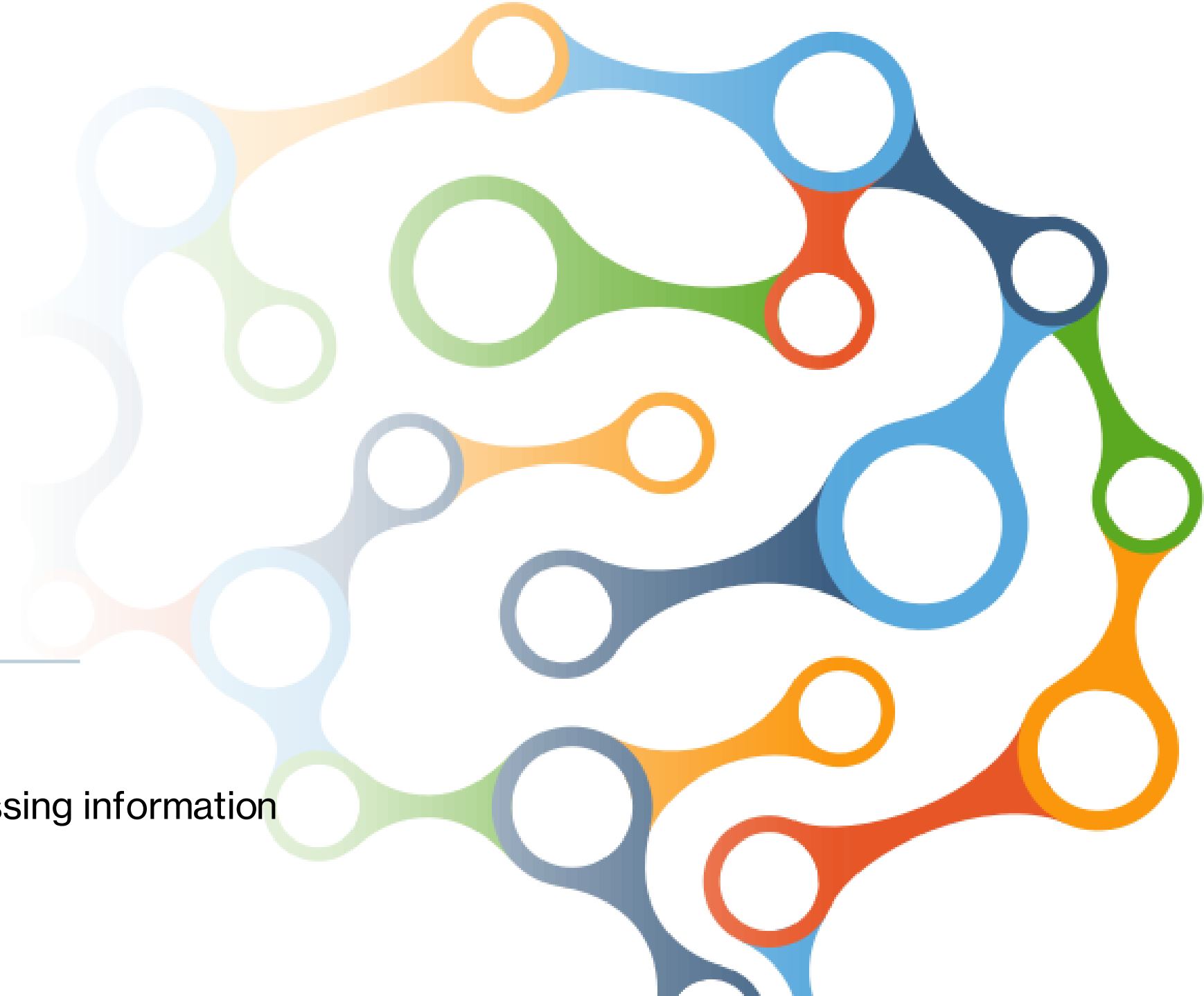
# Cognition

PSYC 2040

W2: Building blocks / processing information



# logistics

- Feb 11 class canceled
- reading + annotation to complete instead
- work on SPARK

| | | |
|---|---|---|
| 2 | T: January 28, 2025 | W2: Building blocks |
| 2 | Th: January 30, 2025 | W2 continued… |
| 2 | Su: February 2, 2025 | **Quiz 2 due** |
| 2 | Su: February 2, 2025 | **Jennifer's Office Hours (7-9 pm, Kanbar 200)** |
| 3 | M: February 3, 2025 | **Project: Questions of Interest due** |
| 3 | T: February 4, 2025 | W3: Cognitive limitations |
| 3 | Th: February 6, 2025 | W3 continued… |
| 3 | Su: February 9, 2025 | **Quiz 3 due** |
| 4 | T: February 11, 2025 | W4: Learning and association \| No Class! |
| 4 | Th: February 13, 2025 | W4 continued… |
| 4 | Su: February 16, 2025 | **Quiz 4 due** |
| 4 | Su: February 16, 2025 | **Jennifer's Office Hours (7-9 pm, Kanbar 200)** |
| 5 | T: February 18, 2025 | W5:Categorization |
| 5 | Th: February 20, 2025 | **President Safa Zaki Guest Lecture!** |
| 5 | Su: February 23, 2025 | **Quiz 5 due** |
| 6 | M: February 24, 2025 | **Project: SPARK due** |

# Project Milestone 1: Questions of Interest

Start Assignment

**Due** Feb 3 by 11:59pm **Points** 2 **Submitting** a text entry box

This is the first milestone for your final project. This is an individual assignment, i.e., each student will fill this out. Groups will be made based on the responses you provide in this milestone.

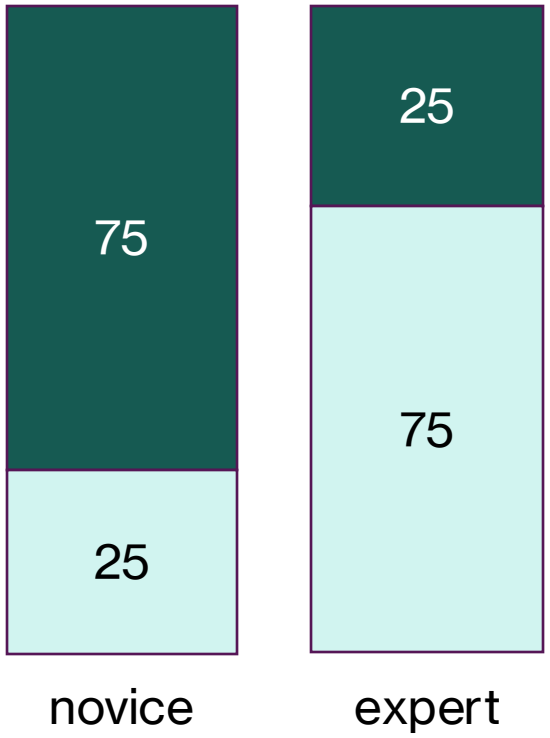
In this milestone, we would like to know what kinds of topics you may want to explore in your final project. Remember, the final project is a way for you to explore the real-life implications of any topic/aspect of cognition we cover in class.

Please answer the following questions:

- What kinds of **cognition-related topics** are you interested in exploring through the final project? Give specific examples of **real-world implications** you would want to explore.
- When are you available during the week/weekend to meet group members and work on the group project? List specific days and times that you could commit to **meet for at least an hour**.
- What is your general experience with group projects? How do you contribute in a group (e.g., are you more likely to lead, coordinate logistics, proofread everything, etc.)?
- Would you like to share anything specific about anyone you *would* like to be in a group with or *would not* like to be in a group with in this class? We will try our best to honor these preferences!

