



# Cognition: Methods and Models

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PSYC 2040

L1: What is Cognition?

# recap: Jan 24, 2023



- what we covered:
  - L0: Getting Started
  - course [overview](#)
- your to-dos were:
  - *filling out*: pre-class survey + poll
  - *finishing* L0 quiz + assignment
  - *reading* L1: What is Cognition chapter
    - 1.1 to 1.8 from reading/textbook
  - *submitting* L1: Conceptual question



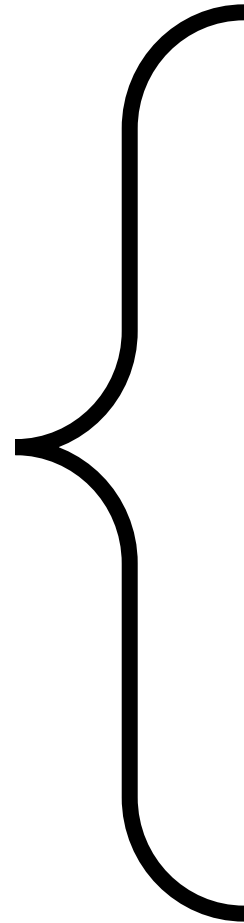
# logistics

- questions about canvas/website/L0 assignments?
- this is a weird week because you have 2 “modules” (L0 + L1)
  - L0 (quiz + assignment, both required)
  - L1 (conceptual question, quiz and/or writing, meme)
- weeks going forward will be easier to manage
- conceptual questions are due at 10 AM on Thursday (late submissions will need to use a flex day OR only get 50% credit, starting next week)
- I recommend doing the quiz/writing assignments AFTER Thursday as we may cover fresh content in classes
- if you anticipate having questions, please email me before 4.30 pm
- I will not be responding to emails after 5 pm and before 8 am

# today's agenda



COGNITION



questions

methods

findings

explanations

applications

implications

# today's agenda

COGNITION

questions

methods

findings

explanations

applications

implications



- we **will** cover in class:
  - what is cognition? (1.1 to 1.7 from the reading/textbook)
  - conceptual questions discussion
  - meme tutorial [Matt] – if we have time (otherwise watch on your own)
- we will **not** cover in class (but you are expected to study)
  - 1.8-1.11 of the textbook (QALMRI)
  - there will be quiz questions from the entire module

reading a  
research paper  
(homework)

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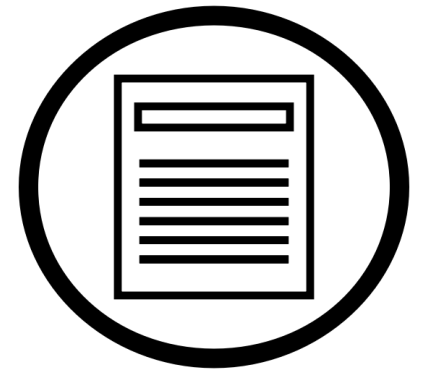
I  
nferences

# cognition is a museum



- just as a museum has many rooms, stories, and artifacts, **cognition** also has a **broad array** of **ideas**, **concepts**, and **theories**
- you cannot fully explore a museum in a day, and you cannot fully explore cognition in a semester!
- this course is meant to give you **slivers and slices and instances** of cognition (think of them as amuse-bouches)

