Cognition

PSYC 2040

W10: Problem solving

today’s agenda

- class survey discussion
- midterm discussion + a note about metacognition
- literature review tutorial
- problem solving fundamentals

effective learning strategies

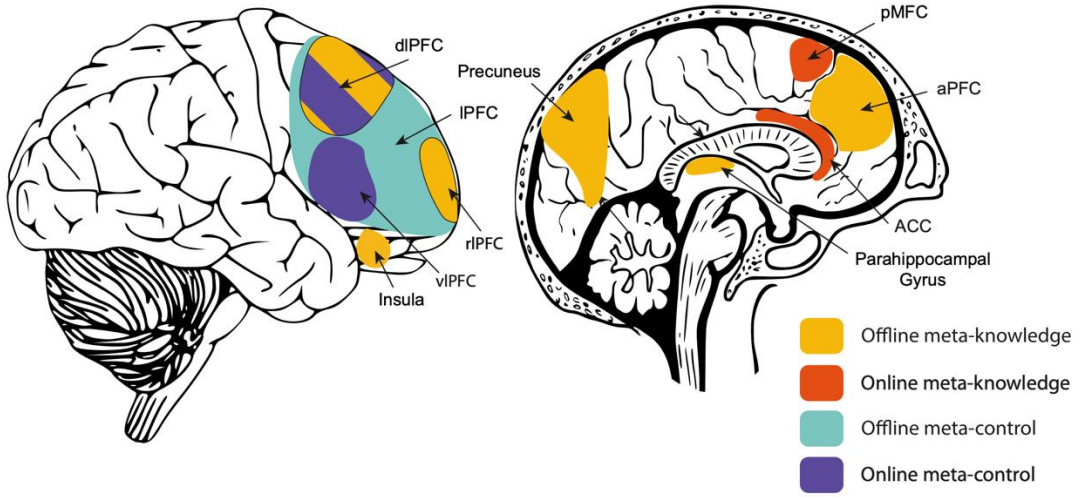
- **effective note-taking**: don’t copy off the slides, paraphrase & restructure!
- **active recall:** weekly quizzes, exit tickets, class discussions
- **spacing & elaborative encoding**: review regularly & find connections
- **asking questions**: use all resources, challenge yourself, treat your mistakes as learning opportunities!

metacognition

- meta-knowledge: the knowledge individuals have of their own cognitive processes and their ability to monitor and reflect on them.
  - tested via metacognitive judgments
  - "offline": past/future reflection
  - interviews: answer questions regarding hypothetical situations
  - learning journals: write about their learning experience and their thoughts on learning
  - think-aloud protocols: asked to verbalize their thoughts while performing a problem-solving task
- meta-control: someone's self-regulatory mechanisms, such as planning and adapting behavior based on outcomes
  - tested via WM/attention experiments (e.g., Stroop)
  - "online": during task error monitoring

Table 1 Components of metacognition about practice testing

Component of metacognition	Definition	Common examples in the context of testing
Beliefs	Declarative, procedural, and conditional knowledge or perceptions about how one learns	• Believing that restudying is more effective than testing for memory under certain conditions • Believing daily quizzes reduce anxiety about high-stakes exams
Monitoring	Assessing the current state of learning or performance	• Evaluating past memory performance or estimating future memory performance for material that was tested or restudied
Control	Regulating some aspect of learning	• Planning to test oneself on easy material and to restudy difficult material • Testing oneself until all material is correctly recalled once



metacognitive judgments

- feelings of knowing (FOK): the belief of knowing the answer to a question or a problem and being able to recognize it from a list of alternatives, despite being unable to explicitly recall it
  - after the retrieval attempt
- judgments of learning (JOL): prospective judgments during learning of one's ability to successfully recall an item on subsequent testing
  - before the retrieval attempt
- retrospective confidence judgments (2AFC task):
  - metacognitive sensitivity (the ability to discriminate one's own correct and incorrect judgments)
  - metacognitive bias (the overall level of confidence during a task)
  - metacognitive efficiency (the level of metacognitive sensitivity when controlling for task performance)

importance of accurate metacognition

- when students have poor calibration and are overconfident in their understanding, they stop studying too early (Dunlosky & Rawson, 2012; Karpicke, 2009; Kornell & Bjork, 2008)
- repeated successful retrievals are important: students learn significantly more when they do not drop flashcards for correct retrievals and continue practicing beyond the first successful recall attempt (cf. Bahrick, 1979; Rawson et al., 2013).