# lingering question #1

- I am a little confused why the exponential law for practice makes sense. If someone had never played soccer before and got two hours of instruction on how to dribble, pass, and shoot, wouldn't they have a much higher rate of learning than when they are a pro soccer player and they practice skills for 2 hours?
- exponential law: $\mathrm{RT} = e^{-\alpha N}$
- power law: $\mathrm{RT} = N^{-\beta}$
- learning rate is relative to how much remains to be learned



# lingering question #1

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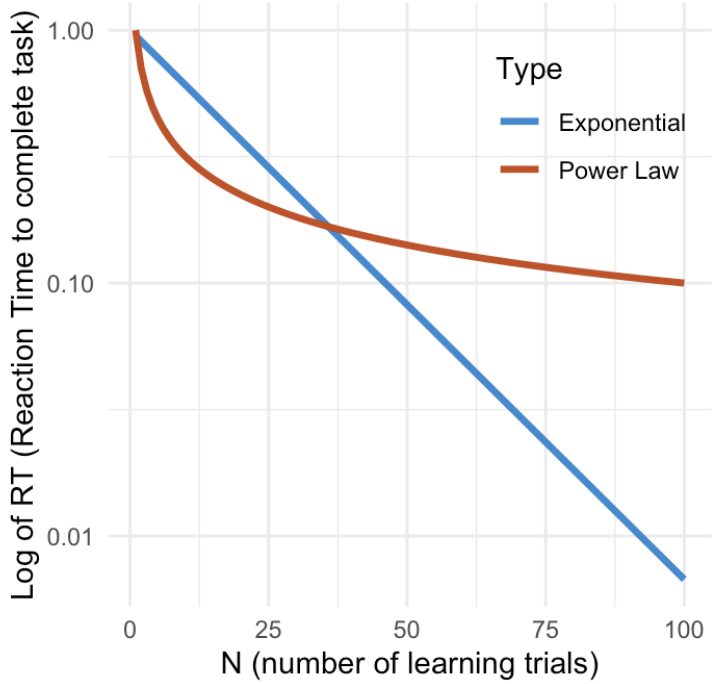


# lingering question #2

- I'm a little bit confused by the concept of external validity and how if an experiment is too controlled it cannot be generalized. Isn't the whole point of conducting experiments is to isolate variables to make sure that any observed change is due to the isolated variable?

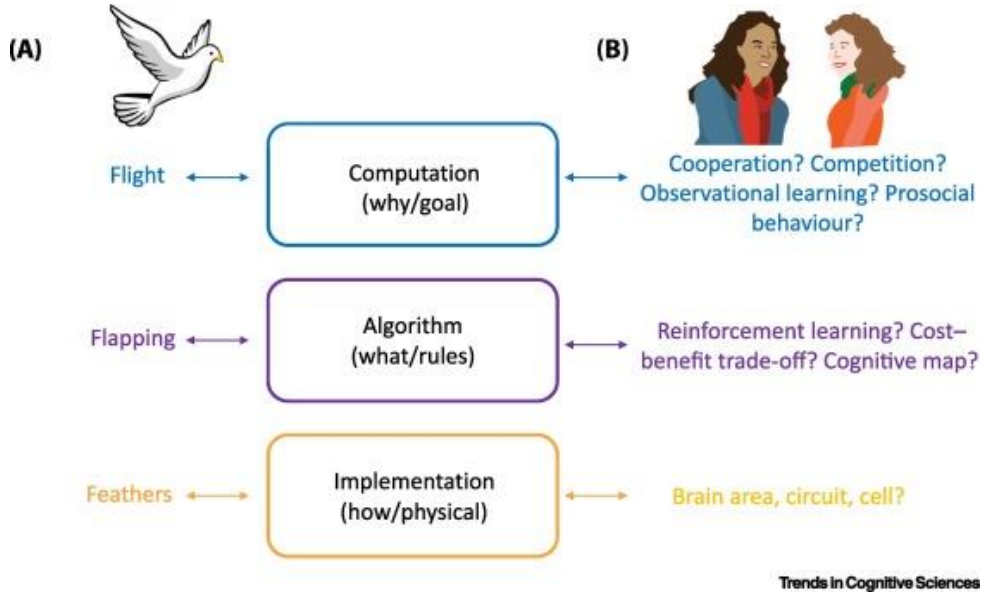
# recap


COGNITION

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

# 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)



# today’s agenda

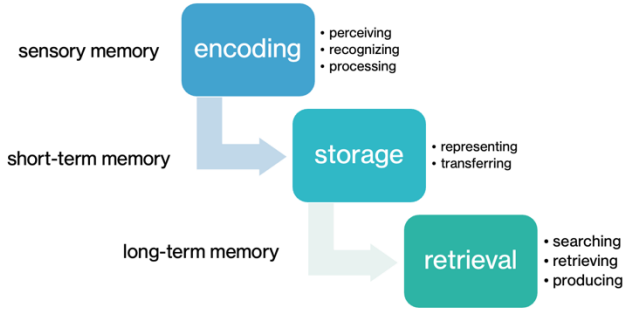
pattern recognition

sensory memory

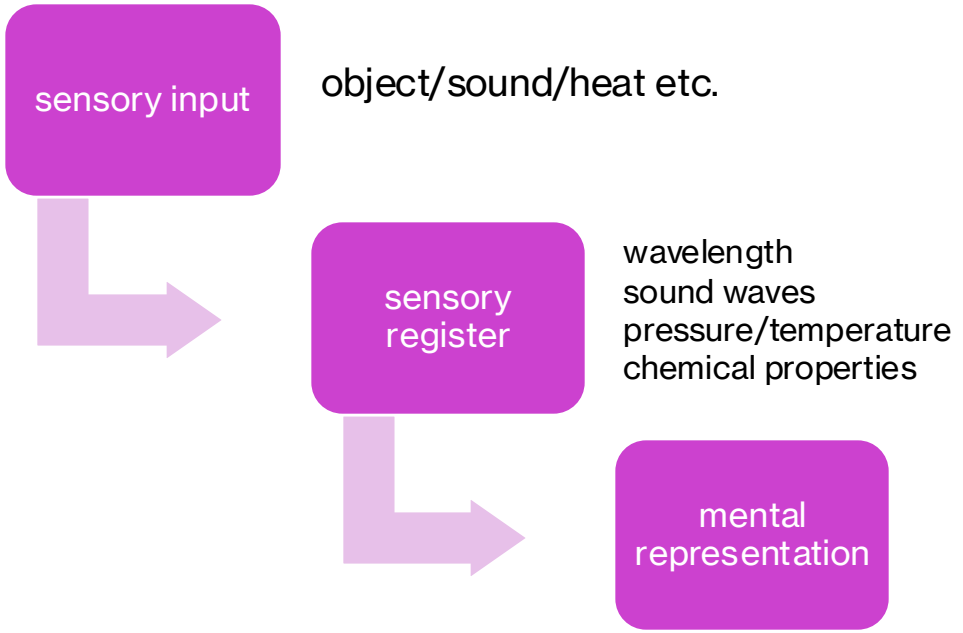
short-term memory

working memory

# pattern recognition

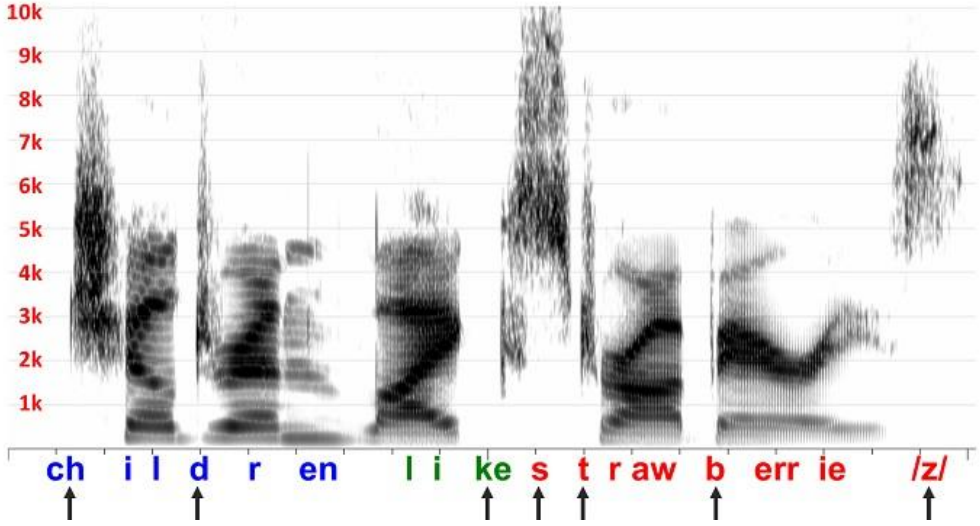



- the process by which we recognize, label, and identify objects and events in the world
- a good system needs to be fast, accurate, be able to discriminate between similar items, and ignore irrelevant variability



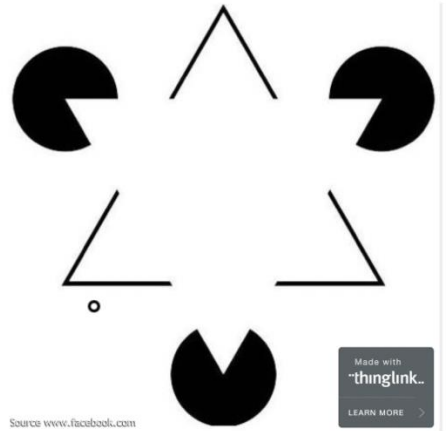
# how do we do this?

