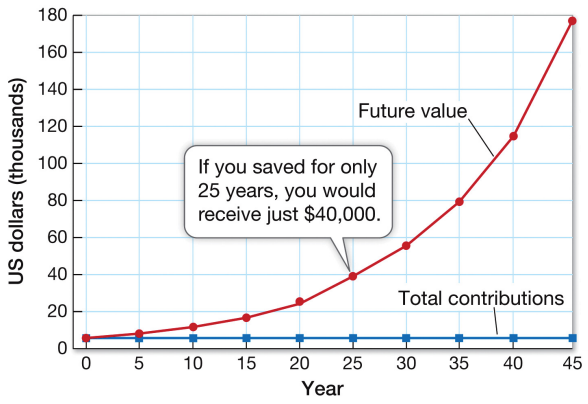
Reasoning and Problem Solving

PSYC 313 - Lecture 17
Dr. J. Nicol



Delay Discounting

- Delay discounting relates to a lack of self-control, which is a crucial function of the self that involves initiating, sustaining, and inhibiting behaviour (i.e., executive function)
- ***Ego depletion:*** a fatigued mental state in which we have consumed the cognitive resources required to maintain self-control (Baumeister et al., 1998)
- Ego depletion leads to more delay discounting (Joireman et al., 2008)
- Drug addicts show higher discount rates for money options compared to controls—especially when they are experiencing withdrawal symptoms (Giordano et al., 2002)

Delay discounting starts in childhood—many children will eat one marshmallow now, rather than to delay gratification and wait for two

COGNITION 7e, In-Text Art, Ch. 10, p. 255
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Mischel (2014)

Reasoning

- ***Reasoning*:** is the process of drawing conclusions and is cognitive processes by which people start with and come to conclusions that go beyond that information (Wason & Johnson-Laird, 1972)
- ***Inductive reasoning*** moves from specific to general
- When we engage in inductive reasoning, we use specific observations to make general inferences about the world

Reasoning

- ***Deductive reasoning*** involves moving from general knowledge and principles to more specific knowledge and examples
- Deductive reasoning allows you to draw ***definite conclusions,*** while inductive reasoning only allows you to make ***probable conclusions***
- Deductive reasoning can allow for true conclusions based on logic, and in contrast, inductive reasoning involves educated guesswork and relies more on existing knowledge and categorization or causation (Hayes & Heit, 2013)

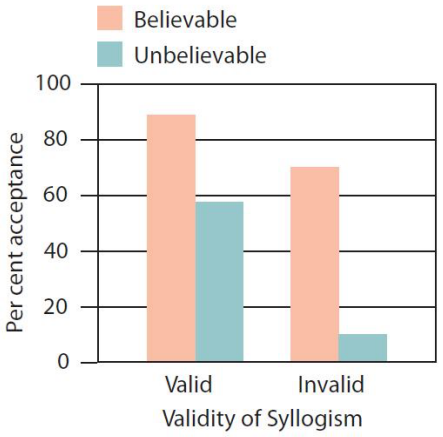
Categorical Syllogisms

All M are B.
All D are M.
Therefore, all D are B.

All X are Y.
Some A are X.
Therefore, some A are Y.

Some A are not B.
All A are G.
Therefore, some G are not B.

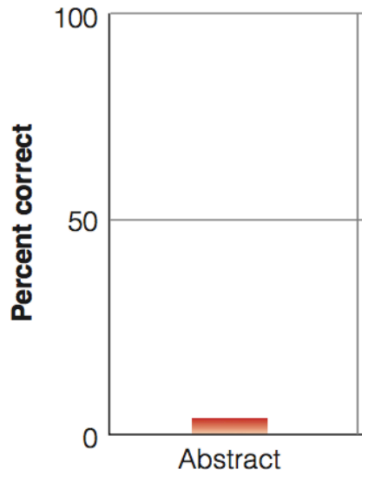
All of these syllogisms are valid— the two premises are true, so the conclusion must be true



Newstead et al. (1992)

To validate the rule "If there is a vowel on one side, then there is an even number on the other side", which of the following cards do you need to check?

