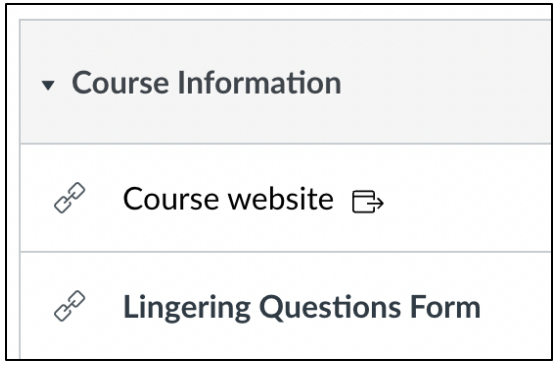
Cognition

PSYC 2040

W1: What is Cognition?

more Qs

- are flex days still used up if there is a pressing emergency (health, family, etc.)?
- How long is the SPARK summary?



Cognition: Lingering Questions

Use this form to ask questions anonymously about the course content. We will try to answer them in class!

Week 1 Exit Ticket

Start Assignment

Due Thursday by 11:59pm **Points** 1 **Submitting** a text entry box

This is an opportunity to engage in retrieval practice and elaborative encoding, so try your best to answer the question from memory, i.e., **without looking at notes or slides**. These responses will only be graded as **complete/incomplete**.

Answer any ONE of the following questions.

- Describe the difference between top-down and bottom-up processes using a real-life example.
- In experimental research, what is the logic behind random assignment?
- Describe Donders' subtractive logic and how it is used in cognitive research.

If you have lingering questions, you can leave them in this form!

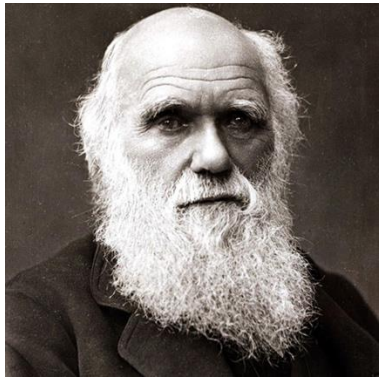
today's agenda

COGNITION

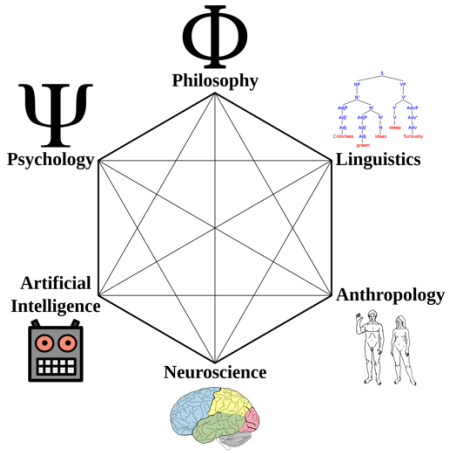
- questions
- methods
- ideas
- explanations
- applications
- implications

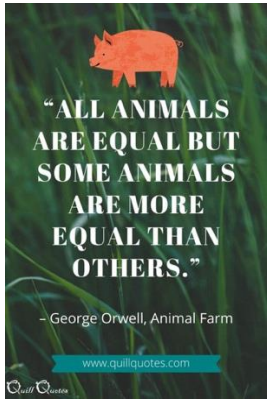
origins

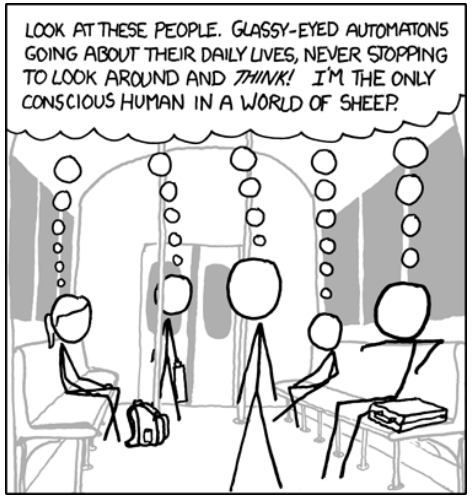
Robert Hooke



Charles Darwin





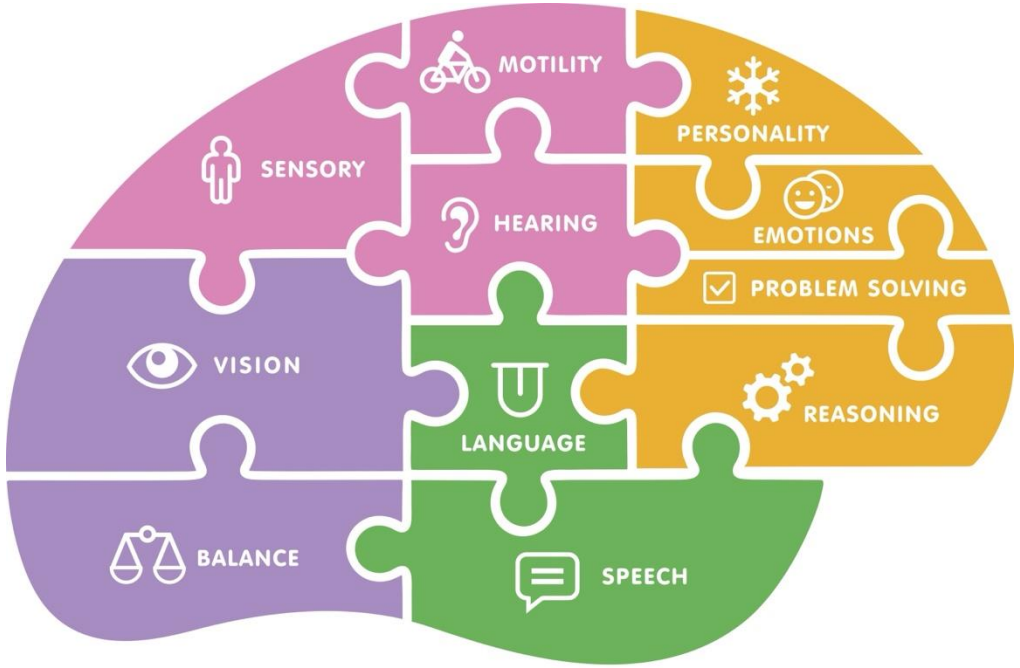


defining cognition

- many researchers, many views
- Ulric Neisser: "*…all processes by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used* "
- Oxford dictionary: "*the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses*"
- many metaphors
  - assembly line, telephone network
  - **information processor** / computer / machine

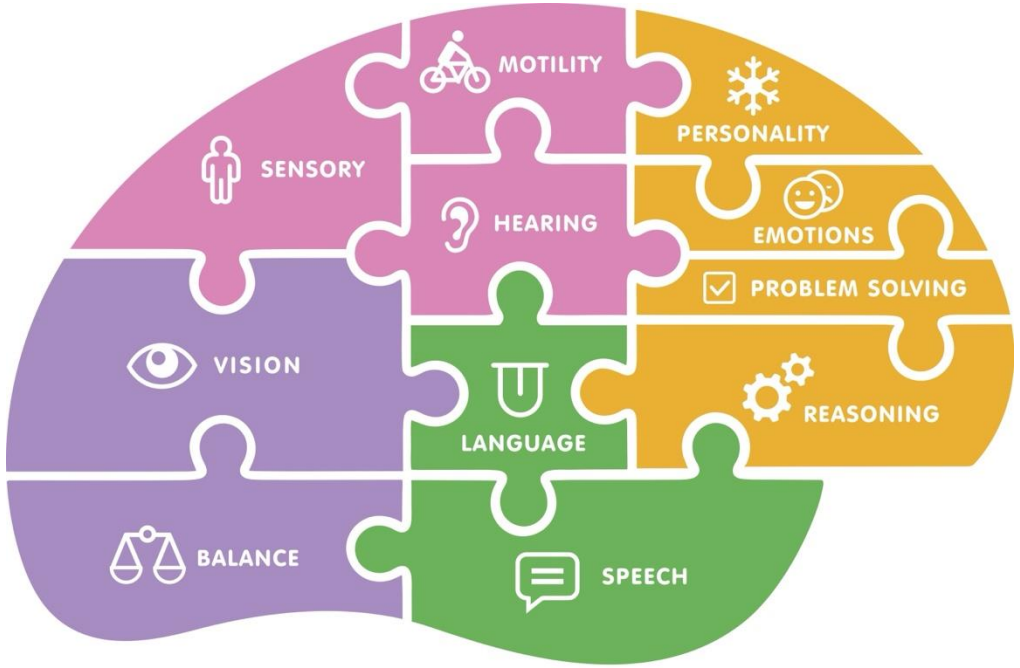
questions of cognition

- **how** does a cognitive ability come about, work, and break down?
- questions are often grouped into research **domains and [sub-domains]**
  - memory
  - perception [object recognition, vision]
  - language [speech, pragmatics]
  - .....