- the incoming sensory signal is extremely noisy



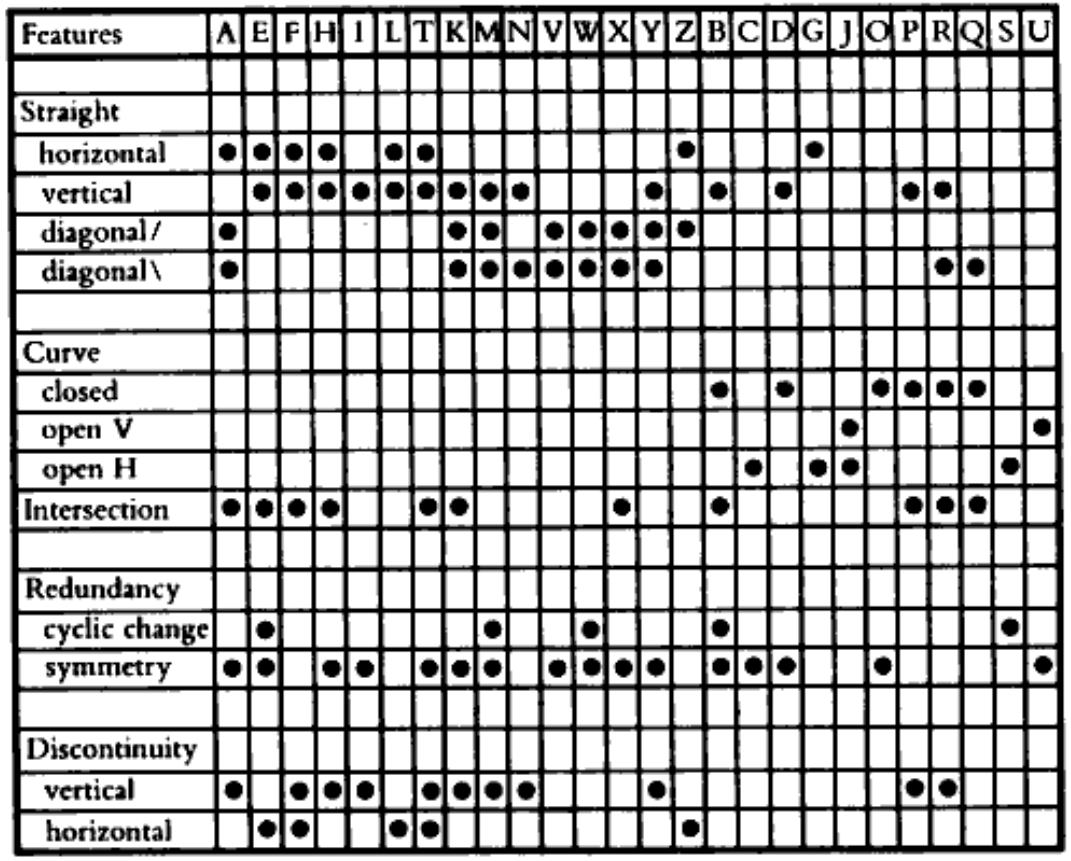
# recognizing patterns: template theory

- compare stimulus to stored “templates”/copies
- problems:
  - orientation / rotation issues
  - gestalt recognition
  - novel stimuli
  - how many templates??



# recognizing patterns: feature theory

- match to features, not templates
- defining features and their combinations
- features are extracted from sensory register
- compare to what is in LTM and make decision



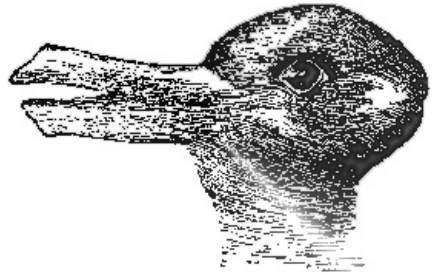
| Features | A | E | F | H | I | L | T | K | M | N | V | W | X | Y | Z | B | C | D | G | J | O | P | R | Q | S | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Straight | | | | | | | | | | | | | | | | | | | | | | | | | | |
| horizontal | ● | ● | ● | ● | | ● | ● | | | | | | | | ● | | | | ● | | | | | | | |
| vertical | | ● | ● | ● | ● | ● | ● | ● | ● | ● | | | | ● | | ● | | ● | | | | ● | ● | | | |
| diagonal / | ● | | | | | | | ● | ● | | ● | ● | ● | ● | ● | | | | | | | | | | | |
| diagonal \ | ● | | | | | | | ● | ● | ● | ● | ● | ● | ● | | | | | | | | | ● | ● | | |
| Curve | | | | | | | | | | | | | | | | | | | | | | | | | | |
| closed | | | | | | | | | | | | | | | | ● | | ● | | | ● | ● | ● | ● | | |
| open V | | | | | | | | | | | | | | | | | | | | ● | | | | | | ● |
| open H | | | | | | | | | | | | | | | | | ● | | ● | ● | | | | | ● | |
| Intersection | ● | ● | ● | ● | | | ● | ● | | | | | ● | | | ● | | | | | | ● | ● | ● | | |
| Redundancy | | | | | | | | | | | | | | | | | | | | | | | | | | |
| cyclic change | | ● | | | | | | | ● | | | ● | | | | ● | | | | | | | | | ● | |
| symmetry | ● | ● | | ● | ● | | ● | ● | ● | | ● | ● | ● | ● | | ● | ● | ● | | | ● | | | | | ● |
| Discontinuity | | | | | | | | | | | | | | | | | | | | | | | | | | |
| vertical | ● | | ● | ● | ● | | ● | ● | ● | ● | | | | ● | | | | | | | | ● | ● | | | |
| horizontal | | ● | ● | | | ● | ● | | | | | | | | ● | | | | | | | | | | | |

# evidence for feature theories

- “same or different” RT task
  - perceptual overlap => slower
- pros:
  - can account for orientation & variability issues from template theory
  - visual cortex responds to specific features
- issues
  - what is a feature?
  - bidirectional/ambiguous images
  - context / top-down effects

