Lecture 20:
Thinking and Rationality

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I. INTRODUCTION
A. Mind as a computer

- During the past weeks, we have considered **cognitive** explanations of behavior.
  - Cognitive explanation examines how information is processed: The rules by which information is encoded, stored, retrieved, analyzed, and manipulated.
- Cognitive Psychology holds that people, like computers, can be characterized as having rules for processing information.
  - Computers and human are similar in that each can be characterized as a "rule-based processor of information".

I. INTRODUCTION
A. **Mind as a computer**

- The metaphor of the mind as a computer…
  - is NOT the view that the mind **is** a computer.
    - There are many differences between minds and computers
  - holds that the same language which explains computer operation (input, processing, storage, retrieval, output, RAM, chip speed, etc.) can explain mental operations.
- As a result we can talk about mental processes without falling into the trap for folk psychology
  - Cognitive psychology is a design explanation (we are designed to process information).

I. INTRODUCTION
B. Complex thought

- Central in our account of the rules for processing information is a distinction between rules which are…
  - Automatic **(Unconscious, passive, automatic)**
  - Effortful **(Conscious, active, effortful)**
- Today we will consider **automatic and effortful** rules for **complex cognition.**
  - Reasoning
  - Decision-making
  - Problem-solving

II. Thinking
    A. Definitions

- **Thinking** is defined as the manipulation of mental entities for the purpose of problem-solving or reasoning.
  - **Reasoning**: Drawing conclusions or inferences from observations, facts or assumptions
  - **Problem-solving**: Finding a solution or overcoming an obstacle to a goal.

II. Thinking
    A. Definitions

- **Mental entities**
  - **Images**: picture-like representations.
  - **Concepts**: A mental category that groups objects, relations, activities, or abstractions having common properties. (Bird)
  - **Prototype**: An especially representative example of a concept (robin as prototype bird).
  - **Propositions**: Mental sentences that relate a subject to a predicate (birds are animals).
  - **Cognitive schema**: Mental network of knowledge, beliefs, and expectations (schema for birds).

II. Thinking
    A. Definitions

- Manipulate mental entities
  - Consciously:
    - Effortful and with awareness.
  - Subconsciously:
    - Accessible to conscious awareness when necessary.
  - Non-consciously:
    - Outside of consciousness and not available to consciousness
    - Includes: insights, intuitions.

II. Thinking
    B. Thinking and Rationality

- At the heart of thinking is the ability to manipulate mental elements <u>rationally</u>.
- To be rational in cognitive psychology means manipulating information <u>consistently</u> by following <u>appropriate</u> rules.
- Appropriate and consistent rules to manipulate information may take a variety of forms:
  - Logical or mathematical rules for combining information.
  - Practical rules to reach a goal.
  - Causal rules to make changes.

II. Thinking
  C. Forms of Thinking

- Two kinds of ways to thinking: Formal and Informal
- **1. Formal Reasoning:** Involves the use of <u>algorithms</u> to solve a problem
  - Suppose you were given three letters A T C and had to figure out all the words you can make. How would you do it?
  - **Algorithm:** Step-by-Step procedure that generates <u>all possible solutions</u>.
    - A T C has six possible orders
    - TCA, TAC, CTA, **CAT**, ATC, **ACT**.

II. Thinking
  C. Forms of Thinking

- Formal Reasoning is algorithmic and includes such things as <u>logical deduction</u>:
  - All men are mortal
  - Socrates is a man
  - Is Socrates mortal?
- Although it may appear simple, we make errors when the premises are false.
  - All men are good
  - Osama bin Laden is a man
  - Is Osama bin Laden good?
- We automatically judge premise truth without algorithmically evaluating its logical validity.

II. Thinking
  C. Forms of Thinking

- **2. Informal Reasoning:** Involves use of <u>heuristics</u> to figure out an answer.
  - **Heuristic:** Mental short-cuts or rules of thumb that suggest possible solution.
  - Heuristics are often effectively used in problem-solving.
  - Three general heuristics:
    1. Means-ends: Define sub-goals and seek to solve particular sub-goals.
    2. Working backward: Specify the goal state and work backward from to achieve it.
    3. Analogy: Solve one problem by finding a solved problem like it.

II. Thinking
  C. Forms of Thinking

- 2a. Heuristics and Problem-solving
  - Consider the problem of choosing a major:
  - A formal algorithmic solution (trying all majors) is inadequate
  - An informal heuristic solution is better. Three heuristics can be applied to the problem"
    - **Means-end**: Gain information about a variety of disciplines by taking a variety of courses
    - **Working backward**: Figure out your career aspirations and work backward to identify the major that would most help you.
    - **Analogy**: How did you make other major choices in your life (e.g., asking your parents).

II. Thinking
D. Reasoning and Gambling

- While effective in problem-solving, using heuristics are not always rational when reasoning (drawing conclusions based on mathematics and logic).
- We already saw mistakes made on logical reasoning tasks when heuristics override algorithms
  - Consider throwing a coin 8 times on two separate occasions. Which one do you consider more likely?
  - Throw 1: H H H H T T T T
  - Throw 2: H T H T H T H T
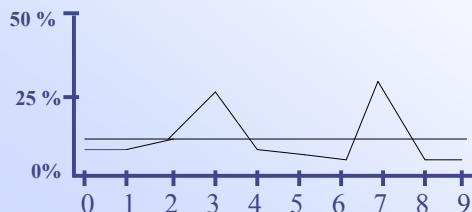

II. Thinking
D. Reasoning and Gambling

- Throw 2 is often often judged as a more likely!
  - As opposed to calculating the probability of each sequence we make quick judgments of which sequence matches our representative example of a random sequence in memory.
    - H T H T H T H T is our representative example of a random sequence, so we think it is more likely than H H H H T T T T
- 1. This judgment reflects the operation of the **Representativeness Heuristic:** a tendency to make decisions or judge information that fits our preconceived categories or stereotypes of a situation.