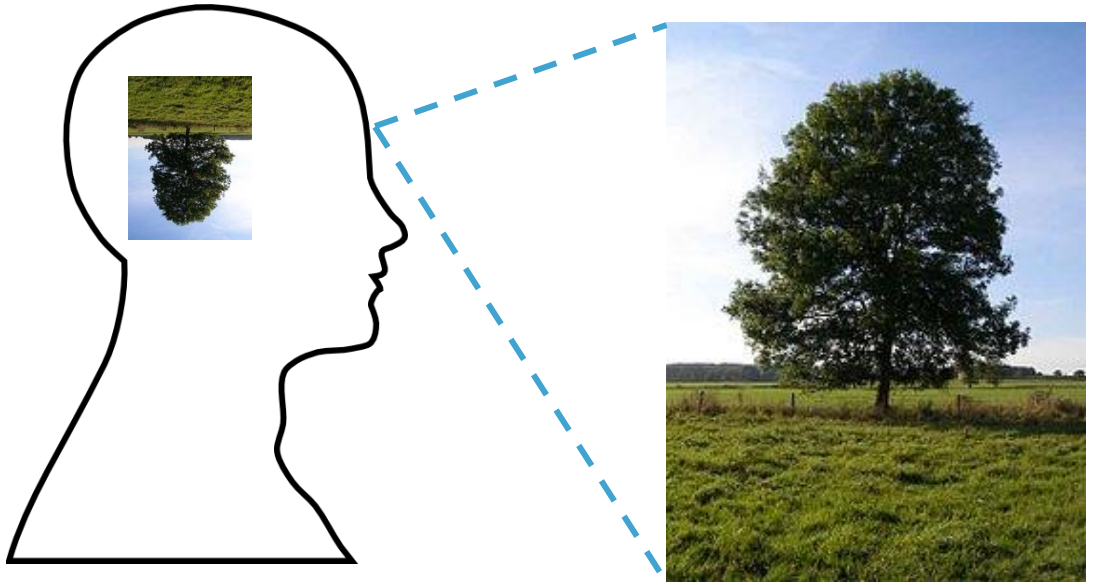
ideas in cognition

- mental representations
- stages of processing
- top-down & bottom-up processing
- serial and parallel processing
- automatic and controlled processes
- representation & process interactions



