Cognition: Methods and Models

PSYC 2040

L2: Mental Imagery

recap

- what we covered:
  - L0: Getting Started
  - L1: What is Cognition
- your to-dos were:
  - *complete:* L1 quiz and/or writing assignment + meme
  - *read:* L2 (mental imagery) chapter
  - *complete*: experiment on Canvas

today's agenda

- mental imagery
  - early explorations and introspection
 - imagery and memory
  - the imagery debate

so, what is mental imagery?

- a *subjective* experience of perception-like sensations
  - visual: "seeing" with your mind's eyes
  - auditory: "hearing" sounds/voices/music in your head
  - olfactory/gustatory: "smelling" or "tasting" things
- why study mental imagery?
  - it's cool and might be key to our imaginative abilities
  - it can inform how we learn and teach people with different abilities
  - it can help develop better models/AI

studying mental imagery

- studying *subjective* experience is hard

- method #1: ask people to **introspect**!

- Breakfast Table Task (Sir Galton Francis, 1880)
  - asked 100 people to rate their mental image of what they had for breakfast on three scales:
 - illumination, definition, coloring
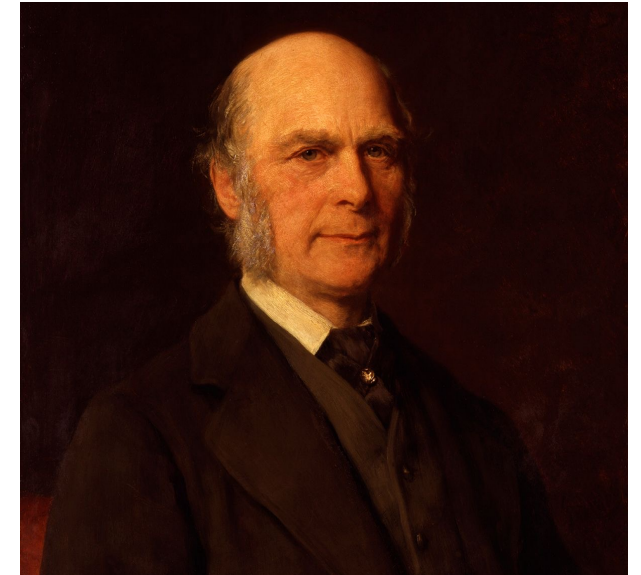
how well can you visualize your room?

- extremely vivid, as if you are back on your bed again
  - "brilliant, distinct, never blotchy"
  - "I feel as though I was dazzled"
- vivid, pretty clear picture
  - "fairly clear as a general image; details rather misty"
- fuzzy, not super clear image but you can "see" some things
  - "dim and indistinct, yet I can give an account"
- nada, no mental pictures
  - "my powers are zero", "I recollect...but do not see it"
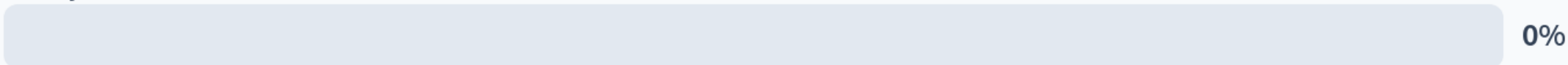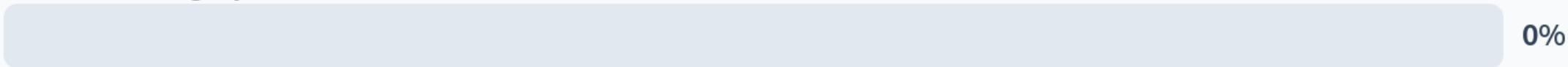
how well you can visualize your room?

extremely vivid

0%

vivid

0%

fuzzy

0%

nada, no imagery

0%
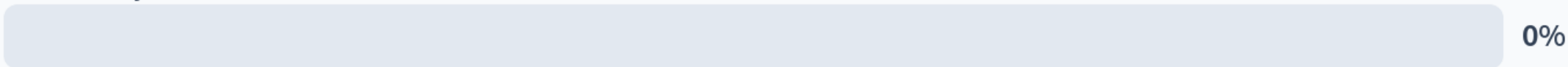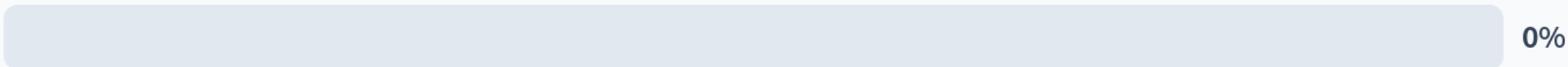
individual differences in imagery