II. Thinking
D. Reasoning and Gambling

- Choose a random number between 0 and 9
- If we can truly generate random number then 10% of students should choose each number
- Usually this is not what happens

II. Thinking
D. Reasoning and Gambling

- In America do more people die due to homicide or diabetes-related diseases**?**
- In Israel do more people die due to car accidents or terrorists attacks?
  - Diabetes and car accidents are much higher. Why do we get this wrong?
- We make judgment of likelihood based on how easily information comes to mind
  - Media reporting of homicides and terrorist attacks make them more available.

II. Thinking
    E. Reasoning and Gambling

- 2. This is called the **Availability Heuristic**:
  - The Availability Heuristic: A cognitive heuristic in which a decision maker relies upon knowledge that is readily available rather than examine other alternatives or procedures.
- 3. Memory Factors
  - Consider a person thinking about how he spent the day in Las Vegas
    - Does he better remember wins or losses?
    - He thinks he lost more often than the did changing he perception of the odds of winning.
    - Instead of winning 1 time out of 300, he may remember winning 1 time in 50, resulting in him thinking that he can beat the odds.

II. Thinking
    D. Thinking and Gambling

- From a cognitive perspective, we are awful in judging probabilities in gambling contexts.
  - We think we can control probabilities
    - Throw a dice lightly to get a small number
  - We get affected by the framing of probabilities
    - We prefer a gamble expressed as a 80% chance of winning than one of a 20% chance of losing
  - We ignore the likelihood of gambles and instead are affected by concrete information
    - We prefer a 10/100 gamble over a 1/10 because of the concrete number of targets available.
    - Research Project.

II. Thinking
    E. Barriers to Rationality

- From a cognitive perspective, we are irrational in so many ways..
  - **A. Exaggerating the likelihood of improbable** events
    - The availability heuristic makes improbable events seem likely.
  - **B. Avoiding Loss**
    - We are are sensitive to losses and prefer a gamble giving us a 10% of winning than one giving us 90% chance of losing, despite them being exactly the same.
  - **C. Confirmation Bias**
    - We tend to look for or pay attention only to information at confirms your own belief, ignoring information which disconfirms our beliefs. .

II. Thinking
    E. Barriers to Rationality

- From a cognitive perspective, we are just irrational in so many ways..
  - **D. Mental Sets**
    - We tend to solve problems using procedure that worked before on similar problems, even if they are inappropriate in a given context.
  - **E. Hindsight Bias**
    - We overestimate our ability to have predicted an event or outcome once the outcome is known, "I knew it all along"
    - Neighbors of murderers often describe themselves as knowing all along that something was wrong with that person!

II. Thinking
   E. Barriers to Rationality

- From a cognitive perspective, we are just irrational in so many ways..
  - **F. Cognitive Consistency**
    - We want to be right we want to smell like a rose. We will do anything to be right.
    - Lets say we find ourselves with a contradiction between a behavior (smoking) and an attitude (smoking is bad).
    - We will be motivated to change the behavior or more likely to change the attitude (more likely the attitude).
    - <u>Cognitive Dissonance</u>: State of tension that occurs when person simultaneously holds two cognitions that are psychologically inconsistent or when a person's belief is incongruent with behavior.

II. Thinking
   E. Barriers to Rationality

- From a cognitive perspective, we are just irrational in so many ways..
  - **G. Biased Attributions.**
    - **Attribution Theory**: The theory that people are motivated to explain their own and other peoples' behavior by attributing causes of that behavior to an external situation or an.internal disposition
  - We are biased in how we identify causes
    - **Fundamental Attribution Error:** The tendency, in explaining other people's behavior, to overestimate personality factors and <u>underestimate</u> the influence of the situation.
    - You cutting off others vs. others cutting you off on I-15

II. Thinking
   E. Barriers to Rationality

- From a cognitive perspective, we are just irrational in so many ways..
  - **H. Stereotyping**
    - A cognitive schema or summary impression of a group, in which a person believes at all members of the group share a common trait.
  - **Characteristics of Stereotypes**
    - **Automatic**
      - Not aware of using a stereotype, although we are aware of its content.
    - **Some Positive Consequences**
      - Speed: Easy to group and react to things or people:
    - **Some Negative Consequences**
      - Distort reality: Exaggerate any differences between groups and underestimate differences within the group.

II. Thinking
   F. Overcoming Bias

- Automatic and Effortful processing in rationality
- Create the software of a robot to explore hostile alien planets.
  - Fast, automatic but incorrect processes vs. Slow effortful but correct ones?
    - Heuristics are often automatic and efficient cognitive processes but are not necessary rational
    - Algorithms are often effortful and inefficient cognitive processes by are necessarily rational.
- Both are really important at different times.
  - To make fast and efficient decisions, use heuristics
  - To make rational decisions use algorithms.