paper

wait-generate-validate

Table 1. A summary of the wait-generate-validate strategy

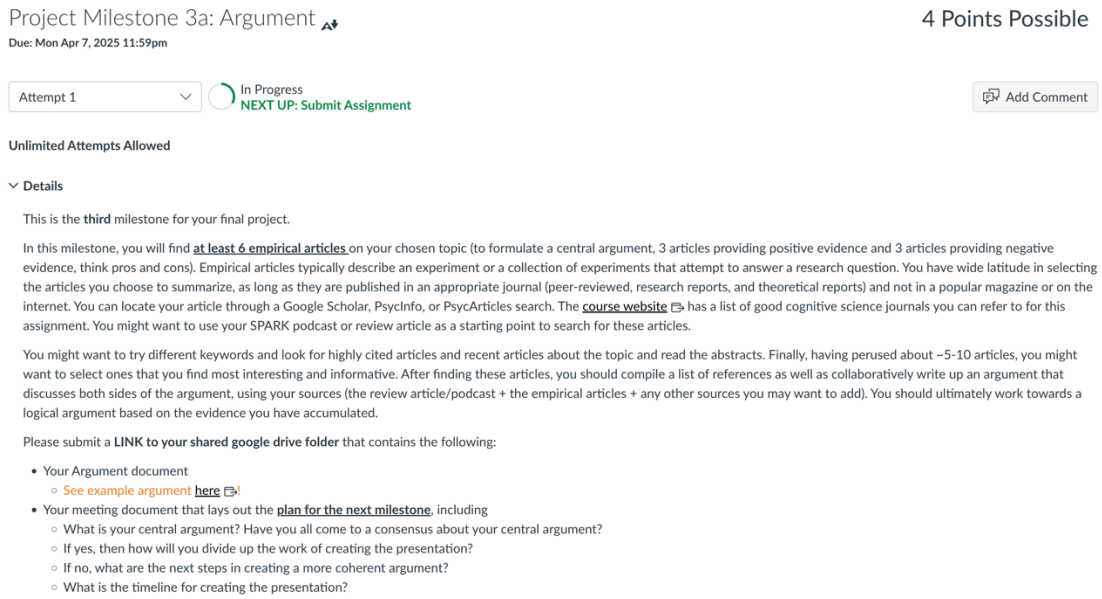
	Step 1: Wait	Step 2: Generate	Step 3: Validate
What it is	Wait minutes to days after learning material.	Then try to generate the material from memory.	Finally, validate the accuracy and completeness of the information you generated. Now you can judge your understanding of the material.
Why it works	Waiting will give you a more accurate sense of what information you can actually remember long enough for the test, rather than what information is just fresh on your mind.	Generating will give you a more accurate sense of what information you can produce on your own, without the help of your notes or book, just like you will have to do on a test.	Validating will give you a more accurate sense of how much you know, whether the information you can recall is correct, and whether you still have any misconceptions.
An example of how to do it	Wait until the day after a lecture to judge your understanding.	Then try to write down the key terms and concepts from the lecture without looking at your notes.	Finally, check your notes to verify that the terms and concepts you recalled were correct. Make sure you did not miss any major terms or concepts.

Note. For accurate metacognitive monitoring, students should use the wait-generate-validate strategy after learning material but before judging how well they understand it.

paper

logistics: project

- next milestone: argument
  - formulate
  - 3 sources per “side” of argument
- sample argument available on Canvas
- SPARK common issues
  - article not being a peer-reviewed article
  - writing the summary in first person
  - collaboration/accountability issues
- final presentation (3) + team skills (2)



Project Milestone 3a: Argument

4 Points Possible

Due: Mon Apr 7, 2025 11:59pm

Attempt 1

In Progress
NEXT UP: Submit Assignment

Add Comment

Unlimited Attempts Allowed

Details

This is the **third** milestone for your final project.