# defining cognition

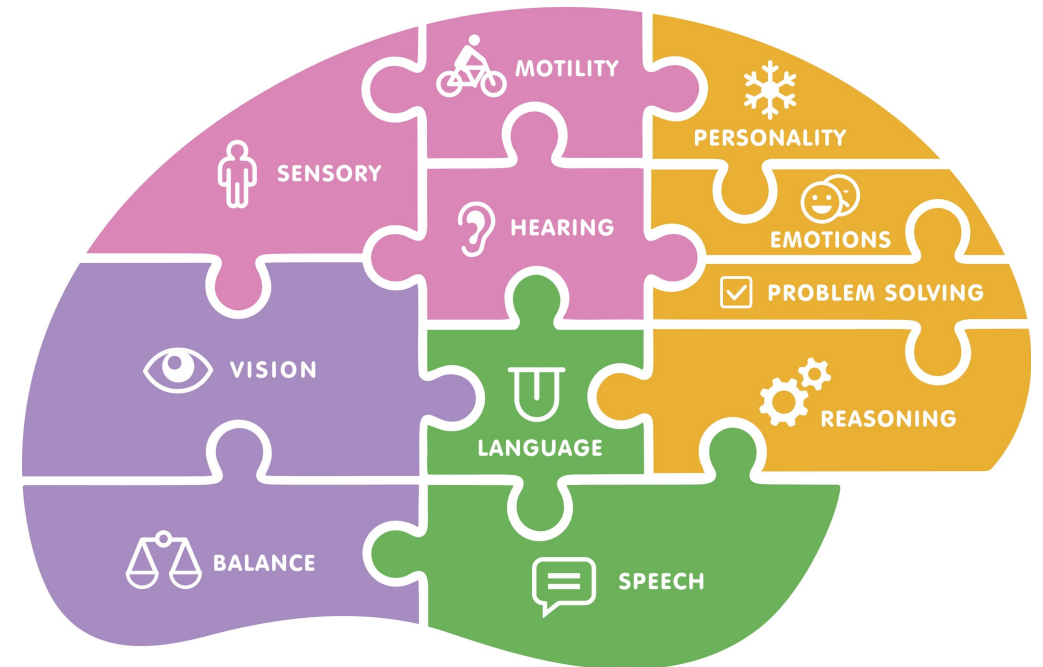


- many researchers, many views
- Ulric Neisser: “...all processes by which the *sensory input* is transformed, reduced, elaborated, stored, recovered, and used”
- Oxford dictionary: “the *mental* action or process of acquiring *knowledge* and *understanding* through thought, experience, and the senses”

# questions of cognition



- what kinds of **questions** are cognitive scientists asking and trying to answer?
  - typically: **how** does a cognitive ability come about and work?
- questions are often grouped into research **domains and [sub-domains]**
  - memory
  - perception [object recognition, vision]
  - language [speech, pragmatics]
  - .....





# methods of cognition

- the research cycle employs *the scientific method* to answer questions about cognition
- let's examine the research cycle with the example from *the education literature*

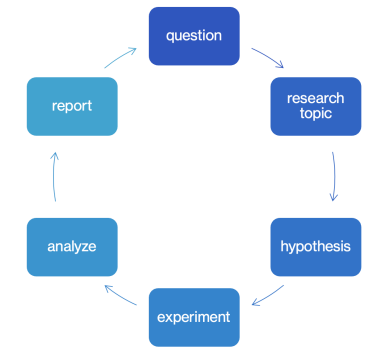


# methods of cognition: question



- **broad** question: does the **manner of notetaking** impact learning outcomes?
- **empirical** question: do **longhand vs. laptop-based** notes produce differences in long-term retention?

# methods of cognition: topic



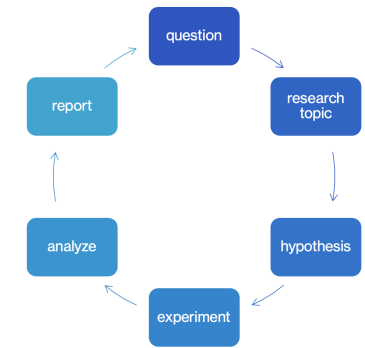
- once you have identified a broad question, the next step is to conduct some **background research** on the topic
- this typically involves:
  - **searching** for classic and new papers
  - **consolidating** and reading all papers
- quick **exploration** exercise:
  - log on to Google Scholar (<https://scholar.google.com/>)
  - search for: “longhand vs. laptop”
  - trying different keywords is part of the process!

Google Scholar

The screenshot shows the Google Scholar search results for the query "longhand vs laptop". The search bar at the top contains the query and a search button. Below the search bar, there are filters for "Articles" (selected) and "Case law". The results are listed in a table with columns for the article title, author, year, journal, and a link to the full text. The first result is "The pen is mightier than the keyboard: Advantages of longhand over laptop note taking" by Mueller and Oppenheimer, published in Psychological Science in 2014. The second result is "Laptop versus longhand note taking: effects on lecture notes and achievement" by Luo, Kiewra, Flanigan, and Peteranetz, published in Instructional Science in 2018. The third result is "Examining longhand vs. laptop debate: Evidence from a replication" by Mitchell and Zheng, published in researchgate.net in 2017. The fourth result is "Don't ditch the laptop just yet: A direct replication of Mueller and Oppenheimer's (2014) study 1 plus mini meta-analyses across similar studies" by Urry, Crittle, and Floerke, published in Psychological Science in 2021. Each result includes a brief abstract and a link to the full text.