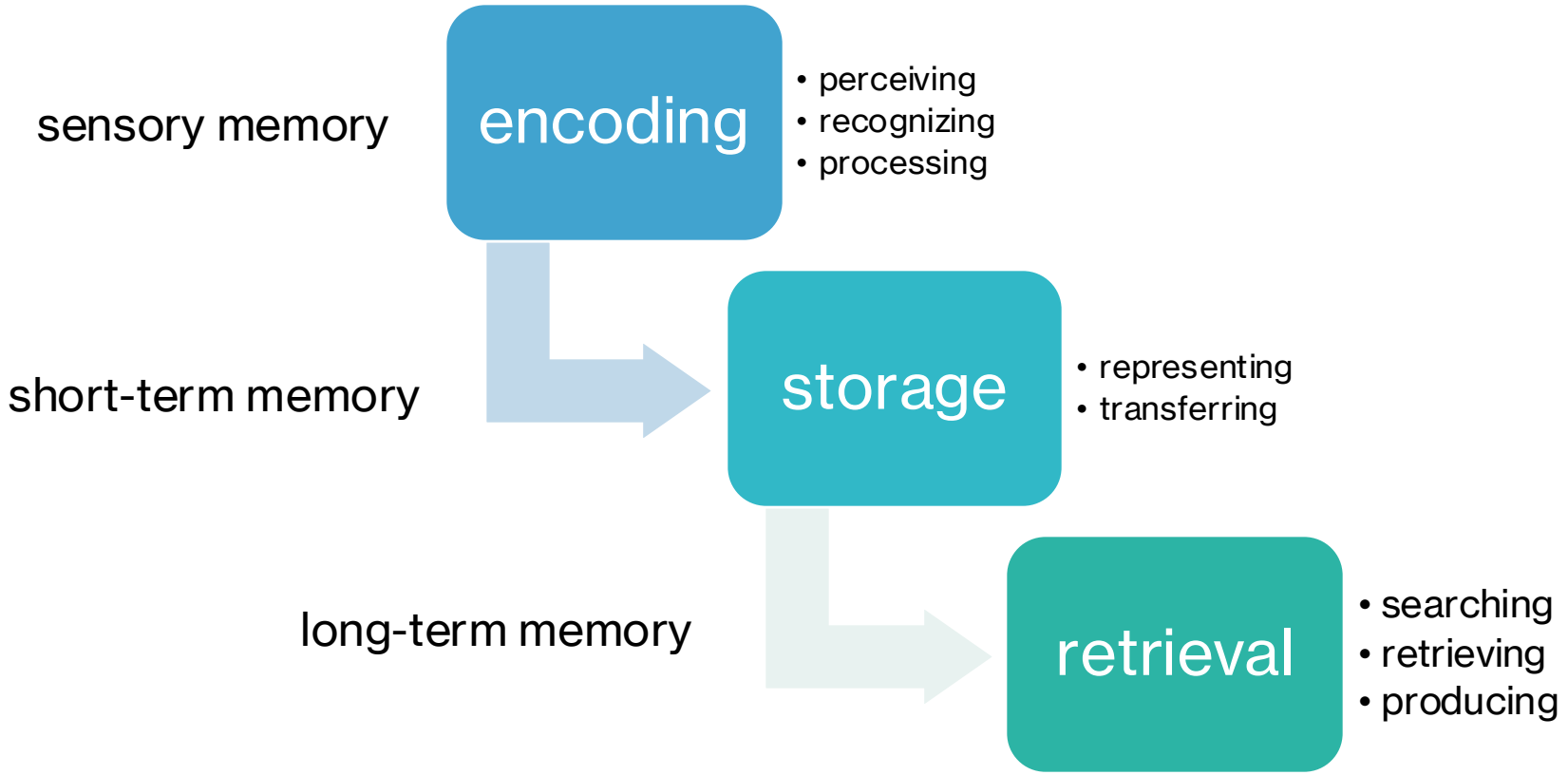
ideas: mental representations

- the “what” of cognition
- our *internal* “format” for storing information

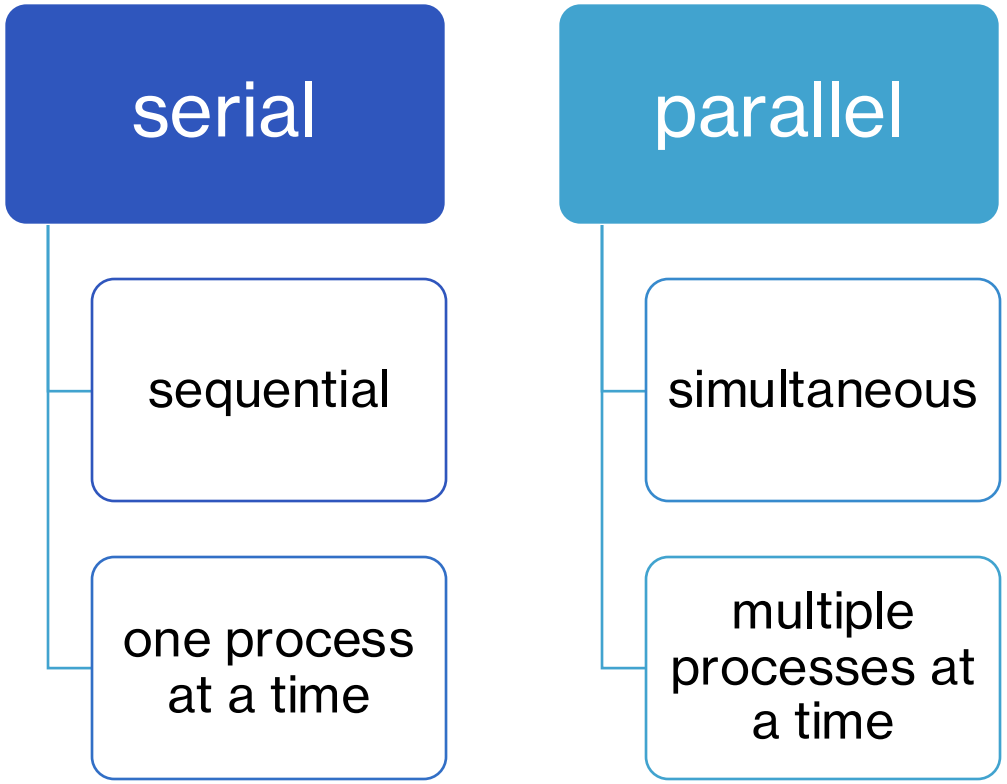


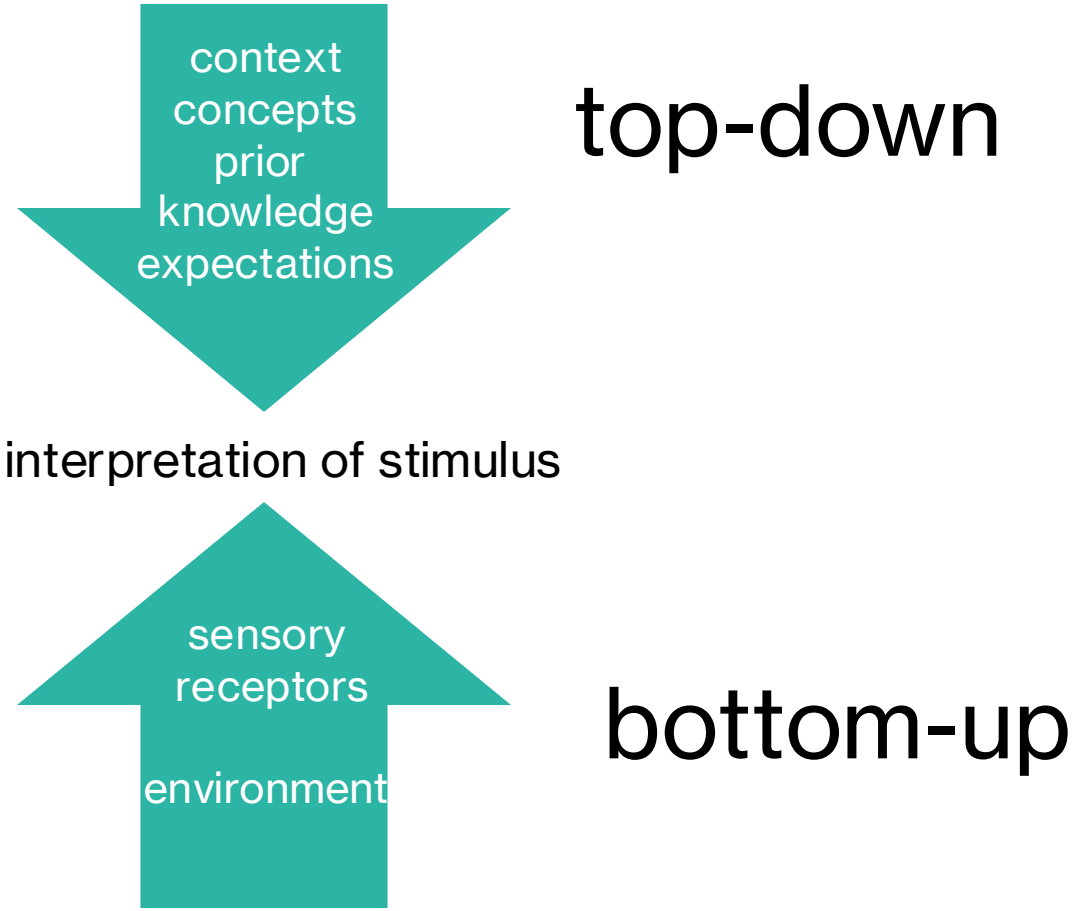
read about aphantasia

ideas: stages of information processing



ideas: serial/parallel and top-down/bottom-up





ideas: controlled vs. automatic processing

controlled

slow

effortful

demands resources

novelty

automatic

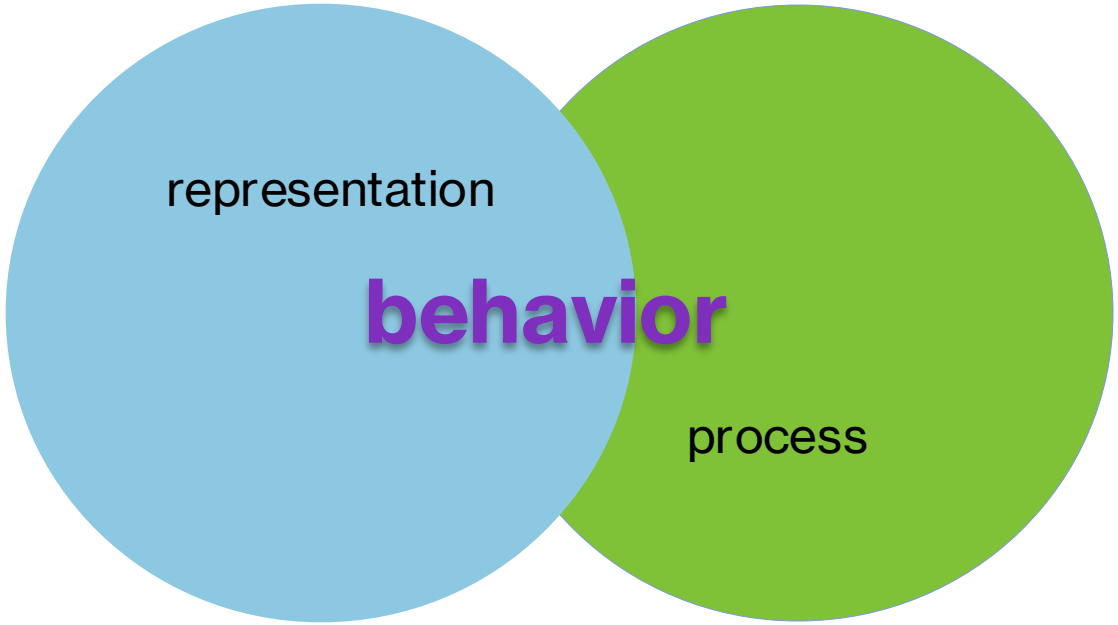
fast

effortless

practiced

few resources

ideas: representation and process interactions



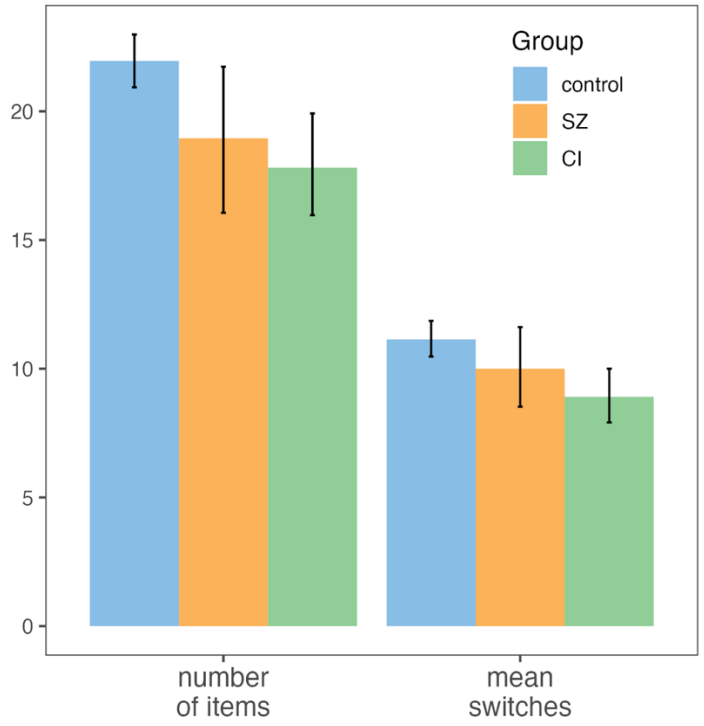
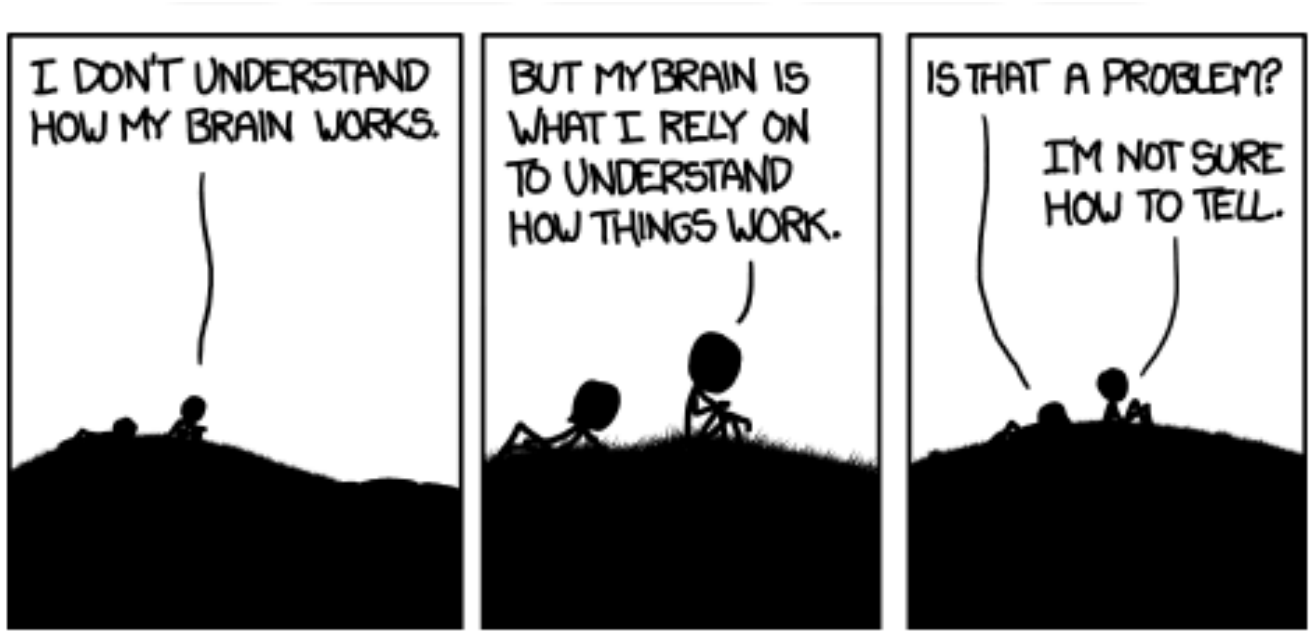
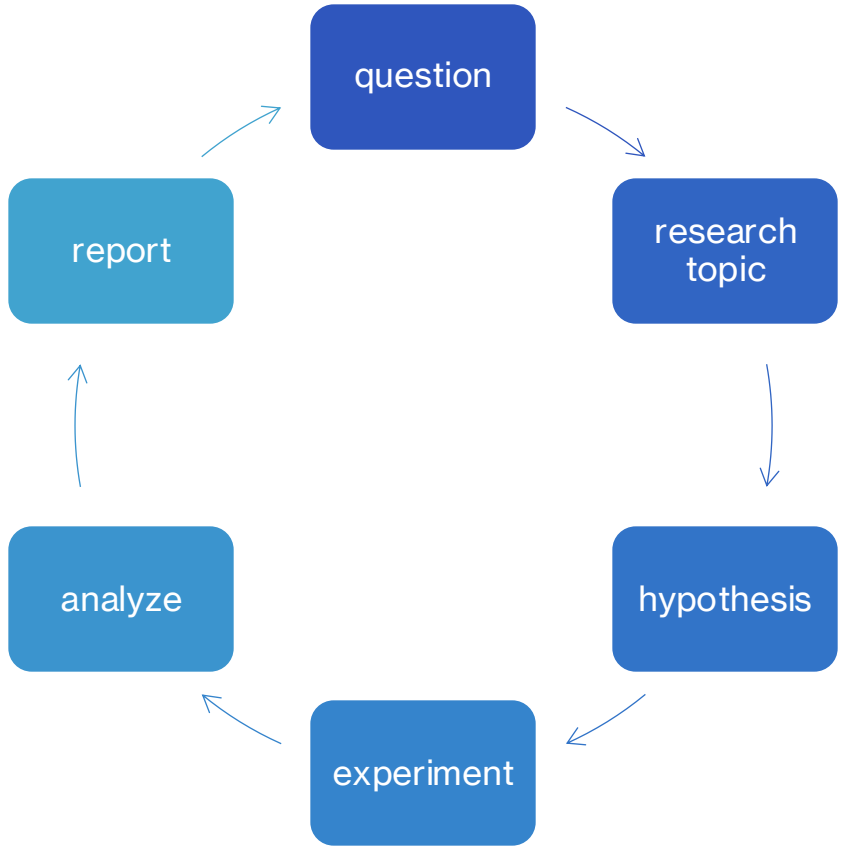


Figure 1. VFT performance of healthy controls, individuals with schizophrenia (SZ) and individuals with cochlear implants (CI)


I DON'T UNDERSTAND HOW MY BRAIN WORKS.
BUT MY BRAIN IS WHAT I RELY ON TO UNDERSTAND HOW THINGS WORK.
IS THAT A PROBLEM?
I'M NOT SURE HOW TO TELL.

methods of cognition

