Lecture #11

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Decision Making and Response Selection

- Decision making: considering alternatives & choosing an appropriate response
- Decision making may take:
  - Seconds: what to do when a deer jumps in front of your car?
  - Minutes: what route should airplane take around a thunderstorm?
  - Days/months: what launch plan to follow for the next space mission?
- Perception, decision making and response selection are not always easily separable.
- Decision making – undertaken by individuals or groups

Some observed challenges in human decision making

- People tend to focus on only one alternative or hypothesis at a time – once selected others are often ignored.
- Undue weight given to early clues, later ones often ignored.
- More information (even if relevant) can reduce decision making effectiveness (information overload).

More decision making challenges

- Not good at exhaustive exploration of a problem space, or remembering what has been explored and what has not
- Not great at working with uncertainty
- Variables with unknown values often ignored

Information Processing Speed in Simple Decision Making

- **Hick-Hyman Law: (Hick, 1952; Hyman, 1953) predicts how number of alternatives impact response speed.**

Constants

$$T = a + bH$$

Response Time (seconds)   Amount of information (bits)

Information Processing Speed in Simple Decision Making

- **Fitz Law (1954) Index of Difficulty (to predict movement time)**

$$I = \log_2 (2D / W)$$

Index of Difficulty

Target width

Distance between
Target centers

Typical Decision Making Task

- **One decision-making task:**
  - A person must select one option from a number of alternatives
  - There is some amount of information available with respect to the option
  - The timeframe is relatively long
  - The choice is associated with uncertainty

Decision Making

- By definition, decision making involves risk, and a good decision maker effectively assesses risks associated with each option (Medin & Ross,1992)

Decision Making – Three Phases

1. Acquiring and perceiving information or cues relevant for the decision
2. Generating and selecting hypotheses or situation assessment about what the cues mean
3. Planning and selecting choices to take, on the basis of the inferred state, and the costs and values of different outcomes.

Decision-Making Models

- Rational Decision Making – Normative Decision Models – what should people do?? – Optimal decisions

- Normative decision models revolve around the central concept of utility, the overall value of a choice, or how much each outcome of product is "worth" to the decision maker

Normative decision models - examples

- Choosing between different:
  - Corporate investments
  - Materials for product
  - Jobs
  - Cars
- These choices can be modeled using "multi-attribute utility theory"

Multi-attribute utility theory

- It assumes that the overall value of a decision option is the sum of the magnitude of each attribute multiplied by the utility of each attribute.
  - U(v) = overall utility of an option
  - A(i) = magnitude of the option on the ith attribute
  - U(i) = utility (goodness or importance) of the ith attribute
  - n = number of attributes

Multi-attribute utility theory

$$U(v) = \sum_{i=1}^{n} a(i)u(i)$$

Multi-attribute utility theory: car example

The utility of each attribute (u)

Sound system quality

Maintenance costs

The magnitude of each attribute

Options (different cars)	A1	A2	A3	A4	A5	
	4	5	2	1	8	
01	3	3	9	3	1	56
02	3	3	3	3	3	60
03	9	1	3	1	9	120
04	1	3	9	9	9	118

Attributes

1999 Honda Accord

Sum of the magnitude of each attribute (a) multiplied the utility (u) of that attribute
$\Sigma\, a(i) * u(i)$

For this example:
$1 * 4 + 3 * 5 + 9 * 2 + 9 * 1 + 9 * 72 = 1$

Expected Value Theory

- This theory replaces the concept of utility in the previous context with that of expected value and applies to any decision that involves a "gamble" type of decision, where each choice has one or more outcomes with an associated worth and probability.

Expected Value Theory - Example

- A person might be offered a choice between
  - Winning $50 with a probability of 0.20, or
  - Winning $20 with a probability of 0.60.

Expected Value Theory - Example

- This theory assumes that the overall value of a choice is the sum of the worth of each outcome multiplied by its probability where E(v) is the expected value of the choice, p(i) is the probability of the ith outcome, and v(i) is the value of the ith outcome.

Expected Value Theory

$$E(v) = \sum_{i=1}^{n} p(i)v(i)$$

- **The expected value of the first choice for the example is:**
  - **$50 (0.20) = $10, meaning that if the choice were selected many times, one would expect an average gain of $10**
- **For the second choice, $20 (0.60) = $12, which is a higher value**

Problem Solving

- **Storage in LTM, then application**
- **Reasoning**
  - **Deductive-** If A, then B
  - **Inductive-** Generalizing from previous cases to learn about new ones
  - **Abductive-** Reasons from a fact to the action or state that caused it

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Observations

- People are more heuristic than algorithmic
  - Try a few quick shots rather than plan
    - Resources simply not available
- People often choose suboptimal strategies for low priority problems
- People learn better strategies with practice

