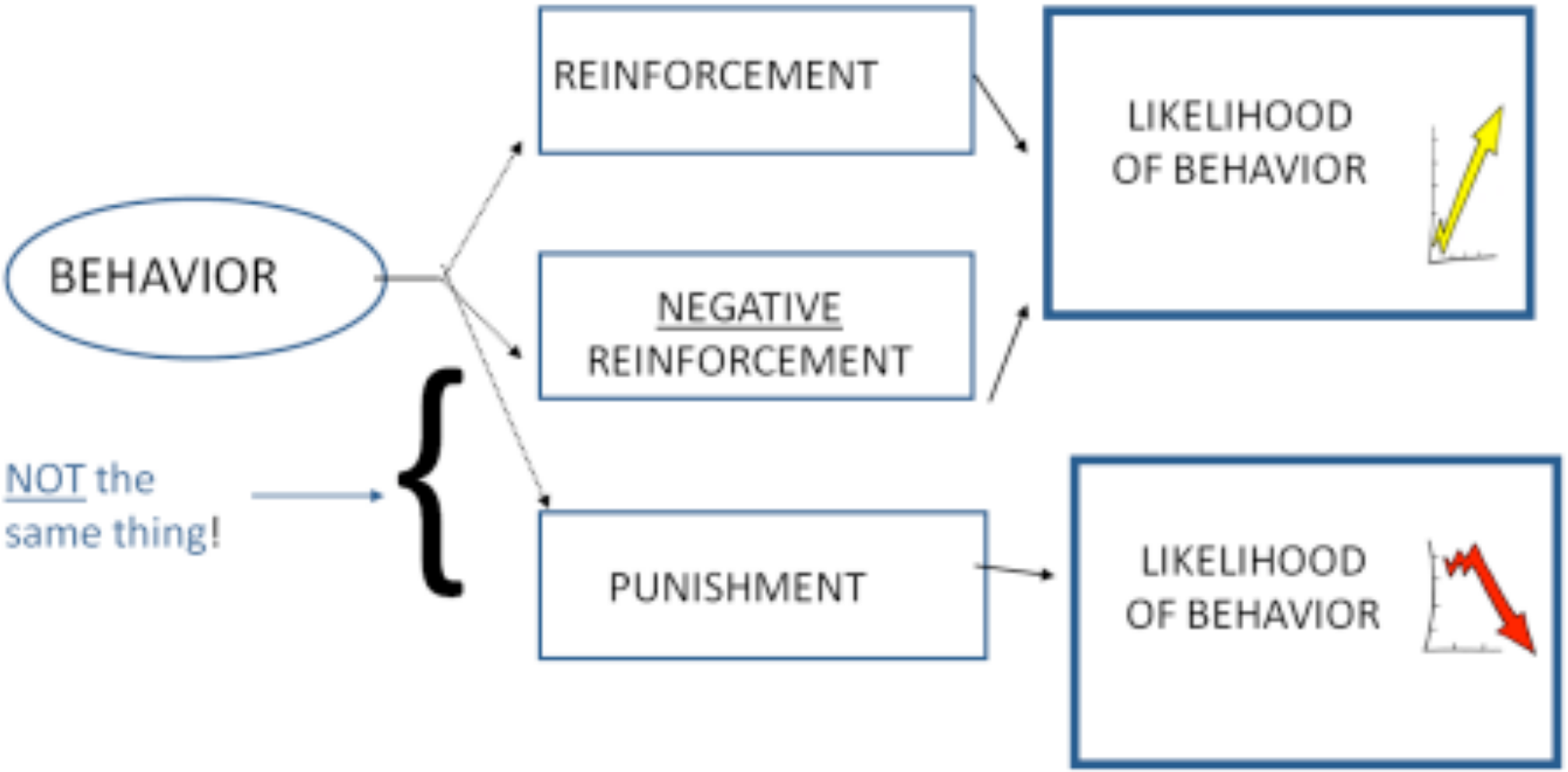
- B.F. Skinner (1904-1990)
- A great innovator in the field of learning.
- Believed that most learning, even in humans, works according to the principles of operant conditioning.