- Galton found wide individual differences in reports of mental imagery

- fast-forward: Adam Zeman & colleagues coined aphantasia (little or no mental imagery) and hyperphantasia (heightened mental imagery, visions)
  - Aphantasia Network

Imagination Spectrum

Aphantasia   Hypophantasia   Phantasia   Hyperphantasia
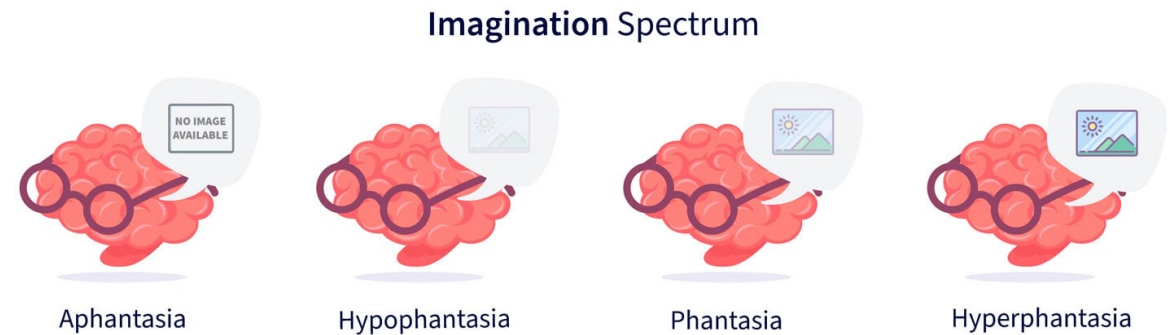
introspectionism to experimental psychology

- introspectionism was criticized by behaviorists but is still very much a part of psychological research
  - e.g., Big Five personality questionnaire, clinical questionnaires, etc.
- other methods of studying psychological phenomena
  - associationism, behaviorism, cognitive revolution, etc.
- when mental imagery did come back in the 1960s, it came back as a possible explanation for other cognitive abilities such as memory

Paivio's (1963) memory task

- question: do words have imageable qualities? are some words easier to imagine and if so, are they easier to remember?

- Paivio asked if remembering word pairs would be easier if they were more concrete vs. abstract

A concrete word comes with a higher rating and refers to something that exists in reality; you can have immediate experience of it through your senses (smelling, tasting, touching, hearing, seeing) and the actions you do. The easiest way to explain a word is by pointing to it or by demonstrating it (e.g. To explain 'sweet' you could have someone eat sugar; To explain 'jump' you could simply jump up and down or show people a movie clip about someone jumping up and down; To explain 'couch', you could point to a couch or show a picture of a couch).

An abstract word comes with a lower rating and refers to something you cannot experience directly through your senses or actions. Its meaning depends on language. The easiest way to explain it is by using other words (e.g. There is no simple way to demonstrate 'justice'; but we can explain the meaning of the word by using other words that capture parts of its meaning).

(Brysbaert et al. 2014)

Paivio's (1963) memory task

- each person learned half concrete, half abstract word pairs and then were given the adjective and had to recall the noun
- Paivio found that concrete pairs were easier to remember than abstract word pairs
- why?

Concrete pairs	Abstract Pairs
ingenious-inventor	ingenious-interpretation
technical-advertisement	technical-discourse
massive-granite	massive-rebellion
subtle-magician	subtle-prejudice
profound-philosopher	profound-analysis
colorful-maple	colorful-scenery
reliable-luggage	reliable-merchandize
expressive-actress	expressive-temperament
amazing-circus	amazing-crusade
noisy-trumpet	noisy-gossip
fashionable-overcoat	fashionable-apparel

# **possible** explanations/inferences

- concrete pairs are more "imageable"
  - imagery!
- concrete pairs were already highly associated (e.g., noisy-trumpet vs. noisy-gossip)
  - no need for imagery!
- how would you tease these two explanations apart?

Concrete pairs	Abstract Pairs
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follow-up experiment: Paivio (1965)

- you learned some word pairs and were asked to retrieve them

follow-up experiment: Paivio (1965)
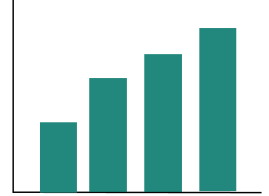
- used only noun-noun pairs
  - concrete-concrete (CC) / concrete-abstract (CA) / abstract-concrete (AC) / abstract-abstract (AA)