Article Title	Author	Year	Journal	Link
The pen is mightier than the keyboard: Advantages of longhand over laptop note taking	PA Mueller, DM Oppenheimer	2014	Psychological science	[PDF] sagepub.com
Laptop versus longhand note taking: effects on lecture notes and achievement	L Luo, KA Kiewra, AE Flanigan, MS Peteranetz	2018	Instructional Science	[PDF] researchgate.net
Examining longhand vs. laptop debate: Evidence from a replication	A Mitchell, L Zheng	2017	researchgate.net	[PDF] researchgate.net
Don't ditch the laptop just yet: A direct replication of Mueller and Oppenheimer's (2014) study 1 plus mini meta-analyses across similar studies	HL Urry, CS Crittle, VA Floerke	2021	Psychological Science	[HTML] sagepub.com Full View

# methods of cognition: topic



- reading **highly cited** articles is a good first step:
  - it informs you about **prior research** that has generated interest (NOT always a proxy for **good** research)
  - it can provide ideas about **testable hypotheses**
- sometimes, **review articles** are also a good first step

## The Pen Is Mightier Than the Keyboard: Advantages of Longhand Over Laptop Note Taking

Pam A. Mueller and Daniel M. Oppenheimer [View all authors and affiliations](#)

Volume 25, Issue 6 | <https://doi.org/10.1177/0956797614524581> | [View correction](#)

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### Abstract

Taking notes on laptops rather than in longhand is increasingly common. Many researchers have suggested that laptop note taking is less effective than longhand note taking for learning. Prior studies have primarily focused on students' capacity for multitasking and distraction when using laptops. The present research suggests that even when laptops are used solely to take notes, they may still be impairing learning because their use results in shallower processing. In three studies, we found that students who took notes on laptops performed worse on conceptual questions than students who took notes longhand. We show that whereas taking more notes can be beneficial, laptop note takers' tendency to transcribe lectures verbatim rather than processing information and reframing it in their own words is detrimental to learning.

## Don't Ditch the Laptop Just Yet: A Direct Replication of Mueller and Oppenheimer's (2014) Study 1 Plus Mini Meta-Analyses Across Similar Studies

Heather L. Urry , Chelsea S. Crittelle, et al., and Jonah E. Zarrow [View all authors and affiliations](#)

Volume 32, Issue 3 | <https://doi.org/10.1177/0956797620965541>

## The effect of notetaking method on academic performance: A systematic review and meta-analysis

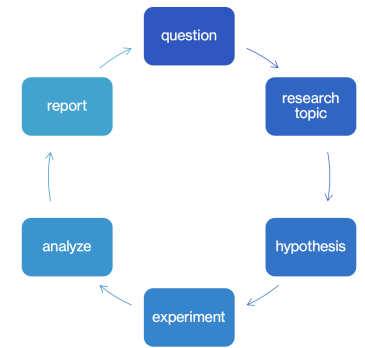
Daniel Voyer , Scott T. Ronis, Narissa Byers

[Show more](#)

## activity: key **takeaway** from background research

- go to **course website** > **L1: What is Cognition?**
- under “view/watch/listen”, open the webpage of the paper assigned to your group
  - **groups 1 and 2**: the pen is mightier than the sword
  - **groups 3 and 4**: don’t ditch the laptop just yet
  - **groups 5 and 6**: effect of notetaking: meta-analysis
- **read the abstract**, discuss, and note down your **main takeaway(s)**
  - 2 minutes
- come back and **debrief**

# methods of cognition: hypothesis

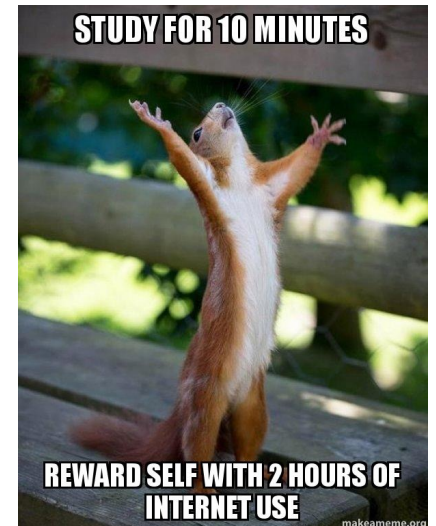


- **prior research** tells us that: students who take longhand notes **may** perform better on conceptual questions than students who take notes via laptops but **findings vary and are inconclusive**
- **hypothesis: distraction** is a moderator of this finding, i.e., students are more likely to get distracted on digital devices, which may in turn affect performance
- **inference**: when controlling for distraction, the effect of medium (longhand vs. notetaking) on performance should go away

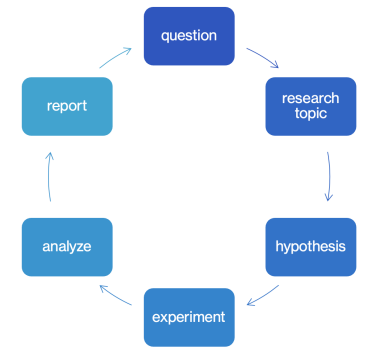
## The impact of digital distraction on lecture note taking and student learning