- cognitive science employs the *scientific method* to answer questions about mental processes



experimental method: review

- independent and dependent variables
- control / subject variables
- confounds
- random assignment
- experimental control vs. external validity
- cause and effect

class activity debrief

- when learning a list of words, is there any typical pattern of results one would expect?
- Tzeng (1973) conducted a memory experiment where participants performed arithmetic after hearing each word

- discuss in groups:
  - independent and dependent variables
  - control / subject variables
  - confounds
  - random assignment
  - experimental control vs. external validity
  - cause and effect
  - plot a predicted pattern of results

Tzeng's data vs. your data

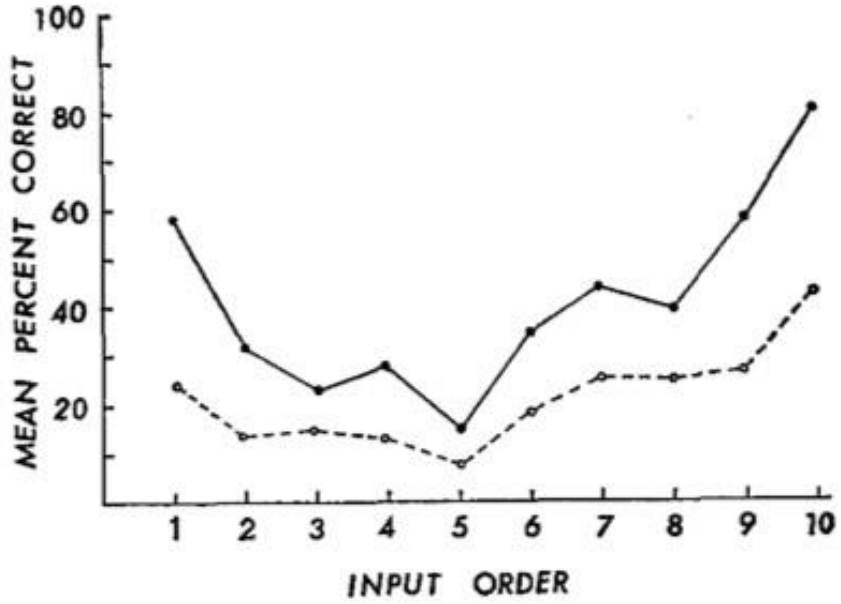
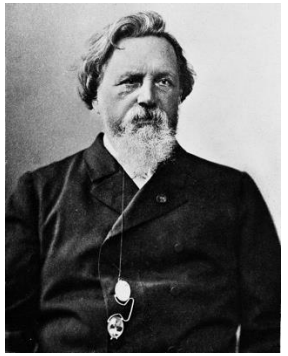


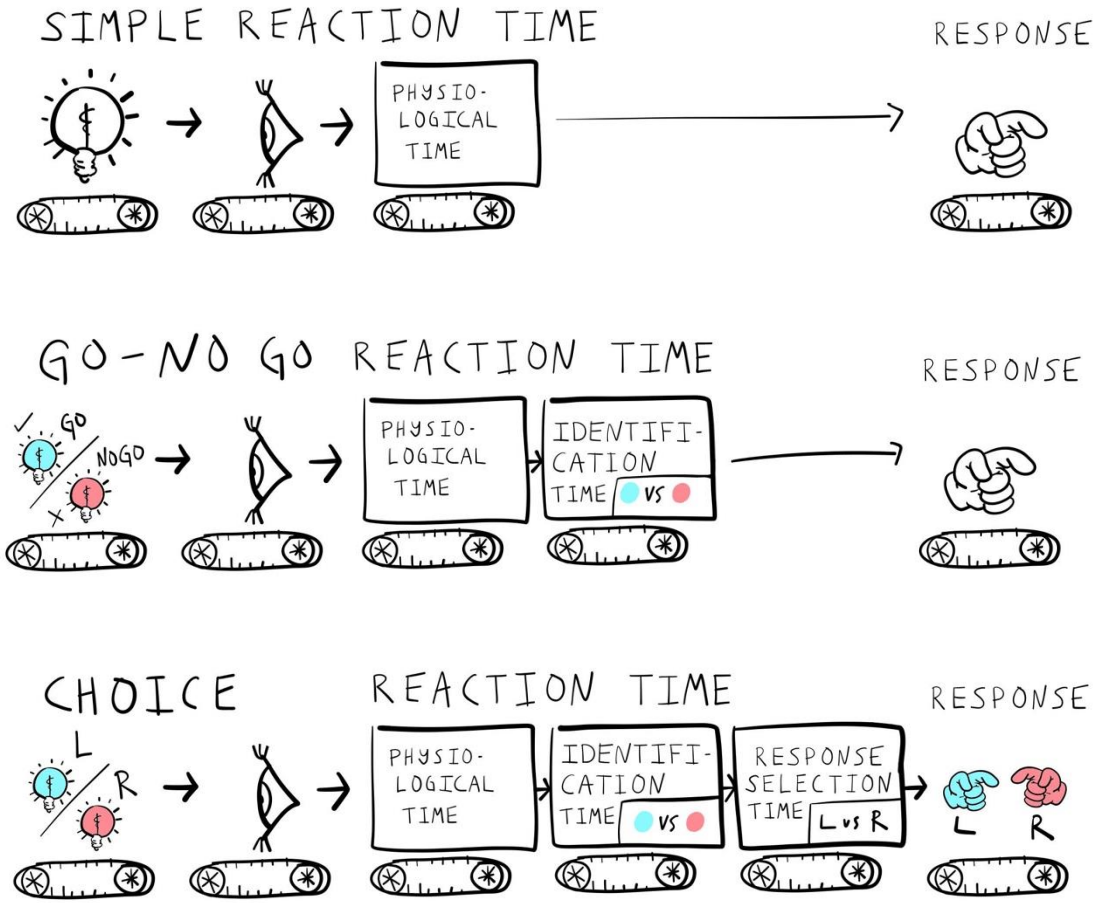
FIG. 1. Mean percent of correct recall on the initial (●—●) and the final (○ - - - ○) free recall as a function of serial positions at input.

