MIE 240: Human-centred system design

Decision-making
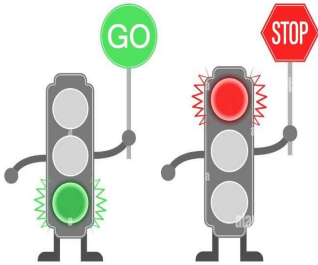
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Learning Objectives

- Define decision-making (DM)
- Distinguish different levels of skilled behaviour
- Distinguish descriptive and normative DM
- Define heuristics and identify varieties of heuristics
- Review design guidelines for decision-making

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Last Lecture

- Reviewed information processing model
- Discussed design guidelines for cognition
  - Attention
  - Working memory
  - Long-term memory

Exploit redundancy

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Design implications for selective attention

1. Optimize bottom-up processing
2. Support automaticity and unitization
3. Optimize top-down processing
4. Maximize discriminating features

Meaningful icons

- A ALPHA   N NOVEMBER
- B BRAVO   O OSCAR
- C CHARLIE   P PAPA
- D DELTA   Q QUEBEC
- E ECHO   R ROMEO
- F FOXTROT   S SIERRA
- G GOLF   T TANGO
- H HOTEL   U UNIFORM
- I INDIA   V VICTOR
- J JULIET   W WHISKY
- K KILO   X X-RAY
- L LIMA   Y YANKEE
- M MIKE   Z ZULU

Phonetic alphabet

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Design Implications of Working Memory

1. Minimize working memory load
2. Provide visual echoes
3. Provide placeholders for sequential tasks
4. Exploit chunking
5. Minimize confusability
6. Avoid unnecessary zeros (e.g., 000478 or 0.700)
7. Ensure congruence of instructions
8. Avoid negation

Results Table

Complete

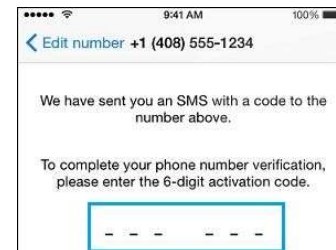|		Reference #	Status	Payment	Login Username
☐	👁 ✏ ✉	8459650	✓	📥 History 23.00	
☐	👁 ✏ ✉	8459646	✓	📥 History 23.00	
☐	👁 ✏ ✉	8455258	ⓘ	ⓘ History	
☐	👁 ✏ ✉	8423067	ⓘ	ⓘ History	

Incomplete

Provide placeholders

‹ Edit number +1 (408) 555-1234

We have sent you an SMS with a code to the number above.

To complete your phone number verification, please enter the 6-digit activation code.

– – – – – –

Requires you to remember code and switch back to app

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LTM implications for design

Standardization

Support correct mental models

| 1/2 hour | 1/2 hour | 1/2 hour | 1/2 hour | 1/2 hour | 1/2 hour | 1/2 hour | 1/2 hour |

Better →

| 1 hour | 1 hour | 1 hour | 1 hour |

4 hours
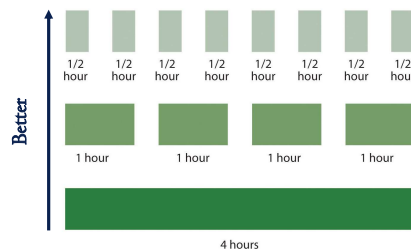
Encourage regular use and active reproduction

ADULT CPR 9 YEARS AND OVER 911

1. Attempt to wake the victim and call for help.
2. Begin chest compressions.
3. Open the airway.
4. Begin rescue breaths.
5. Repeat chest compressions.
6. Repeat rescue breaths.