L vs. O

L vs. E



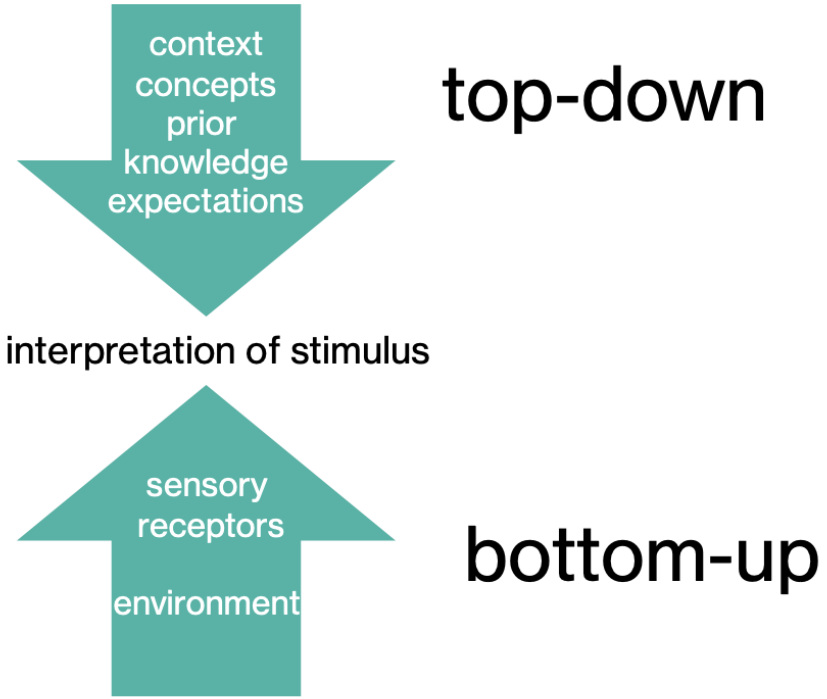
# reminder

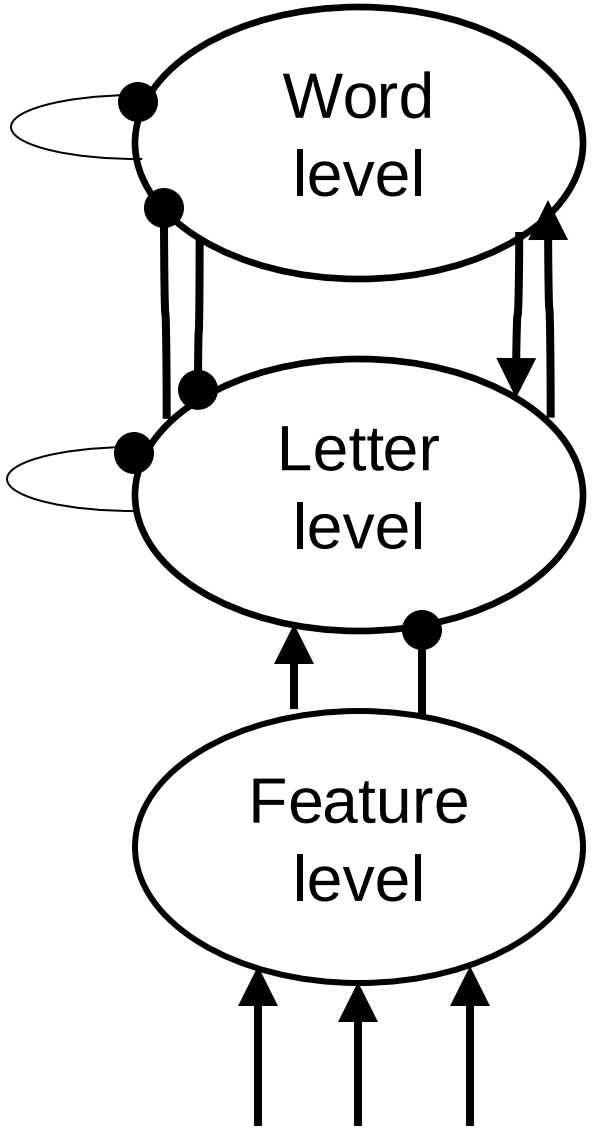
- on the next several slides, I will flash a row of six letters. You will then see two letters, one above and one below a letter that appeared. Guess which of the two letters actually appeared in the indicated location.

XXXX
WORD
_ _ _ D
OR
_ _ _ K

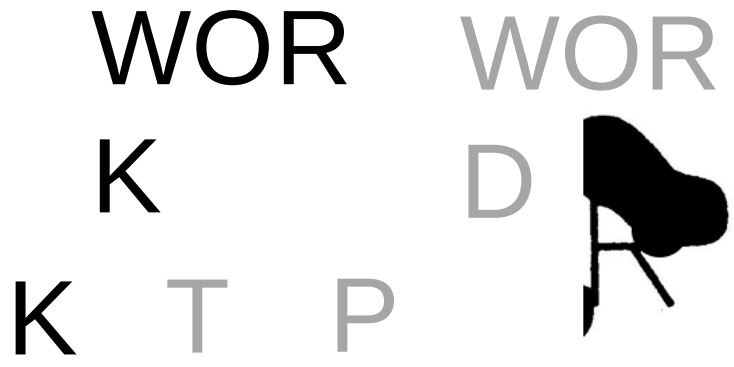
# word superiority effect

- WORD > LETTER (Johnston & McClelland, 1973)
- WORD > NONWORD
- faster and more accurate
- letters are the building blocks of words, so how can letter recognition follow word recognition?
- interactive activation model (top-down + bottom-up influences)

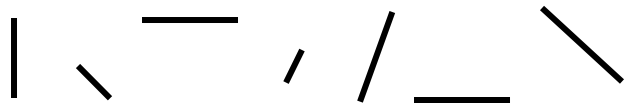


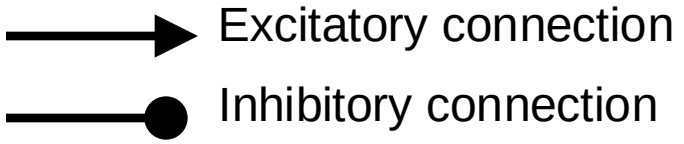



**Top-down influences**




**Bottom-up influences**

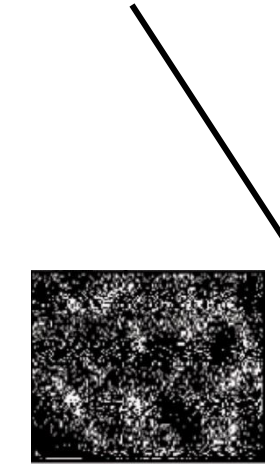


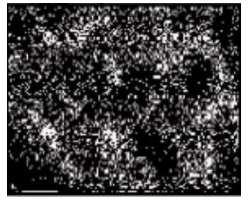


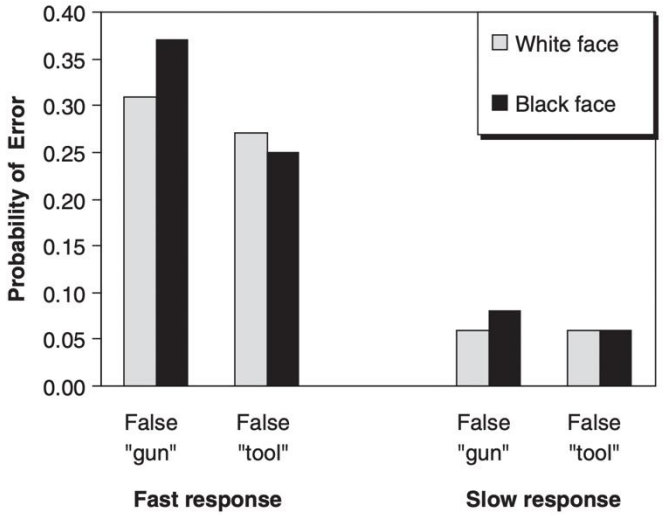
# object recognition

Amadou Diallo (1975-1999)

- biases affect object recognition
- weapon or tool?