# The Skinner Box




See Video

# Operant Conditioning




See Video

# Spatial Learning

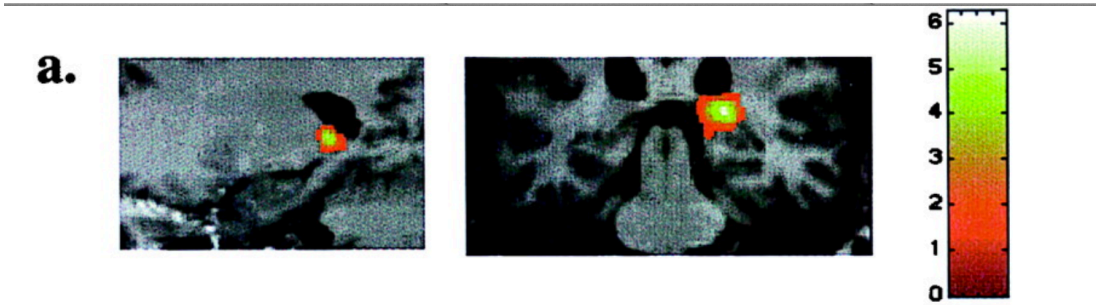
Rats can be placed in mazes to study their spatial memory.

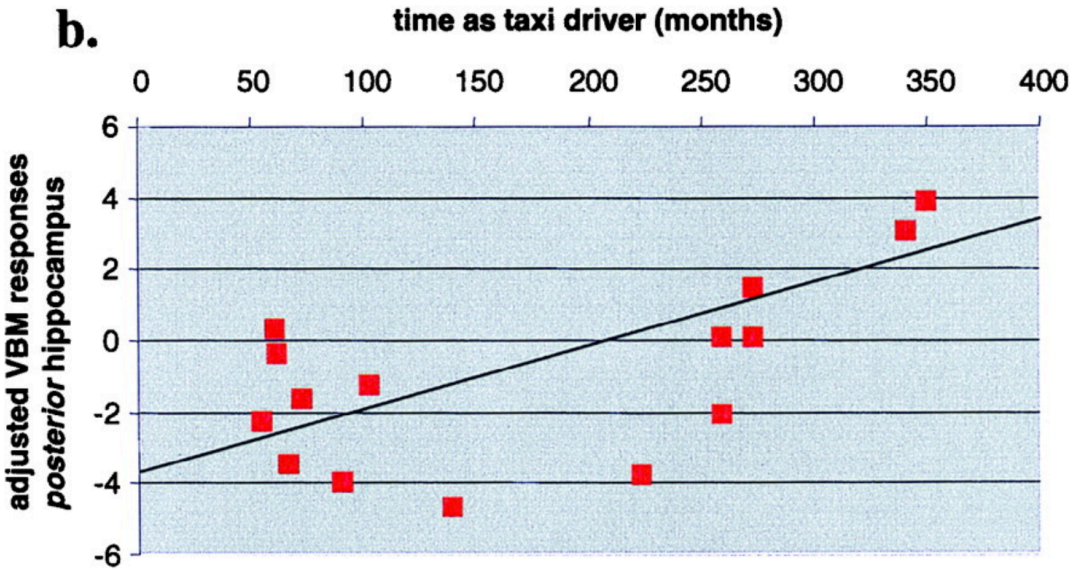
The **Morris Water Maze** is a commonly used test of spatial memory.

Rats are placed in a tub full of murky water, and swim about until they discover a hidden platform. Later on, they are tested for how quickly they can find that platform again.

# Spatial Learning

- Spatial learning depends on the hippocampus.
- Rats with hippocampal lesions cannot solve the Morris Water Maze.
- In a famous study, London taxi drivers were shown to have larger hippocampi as a function of their years of experience on the job.



# Cognition and Perception

# What is perception?

- The five senses deliver the ‘raw material’ for your brain to process, but your brain needs to do a lot of work to interpret this information.

- What you experience is much richer than just what your senses tell you.

- Perception is an ‘ill-posed’ problem

# Why should the brain take shortcuts?

- The truth is that scientists aren't entirely sure as to why we perceive these illusions. But if the brain makes a mistake, there's usually a good reason for it.

# The eyes deliver a poor quality image

- Naturally the world we perceive appears crystal clear. But the message coming from the eyes is anything but.