"Knowledge in the world"

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Decision-making
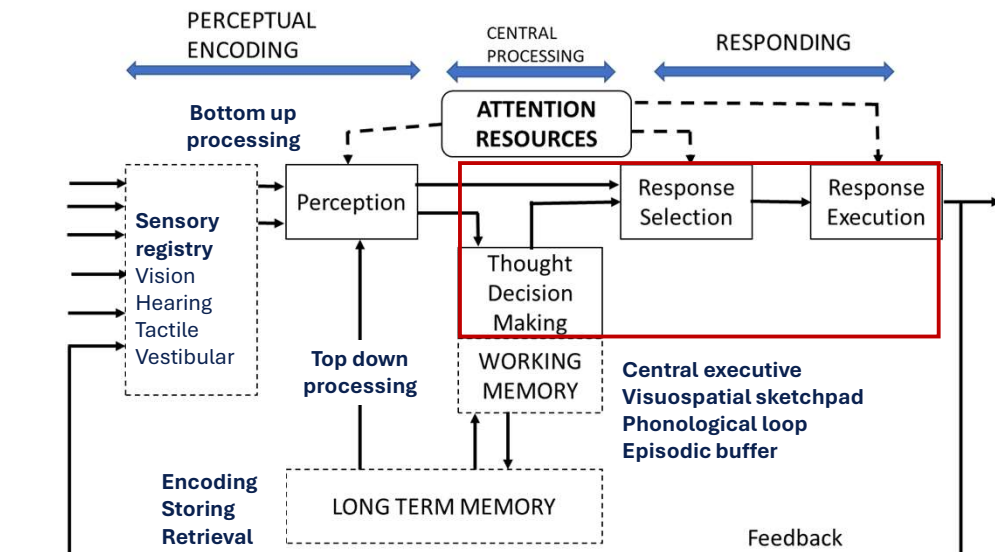
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Information processing model

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What is a decision?

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Decision making (DM)

Characterized by:

- Selecting of *an choice from many*
- <u>Some information available</u> regarding choices
- Time frame is <u>relatively long (> 1 sec)</u>
- *uncertainty* regarding best or acceptable choice

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DM phases

- *acquire & integrate*:
  - Selective attention to cues
  - Completeness, clarity, validity
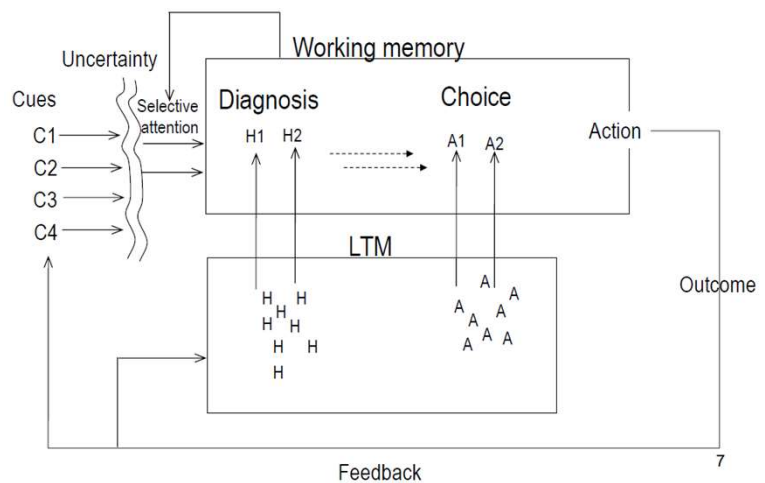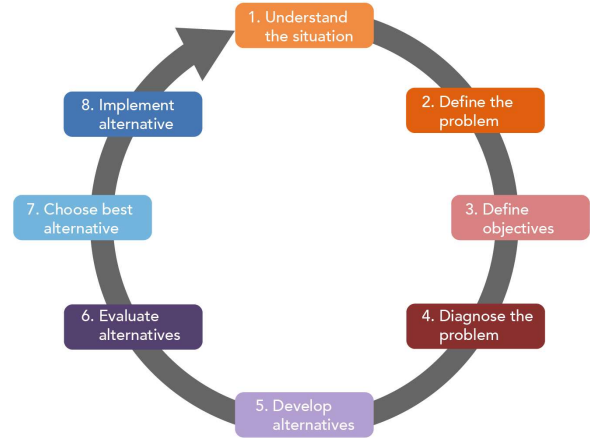- **Interpret and assess the meaning of info:**
  - Often inferential
  - Evaluated for likelihood of correctness
  - Confirming/disconfirming cues
  - Iterative hypothesis selection
- *plan and choose course fashi*:
  - Retrieving alternatives from memory
  - Outcomes; likelihood and consequences
- **Monitor and correct the chosen action**
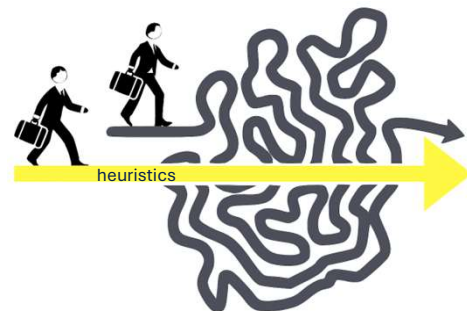