- obtained ratings for all nouns on imagery, meaningfulness (m), and familiarity

- discuss in groups:
  - plot a predicted pattern of results
  - which conditions should produce the best/worst recall?
  - come up with a figure and reasoning

word pair	condition
string-pencil	CC
wheat-dress	CC
star-garden	CC
chair-flower	CC
magazine-virtue	CA
woman-moment	CA
river-idea	CA
coffee-effort	CA
history-potato	AC
theory-star	AC
health-house	AC
fact-tree	AC
soul-opinion	AA
freedom-series	AA
truth-duty	AA
fate-event	AA

yours vs. Paivio's results
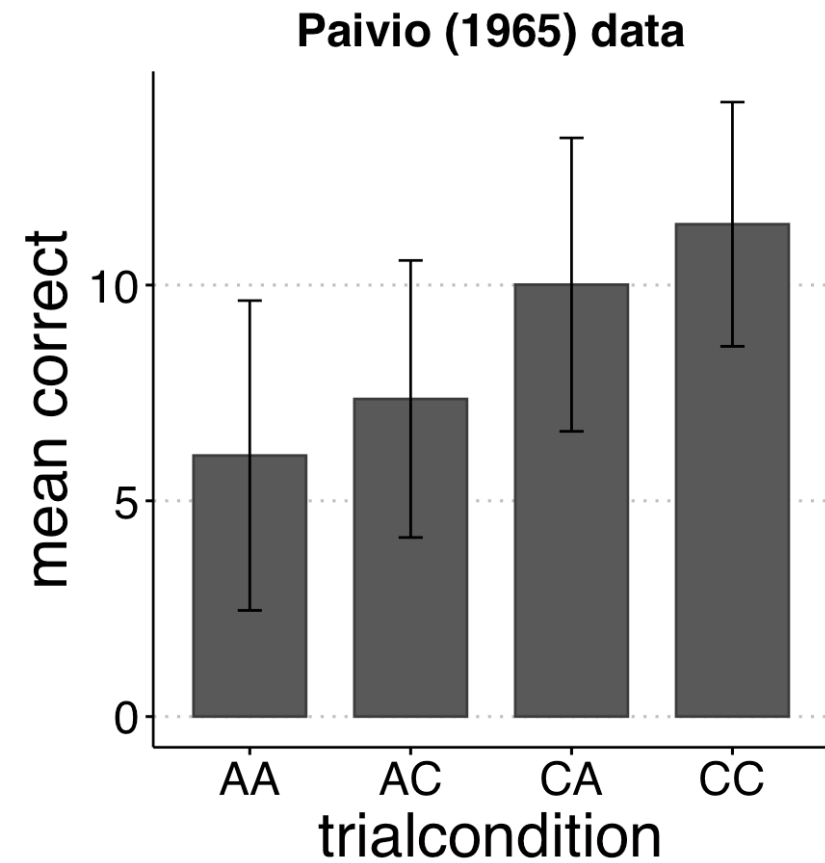
Paivio (1965) data

follow-up experiment: Paivio (1965)

- potential evidence for imagery
- but ...
  - are concrete words also more meaningful or easily verbalized?
  - the words could also differ on several other dimensions (e.g., frequency, valence, etc.)
- bottom line: concreteness is related to imagery but could have alternative explanations

TABLE 1

MEAN TOTAL NUMBER OF CORRECT RESPONSES ON FOUR TRIALS AS A FUNCTION OF STIMULUS AND RESPONSE ABSTRACTNESS

	Response			
	Concrete		Abstract	
Stimulus	Mean	SD	Mean	SD
Concrete	11.41	2.83	10.01	3.21
Abstract	7.36	3.40	6.05	3.59

the imagery debate

- in the 1960s and 70s, there were several studies that suggested the need for mental imagery to perform a variety of cognitive tasks

- this led to a fundamental debate in the field about what exactly happens when people are engaged in mental imagery

- broadly, the imagery debate was about representation

what is a mental representation?

- the idea of a mental representation implies that we have some kind of *internal* "format" for storing information

- external knowledge has formats
  - images on your computer: pixels
  - any information on machines: binary (0/1) digits
  - words and letters: squiggles

- what is the *format* of internal knowledge?

- when you "see" a beach, what are you "seeing"?

mental imagery representations

- pictorial representation
  - image-like representation
  - just like actually seeing a picture
- propositional representation
  - representation based on symbols and rules (like grammar)
  - not image-like at all
- fundamentally different proposals for how we represent knowledge