Abraham E. Flanigan<sup>1</sup>  · Scott Titsworth<sup>2</sup>

Received: 23 August 2019 / Accepted: 6 June 2020  
© Springer Nature B.V. 2020



# methods of cognition: experiment



- an **experiment** helps researchers test the validity of the hypothesis in a controlled setting
  - many types of experiments are possible
- experiment design:
  - **independent variable** (IV): something that the researcher *manipulates* or *varies*
  - **dependent variable** (DV): something the the researcher *measures* for all versions of the independent variable
  - **key question**: did the manipulation cause a change in the measurement?
- often, the basic design can be gleaned from the **abstract** itself

# activity: reading an abstract

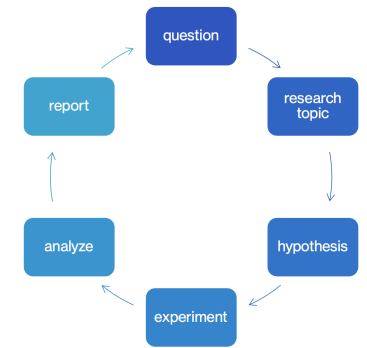
- individually (2 mins), find the:
  - **independent variable (IV):** something that the researcher *manipulates* or varies
  - **dependent variable (DV):** something the the researcher *measures* for all versions of the independent variable
  - **answer to key question:** did the manipulation cause a change in the measurement?

## Abstract

Laptop computers allow students to type lecture notes instead of relying on the traditional longhand (i.e. paper-pencil) method. The present research compared laptop and longhand note-taking methods by investigating how the quality (i.e. complete versus incomplete idea units) and quantity (i.e. total words and total idea units) of typed and handwritten notes differed when students did or did not reply to text messages during a simulated lecture. Accounting for the presence of text messaging while participants took notes situated the present study within the reality facing many students in today's digital age. Findings indicated that a considerable proportion of the idea units captured in participants' notes were incomplete, regardless of note-taking method or exposure to distraction during the simulated lecture. However, only the total number of complete idea units stored in student notes meaningfully predicted lecture learning. Furthermore, the presence of digital distraction was particularly disruptive to the quality and quantity of laptop users' lecture notes relative to longhand note takers. Finally, digital distraction emerged as a more meaningful predictor of lecture learning than note-taking method. Recommendations for improving the quality of student lecture notes are discussed and avenues for future research into note-taking completeness and the interplay between digital distraction and note-taking method are proposed.



# methods of cognition: experiment



- independent variable(s):
  - note-taking medium: laptop vs. longhand
  - distraction level: texting vs. no-texting
- dependent variable
  - quality and quantity of notes
  - but how do we measure *quality & quantity*??
    - the number of words and “idea units” in notes
    - a test after note-taking (after how long, allow note review?)
  - measurements are not perfect!
- answer to key question
  - distraction was disruptive for both methods, but maybe some more disruption for laptop
  - could take away other mini-findings too

## Abstract

Laptop computers allow students to type lecture notes instead of relying on the traditional longhand (i.e. paper-pencil) method. The present research compared laptop and longhand note-taking methods by investigating how the *quality* (i.e. complete versus incomplete idea units) and *quantity* (i.e. total words and total idea units) of typed and handwritten notes differed when students did or did not reply to text messages during a simulated lecture. Accounting for the presence of text messaging while participants took notes situated the present study within the reality facing many students in today's digital age. Findings indicated that a considerable proportion of the idea units captured in participants' notes were incomplete, regardless of note-taking method or exposure to distraction during the simulated lecture. However, only the total number of complete idea units stored in student notes meaningfully predicted lecture learning. Furthermore, the presence of digital distraction was particularly disruptive to the quality and quantity of laptop users' lecture notes relative to longhand note takers. Finally, digital distraction emerged as a more meaningful predictor of lecture learning than note-taking method. Recommendations for improving the quality of student lecture notes are discussed and avenues for future research into note-taking completeness and the interplay between digital distraction and note-taking method are proposed.