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Normative vs. Descriptive Models

Normative
– What people *should* do, rationally speaking
– Based on *utility*: value of a choice
– Multi-attribute, Expected value theory

Descriptive
– Describe what people *actually* do
– Description of what can influence DM
– Apply heuristics
– Satisficing

heuristics

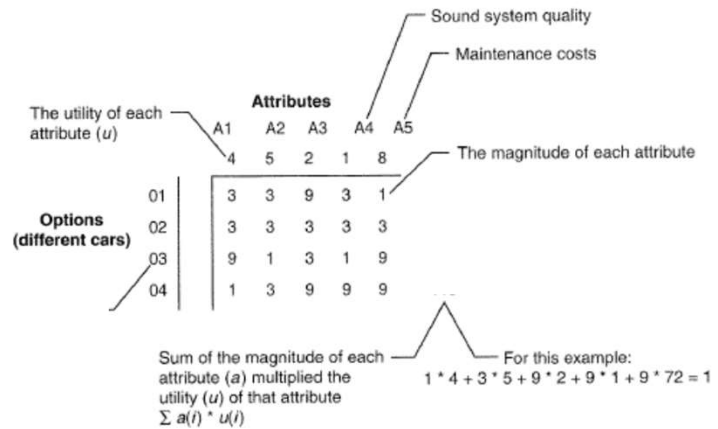MIE240: Human-Centred Systems Design   13

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Normative approach

Multi-attribute utility theory

- **Define criteria (attributes)**
- **Assign weights (utility)**
- **Rate options**
- The overall value of each option = summation of the criterion (attribute) multiplied by the weight (utility) of each criterion

Best choice: highest value

The utility of each attribute (u)

Attributes

| | A1 | A2 | A3 | A4 | A5 |
| | 4 | 5 | 2 | 1 | 8 |

Sound system quality

Maintenance costs

The magnitude of each attribute

Options (different cars)

	A1	A2	A3	A4	A5
O1	3	3	9	3	1
O2	3	3	3	3	3
O3	9	1	3	1	9
O4	1	3	9	9	9

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

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

Multi-attribute utility theory

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Normative approach

Expected value theory

- Assign each option a value
- Estimate the probability of the option
- Multiply value by probability
- ***Best choice:*** Highest expected value