Descriptive Decision Models

- How people actually make decisions
- Human decision making frequently violates key assumptions of the normative models – need more descriptive models that would capture how humans actually make decisions.
- One idea is to use descriptive models where people rely on simpler and less-complete means of selecting among choices

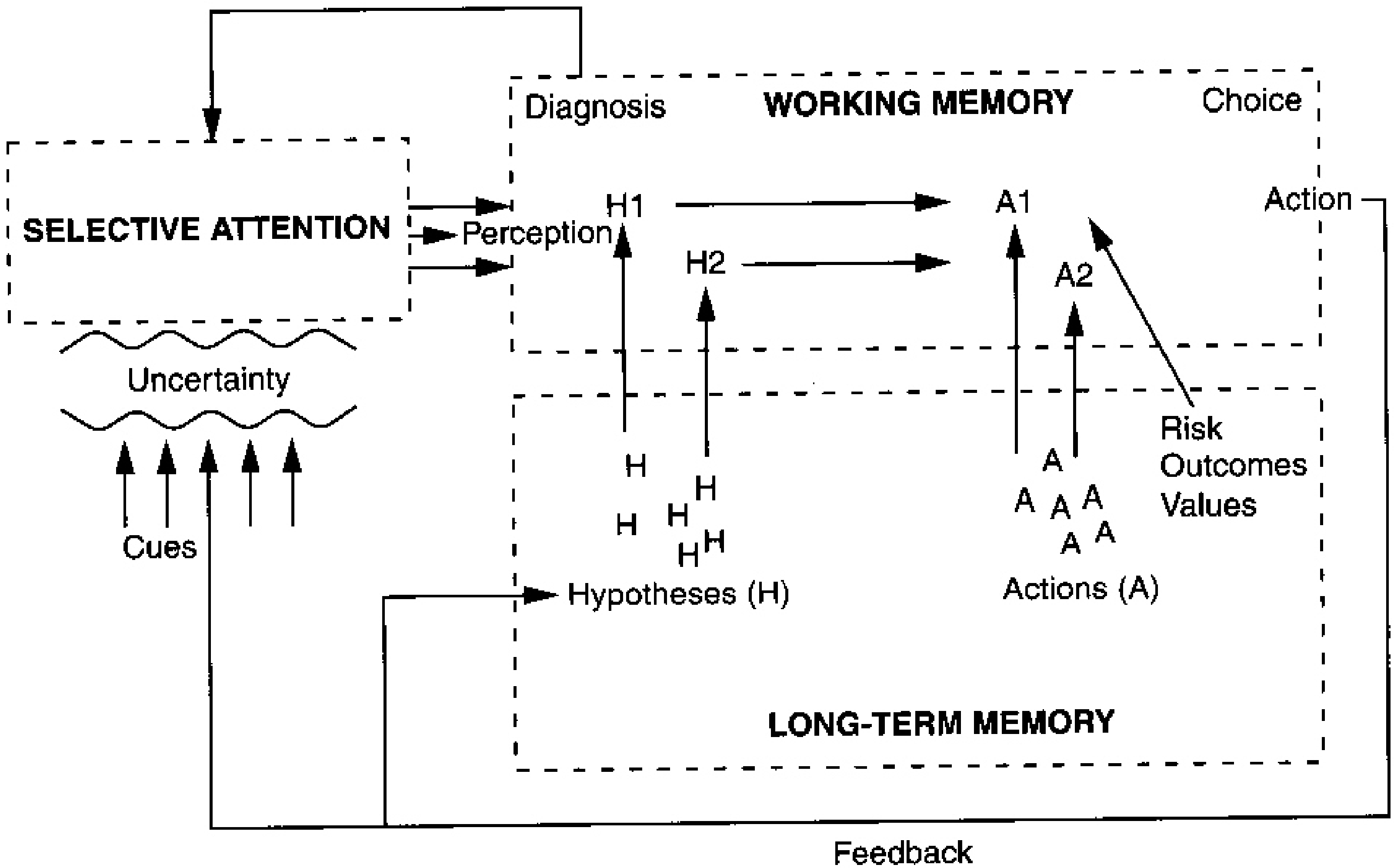
Descriptive Decision Models

- People often rely on simplified shortcuts or rules-of-thumb that are sometimes referred to as "heuristics".

Heuristics and Biases

- Heuristics are usually very powerful and efficient, but they do not always guarantee the best solution.
- Heuristics occasionally lead to systematic flaws and errors called biases.