Wason (1966)



Wason (1966)

The rule:
If there is a vowel on one side,
then there is an even number on the other side.

If turn over . . .	And the result is . . .	Then this _____ the rule
E	Even	confirms
E	Odd	**falsifies**
K	Even	is irrelevant to *
K	Odd	is irrelevant to
4	Vowel	confirms
4	Consonant	is irrelevant to
7	Vowel	**falsifies**
7	Consonant	is irrelevant to

* This outcome of turning over the card is irrelevant because the rule does not say anything about what should be on the card if a consonant is on one side. Similar reasoning holds for all of the other irrelevant cases.

Wason (1966)

Confirmation Bias

- ***Confirmation bias:*** the favouring of evidence that supports one's beliefs, expectations, or hypotheses (Nickerson, 1998)
- The tendency to selectively look for information that conforms to our beliefs and to overlook information that argues against them—is a major roadblock to accurate reasoning (Nisbett & Ross, 1980)

Confirmation bias exists in many forms

- First, when people are assessing a belief or a hypothesis, they're more likely to seek evidence that might confirm the belief than evidence that might disconfirm it.
- Second, when disconfirming evidence is made available to them, people often fail to use it in adjusting their beliefs.
- Third, when people encounter confirming evidence, they take it at face value; when they encounter disconfirming evidence, they reinterpret the evidence to diminish its impact.
- Fourth, people often show better memory for confirming evidence than for disconfirming evidence, and, if they do recall the latter, they remember it in a distorted form that robs the evidence of its force.
- Finally, people often fail to consider alternative hypotheses that might explain the available data just as well as their current hypothesis does.

TABLE 1

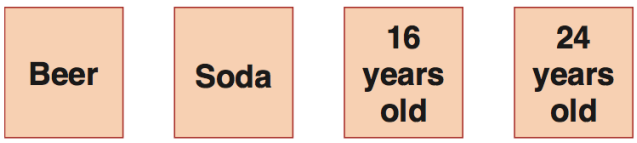
ACTORS' POSTDEBRIEFING PERCEPTIONS OF THEIR PERFORMANCE AND ABILITY, EXPERIMENT 1

Item	Success	Average	Failure	F for linear trend
Estimated initial no. correct[a]	17.05	15.85	12.75	25.30**
Estimate for average student[a]	15.50	15.82	14.20	2.82
Predicted future no. correct[a]	16.67	15.72	13.48	10.96*
Rated ability at task[b]	5.28	4.92	3.90	14.82**
Rated abilities at related skills[b]	4.78	4.45	4.20	8.41*

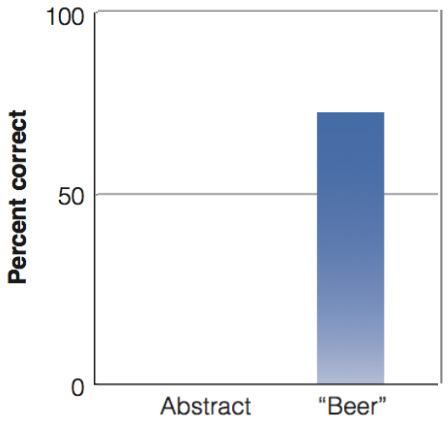
[a] Maximum number correct was 25.
[b] Subjective rating scales ranged from 1 (low ability relative to average student) to 7 (high ability).
* $p < .01$.
** $p < .001$.

Ross et al. (1975)

To validate the rule "If a person is drinking beer, then he or she must be at least 19 years old", which of the following cards do you need to check?