Game 1

Amount	Prob
100	.05
0	.60
-25	.30

Game 2

Amount	Prob
70	.10
0	.50
-15	.40

Expected Utility = value X probability ratio

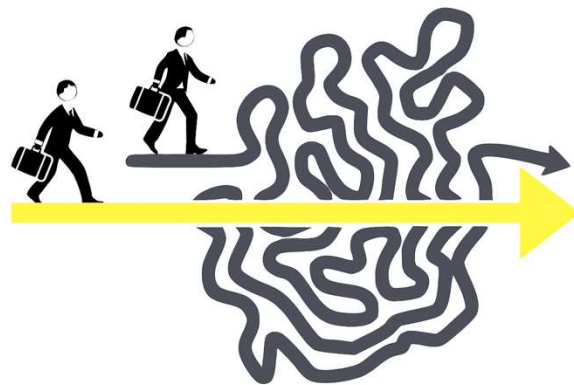MIE240: Human-Centred Systems Design

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Heuristics and biases

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Heuristics

- Methods for simplifying DM
- Subconscious shortcuts
- Powerful and efficient
- Prone to misapplication (biases)
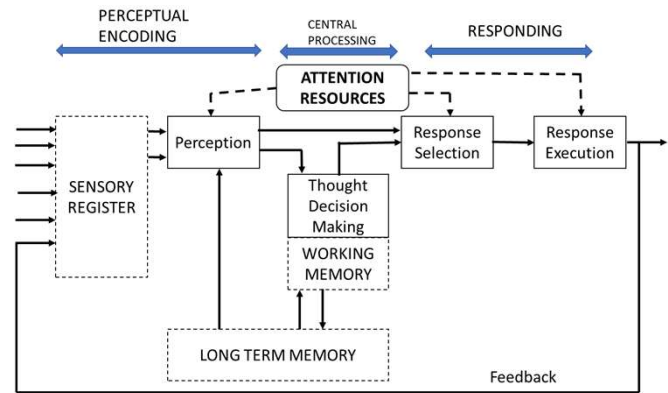- Consider heuristics by sub-process

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Heuristics

Factors influencing heuristics (& biases)

• Selective attention
• Limited attentional resources
• Limited capacity of working memory
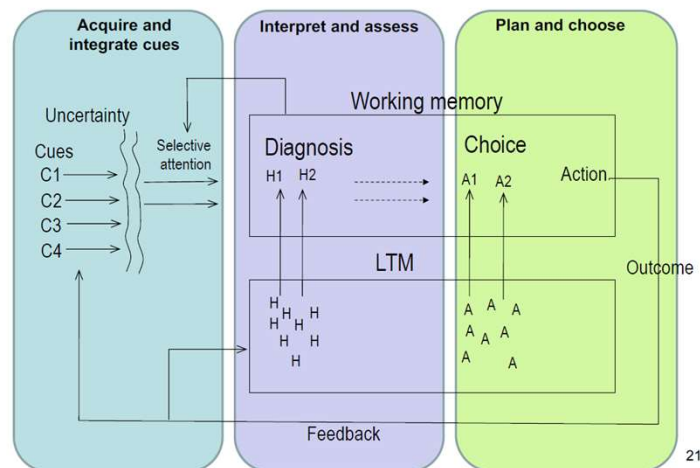• Limited knowledge (LTM)
• Time available

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Biases in DM

1. Acquire and integrate information
2. Interpret and assess info meaning
3. Plan and choose course of action

Information processing model of DM

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Biases in DM

1. Anchoring and cue primacy
2. Attention to limited no. of cues
3. Availability
4. Availability heuristic for actions
5. Availability heuristic for outcomes
6. Cognitive tunneling
7. Confirmation bias
8. Cue salience
9. Default heuristic
10. Framing bias
11. Hindsight bias
12. Overconfidence
13. Overweighting unreliable cues
14. Planning bias
15. Representativeness
16. Retrieve small number of actions
17. Simplicity seeking and choice aversion

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Knowledge – analytical processing
- New situation
- Slow, conscious, deliberating

Rule – recognize signs, apply rule
- Task familiarity
- Limited experience

Skill – respond to cues as signals that guide responses
- Proficient
- Intuitive
- Fast, subconscious