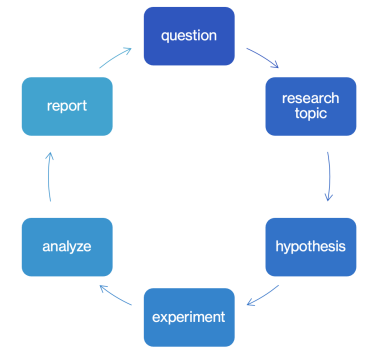
# findings in cognition



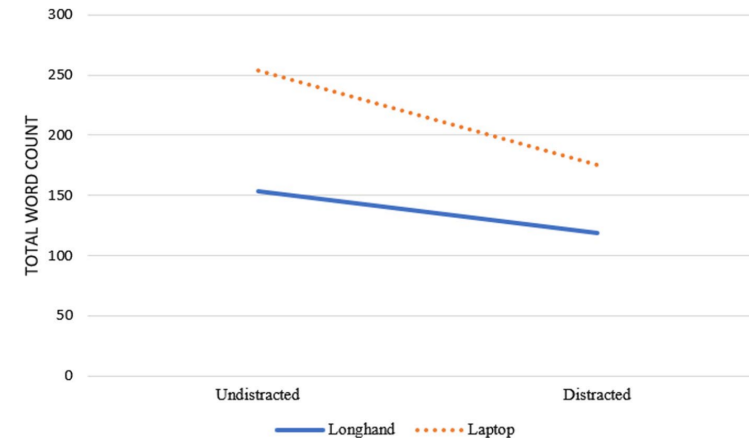
- one outcome of the research cycle is the **findings** it produces
- within an experiment, a finding refers to whether or not the manipulation (IV) **influenced** the measurement (DV)
- answering this empirical question requires **analyzing data** from the experiment



# findings in cognition: analysis



- **analysis** involves **inferring patterns** from data using statistics
- the findings from these analyses are then **summarized** and **reported** publicly via visualizations (typically tables and figures)
- after findings have been reported, researchers generally draw inferences, ask more questions, and generate **new hypotheses**, thus starting over in the research cycle!



**Table 5** Differences in posttest scores and note-taking outcomes across groups

	Distracted laptop	Distracted longhand	Undistracted laptop	Undistracted longhand
Total posttest score	22.12 (5.66)	21.88 (6.02)	24.32 (5.13)	24.84 (6.71)
Total words	175.12 (58.88)	119.80 (36.69)	253.84 (73.67)	153.08 (51.91)
Total complete ideas	31.32 (7.66)	27.00	43.12	33.92

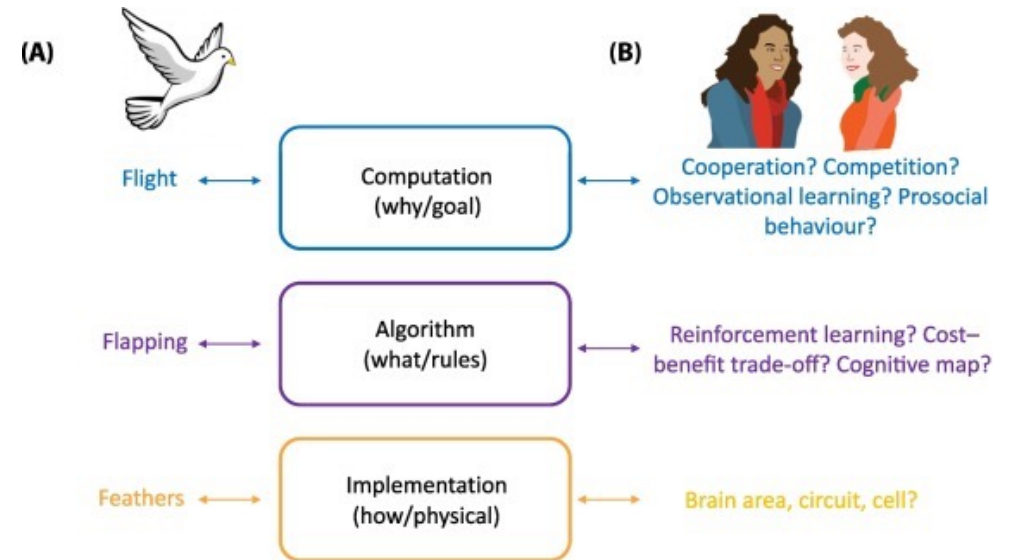
# so what do we know so far?

- distractions **disrupt** student learning
- the medium of note-taking is less important than the **quality** of note-taking and the **amount of distraction**
- think about **how** you take notes:
  - are you noting down everything I'm saying verbatim or trying to interpret, paraphrase, and connect ideas?
  - are you distracted? how can you minimize distractions?
    - laptop: exit out of browsers / [enable "focus" on Mac](#) / do not switch windows
    - handwritten: listen actively, make connections, jot down takeaways