Griggs & Cox (1982)



Griggs & Cox (1982)

Inductive Reasoning

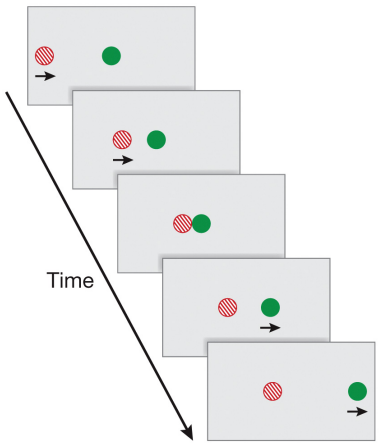
- ***Inductive reasoning*:** reasoning from specific facts or observations to reach a conclusion that may explain them
- Involves using past observations and knowledge to make predictions about novel cases (Hayes & Heit, 2013)
- Anytime we make a prediction about *what will happen* based on our observations about *what has happened* in the past, we are using inductive reasoning
- ***Property induction*** describes how people generalize properties or features from one instance of a category to another (Rips, 1975)

Inductive Reasoning

- ***Premise-conclusion similarity*** states that the more similar the premise and conclusion categories, the stronger the inductive argument will be
- ***Premise typicality*** states that when the premises are more typical or representative of a category, they will lead to stronger inductions
- ***Premise diversity:*** the more diverse the premises, the stronger the induction
- ***Premise monotonicity:*** the larger number of premises that share a property, the stronger the induction

Causal Reasoning

- ***Causal reasoning:*** the ability to understand why something happens, to determine the causes of specific effects (Holyoak & Cheng, 2011)
- Causal relationships have ***directionality*** (i.e., causes precede effects)



Scholl & Tremoulet (2000)

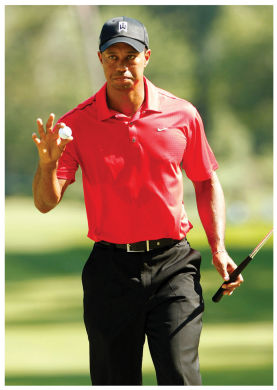
Causal Reasoning

- ***Causal learning*** (or causal induction) describes how people acquire the causal structure of the events around them through observation
- People use are variety of cues to determine casual relations, but knowledge about statistical relationships, or ***covariation*** is essential
- Covariation does not reveal casual direction, so another important cue is ***temporal order***—the arrangement of events over time

Illusory Correlations

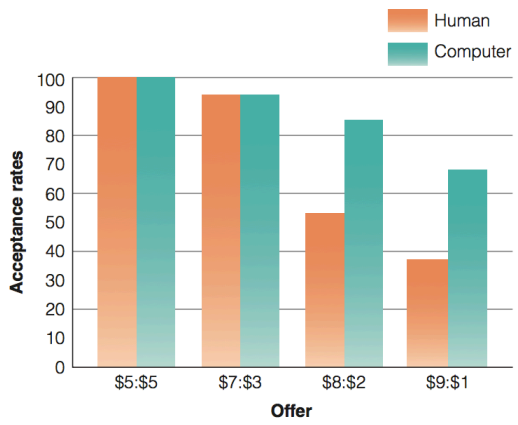
- ***Illusory correlations*** occur because people will often make connections between to events or variables that actually are unrelated
- In a group of arthritis patients studied for over a year there was no relationship found between arthritis pain and the weather conditions (Redelmeier & Tversky, 1996)
- Illusory correlations tend to occur for statistically infrequent events (Chapman, 1967)

Illusory correlations can lead to superstitious behaviour

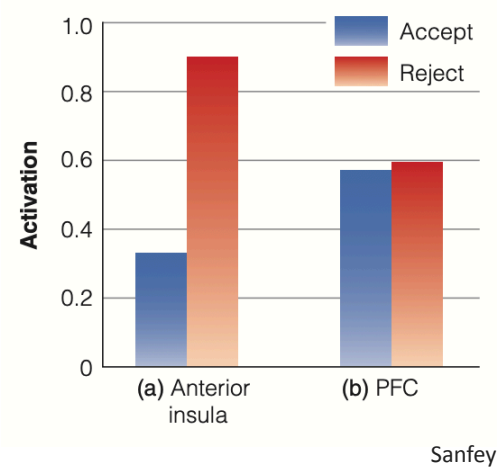


Social Reasoning

- Everyday economic decisions are not made in isolation but rather typically involve social interactions
- Each party wants to maximize his or her gain, but each must also consider what's reasonable to the other party or the transaction will fail and no one will gain
- The ability to consider what the other party is thinking is called ***theory of mind***