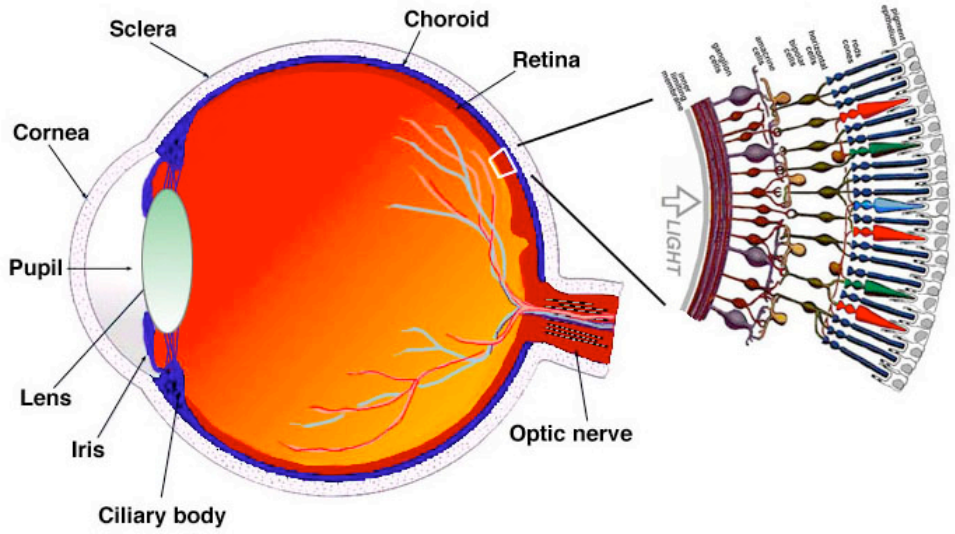
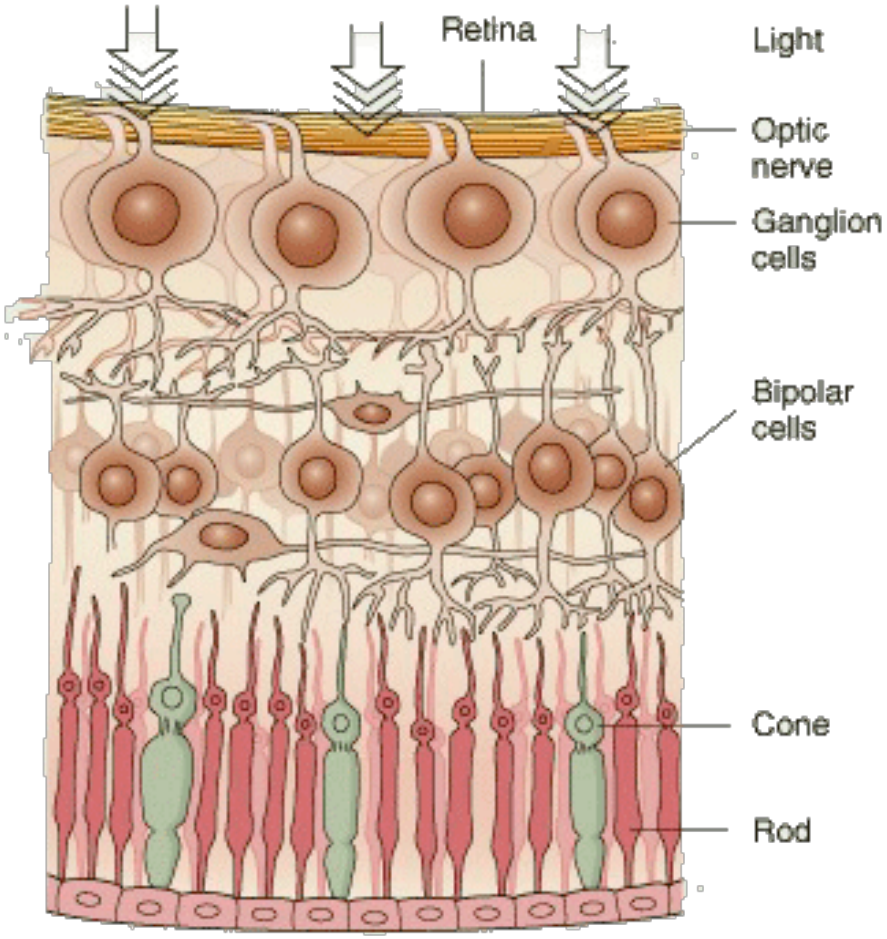



*Fig. 1.1. A drawing of a section through the human eye with a schematic enlargement of the retina.*

# The retina is poorly designed




- Rods and cones are the light-sensing cells of the retina.
  - **Rods**: low resolution, can't see colour.
  - **Cones**: high resolution, can see colour.