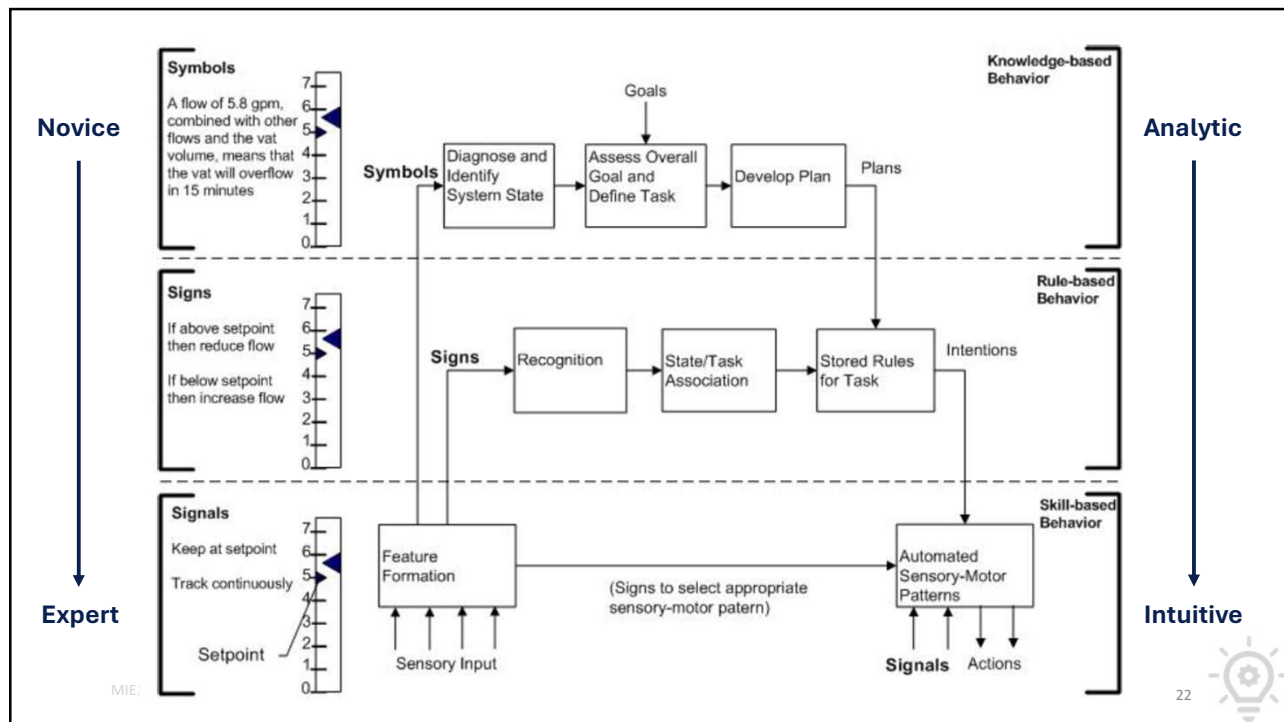| Skill in Decision Making	Less Proficient (Novice)		Very Proficient (Expert)
Reasoning Level	Knowledge-based	Rule-based	Skill-based
Decision Type	Analytic		Intuitive
Decision System	System 2		System 1
School of Decision Research	Heuristic and Biases "What's wrong"		Naturalistic Decision Making "What's right"
Adaptive Decision Making	Less		More

Increasing Experience

SYSTEM ONE — Fast, Unconscious, Automatic, Everyday decisions, Error prone

SYSTEM TWO — Slow, Conscious, Effortful, Complex decisions, Reliable

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Decision-making guidelines

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Principles for Improving Decision Making

Task redesign

Drawing medications

Prefilled Syringes

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Principles for Improving Decision Making

Choice architecture - influence the decision by recognizing the natural cognitive tendencies.