testing the **format** of representations

- Stephen Kosslyn and colleagues came up with clever mental scanning experiments

- participants were asked to mentally navigate different locations on the map, some close and some far
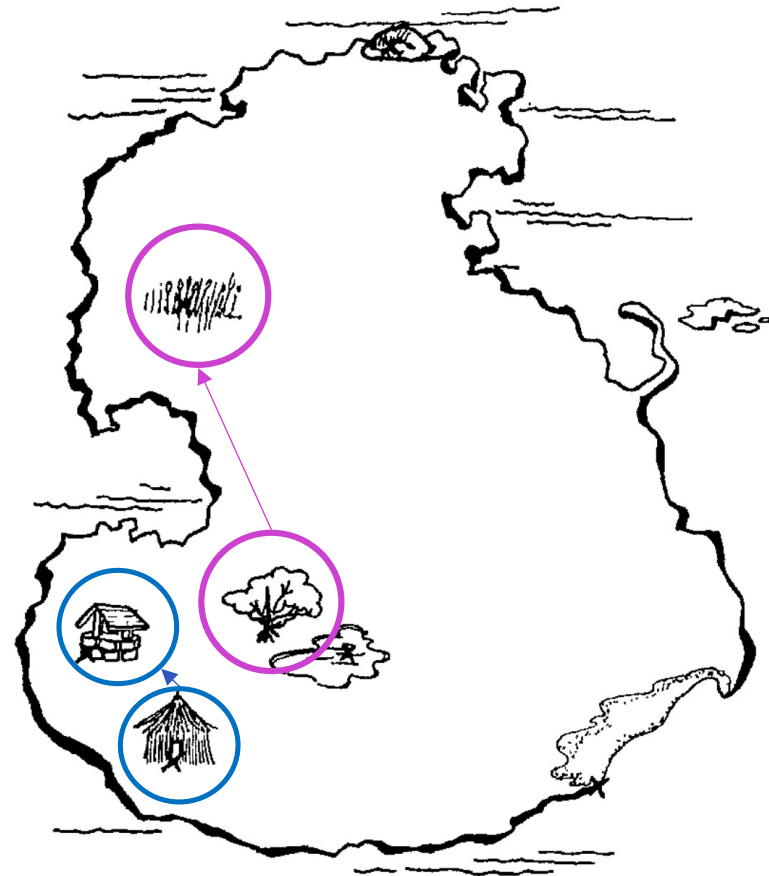
possible **predictions** of pattern

- when plotting patterns (predicted or actual), independent variables are often the X-axis and dependent variables are the Y-axis

- what would a "same-time" prediction look like?
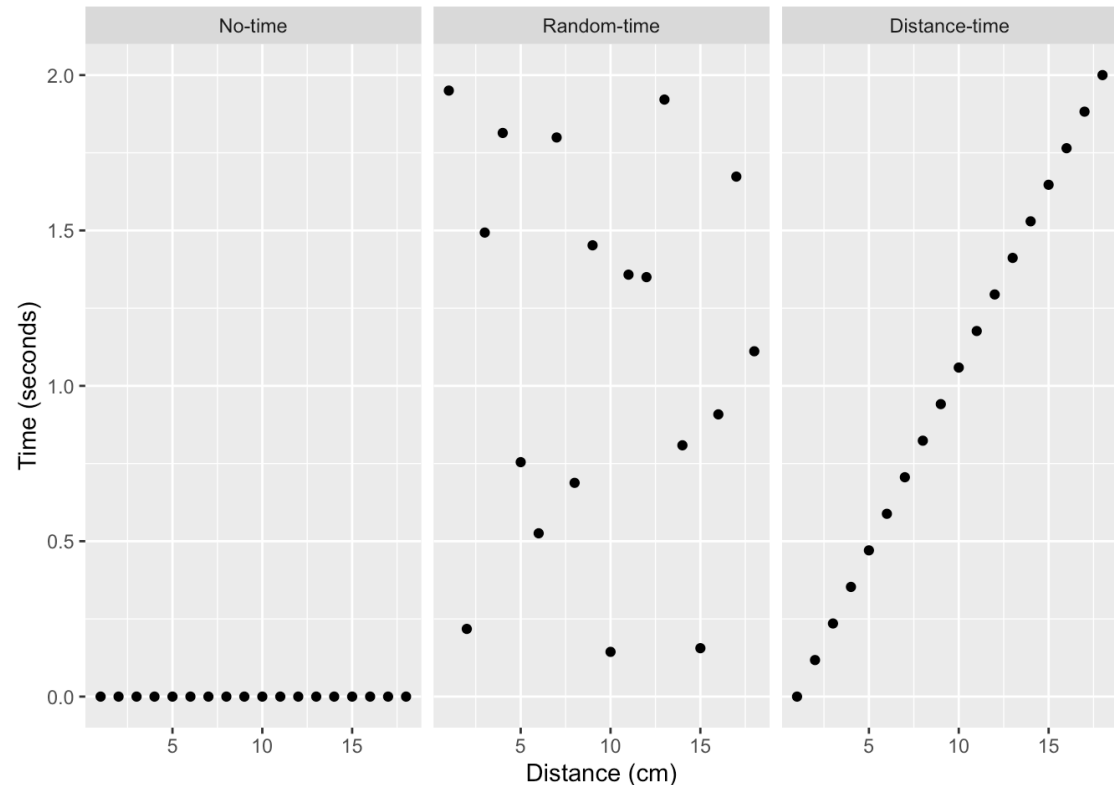
Kosslyn et al. (1978) results and inferences