- But the rods and cones are at the back of the retina, behind all kinds of other cells!

# Only a small part of the eye has good definition

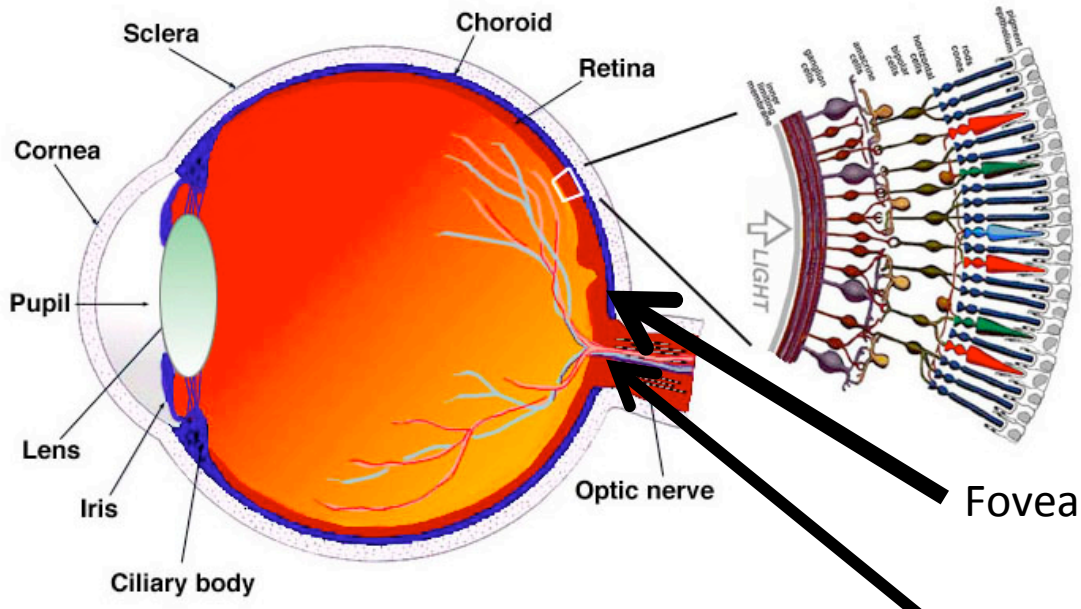



*Fig. 1.1. A drawing of a section through the human eye with a schematic enlargement of the retina.*

- Almost all of your cones are concentrated in your fovea.
- This means that only the fovea has colour vision and high definition
- There's also a big spot on your retina where there are no photoreceptors – a blind spot.

# The bottom line: your eyes deliver a poor quality image.

- Yet we never notice (usually).