In this milestone, you will find **at least 6 empirical articles** on your chosen topic (to formulate a central argument, 3 articles providing positive evidence and 3 articles providing negative evidence, think pros and cons). Empirical articles typically describe an experiment or a collection of experiments that attempt to answer a research question. You have wide latitude in selecting the articles you choose to summarize, as long as they are published in an appropriate journal (peer-reviewed, research reports, and theoretical reports) and not in a popular magazine or on the internet. You can locate your article through a Google Scholar, PsycInfo, or PsycArticles search. The course website has a list of good cognitive science journals you can refer to for this assignment. You might want to use your SPARK podcast or review article as a starting point to search for these articles.

You might want to try different keywords and look for highly cited articles and recent articles about the topic and read the abstracts. Finally, having perused about ~5-10 articles, you might want to select ones that you find most interesting and informative. After finding these articles, you should compile a list of references as well as collaboratively write up an argument that discusses both sides of the argument, using your sources (the review article/podcast + the empirical articles + any other sources you may want to add). You should ultimately work towards a logical argument based on the evidence you have accumulated.

Please submit a **LINK to your shared google drive folder** that contains the following:

- Your Argument document
  - See example argument here
- Your meeting document that lays out the **plan for the next milestone**, including
  - What is your central argument? Have you all come to a consensus about your central argument?
  - If yes, then how will you divide up the work of creating the presentation?
  - If no, what are the next steps in creating a more coherent argument?
  - What is the timeline for creating the presentation?

mid-semester check-in

- calendly link
- groups
  - schedule a 15-minute meeting post spring break
  - argument articles must be preliminarily “approved”
- individually
  - set up an individual time to chat separately from group

types of scientific sources

peer reviewed

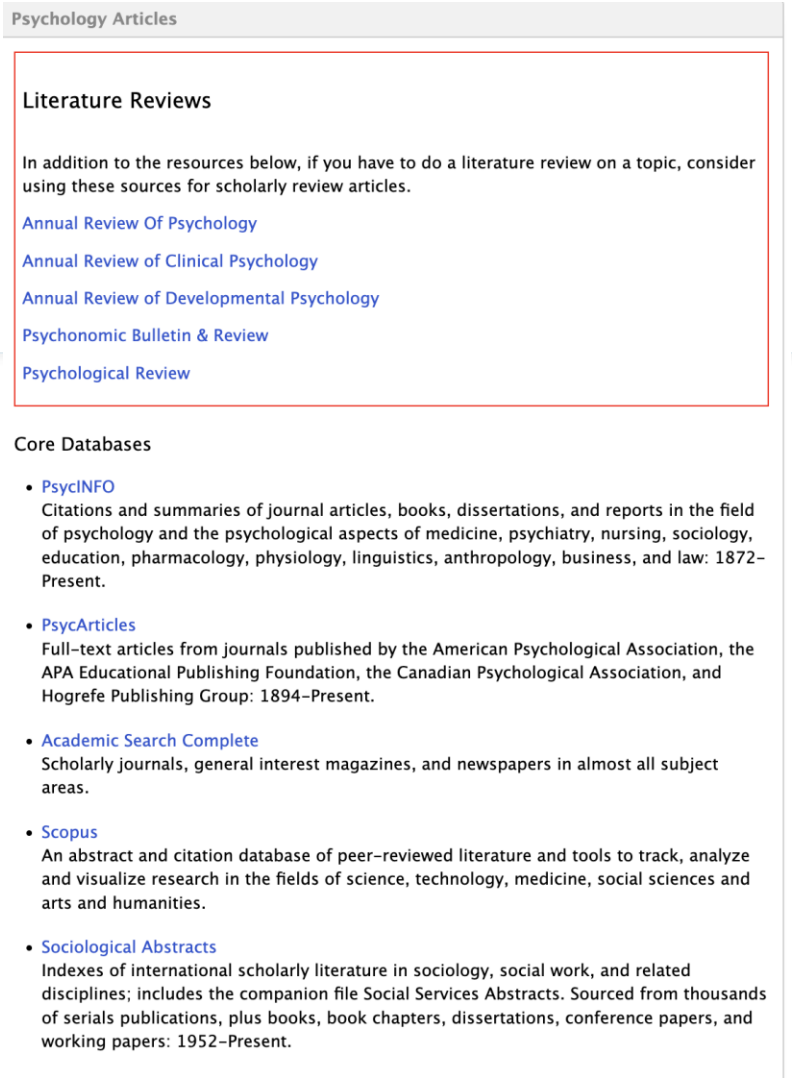
- published in scientific journals
- undergo rigorous review by field experts
- types:
  - empirical articles
  - meta-analyses
  - review articles