- finding: reaction time was linearly predicted by the distance between the objects
- inference: the time to mentally scan an image is influenced by the actual distances
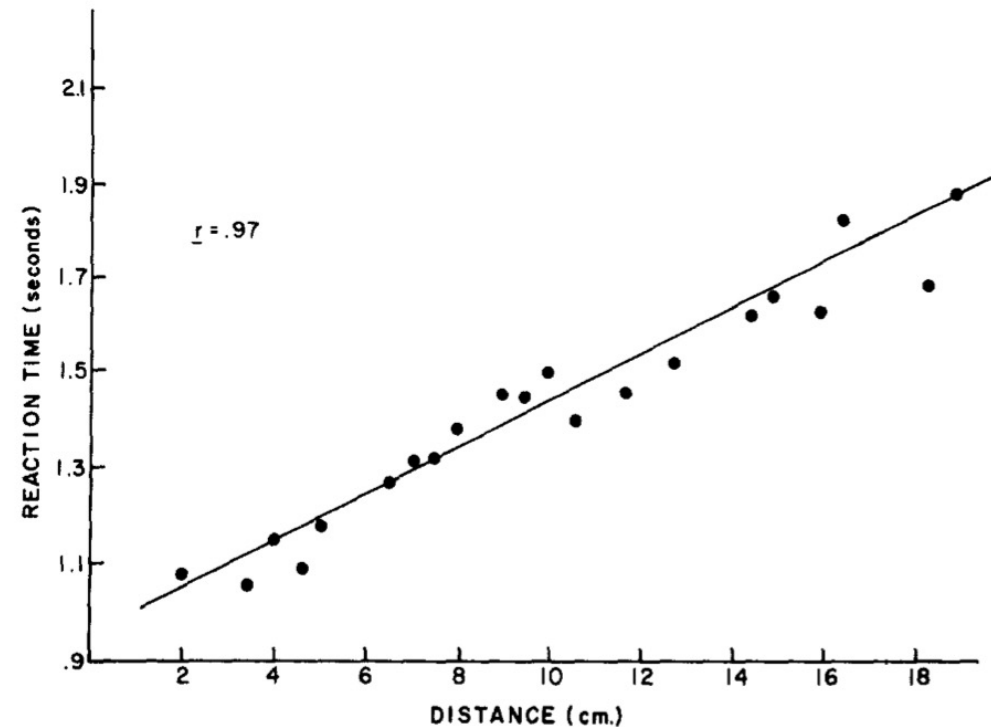- support for the pictorial format of the representation
 - why??

Figure 3. The results of Experiment 2: Time to scan between all pairs of locations on the imaged map.