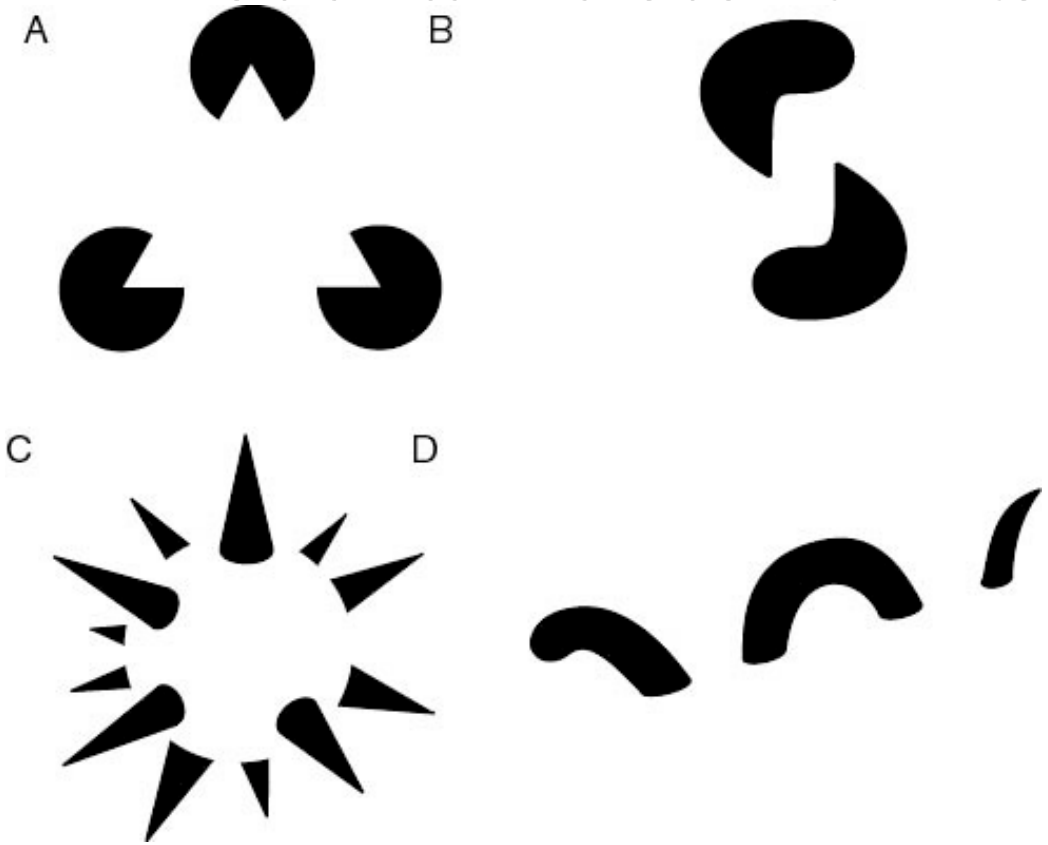
# The brain has to 'fill in the blanks'

- Because vision is ambiguous, the brain has to do a lot of work in order to make sense of the world.

- The brain has to make assumptions about things, since it would take too long to test everything.

# What can illusions teach us about the brain?

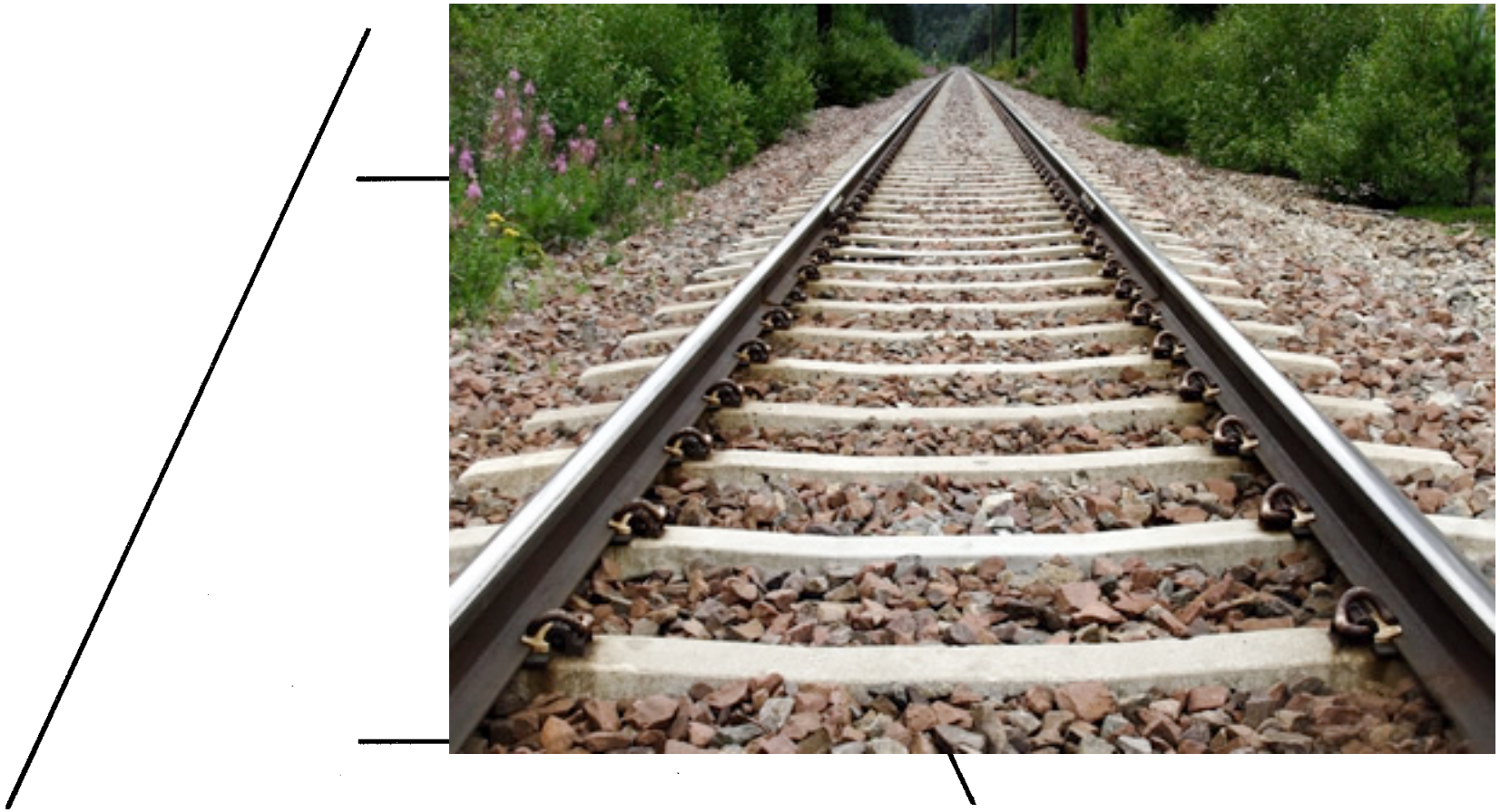
- The brain can make do with limited information – it