NOT peer reviewed

- meant for a non-expert audience
- (typically) do not undergo **rigorous** review by field experts
- types
  - book chapters
  - dissertations/theses
  - press releases

lit review avenues

- Bowdoin library database
- APA PsycNet
- Google Scholar
- Journal websites



Psychology Articles

Literature Reviews

In addition to the resources below, if you have to do a literature review on a topic, consider using these sources for scholarly review articles.

Annual Review Of Psychology

Annual Review of Clinical Psychology

Annual Review of Developmental Psychology

Psychonomic Bulletin & Review

Psychological Review

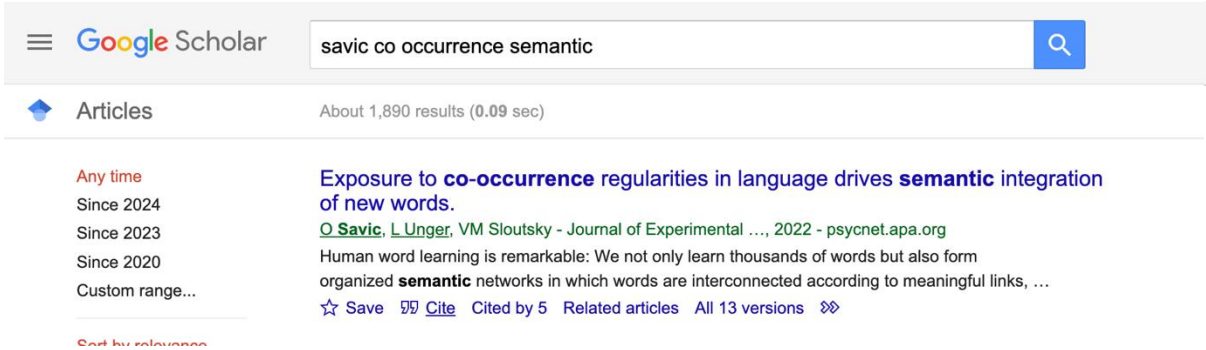
Core Databases

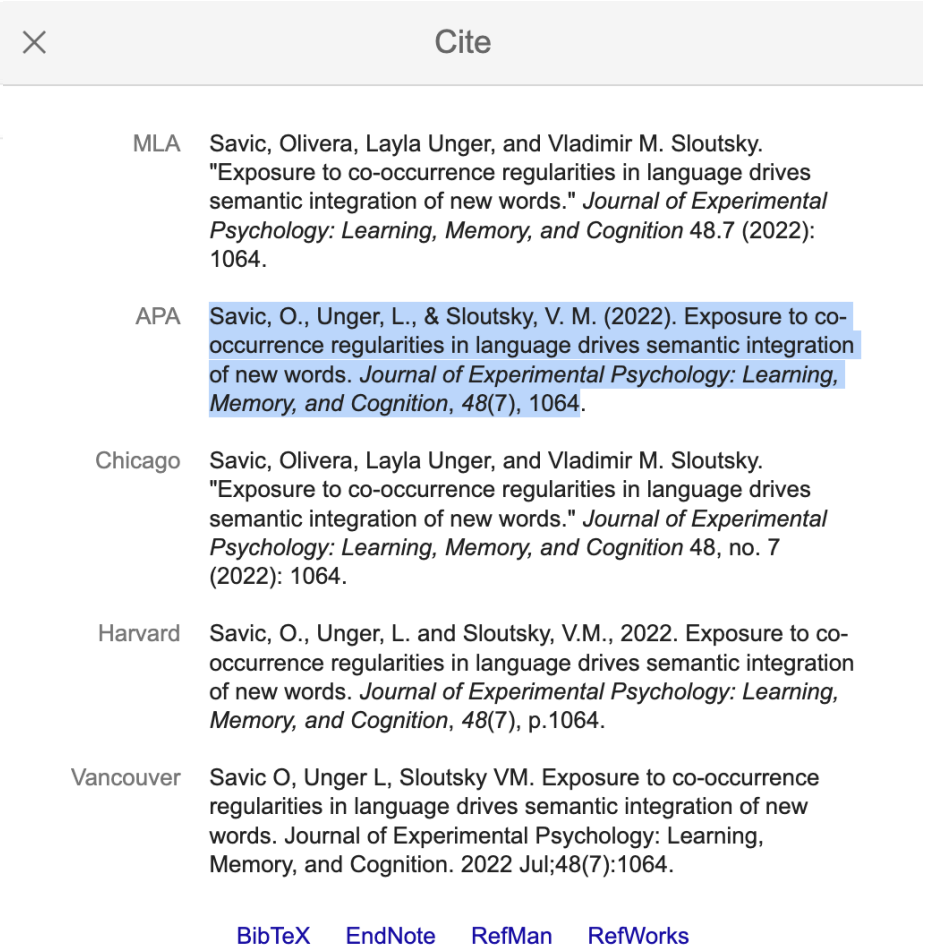
- PsycINFO
  Citations and summaries of journal articles, books, dissertations, and reports in the field of psychology and the psychological aspects of medicine, psychiatry, nursing, sociology, education, pharmacology, physiology, linguistics, anthropology, business, and law: 1872-Present.
- PsycArticles
  Full-text articles from journals published by the American Psychological Association, the APA Educational Publishing Foundation, the Canadian Psychological Association, and Hogrefe Publishing Group: 1894-Present.
- Academic Search Complete