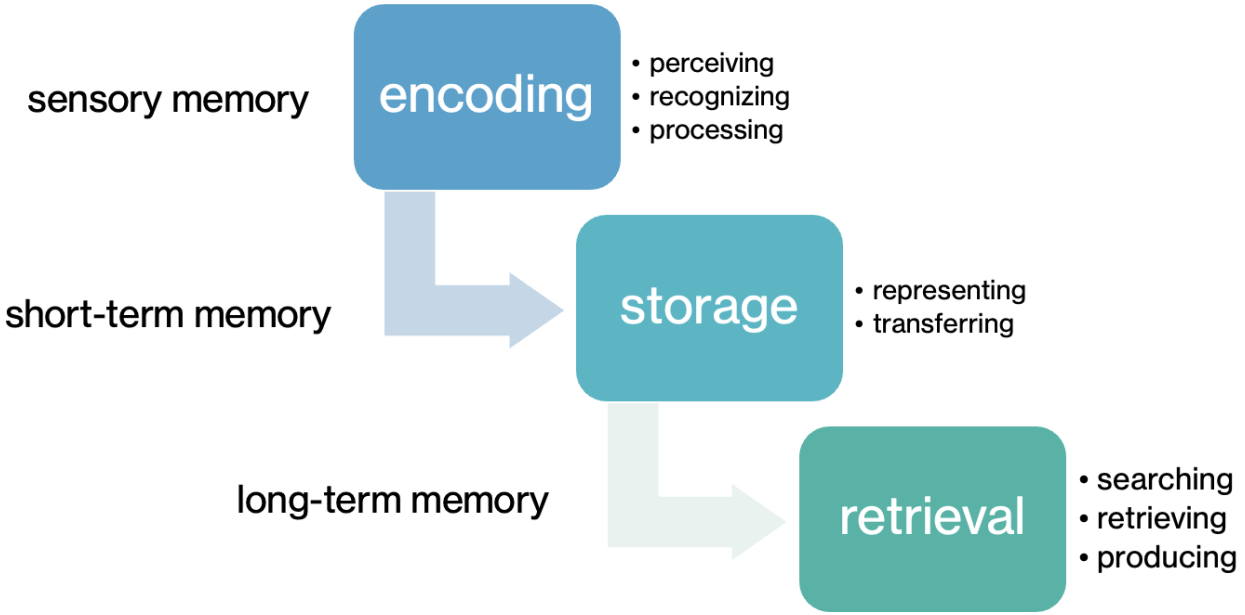


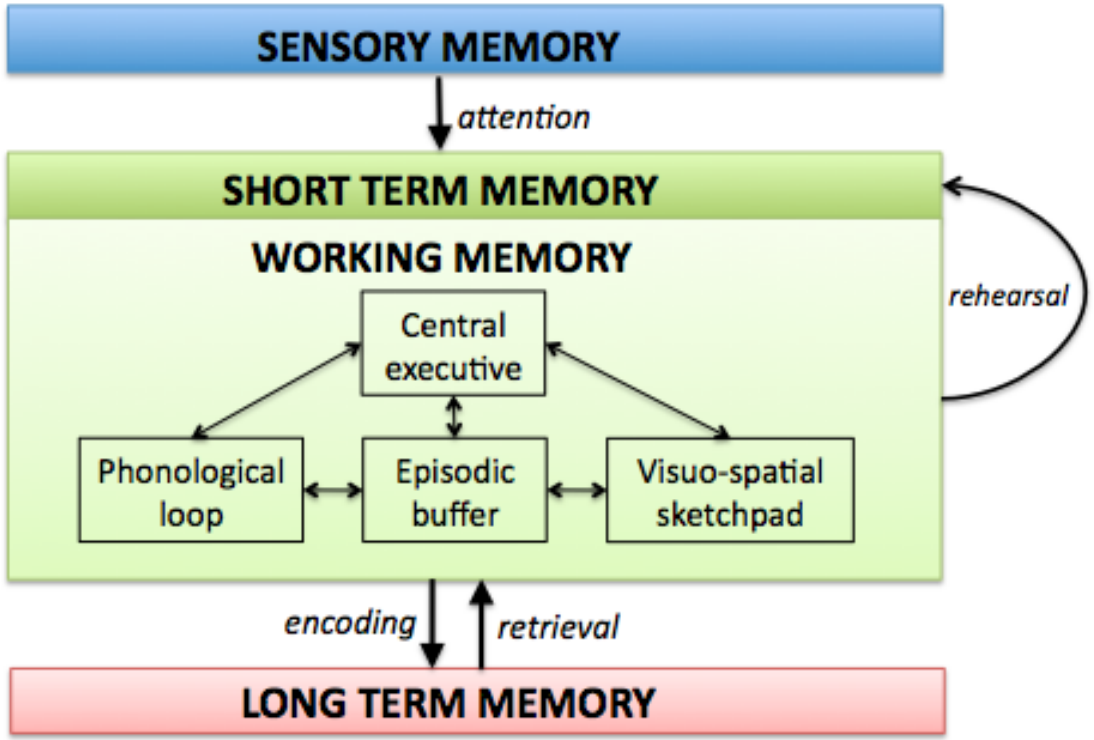





https://doi.org/10.1111/j.1467-8721.2006.00454.x

# how do we process information?



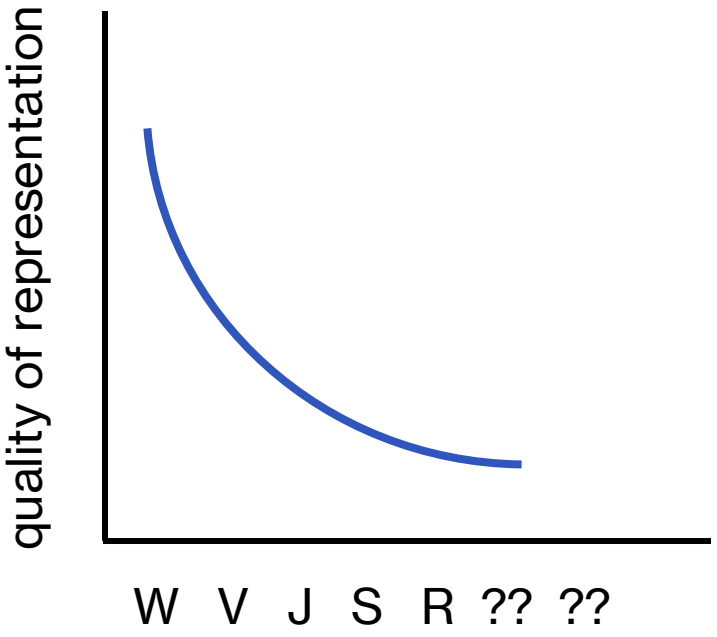



# reminder

- I will present some letters very briefly to you
- once the letters are gone, try to report as many as possible

# sensory memory

- brief persistence during which perception and pattern recognition take place
- modality-specific
  - iconic (visual)
  - echoic (auditory)
  - haptic (touch)
  - proprioceptive

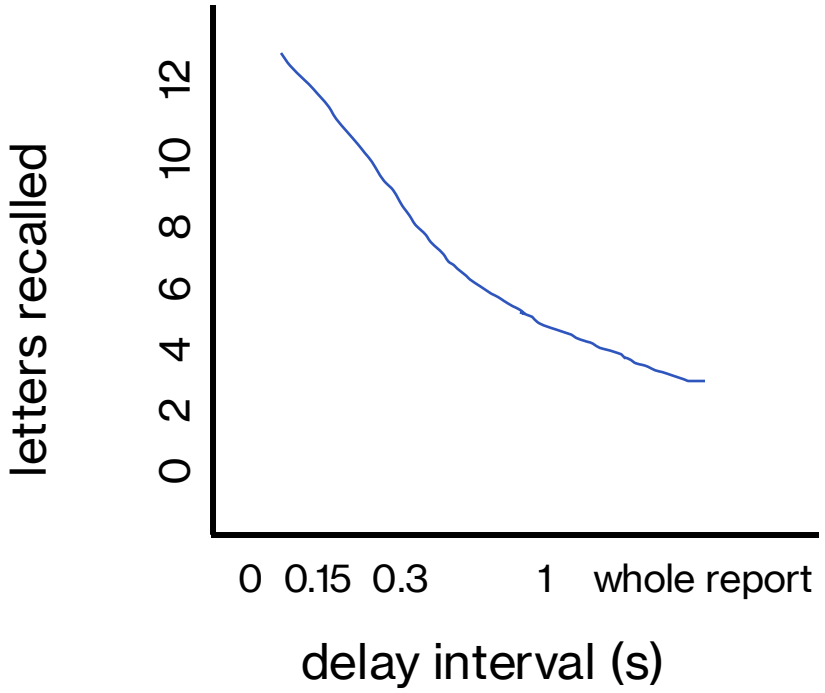


# another reminder

- I will present again some letters very briefly to you
- once the letters are gone, I will ask you to report items from a particular row (you won’t know which one)

# sensory memory: capacity & duration

- whole report technique
  - very limited capacity (3-5 items)
- partial report technique
  - report only items from a row
  - 3/3 or 3/4: high capacity?
  - immediate vs. delayed reporting
- large capacity, short duration (<1 sec)



# sensory memory: representation

- veridical (true / exact)
- have not been processed yet
- does not rely on pattern recognition
- can use perceptual features

report only letters

G 6 B L

3 Z 9 P

7 K N 8

report only red stimuli

8 S V M

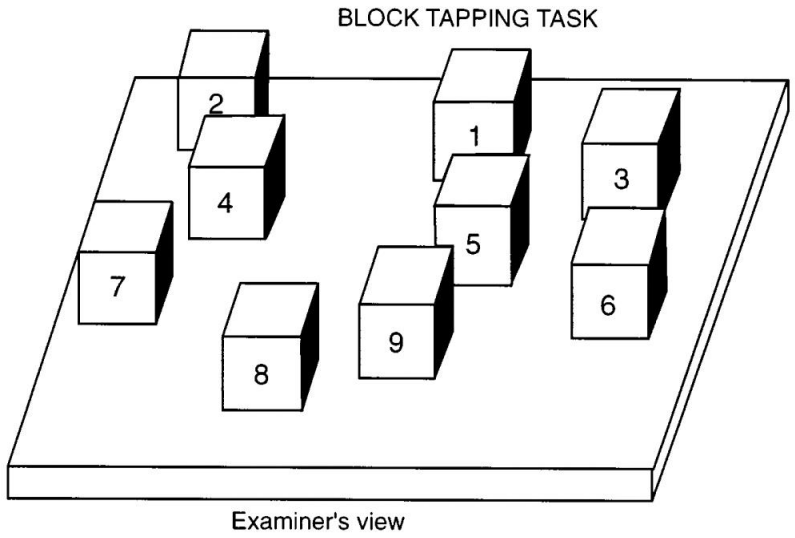
A 1 B T

J 6 R Q

Von Wright, 1968

# class activity debrief

- you did an activity before class
- Corsi span task

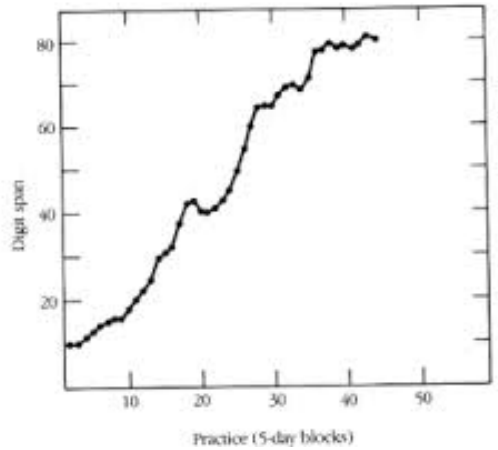



Kessels and colleagues (2000) carried out a study with healthy participants and participants with some form of brain damage. In their study, healthy adults had an average block span of 6.2 blocks (SD=1.3). Thus, if you are healthy, you are most likely to have a block span of somewhere between 5 and 7 blocks. That is, 68% of the population scores 1 standard deviation from the mean, so if you belong to this 68%, you would have a Corsi block span between 5 and 7 blocks. You can test this yourself with the demo below.