Provides options that will take advantages of the cognitive tendencies to generate good decisions.
- **Limit the number of options**
- **Select useful defaults**
- **Make choices concrete**
- **Create linear, comparable relationships**
- **Sequence and partition choices**
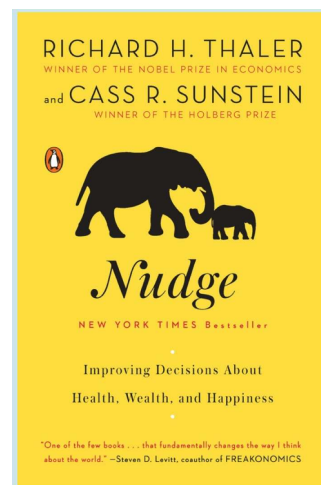
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Principles for Improving Decision Making

Ex. 1 *select defaults*
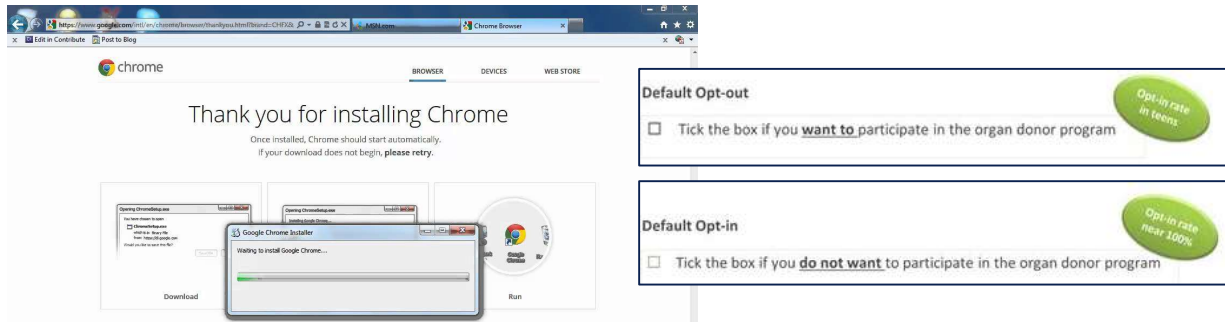
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Principles for Improving Decision Making

Ex. 2 *Concrete Choice*

- Translate abstract future value choices into immediate salient consequences
- To counteract people's tendency to neglect the abstract future situation, a limited window of opportunity can focus their attention.

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Principles for Improving Decision Making

Ex. 3 *limiting # options*

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Principles for Improving Decision Making

Ex. 4 *sequence & partition*

select defaults

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Principles for Improving Decision Making

Ex. 5 *linear comparable relationship*

Different quantity of same product

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Principles for Improving Decision Making

pseudoubligation

- Procedure can make decisions more consistent and accurate

- Decision trees enable fast and understandable way to guide decisions.
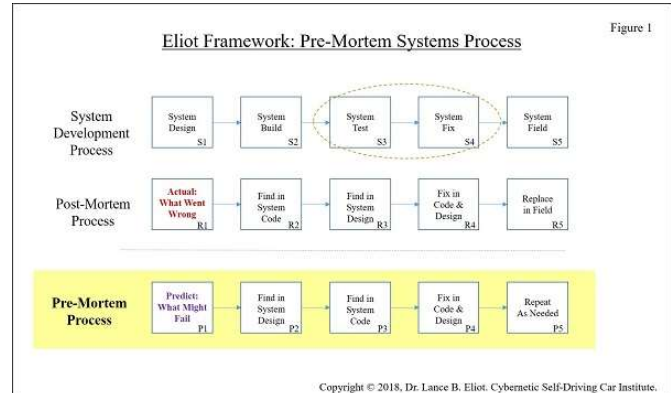