  Scholarly journals, general interest magazines, and newspapers in almost all subject areas.
- Scopus
  An abstract and citation database of peer-reviewed literature and tools to track, analyze and visualize research in the fields of science, technology, medicine, social sciences and arts and humanities.
- Sociological Abstracts
  Indexes of international scholarly literature in sociology, social work, and related disciplines; includes the companion file Social Services Abstracts. Sourced from thousands of serials publications, plus books, book chapters, dissertations, conference papers, and working papers: 1952-Present.

lit review activity

- find your group and finalize your research question
- then look for empirical articles together

APA citations



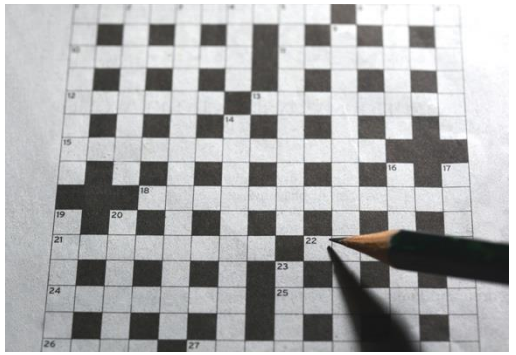


today’s agenda

- defining problems
- restructuring
- analogy

what is a problem?

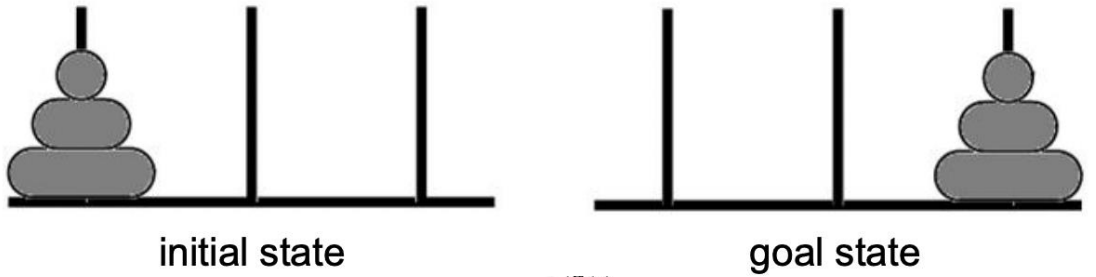
- a state that differs from a desired goal
- well-defined problems
  - clearly defined current state
  - finite set of possible operations/rules
  - clear goal state
  - examples: chess, tower of Hanoi, etc.
- ill-defined problems
  - underspecified current/goal state and/or rules
  - examples: finding a partner, writing a poem, etc.