Sanfey et al. (2003)



Sanfey et al. (2006)

Social Reasoning

- Autism is a developmental disorder that results in impairments of theory of mind (Baron-Cohen et al., 1985)
- Compared with unaffected children who demonstrate theory of mind in a different task, children diagnosed with Autism make more low-ball offers in the ultimatum game (Sally & Hill, 2006)

Problems

- A ***problem*** is a situation where someone has a goal but does not know how to achieve it (Mayer, 2013)
- A problem occurs when there is an obstacle between a present state and a goal and it is not obvious how to get around that obstacle (Duncker, 1945)

Problems

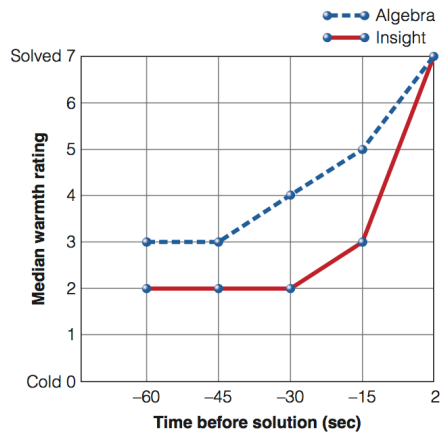
- ***Routine problems*** are familiar, such that the solutions are known
- Similarly, in ***well-defined problems***, the given state, goal state, and operators are well specified
- ***Non-routine problems*** are more difficult because they are not familiar and the solution is not apparent
- The given state and goal state are clear, but the way to achieve the goal is not, and there is not necessarily even a correct answer to the problem
- These are ***ill-defined problems***, and most problems that we encounter in everyday life are of this variety

Problem Solving

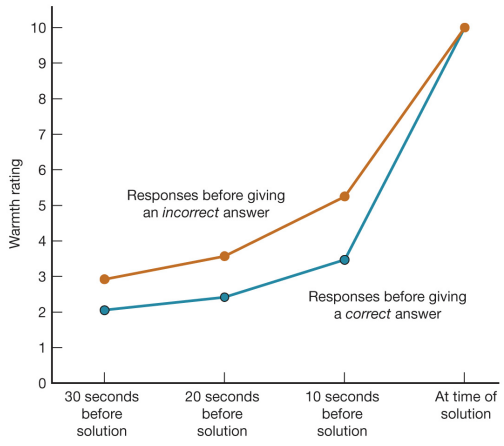
- People often use ***heuristics,*** which are shortcuts or simple strategies, to solve problems (Newell & Simon, 1972)
- One problem-solving heuristic is simply ***random trial-and-error,*** which involves randomly selecting and applying different potential solutions until the problem is solved
- This can be effective for simple problems, but it is typically ineffective and frustrating when used in an attempt to solve complex problems

Insight

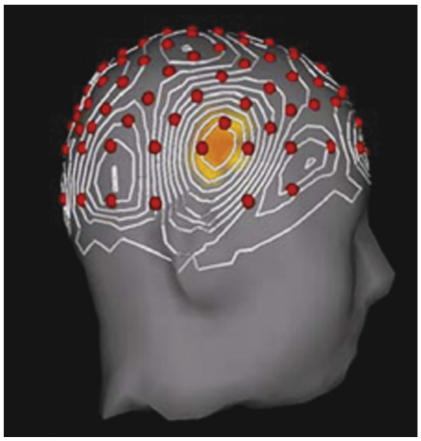
- Insight is commonly a factor in arriving at creative solutions to problems (Metcalfe & Wiebe, 1987)
- ***Insight:*** a sudden comprehension, realization, or problem solution that involves a reorganization of a mental representation of a stimulus, situation, or event to yield an interpretation that was not initially obvious (Kounios & Beeman, 2014)
- Describes the process of suddenly gaining a solution to a problem, typically with an "aha!" sensation (Bassok & Novick, 2012)