# The whole is more than the sum of its parts

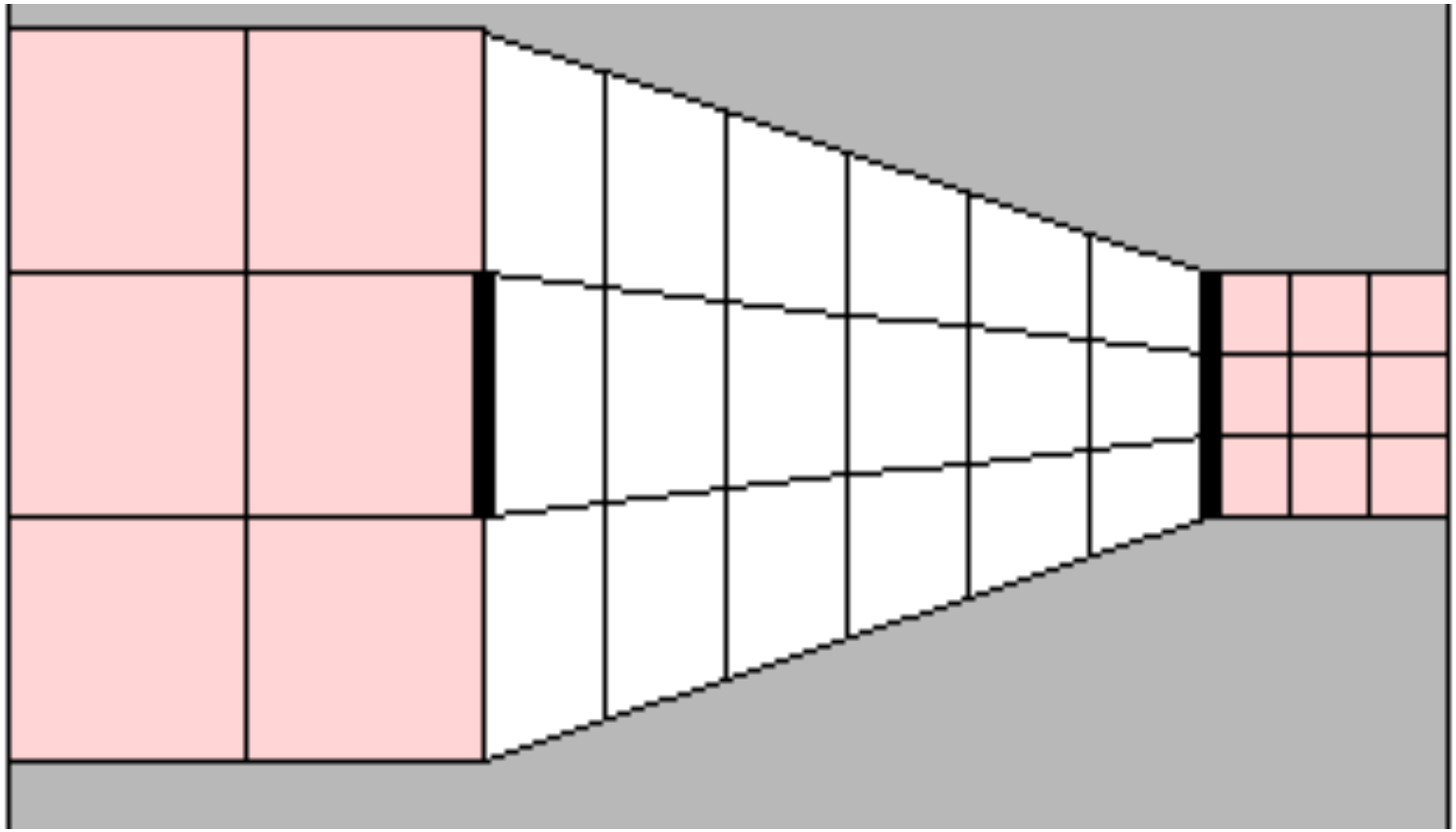
- ~~oh god how did this get in here im not good with computers~~