methods: behavioral



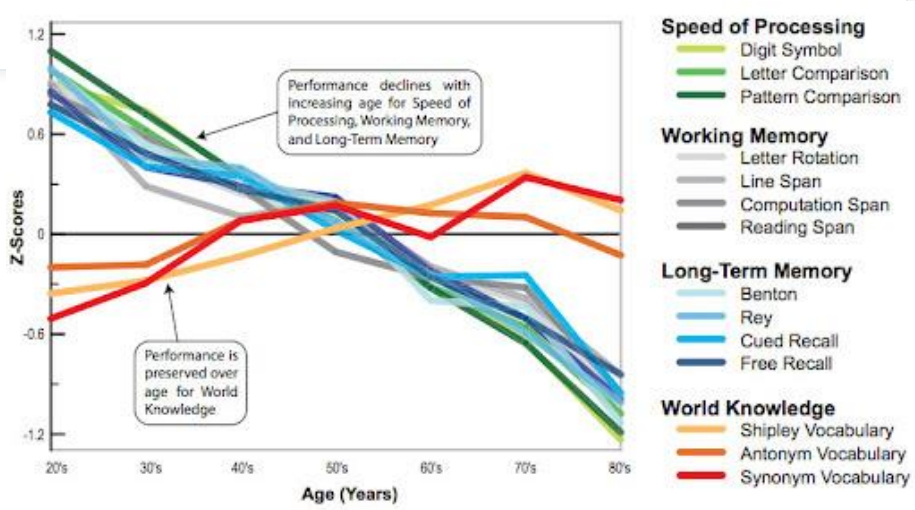
accuracy	• proportion correct
reaction time (RT)	• stimulus onset to response

- Donders' subtractive logic assumed that mental operations occurred in successive stages, i.e., like an assembly line
- this allows us to isolate different components

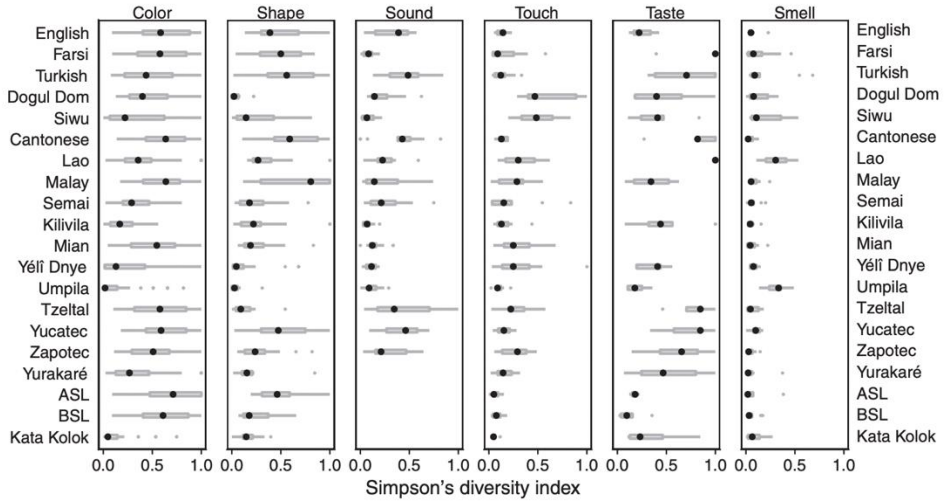


methods: individual differences

- how and why do cognitive processes differ among individuals?
- age, development, gender, race, culture, impairments

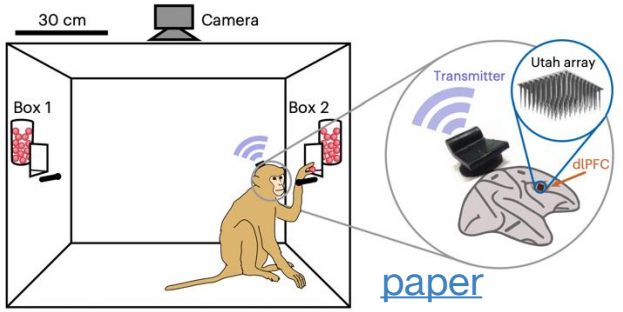


paper



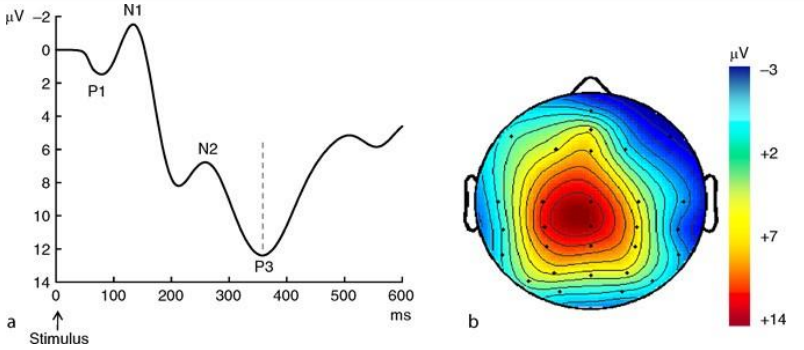
paper

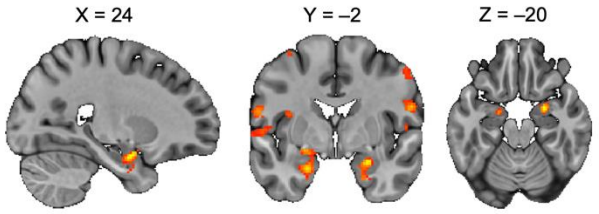
methods: neurological

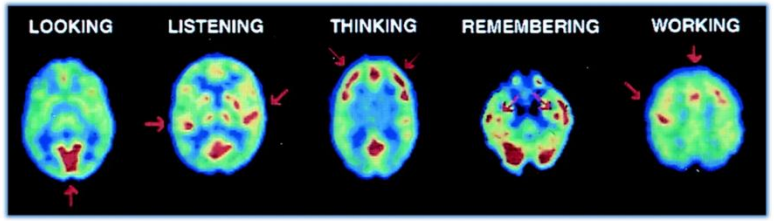


paper

- single-cell recordings
- event-related potentials (ERPs)
- Positron Emission Tomography (PET)
- functional Magnetic Resonance Imaging (fMRI)







PET studies of glucose metabolism to map human brain's response in performing different tasks. Subjects looking at a visual scene activated visual cortex (arrow), listening to a mystery story with language and music activated left and right auditory cortices (arrows), counting backwards from 100 by sevens activated frontal cortex (arrows), recalling previously learned objects activated hippocampus bilaterally (arrows), and touching thumb to fingers of right hand activated left motor cortex and supplementary motor system (arrows). Images are cross-sections with front of brain at top. Highest metabolic rates are in red, with lower values from yellow to blue.

methods: neurological

- single-cell recordings
- event-related potentials (ERPs)
- Positron Emission Tomography (PET)
- functional Magnetic Resonance Imaging (fMRI)