Pylyshyn's propositional account

- could the findings be explained by the time to process the propositions that store information about the map?
    - the grass is on the north-west side
    - the tree and well are on the south-west
    - the lake is south-east of the tree and close
- if mental imagery is necessary for this task, could aphantasics help us resolve this debate?
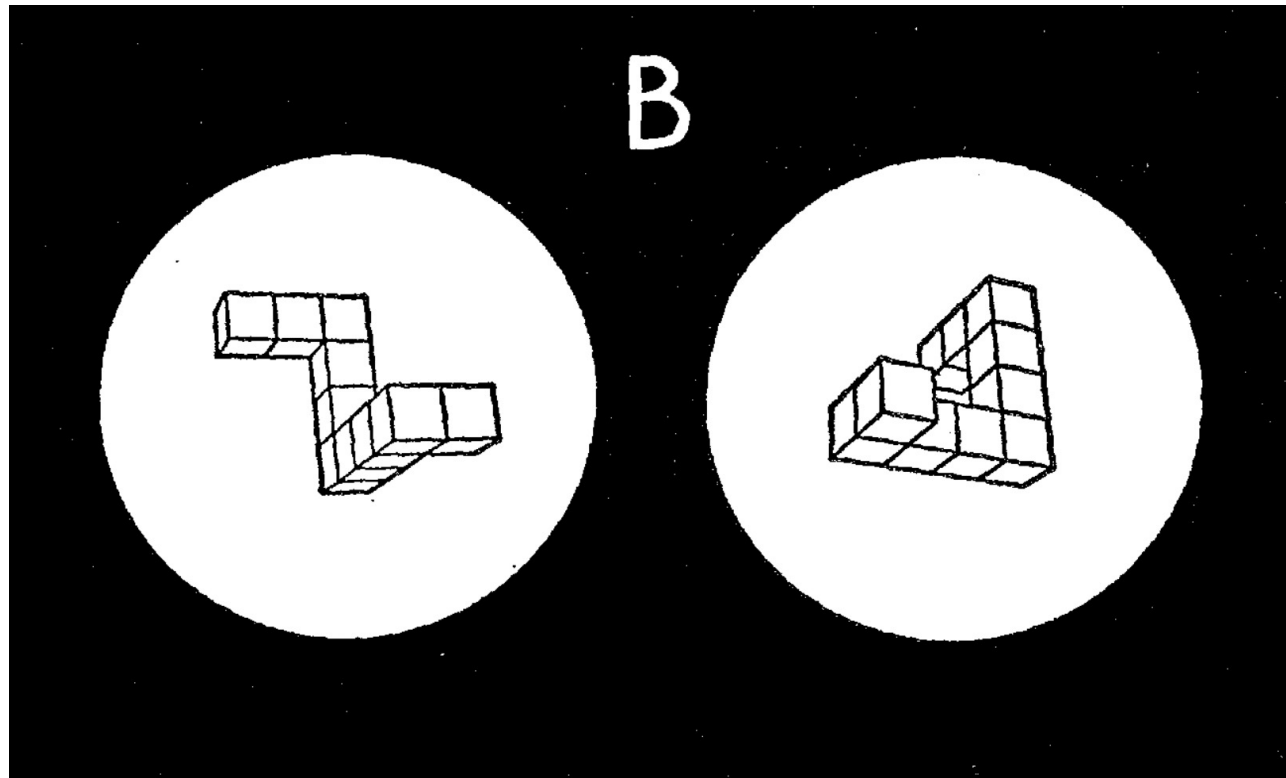   - individual differences help us constrain our theories and predictions
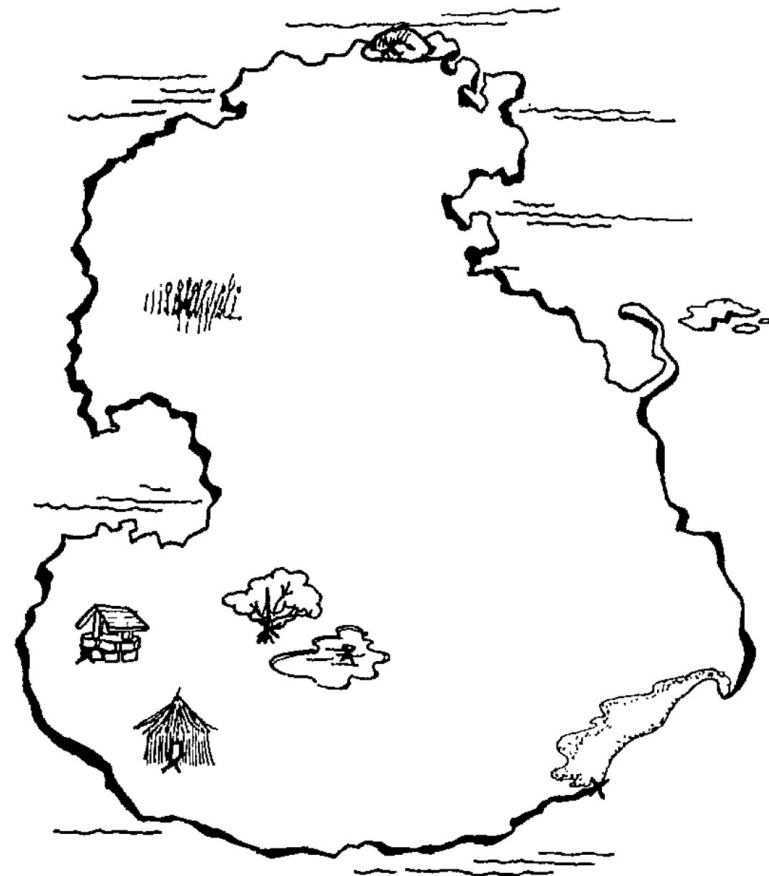
another experiment