review paper

# short-term memory

- “active” contents of the mind
- measured via “memory span” / span task
- capacity: 5-9 units of information (Miller, 1956)
- chunking can enhance capacity
  - practice
  - expertise
- short duration (fast decaying)
- code: analog




THE PSYCHOLOGICAL REVIEW

THE MAGICAL NUMBER SEVEN, PLUS OR MINUS TWO: SOME LIMITS ON OUR CAPACITY FOR PROCESSING INFORMATION [1]

GEORGE A. MILLER

*Harvard University*

My problem is that I have been persecuted by an integer. For seven years this number has followed me around, has intruded in my most private data, and has assaulted me from the pages of our most public journals. This number as- judgment. Historical accident, however, has decreed that they should have another name. We now call them experiments on the capacity of people to transmit information. Since these experiments would not have been done

# serial position curve

- a serial position curve refers to the U-shaped curve typically obtained from memory experiments where accuracy of recalling words is measured
- serial position effect
  - primacy: recalling first-learned items
  - recency: recalling most recently learned items

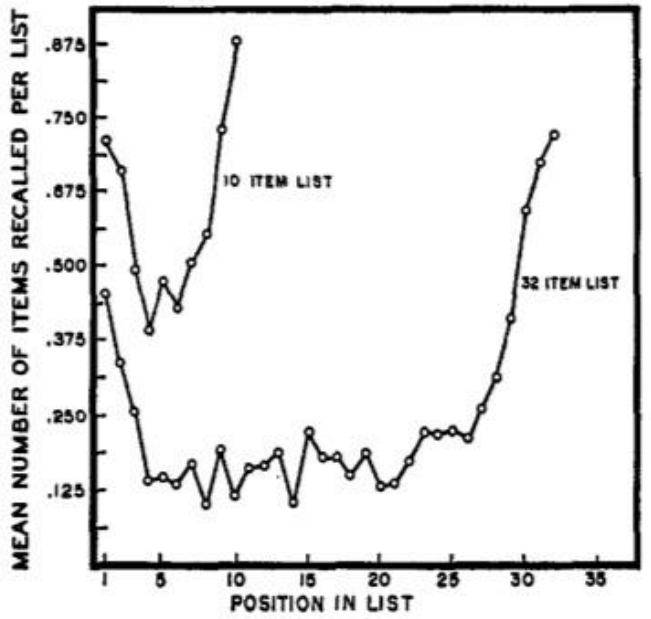



FIG. 1. Mean frequency of recall per list per *S* for lists of randomly arranged words as a function of position of items in original lists.

# multi-store model

- Atkinson and Shiffrin (1968)
- the short-term store is a rehearsal buffer where items can be stored and rehearsed temporarily, and space/capacity is severely limited
- items that stay longer in short-term store have a greater likelihood of being passed to the long-term store
- the long-term store could be affected by decay, interference, etc.

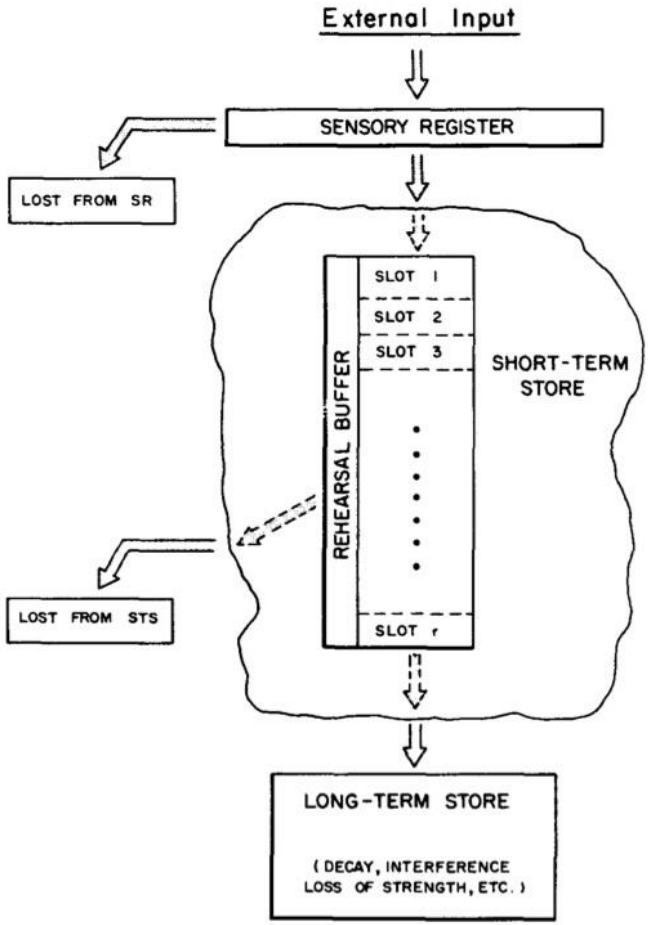
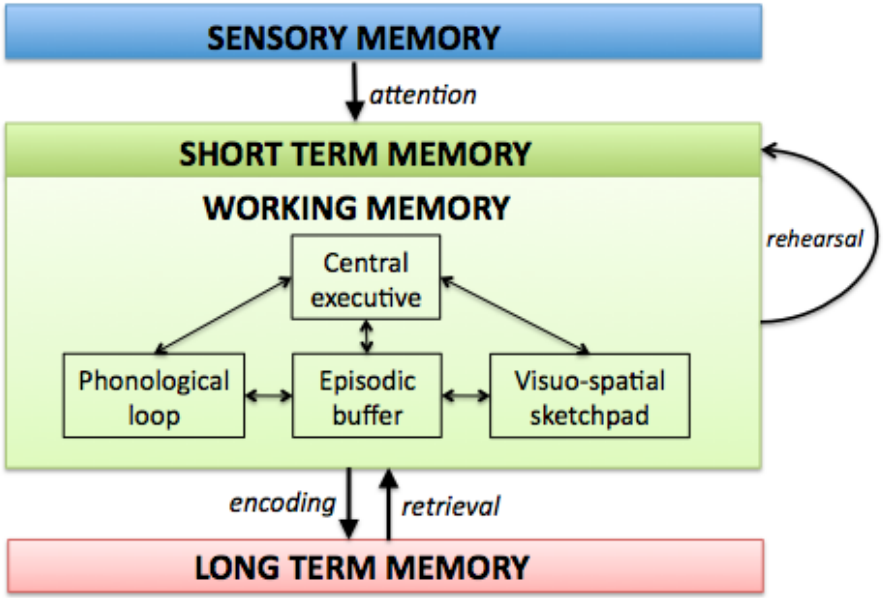



FIG. 2. The rehearsal buffer and its relation to the memory system.