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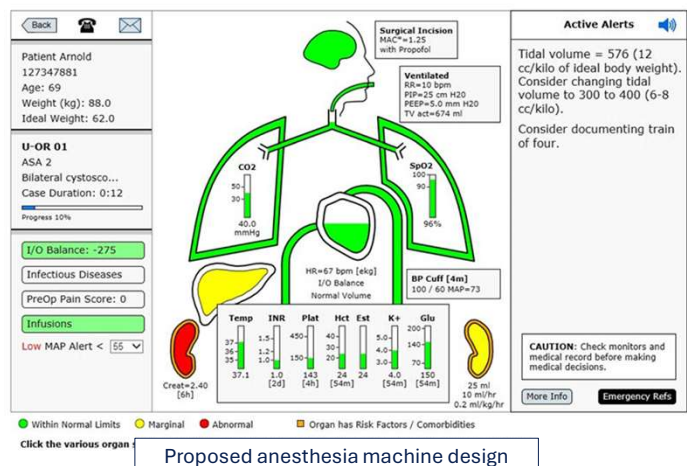# Principles for Improving Decision Making

Training

- Pre-mortem analysis encourages decision makers to consider everything that might go wrong before, if the candidate decision was made.

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Principles for Improving Decision Making

Displays – Influence decision processes by guiding *selective attention*

Standard anesthesia machine

Proposed anesthesia machine design

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Principles for Improving Decision Making

Automation and decision support tools
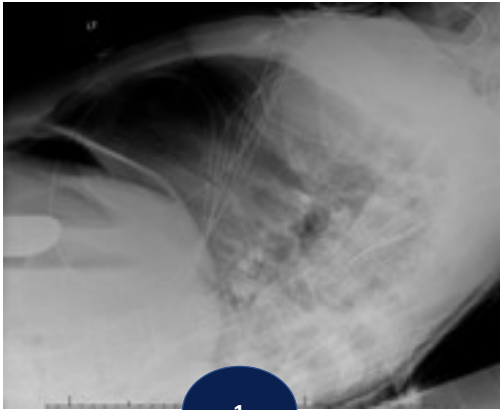
Is a retained foreign object present?

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Summary

Decision-making is a cognitive process that results in the selection of an option or a course of action among several possible alternatives.

Principles for improving decision-making
- Task redesign
- Choice architecture
- Proceduralization
- Training decision-making
- Use displays
- Automation and decision support tools

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Next lecture (Wed., Feb. 9)

Topic: Design guidelines for decision-making
Review: Ch. 8 (skip 8.6)
Review questions: 8.1, 8.3, 8.6, 8.18, 8.24, 8.32, 8.37

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Decision-making biases

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Cue Biases | Biases in Acquiring and integrating cues
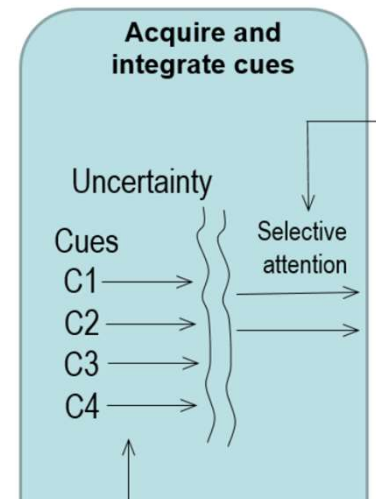
Attention to limited number of cues

Anchoring and cue primacy:

– Early information is more influential

– Inattention to later cues

– Plausible explanations gain momentum

Cue salience: very visible cues are given more weight

– Highlights in a menu

Overweighting unreliable cues

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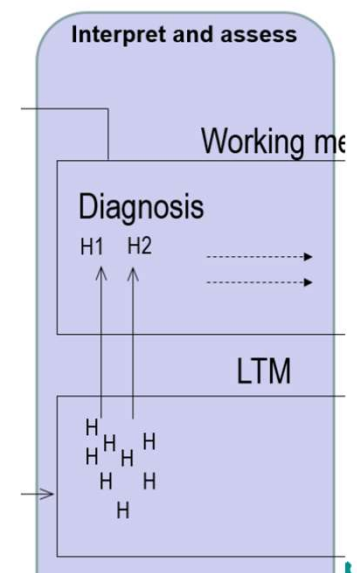# Cue Biases | Biases in Interpretation and Hypotheses Generation