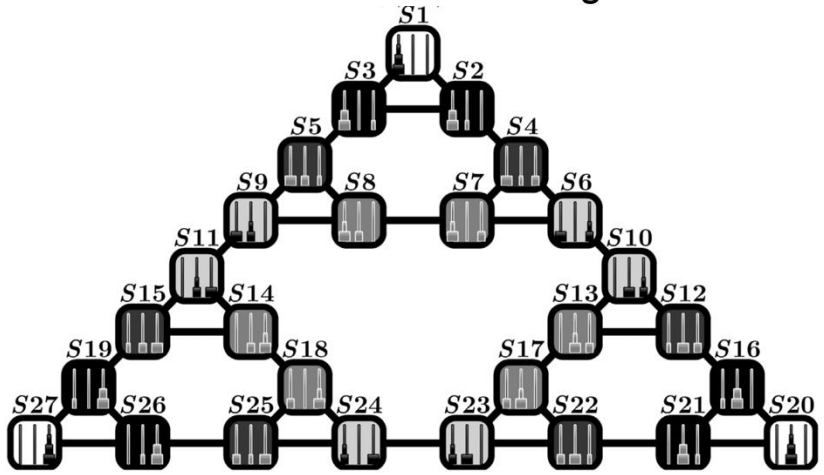
tower of Hanoi

- a well-defined *transformation* problem
- solved via means-end analysis (problem solver gradually reduces the difference between the initial and goal state)
- typically used to assess frontal lobe and executive functioning deficits
- optimal solution: 7 moves ($2^n - 1$)
  - n = number of discs
- strategies:
  - remembering move sequences
  - using sub-goals
  - step-by-step instructions
  - trial-and-error
  - no strategy

Tower of Hanoi with three disks:



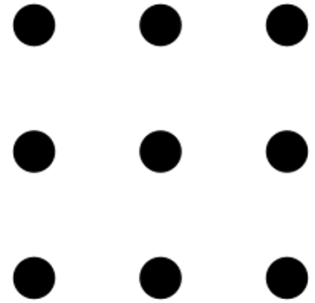
initial state goal state



https://www.youtube.com/watch?v=GxYQCQB4CDM

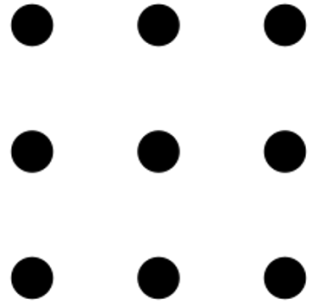
activity

- connect all 9 dots with four lines, without picking up your writing instrument



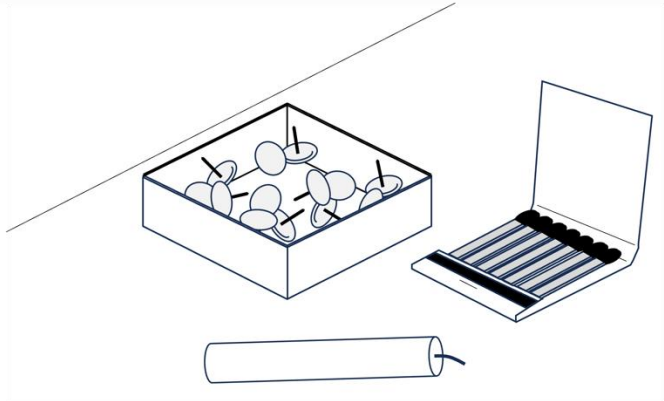
approaches to problem solving

- reproductive thinking
  - guided by past experience
- productive thinking
  - something new and different
  - involves insight (aha moment)