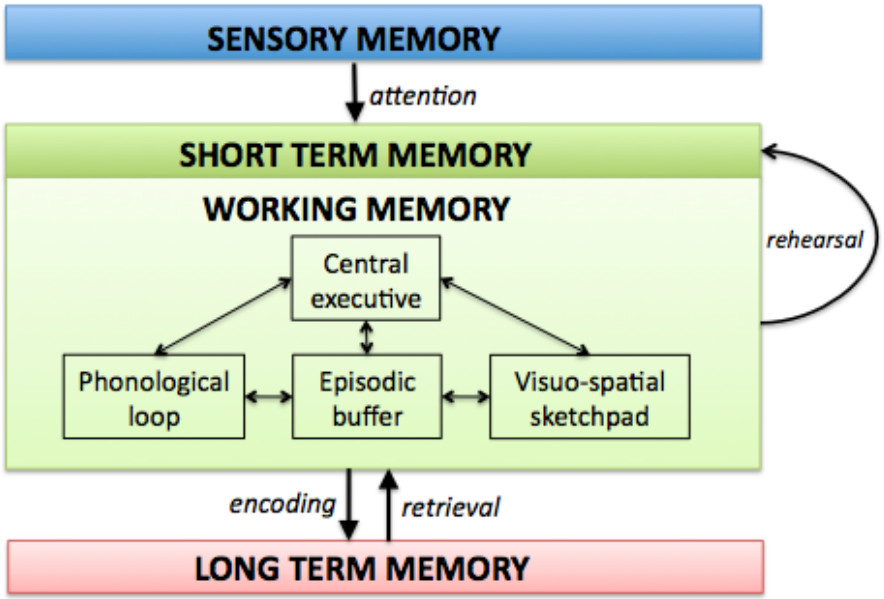
# working memory

- Baddeley's et al.'s working memory model built upon the multi-store model and expanded on the short-term store via the idea of working memory
- key idea was that WM involves storage and manipulation



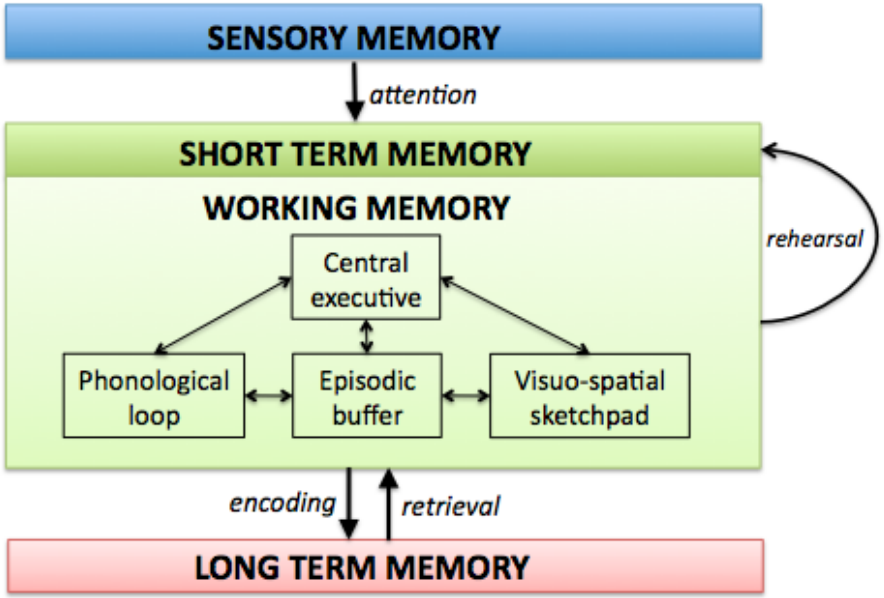
# measuring WM

- “operation span” / O-span: maintenance with challenges
- phonological loop
  - word length effect
  - articulatory suppression effect
  - phonological similarity effect

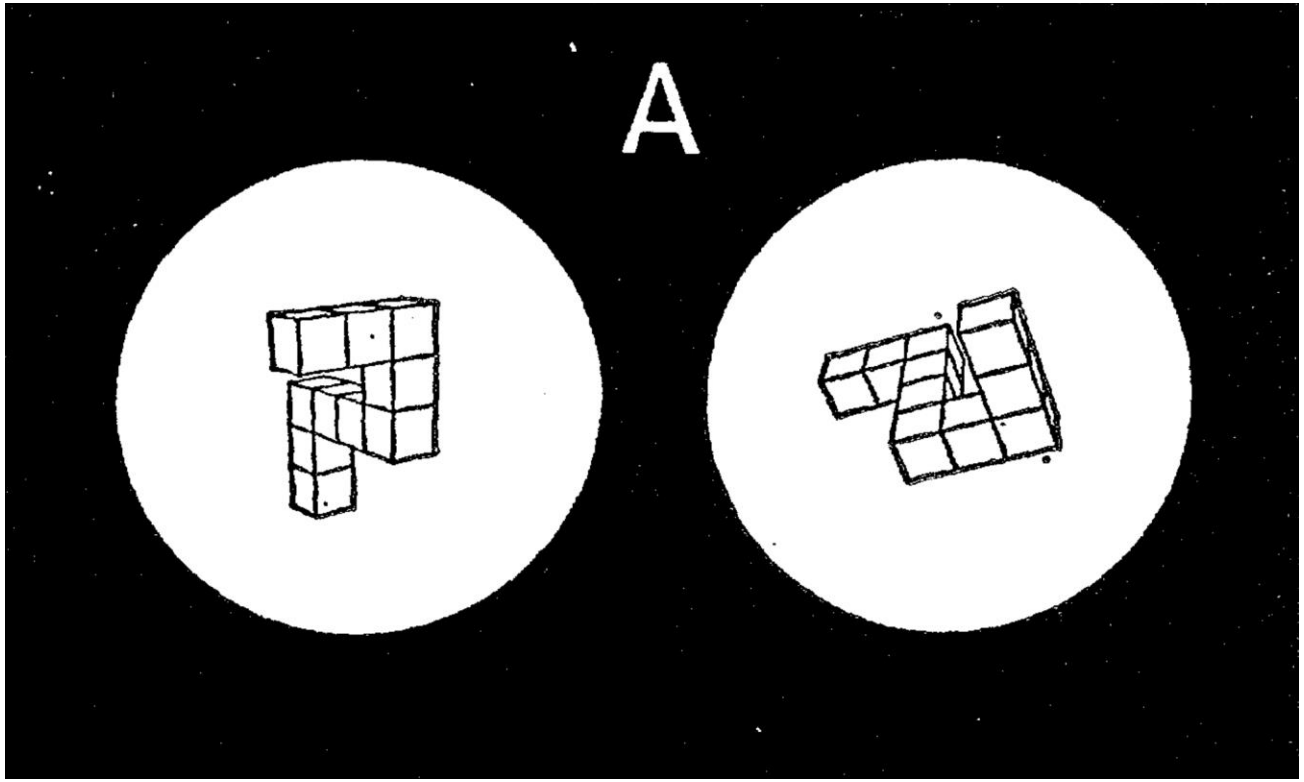


# measuring WM

- “operation span” / O-span: maintenance with challenges
- visuo-spatial sketchpad
  - mental rotation
  - maps
  - faces



# same or different?



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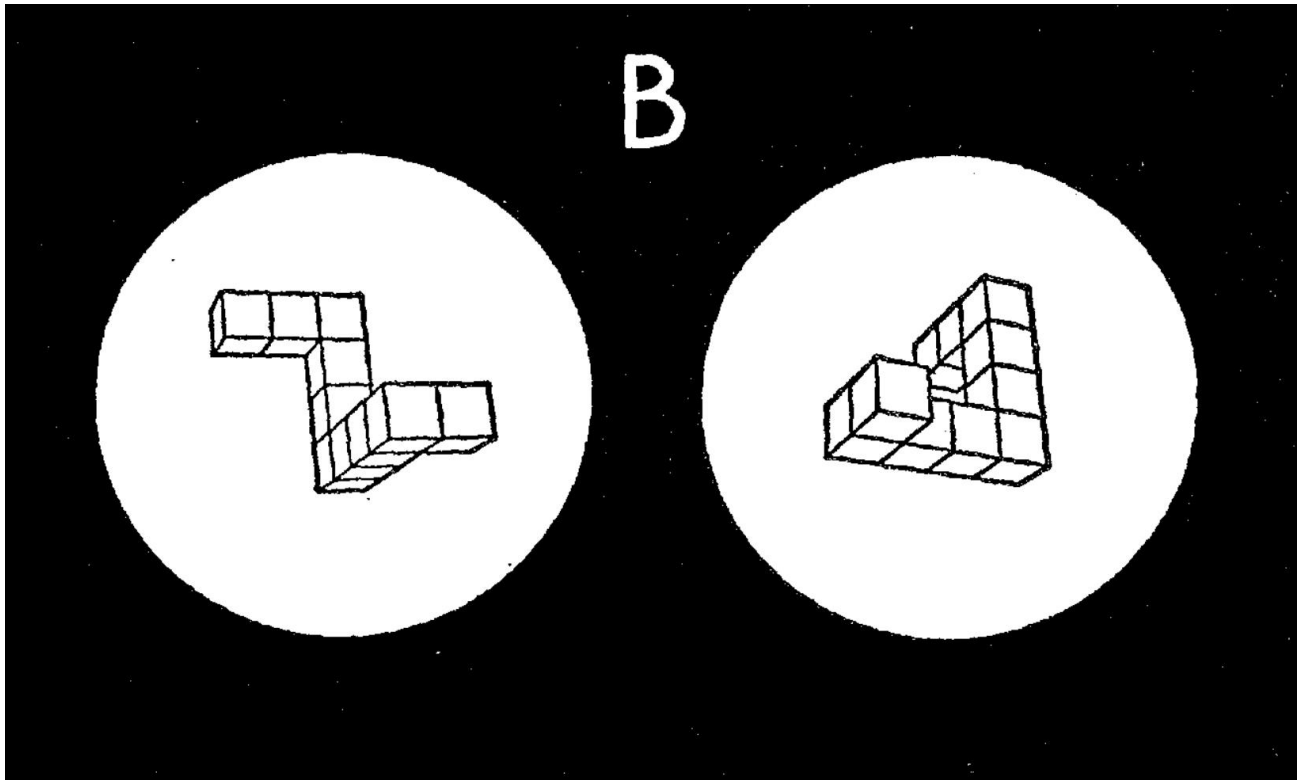