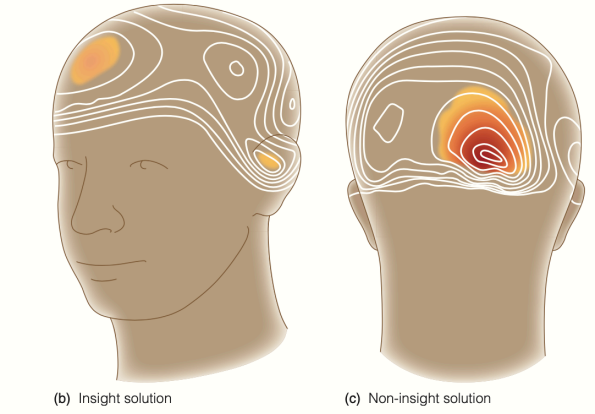
Metcalfe & Wiebe (1987)



Metcalfe (1986)



Jung-Beeman et al. (2004)



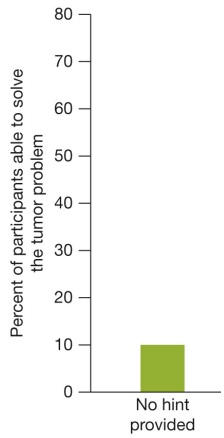
Kounios et al. (2006)

Transfer

- Solving a current problem can benefit from thinking about how we solved a similar problem in the past
- Another way to solve problems is to ***transfer*** solutions, so that learning to solve one problem generalizes to solving others
- Using an analogy to guide the solution to a new problem is called ***analogical problem solving***
- The transfer of one problem solving solution to another is called ***analogical transfer***

Suppose you are a doctor faced with a patient who has a malignant tumor in his stomach. To operate on the patient is impossible, but unless the tumor is destroyed the patient will die. A kind of ray, at a sufficiently high intensity, can destroy the tumor. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumor will also be destroyed. At lower intensities the rays are harmless to healthy tissue but will not affect the tumor. How can the rays be used to destroy the tumor without injuring the healthy tissue?

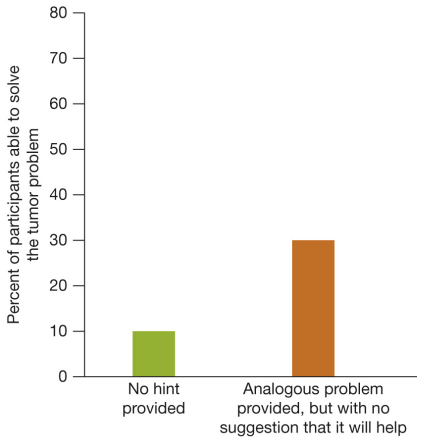
Duncker (1945)



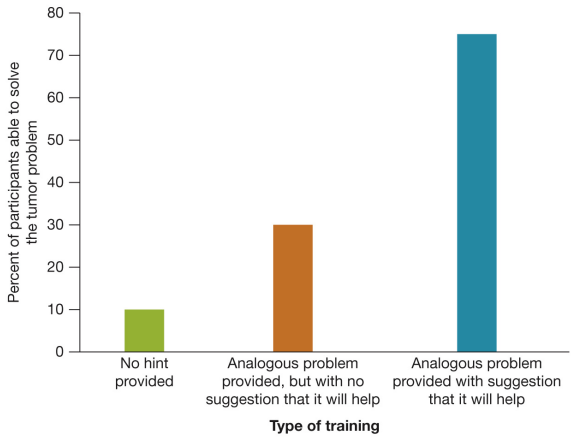
Gick & Holyoak (1980)

A dictator ruled a country from a strong fortress, and a rebel general, hoping to liberate the country, vowed to capture the fortress. The general knew that an attack by his entire army would capture the fortress, but he also knew that the dictator had planted mines on each of the many roads leading to the fortress. The mines were set so that small groups of soldiers could pass over them safely, since the dictator needed to move his own troops to and from the fortress. However, any large force would detonate the mines, blowing them up and also destroying the neighboring villages.