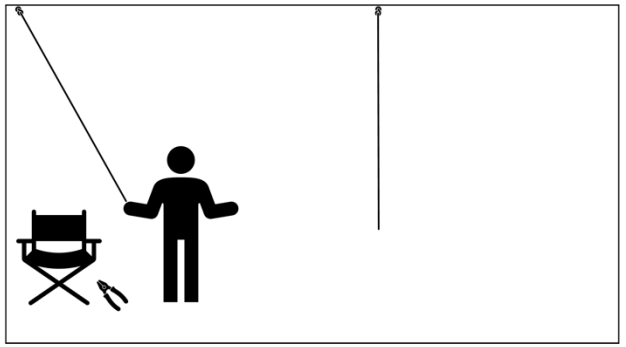
candle problem (Duncker, 1945)

- you are given a book of matches, a box of tacks, and a candle
- on the wall of the room, there is a corkboard.
- your task is to fix the candle to the corkboard in such a way that no wax will drop on the floor when the candle is lit.



functional fixation

- when the usual function of an object is emphasized, it will be far more difficult for a person to use that object in a novel manner



lilypad problem

- on a lake, the area covered by water lilies doubles every 24 hours
- it takes 60 days to cover the whole lake
- how many days does it take to cover half the lake?

mental fixation

- inaccurate interpretation, or representation, of the problem
- is the error due to sloppiness or incorrect representation?
- error feedback should help if error was due to sloppiness but only effective 1/3rd of the time (Dominowski & Dallob, 1995)

activity

- group 1 (first names A-L): close your eyes
- group 2 (first names M-Z): look at the screen

mental fixation

- examples can lead to mental fixation (Smith et al., 1993) but can be avoided if explicitly asked to avoid common examples (George & Wiley, 2020)
- overcoming mental fixation = incubation!

activity

- As a doctor you have to treat a patient with a malignant, inoperable tumor, buried deep inside the body. There exists a special kind of ray which is harmless at a low intensity, but at sufficiently high intensity is able to destroy the tumor. At such high intensity, however, the ray will also destroy the healthy tissue it passes through on the way to the tumor. What can be done to destroy the tumor while preserving the healthy tissue?

activity

- A general wanted to capture his enemy's fortress. He gathered a large army to launch a full-scale direct attack, but then learned that all the roads leading directly towards the fortress were blocked by landmines. These roadblocks were designed in such a way that it was possible for small groups of the fortress-owner's men to pass over them safely, but a large group of men would set them off. The general devised the following plan: He divided his troops into several smaller groups and ordered each of them to march down a different road, timed in such a way that the entire army would reunite exactly when reaching the fortress and could hit with full strength.

Gick & Holyoak (1980)

- Duncker (1945): base (fortress) and target (radiation) problem
- 10% were able to solve the problem right away, but 30% could solve it when they read the story of the general before. After being given an additional hint – to use the story as help – 75% of them solved the problem.
- solution involves recognizing and mapping
- schema induction can be helpful

experts vs. novices

- experts focus on deeper shared principles whereas novices focus on superficial structural similarities
  - Chi, Feltovich, and Glaser (1981): physics (conservation of momentum vs. ramps/pulleys)
  - Stains and Talanquer (2008): chemistry (acid-base reaction vs. water as a product of a reaction)
- experts are better able to spontaneously retrieve prior examples that share key domain principles

analogy generation task

- give people a target phenomenon and ask them to produce a similar phenomenon and to explain their rationale
- what people produce as analogous tells us something about how their knowledge is encoded.
- open-ended vs. prompted task

For the open-ended task, the instructions were "Analogies are based on similarities between two things. Because things may be similar in many ways, there are many ways to draw an analogy and no single correct way. We are studying students' analogies. As part of this study, we would like to compare students' analogies with those drawn by experts. Please complete the analogies on the back side of this page."

For the prompted task, participants were similarly told about the comparison between students and expert analogies, but had different instructions concerning the kind of analogies to focus on: "Science is mostly about understanding what causes things to happen. Often, this understanding is built through analogical reasoning. In this survey, you will be asked to build analogies based on causal similarities." The instructions further included these illustrative examples:

An example of a causal analogy is:

Getting in an auto accident is similar to tripping on a step because they both can be caused by not paying attention.