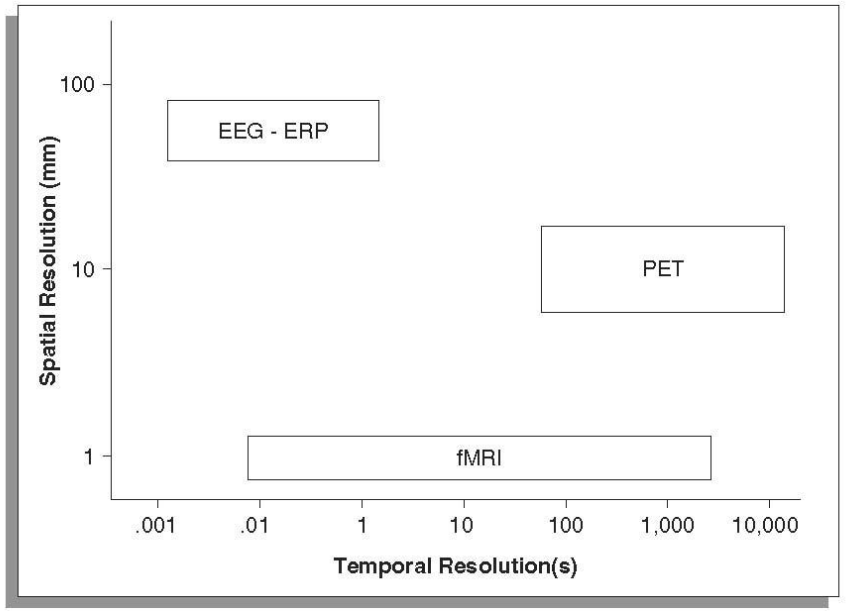
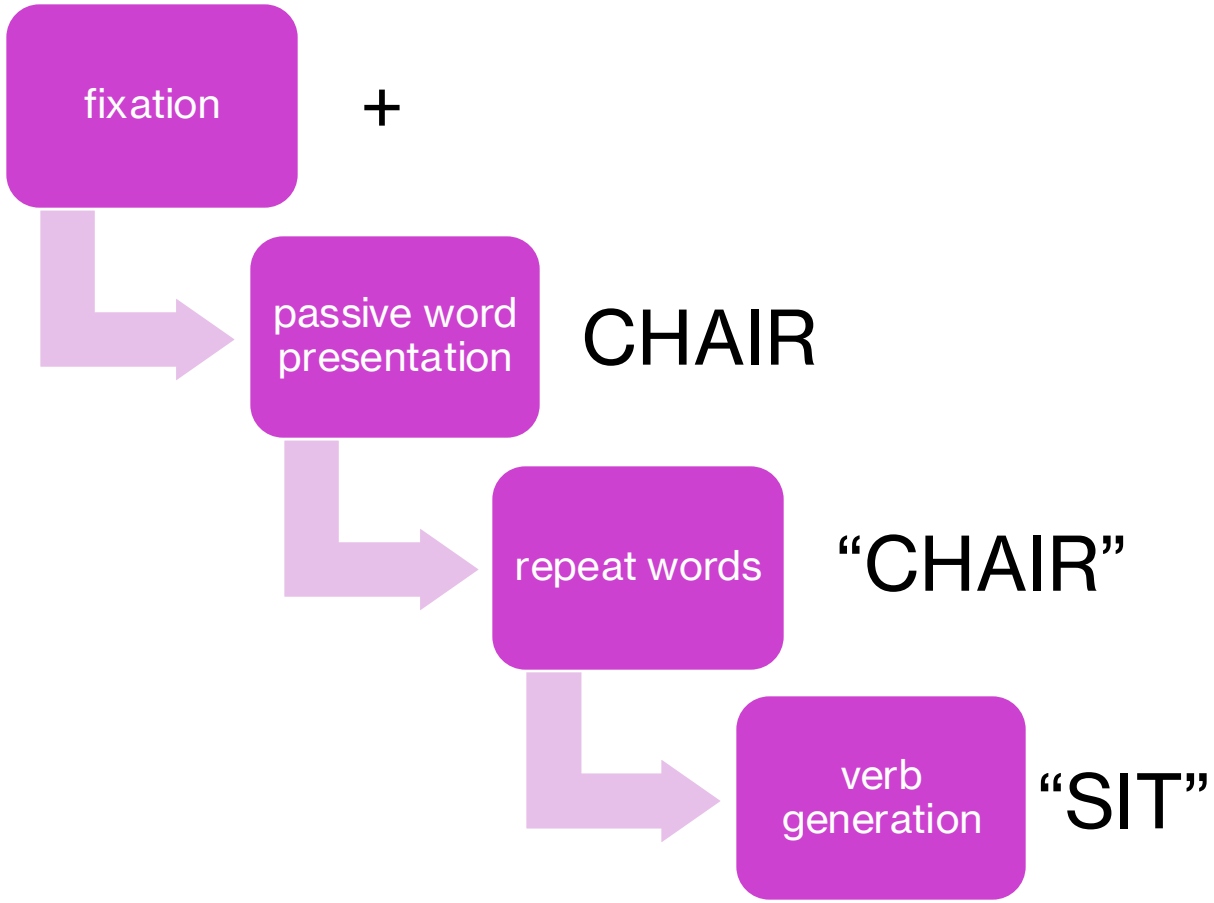


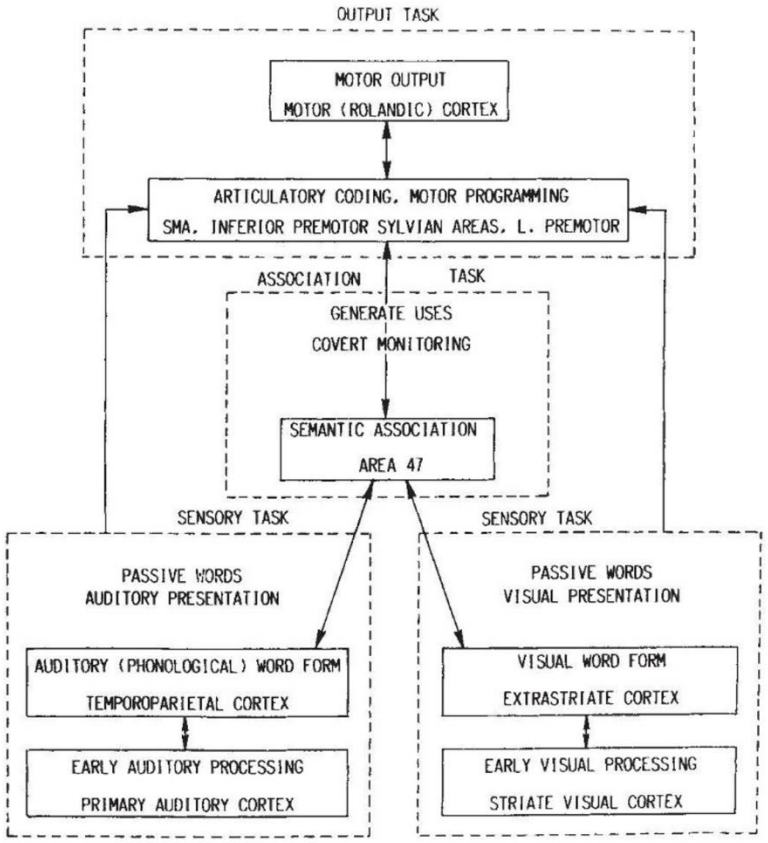
Figure 1.10 The spatial (*y* axis) and temporal (*x* axis) sensitivity of different neuroimaging techniques.

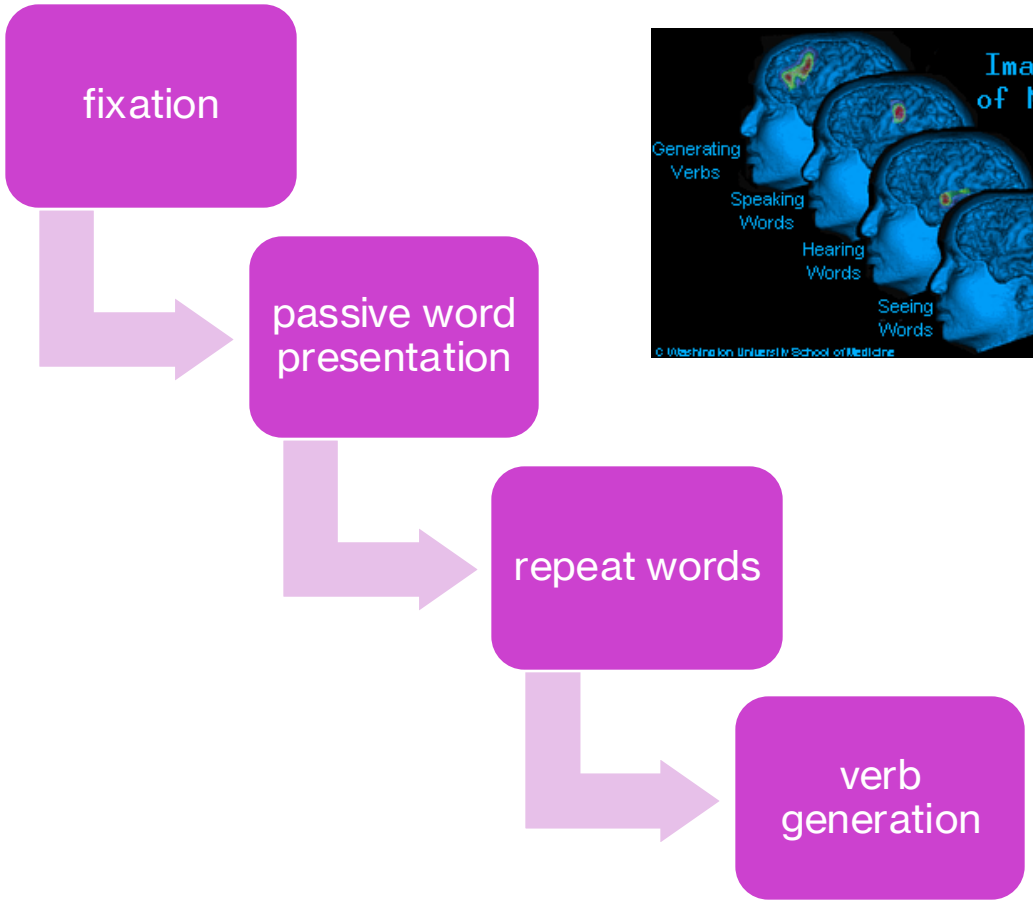
methods: neurological

- Petersen et al. (1988) compared neural activity to a series of tasks with varying cognitive demands
- Positron Emission Tomography (PET) was used to generate images of blood flow in specific brain regions via subtractive logic to identify key brain areas