The general knew, therefore, that he couldn't just march his army up one of the roads to the fortress. Instead, he devised a simple plan. He divided his army into small groups and dispatched each group to the head of a different road. When all were ready, he gave the signal and each group marched up a different road to the fortress, with all the groups arriving at the fortress at the same time. In this way, the general captured the fortress and overthrew the dictator.

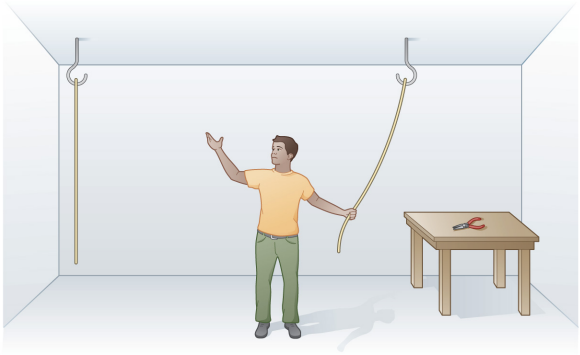


Gick & Holyoak (1980)



Gick & Holyoak (1980)

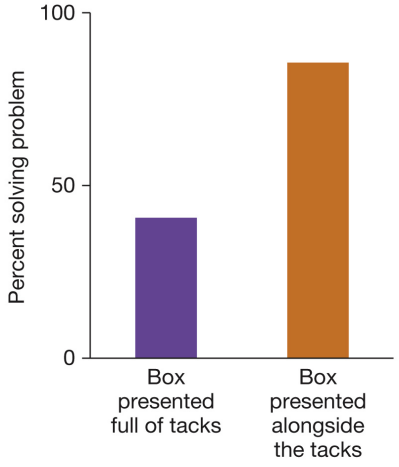
You enter a room in which two strings are hanging from the ceiling and a pair of pliers is lying on a table. Your task is to tie the two strings together. Unfortunately, though, the strings are positioned far enough apart so that you can't grab one string and hold on to it while reaching for the other. How can you tie them together?



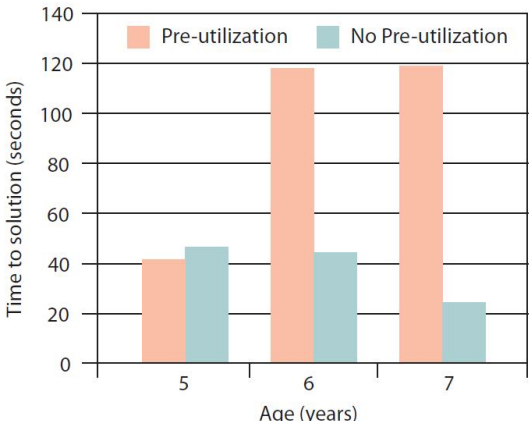
Maier (1931)

Can you mount the candle on the wall so that it will burn without dripping wax on the floor?

Duncker (1945)



Adamson (1952)



German & Defeyter (2000)

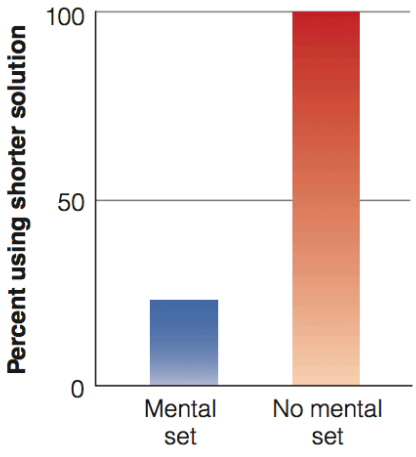
You are given these three jars, an unlimited supply of water, and an uncalibrated bucket. You want to pour exactly 5 ounces of water into the bucket. How do you do it?