# The Ponzo illusion

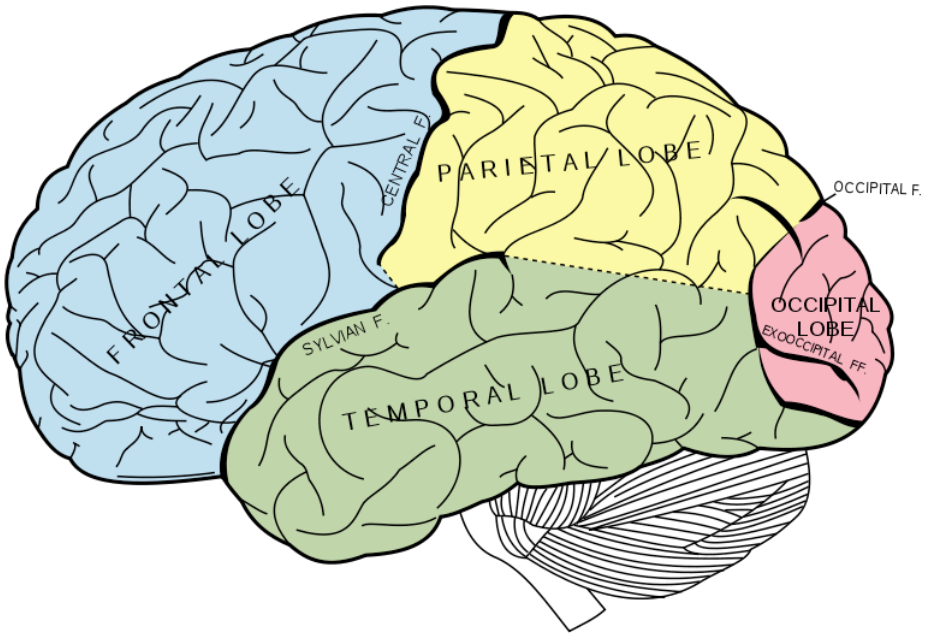


Which line is longer?

# Another “Ponzo” illusion



# Inferred depth/size




Little is known about how the brain perceives depth using cues.

It is currently believed to involve the visual cortex (occipital lobe) and the parietal lobe.