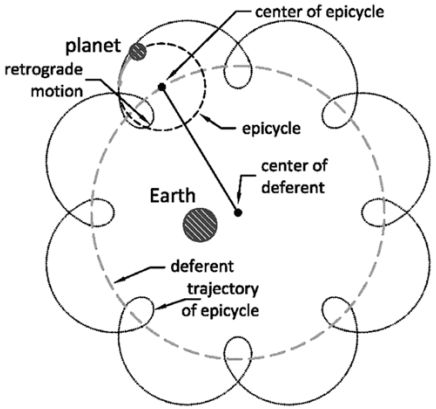
methods: neurological

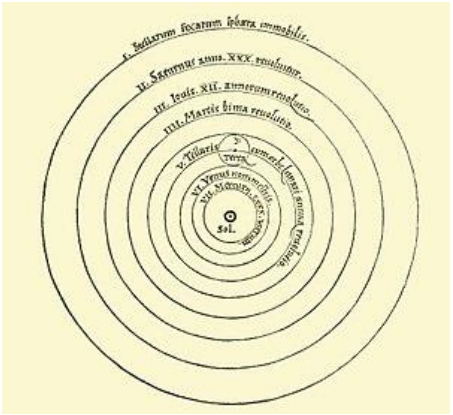


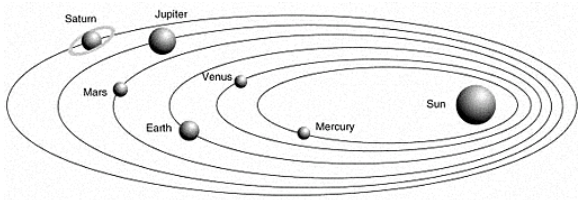


methods: computational

- models are a mathematical approach to understanding behavior
- we use models all the time to describe variation and behavior!
- examples?

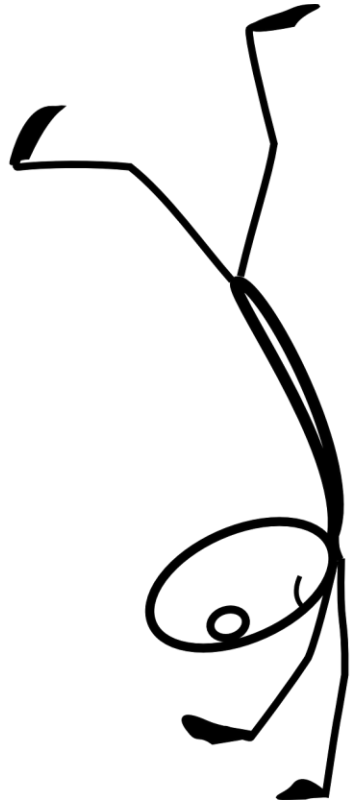






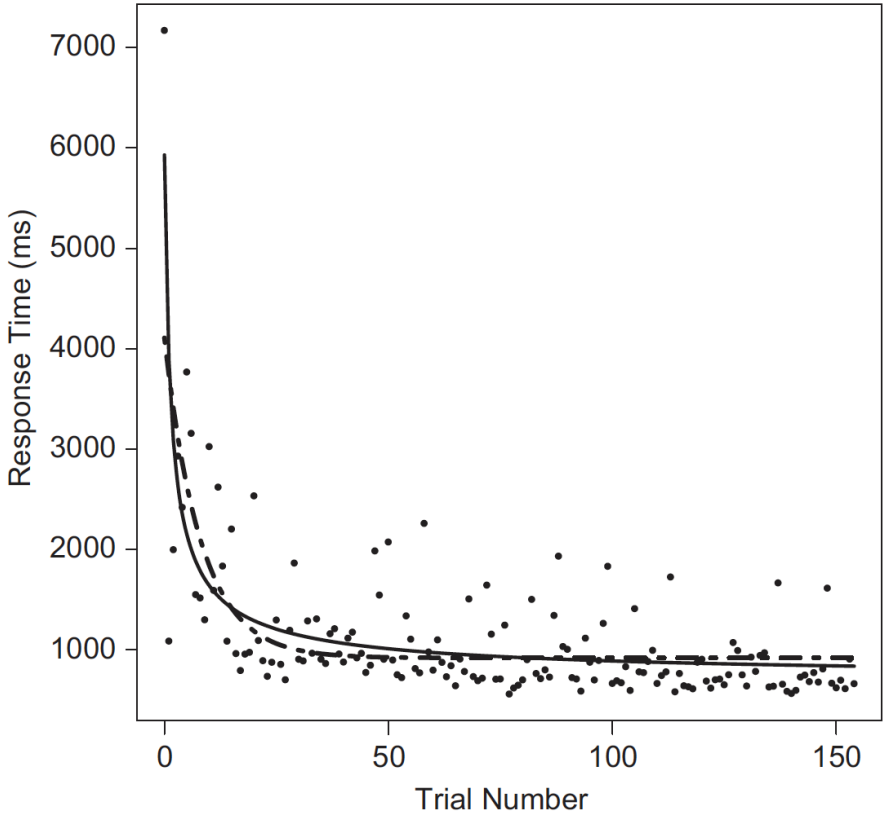
a model of learning

- we know people get better over time at learning a new skill, but how exactly?
- two explanations/models:
  - power law: $\mathrm{RT} = N^{-\beta}$
  - exponential law: $\mathrm{RT} = e^{-\alpha N}$,



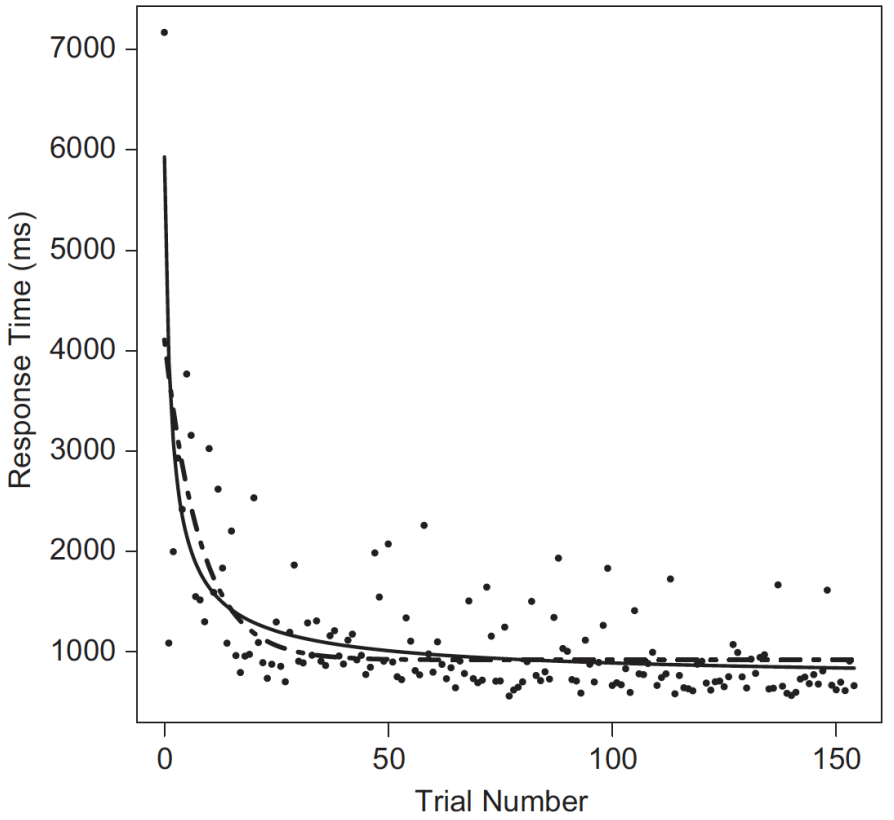
learning: why does it matter?