# explanations in cognition



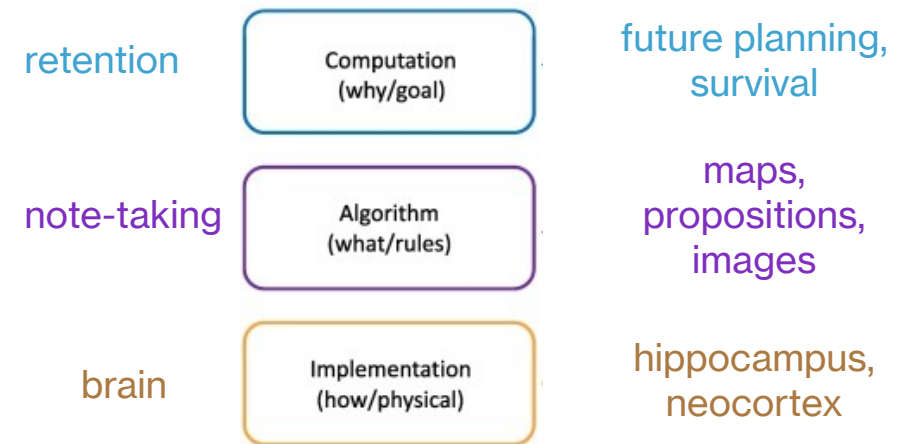
- explanations refer to an **account** of a cognitive phenomena
- explanations can have different forms and levels
- David Marr proposed 3 levels of explanation:
  - **computational** (why/goals)
  - **representational/algorithmic** (what/process)
  - **implementation** (how/hardware)



# explanations in cognition



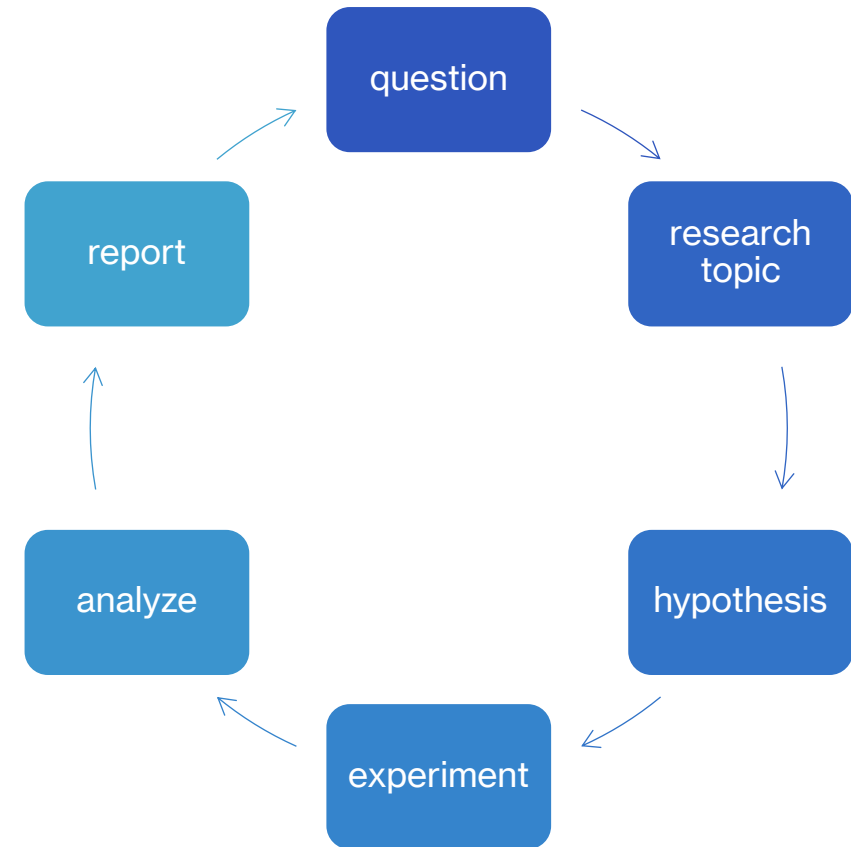
- for our example of **notetaking**
- **computational** (why/goals)
  - why do we retain information?
- **representational/algorithmic** (what/process)
  - cognitive maps, propositions, etc.
- **implementation** (how/hardware)
  - brain area, memory network?



# applications of cognition



- the **cycle of research** produces:
  - more research and novel knowledge
  - real-world applications
- examples of novel knowledge
  - (in)effective study/notetaking strategies
  - how babies learn
- examples of real-world applications
  - eyewitness testimonies
  - AI (e.g., Siri, Alexa, chatGPT, etc.)



# 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
  - machines
- applied cognition has the potential to help **develop interventions** for cognitive impairments, design **better technologies**, and improve **quality of life**



# implications of cognition: big-picture



- there are **several inequalities** in the history of psychological and cognitive science research
- we will spend some time reflecting on this history
- **questions to ask**/ponder over during the semester:
  - what are the goals and who set them?
  - are these goals useful and have they led to benefits?
  - who are the goals benefiting vs. hurting?
  - what kinds of questions are not being asked?
  - how should society decide which research is important?