# The Ebbinghaus illusion

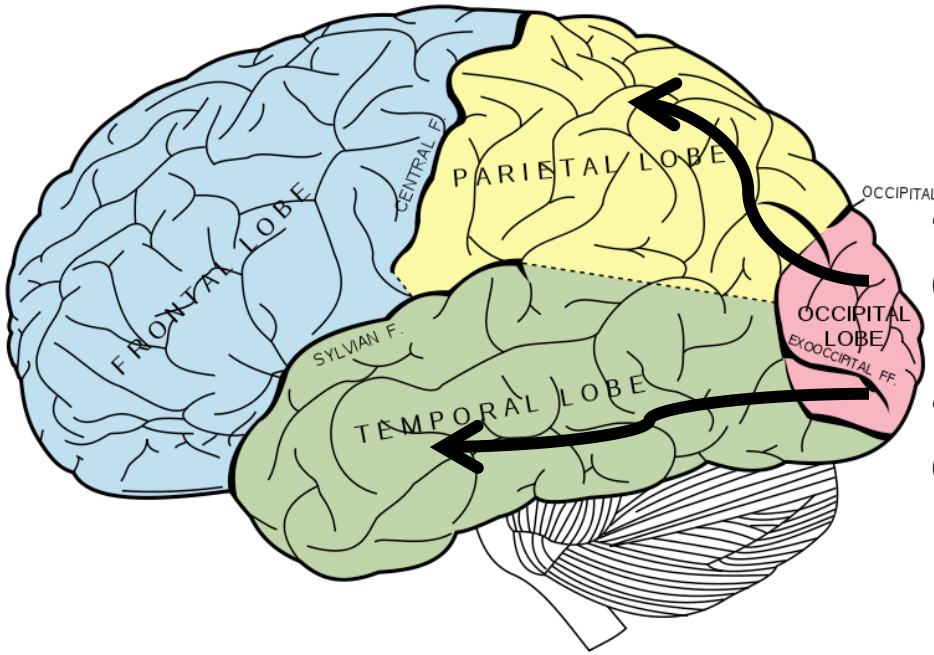
# The Ebbinghaus illusion – a 'cross-modal illusion'

- Our eyes seem to tell us that the two orange circles are different sizes. Even though we know they are the same, they still look different.
- What would happen if we made a real-life version of this illusion, and asked a volunteer to grab the orange circle?
- Would they use the right grip, or would their grip be too big or too small (since their eyes are deceiving them).

# The Ebbinghaus illusion: cross-modality

- The answer: people use the correct grip size!

# How the Ebbinghaus illusion works




**"Where" pathway**
Occipital lobe -> Parietal lobe

**"What" pathway**
Occipital lobe -> Temporal lobe

Basically, the motor areas of the brain get the 'correct' information, but the recognition areas of the brain get the 'wrong' information.

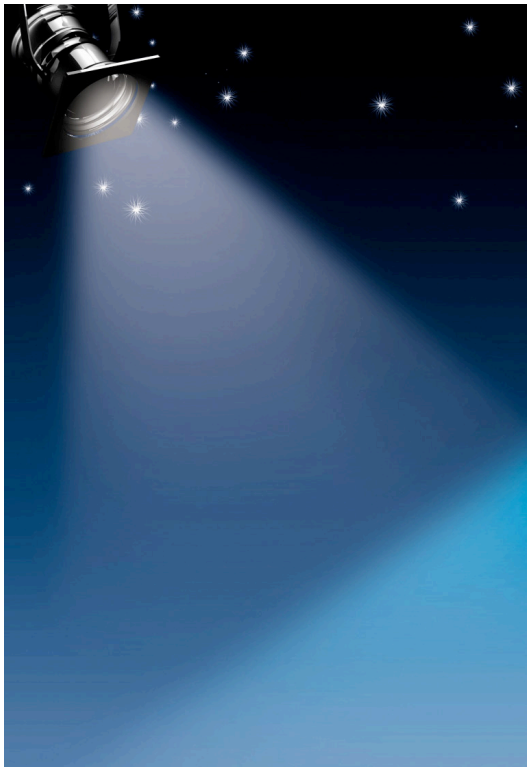
# Attention

- The world is a busy place.  Your brain needs a way to filter out the useless stuff and keep only the important information.

What do people naturally pay attention to?

# Attention

- Attention is like a spotlight.  It helps you see things that are important, and hides the background.



Again, the brain gets a very fuzzy picture of the world, and it can't spend forever deciphering the entire picture.  It has to be selective.

# Two flavors of attention

- Top-down attention:
  - Paying attention to something ‘on purpose’
    - Example: Trying to keep focused in class.

  - Involves the executive functioning in the frontal lobes acting to direct sensory processing.

# Can attention fail you?

- What happens if you don't pay attention to something? That's obviously bad. Are there ways attention can be fooled?

# Change blindness

- See website….

# What's going on?

- Nobody is quite sure why change blindness happens. But we know some things:
  - The brain's visual short-term memory is very limited. It doesn't need to store much information since you usually have your eyes open.
  - You need to know where to look in order to see a change. The brain can only remember a small part of a picture long enough to look for changes.

# Inattentional blindness

- See youtube link

# What's going on?

- Your brain is lazy, and tends to substitute past experience for paying attention to things.  Ball games don't usually have gorillas, so people often don't notice it.

- Example: Flight simulator study

# Some more examples

- See ‘person switch’ video