An example of a non-causal analogy is:

Getting in an auto accident is similar to tripping on a step because they both can result in getting hurt.

The first example is causal because it relates an underlying and common reason for two distinct events. This second example is non-causal because the similarity is a common outcome of two distinct events.

paper

activity

Table 2
Examples of each kind of analogy scored for “A balloon floating is like____ because____”

Kind of Analogy	Example Response
Correct explanatory (Common cause)	Hot water in a cold sea. Both rise in a dense fluid as a result of having a lower density
Incorrect causal	A leaf in the wind. Main propulsion is due to wind.
Social causal	A mother taking her child to college for the first time. They both have to be let go of.
Noncausal	Flying a kite. Both are in the air.

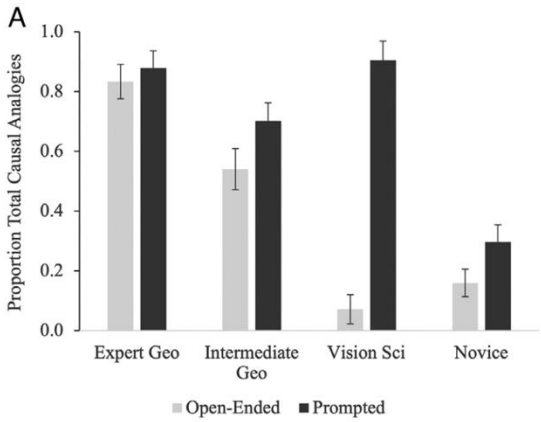
Table 3
Examples of each kind of analogy scored for “Catching a cold is like _____ because____”

Kind of Analogy	Example Response
Common cause	Catching the flu, both are caused by a virus
Result	Being hungover, both make you feel terrible.
Noncausal	Falling asleep; it is bound to happen.

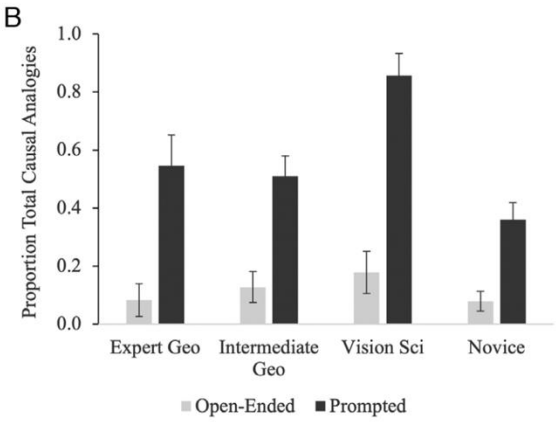
curse of expertise

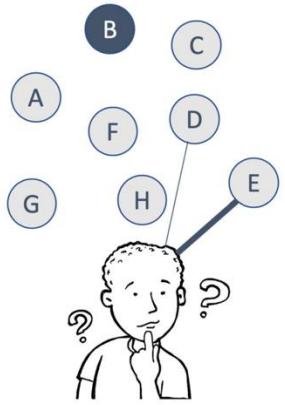
- scientists have more scientific explanatory knowledge than novice nonscientists
- scientists only spontaneously apply their explanatory knowledge specific to their domain of expertise (“curse of expertise”)
- “practicing connections”

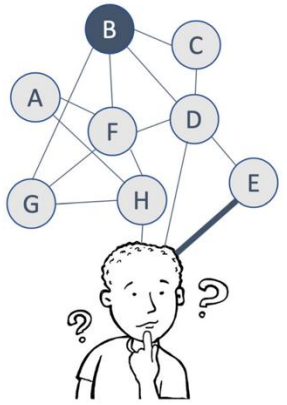
balloon



cold







Practicing Connections: A Framework to Guide Instructional Design for Developing Understanding in Complex Domains

Laura Fries[1] · Ji Y. Son[2] · Karen B. Givvin[1] · James W. Stigler[1]

paper