# conceptual question #1

- “Dr. Crump says that in cognition, **inferences** about cognitive processes must be made from **indirect measurements**. What **challenges**, if any, does this pose for researchers and experimenters who cannot directly measure objects of inquiry like a biologist or geologist might?”
  - **lots of challenges!** behavior is extremely complex...and researchers constantly revise old measures, come up with new measures, criticize other's measures (as we will see), and this cycle continues
  - one recent example of this debate: [implicit association test](#)
  - this is also related to what is called “**method variance**” in statistics
  - the key is **reproducibility and replicability**...if you see the same qualitative/quantitative patterns and can make the same inferences across different measures/methods, then you can be more confident about your claims

# conceptual question #2

- “When Dr. Crump used the **metaphorical** model of **horse racing** to explain the **Stroop phenomenon** I thought of the **social/cultural specificities** that come with metaphors. Rarely do languages share the same metaphors. Are metaphorical models commonly used in cross-cultural research, are they interpreted across cultures, or do they mainly serve to explain concepts within one language/culture?”
  - metaphors are everywhere! They are useful sometimes, but can become problematic for many reasons, including their cross-cultural specificity, but also because we start viewing the problem through the metaphor
  - “brain is a computer” vs. “the computer is brain” (Baria and Cross, 2021)
    - “I can’t process this” / “the computer is sleeping”
  - is the mind a network? (Hills and Kenett, 2021)

# conceptual question #3

- “Crump stated that “many **interesting and socially relevant** aspects of cognition remain **under investigated**.” Why is this the case? Are researchers pressured into more immediate **gratification** research as opposed to more long-term impact, interesting projects?”
  - **behavior is really hard to study!** scientists try to focus on specific “instances” or subsets of cognition, but in principle, everything happens all at the same time (e.g., communication involves vision, perception, interpretation, speech, etc.)
  - there is definitely some truth to “immediate gratification”: the **incentive structure** in science depends on your publication record so instead of solving “communication” as a big problem, scientists take **smaller steps** and progress happens incrementally

# conceptual question #4

- “With the onset of [technology](#) and cognition such as the Xbox Kinect, how will new technology like VR help researchers with their studies? Are there other technologies that will make a greater impact?”
  - technology and science go hand in hand! The advent of new technologies certainly [informs and improves the scientific endeavor](#). VR, in particular, has been useful in understanding spatial cognition, perception more broadly, but also simple search/navigation, some examples below:
  - [spatial cognition](#), [medicine](#), [wayfinding in firefighters](#)
  - other tech includes: e-sports, language AI, etc.