Information Processing Limits in Decision Making



Information Processing Limits in Decision Making

1. Cue reception and integration
   - Attention to a limited number of cues
   - Cue primacy and anchoring
   - Inattention to later cues
   - Cue salience
   - Overweighting of unreliable cues

Information Processing Limits in Decision Making

2. Hypothesis generation and selection

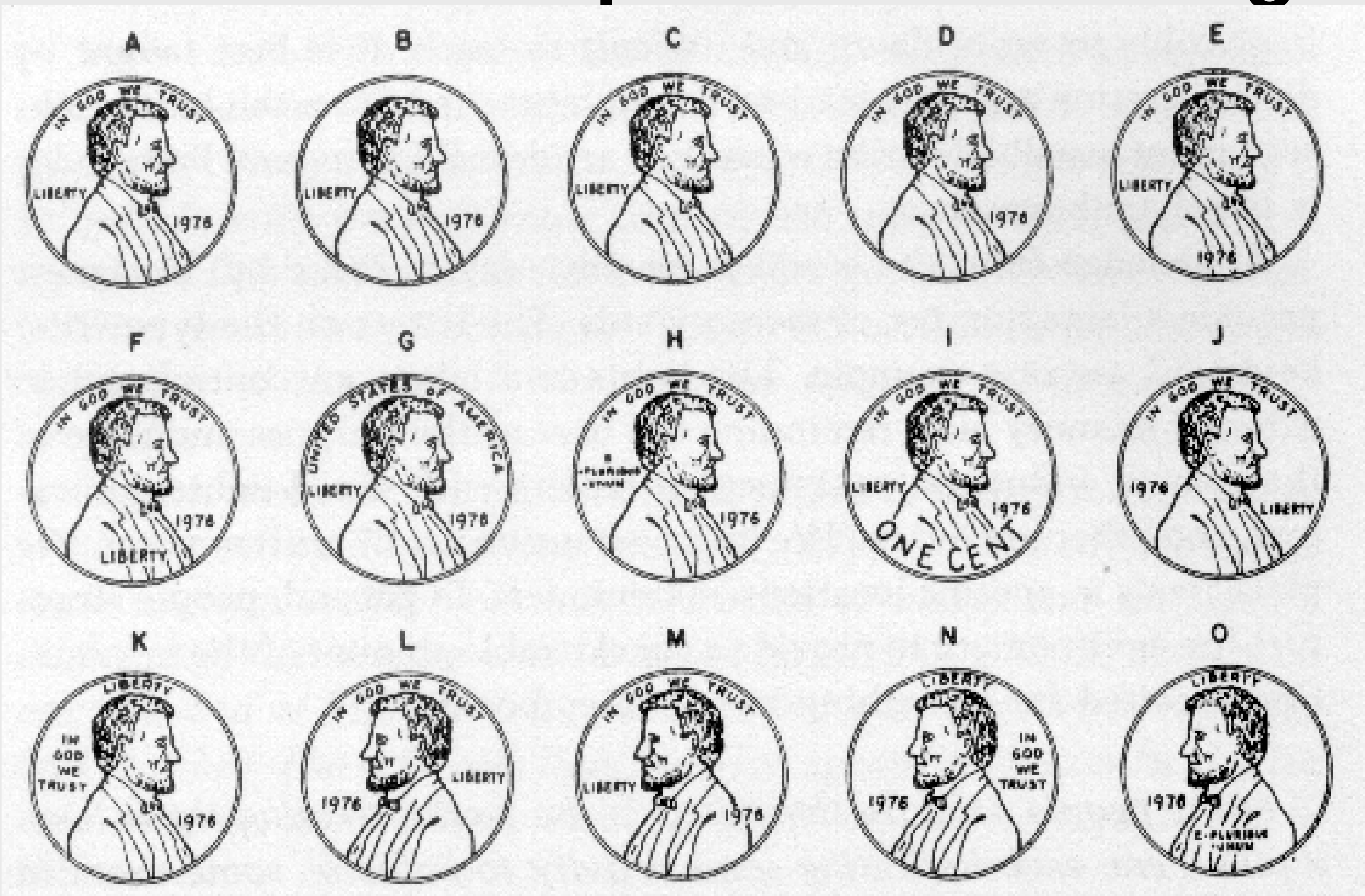
- Generation of a limited number of hypotheses
- Availability of heuristics
- Representativeness “looks like” Heuristic
- Overconfidence
- Cognitive tunneling
- Confirmation bias

Information Processing Limits in Decision Making

3. Plan generation and action choice

- Retrieve a small number of actions
- Availability heuristic for actions
- Availability of possible outcomes
- Framing bias

Which is the penny? Precise decision & imprecise knowledge



Advantages and Disadvantages of Group-Aided Decision Making

Advantages

- Greater knowledge pool
- Different perspectives
- Greater comprehension
- Increased acceptance
- Training ground

Disadvantages

- Social pressure
- Minority domination
- Logrolling
- Goal displacement
- "Groupthink"

Use Discrete Mathematics to describe social networks & group decision making

Why Group-Aided Decision Making?

- Use groups when consistency is important.
- Let the most competent individual make the decision given time constraints.
- Groups make poorer decisions when faced with environmental threats and potential serious impacts of a decision.

Other…

- Culture
- Gender
- Race
- Ethnicity
- Class