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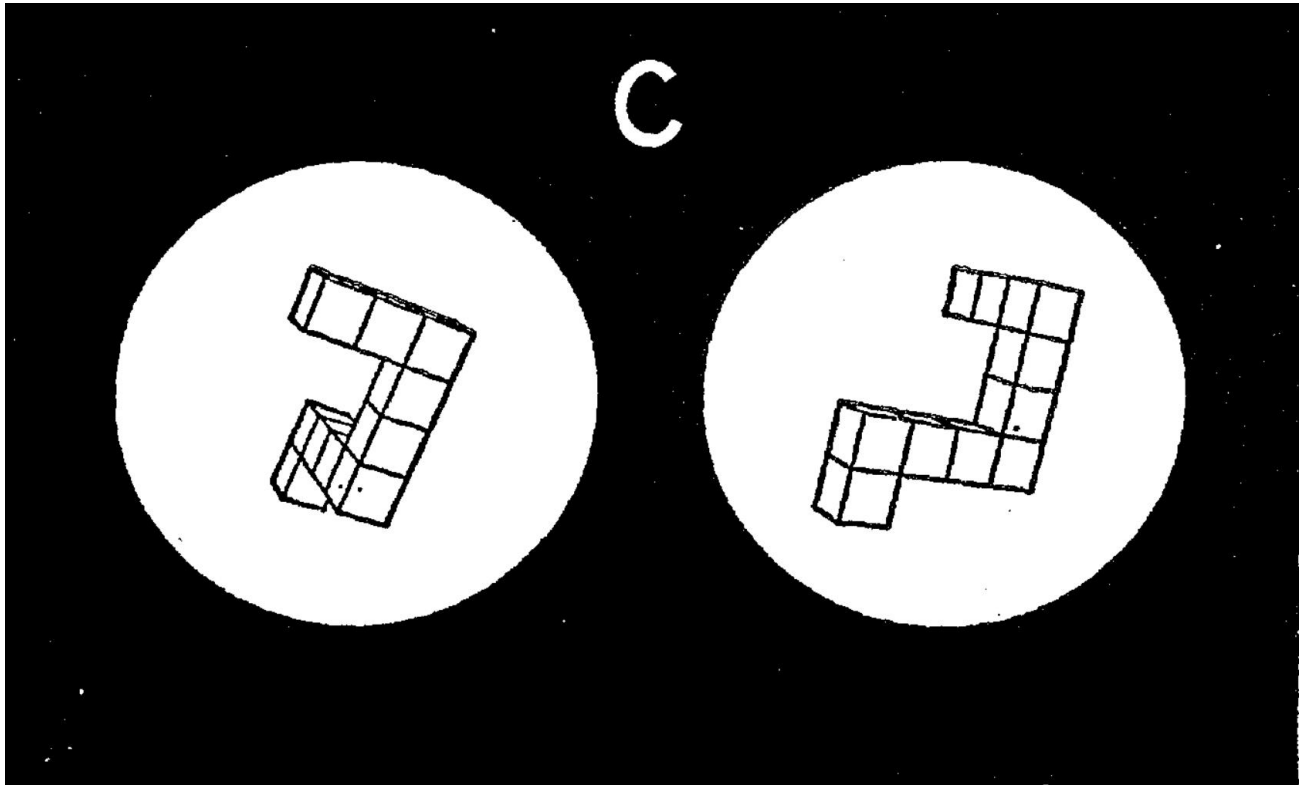
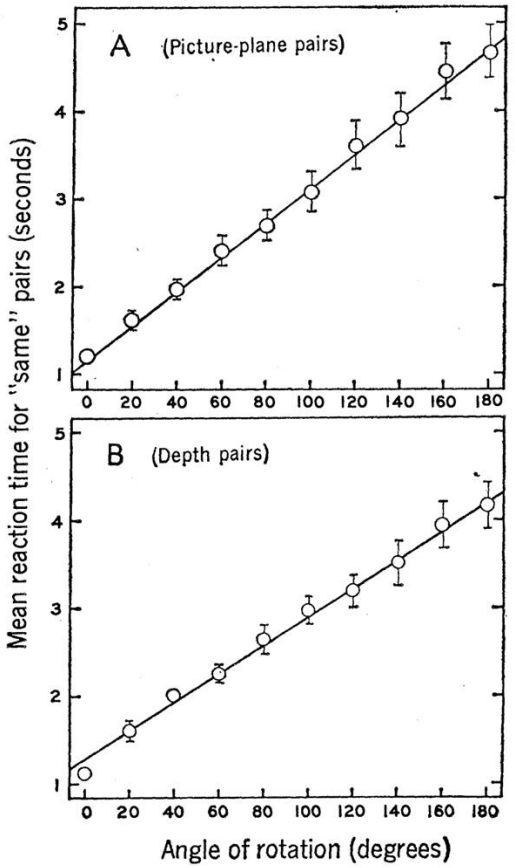
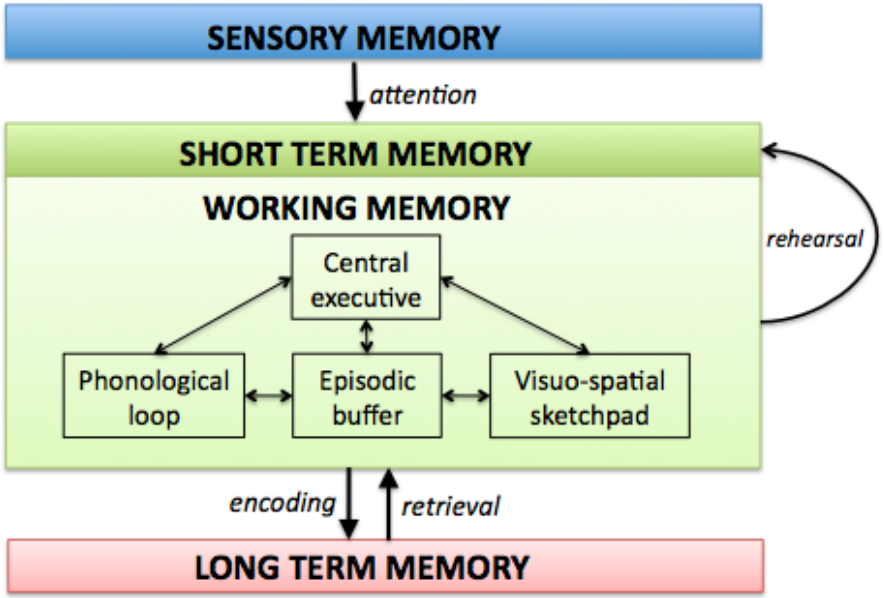


# mental rotation experiment

- Shepard and Metzler (1971) asked participants whether two drawings were of the same object or whether they were of different objects
- finding: reaction time to determine “same” pairs was linearly predicted by the angle of rotation
- inference: people mentally rotate the object holistically during the task



# exit ticket


SENSORY MEMORY
attention
SHORT TERM MEMORY
WORKING MEMORY
Central executive
Phonological loop
Episodic buffer
Visuo-spatial sketchpad
rehearsal
encoding
retrieval
LONG TERM MEMORY

# next class


- long term memory