- you will be shown two three-dimensional objects

- your task is to decide whether these objects are the same object in different orientations or entirely different objects
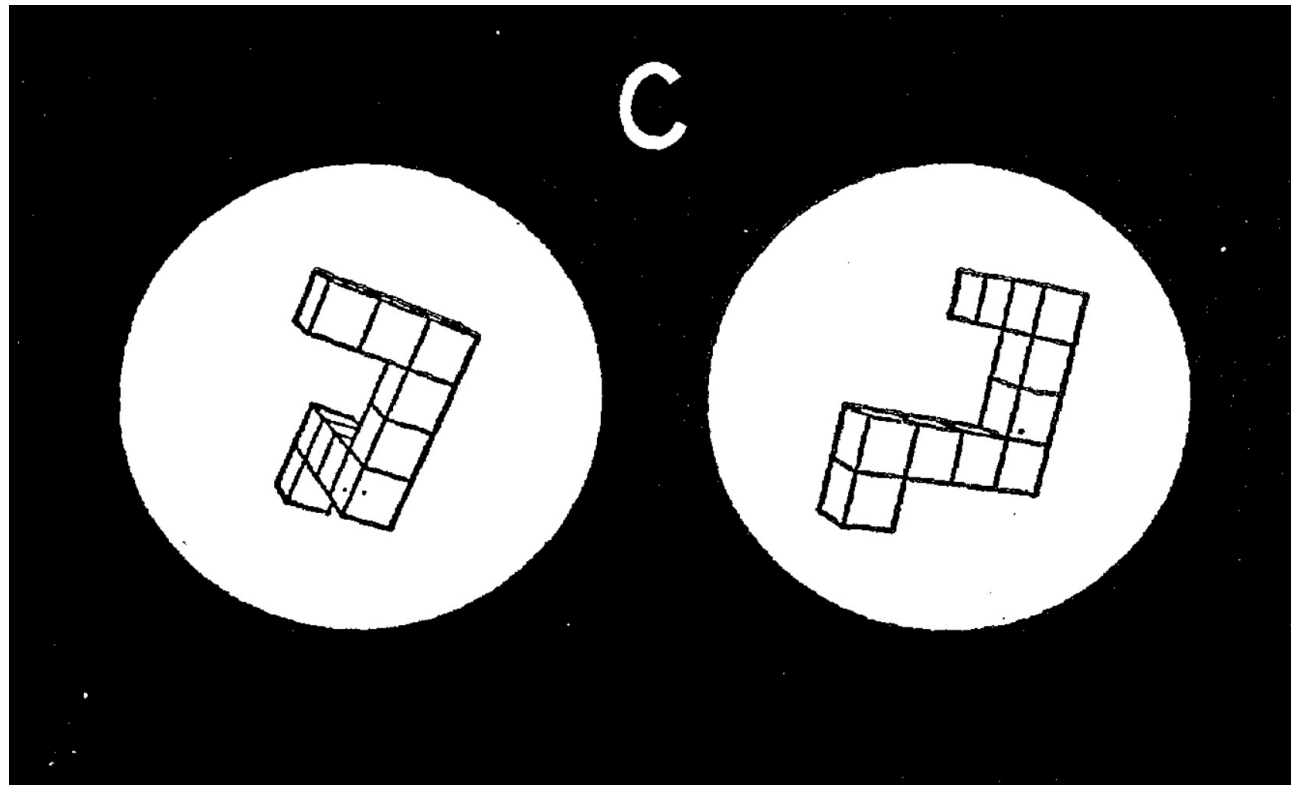
- we will then debrief in groups

same or different?
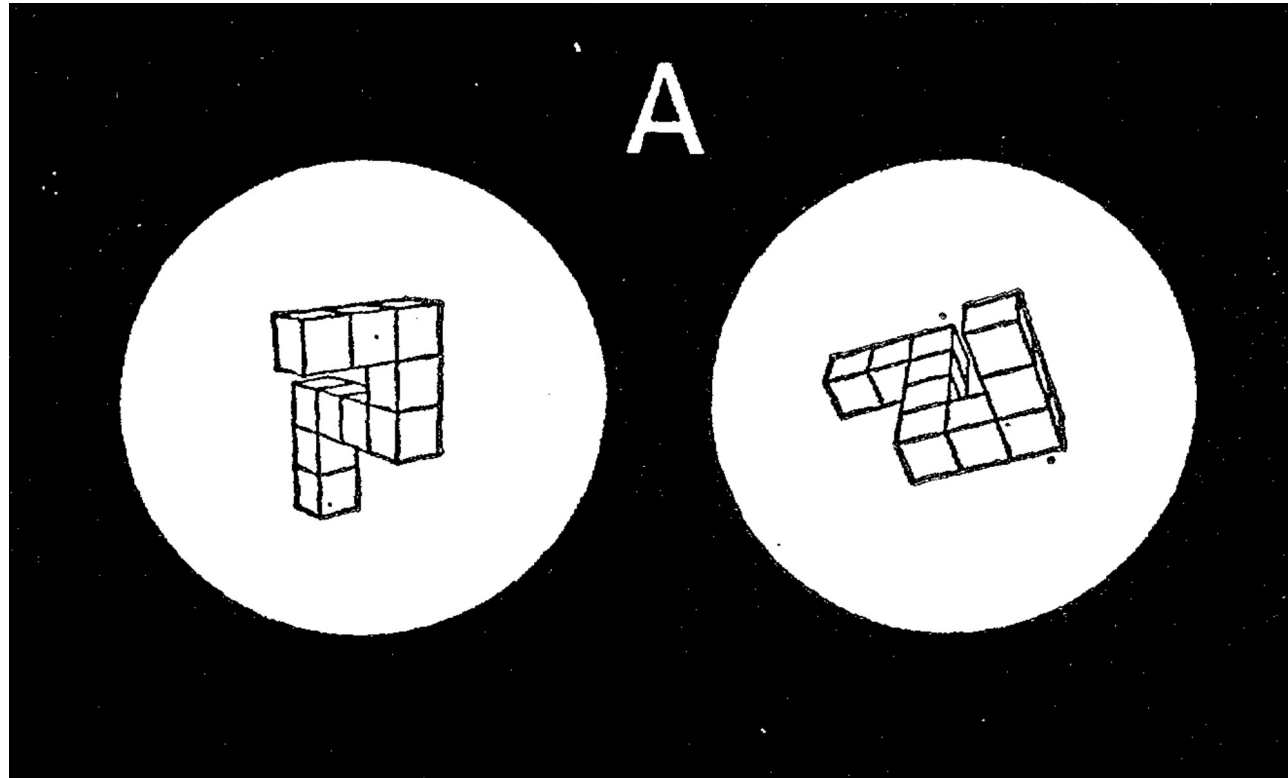
# same or different?