- the exponential form suggests that the relative learning rate remains constant, i.e., regardless of practice, your learning continues to be enhanced by a constant fraction
- the power law suggests that the relative learning rate is slowing down, i.e., as you practice more, you are actually learning less over time



learning: why does it matter?

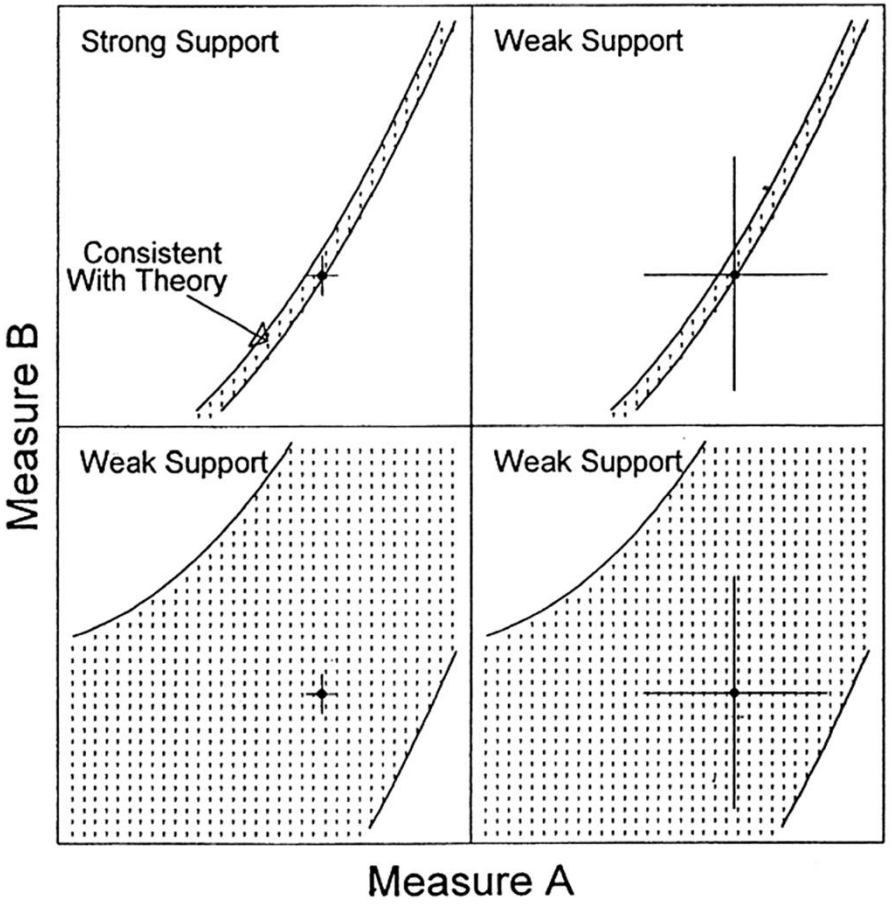
- Heathcote et al. (2000) showed that the exponential function better fit the trial-level data
- learning curve is better explained by the exponential function
- the more you learn, the more you retain



paper link

models: scope and falsifiability

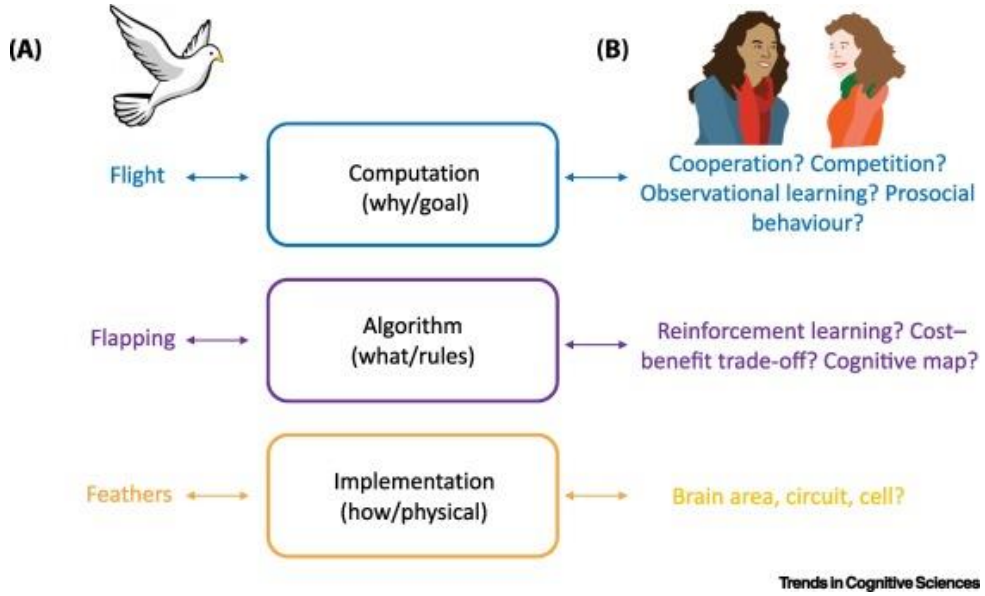
- models should have have maximal scope
- models/theories need to be falsifiable, not false
- examples?



Farrell & Lewandowsky (2018)

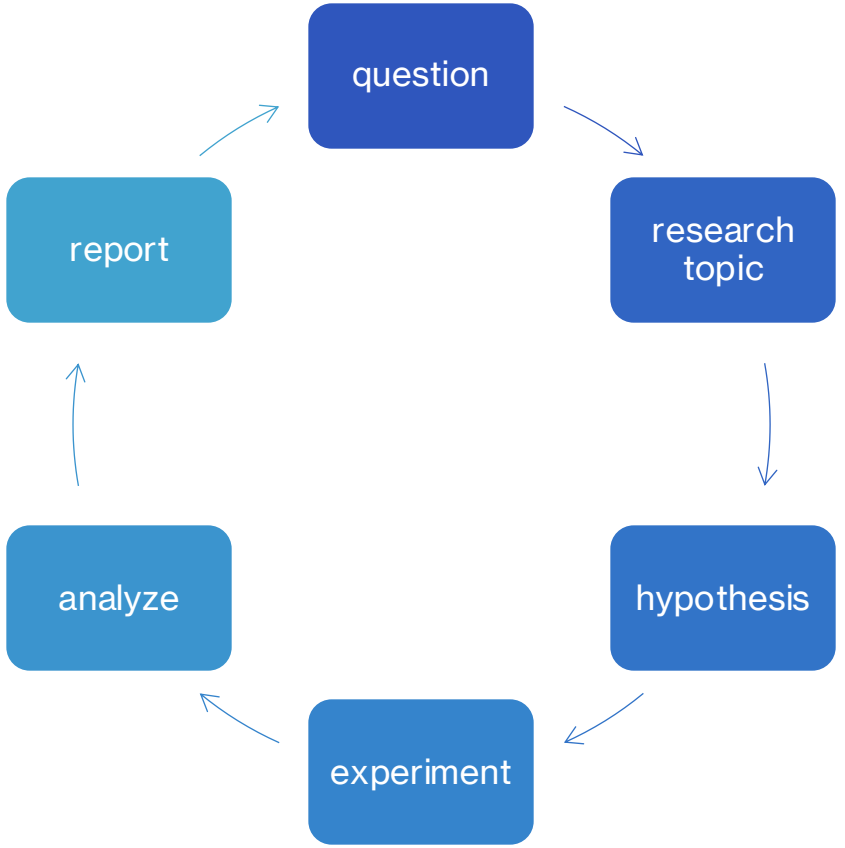
explanations in cognition

- explanations refer to an account of a cognitive phenomena
- David Marr proposed 3 levels of explanation:
  - computational (why/goals)
  - representational/algorithmic (what/process)
  - implementation (how/hardware)



applications of cognition

- novel knowledge
- real-world applications



implications of cognition: basic

- cognition is fundamental to nearly everything we do!
- research on cognition can help us understand:
  - ourselves
  - our society and other creatures
  - (and build) machines
- applied cognition has the potential to help develop interventions for cognitive impairments, design better technologies, and improve quality of life

exit ticket

- go to course website (“try”)
- answer a short answer question
- graded as complete/incomplete
- also: feel free to ask lingering questions!

next class

- building blocks
  - pattern recognition
  - short-term memory
  - working memory

Apply

Here are the to-do's for the week:

- Week 1 Quiz (due Sunday)
- Extra credit opportunities:
  - Submit Pre-class survey (1 point)
  - Submit Exra Credit Questions (1 point for 8 submissions)
  - Submit Optional Meme Submission (1 point for winners!)

Before Tuesday

- Complete W2 Activity 1