Availability

– Options easily brought to mind given

undue weight

– f {frequency, recency, vividness}

Representativeness

– Common cues (of an object or event)

seen as being typical of a category

Overconfidence

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Cue Biases | Biases in Interpretation and Hypotheses Generation

Cognitive tunneling

– Reluctance to change from a hypothesis

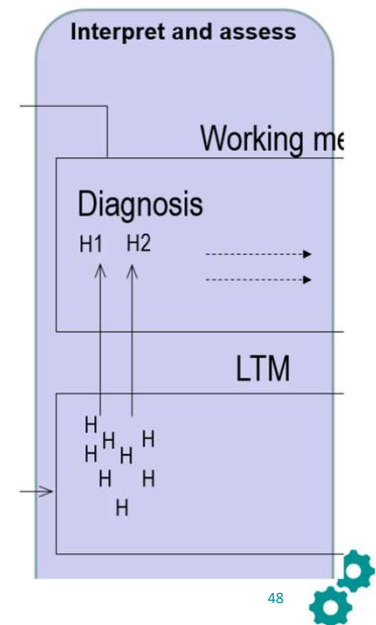– Ignoring contrary information or changing state

Simplicity seeking and choice aversion

– Too many choices degrades decision

Confirmation bias

– Seek only evidence to confirm

– Underweight disconfirming evidence

– Fail to use absence of important cues

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Cue Biases | Biases in Action Selectio

Planning bias

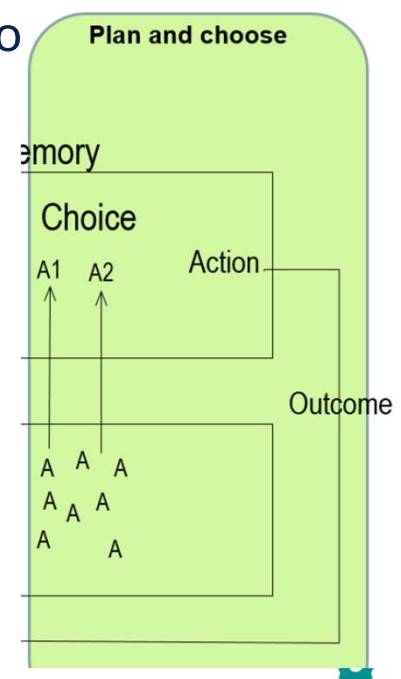– People assume that the best case scenario will unfold

Retrieve small number of actions

– WM limited to process many at the same time

Availability heuristic for actions (frequency, recency)

– Surgeons like to operate

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Cue Biases | Biases in Action Selectio

Availability heuristic for outcomes

– Subjective probability does not equal actual probability (e.g., use of PPE)
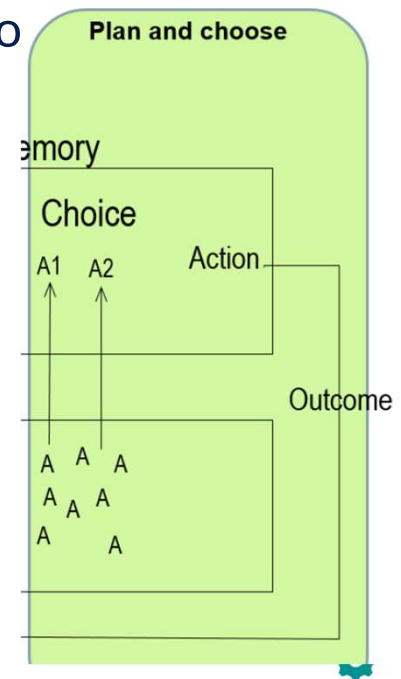
Hindsight bias

– Accident investigators blaming human

Framing bias

– 10% fat vs. 90% lean meat

Default heuristic

– Given hard DM, we tend to choose default (e.g., organ donation)

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