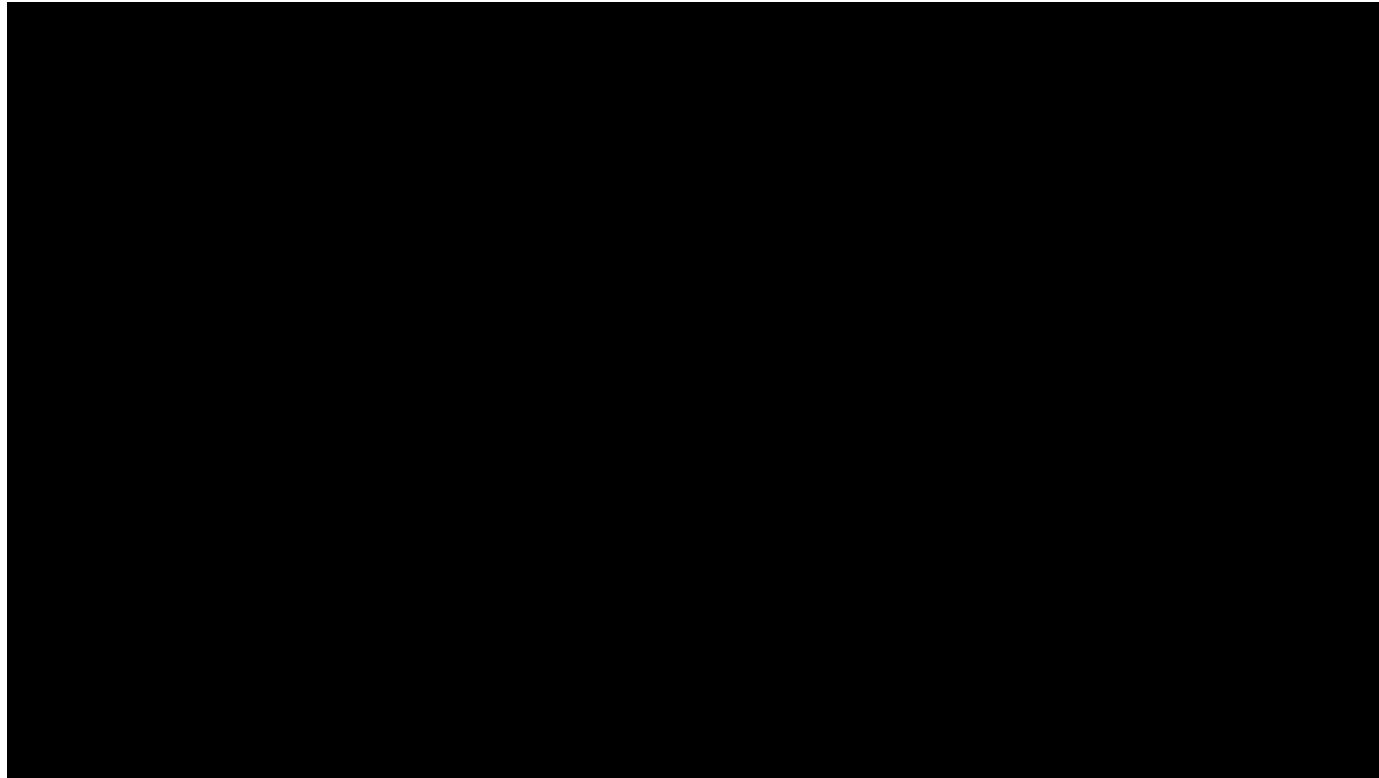
# conceptual question #4

- “Crump says that cognitive research hasn't always had "uniformly positive implications for society". Who decides what experiment is ethical or not? How is it decided that a study will positively or negatively affect a community, before or after the experiment is done?”
  - due to several problematic “experiments” in the past (e.g., Stanford Prison experiment, Little Albert, etc.), any research involving human/animal participants now needs to be approved by **Institutional Review Boards** at universities and must follow certain **ethical standards and principles**. researchers working in labs are typically trained for this.
  - [Read the Belmont Report \(signed in 1974\)](#)
  - having said this, long-term impacts are harder to assess but having standards in place early on (before research is conducted) is **useful in identifying potential harms**

# conceptual question #5

- “I'm thinking about the dissemination of information to the general public. When a supposedly trustworthy study has data that supports a certain hypothesis, it seems like there's nothing stopping someone from citing it in an article [say for the new york times], regardless of whether the results have been replicated in other studies. However, a meta-analysis of the same question might tell a very different story. How does this impact the clarity of communication between scholars and the public?”
  - science communication is very important! over the past few years, there has been a lot more emphasis in psychology on replication and open science, which has improved the field overall.
  - Having said that, scientists do/can not control the media, so it's important to be informed and critical consumers, especially when reading popular science articles
  - look at which study is being cited, when/where it was published, how many scientists have cited the work, etc. popular articles are different from peer-reviewed articles and meta analyses

# **meme tutorial (Matt)**





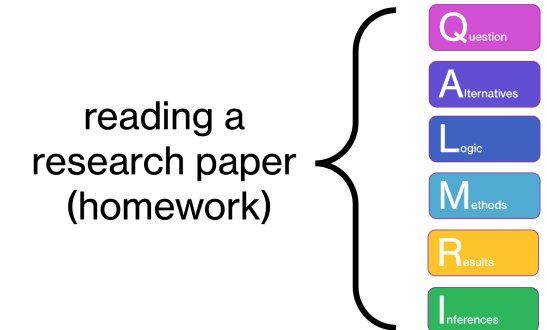
# sample meme (Matt)



# next class



- **before class:**
  - *fill out*: survey + poll
  - *finish*: QALMRI section in Chapter 1 (1.8 onwards)
    - quiz questions will cover **everything** in Chapter 1
  - *complete*: L1 quiz and/or writing assignment + meme
  - *read*: L2 (mental imagery) chapter
- **during class:**
  - what is mental imagery?
  - how has this concept been studied over the years?



# chatGPT demo

- I gave chatGPT the prompt for L1's writing assignment
- it returned a reflection/summary that was not appropriate or accurate
- bottom line: using chatGPT as a tool to probe for ideas is fine, but copying verbatim violates the honor code but may also not be in your best interest, in terms of your learning

A

reflect on this article in 250 words:

<https://onlinelibrary.wiley.com/doi/full/10.1111/cogs.13167>



The article discusses the idea that the human mind is able to simulate different perspectives, which allows for understanding others' mental states and behavior. This ability, known as mentalizing or theory of mind, is important for social interactions and communication. The article also explores the neural basis of mentalizing, and suggests that it may involve specific brain regions such as the medial prefrontal cortex and the temporo-parietal junction.

The research conducted in the article provide evidence that the brain regions responsible for mentalizing are more active when people are exposed to stimuli that are related to other people's mental states, such as social cues and facial expressions. Additionally, the study found that patients with brain damage in these regions have difficulty with mentalizing tasks, further supporting the idea that these regions are important for this ability.

The article also highlights the importance of mentalizing in everyday life, such as understanding the intentions of others and predicting their behavior, as well as in clinical populations such as individuals with autism spectrum disorder who often have difficulty with mentalizing.