Participants were given three jugs of different capacities and were required to use them to measure out a specific quantity of water

Capacities (cups)

Problem	Jug A	Jug B	Jug C	Desired quantity
1	21	127	3	100
2	14	163	25	99
3	18	43	10	5
4	9	42	6	21
5	20	59	4	31
6	20	50	3	24
7	15	39	3	18
8	28	59	3	25

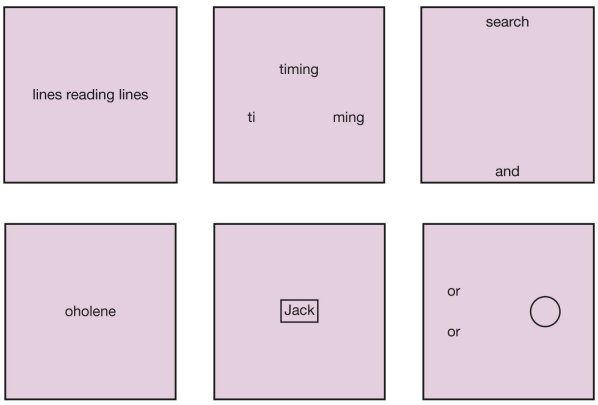
Luchins (1959)



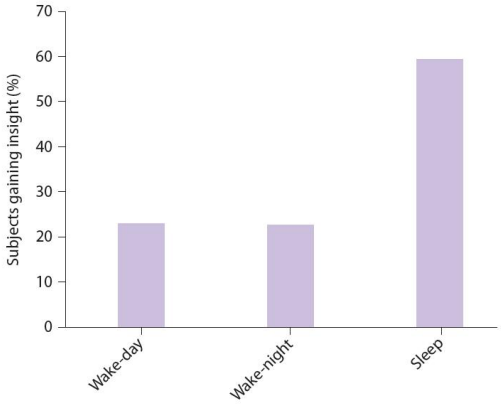
Luchins (1959)

The Incubation Effect

- For many problems, the primary obstacle is not the need to find a suitable analogy for transfer, but rather it is to avoid obstacles associated with adopting an entrenched mental set
- ***Incubation:*** progress toward a solution that occurs when a problem is set aside but is continued to be worked on unconsciously (Wallas, 1926)



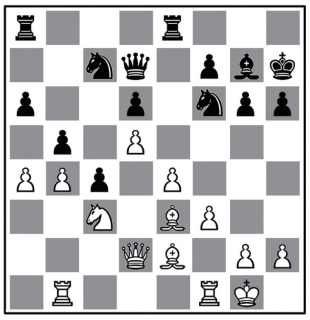
Smith & Blankenship (1991)



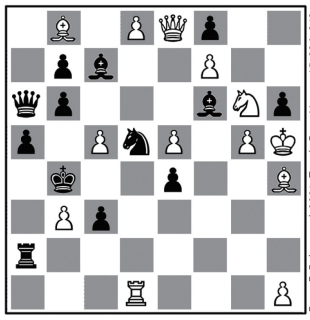
Wagner et al. (2004)

Expertise

- ***Experts*** in a particular field usually solve problems faster and with a higher success rate than beginners or people who have not had the same training (Larkin et al., 1980)
- Overall, experts notice meaningful patterns not obvious to novices, experts organize and remember information in a way that reflects their deeper understanding of the material, and expert knowledge appears to be more specific and contextualized than novice knowledge (Bransford et al., 2000)



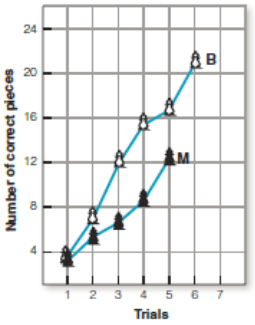
Master's game
Experts recall the entire position almost perfectly, but novices perform poorly.



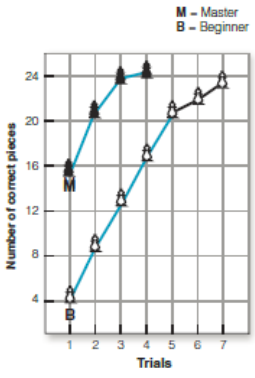
From F. Gobet et al. 2001. *Trends Cogn Neurosci* 5: 236–243.

Random position
There is no difference in recall of random positions between experts and novices.

Chase & Simon (1973)



Random Positions



Actual Game Positions

Chase & Simon (1973)