same or different?

debrief

- in groups, discuss:
    - how did you do this task?
    - did you utilize mental imagery?
    - is this a better test of mental imagery than Paivio's memory experiment?
- come back and share with the class

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

- alternative explanations: could also be using informative or "landmark" features / other strategies
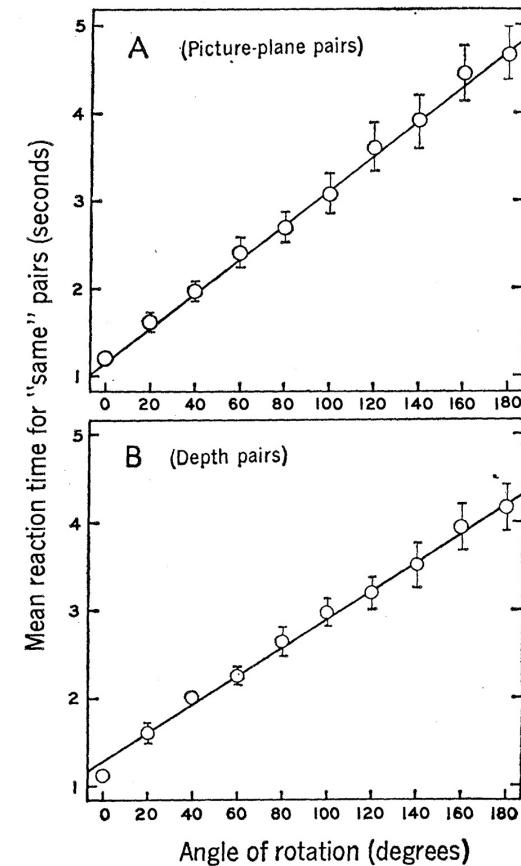
the **aftermath** of the imagery debate

- evidence from neuroscience has been helpful in assessing the utility and presence of visual/pictorial/depictive representations

- there is now general consensus that mental representations likely make use of multiple formats

- there may be a functional role to depictive/pictorial representations
  - "wiring optimization principle"
  - memory & reasoning

The heterogeneity of mental representation: Ending the imagery debate

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Abstract

The possible ways that information can be represented mentally have been discussed often over the past thousand years. However, this issue could not be addressed rigorously until late in the 20th century. Initial empirical findings spurred a debate about the heterogeneity of mental representation: Is all information stored in propositional, language-like, symbolic internal representations, or can humans use at least two different types of representations (and possibly many more)? Here, in historical context, we describe recent evidence that humans do not always rely on propositional internal representations but, instead, can also rely on at least one other format: depictive representation. We propose that the debate should now move on to characterizing all of the different forms of human mental representation.

big **takeaways**

- the subjective experience of mental imagery produces wide individual differences

- the field has moved from introspection to behavioral experiments to physiology & brain imaging (therefore invoking multiple levels of analysis)

- understanding the experience of mental imagery can inform how people learn or interact with the world and improve their quality of life

next class

- **before** class:
  - *read:* L3 (Eugenics + Intelligence Testing chapters)
  - *watch*: video on eugenics & Galton
  - *skim through:* APA historical chronology

- **during** class:
  - a history of how psychology began (and went wrong) + what is intelligence?