

# **Cognitive Science in Engineering Systems**

**MIT Student**

**Lecture 11 Discussion**

# Overview

- Peter M. Todd, “Fast and Frugal Heuristics for Environmentally Bounded Minds,” in *Bounded Rationality: The Adaptive Toolbox*, edited by G. Gigerenzer and R. Selten (Cambridge: MIT Press, 2001)
- Valerie F. Reyna, “Meaning, Memory, and the Interpretation of Metaphors,” in *Metaphor: Pragmatics and Applications*, edited by J. Mio and A. Katz (Hillsdale, NJ: Lawrence Erlbaum Associates, 1996)
- Implications for Engineering Systems

# Todd, “Fast and Frugal Heuristics”

- Thesis: Humans use simple heuristics in decision-making, not because we are forced to by cognitive constraints, but because heuristics worked in the past
- “Nature versus Nurture”
  - Nature: Bounded by internal cognitive wiring
  - Nurture: Bounded by external interactions
- “Virtue or Curse”
  - “Heuristics and Biases” Camp (Tversky & Kahneman)
  - Ecological Rationality (Gigerenzer)

# Todd, “Fast and Frugal Heuristics”

Strategy	Frugality	Accuracy (% correct)	
		Fitting	Generalization
Minimalist	2.2	69	65
Take the best	2.4	75	71
Dawes's rule	7.7	73	69
Multiple regression	7.7	77	68

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# Todd, “Fast and Frugal Heuristics”

## Recognition

Pick the object that is recognized  
Less-is-more

### Stock Market Picks

Which city is bigger?  
Lincoln, NE or Hays, KS

## Search Termination

Investigate only a few alternatives  
before deciding

### Buying a coffee maker

(Simon’s *Satisficing*)

## One-Reason, One-Cue

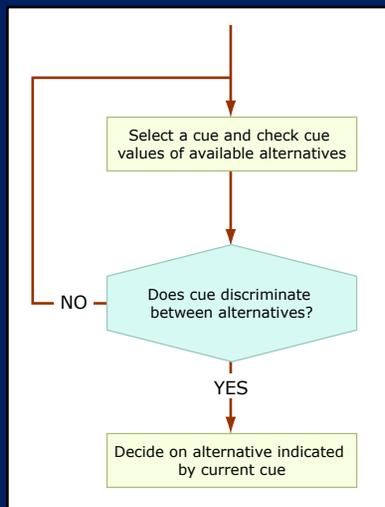


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**Info Search Rule**  
“Take the Best”  
Minimalist

**Decision Rule**

**Stopping Rule**

## Multi-Cue

Categorization by Elimination  
QuickEST

Given the number of taxicabs in City Y,  
how large is the city?



# Todd, “Fast and Frugal Heuristics”

## Accuracy Needed

Extensive, unselective, alternative-based information gathering

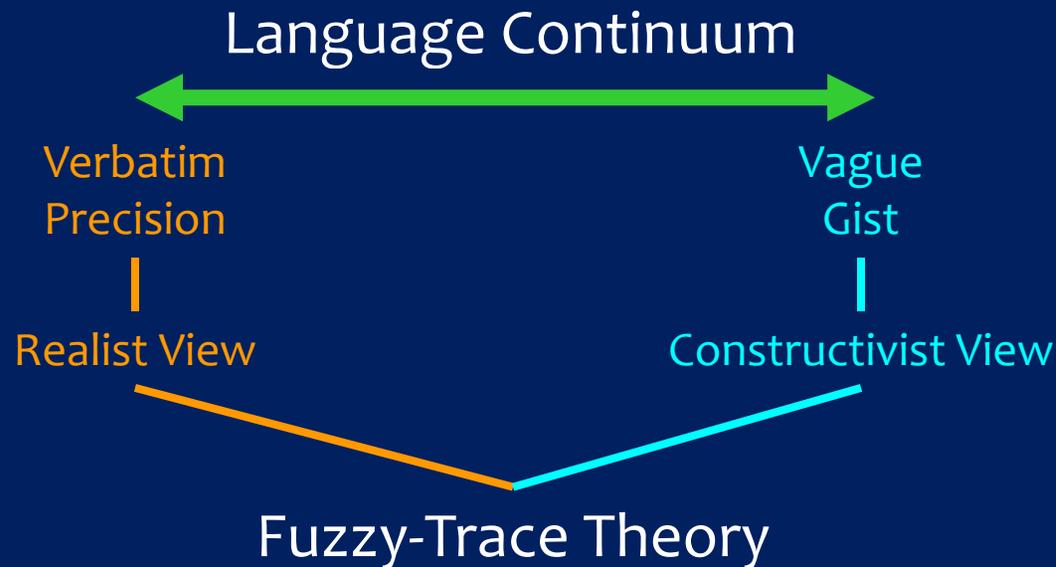
## Speed Needed

Focused, selective, cue-based information gathering

- Does Todd sufficiently rebut the common, negative perception of “heuristics and biases”?
- When do “fast and frugal” heuristics break down?
- Are there ways to improve time-constrained decision-making?

# Reyna, “Metaphors”

- Thesis: Fuzzy-trace theory and its element of verbatim-gist distinction helps explain humans’ interpretation of metaphors



Individuals erroneously accept incorrect inferences if they didn't remember and they reject incorrect inferences if they do remember.

# Reyna, “Metaphors”

- Experimental Design

The woman was an aspirin, kneeling by the lost boy.

Relationship

Literal

John was a pingpong ball, chatting with the guests.

Perceptual

This article is a rotting apple, waiting to be thrown away. Perceptual

<u>Metaphorical Term</u>	<u>Literal Synonym</u>	<u>Perceptual Interpretation</u>	<u>Psychological Interpretation</u>
aspirin	woman as aspirin	round	made boy feel better
cough syrup	nurse	square	stopped a heart attack

# Reyna, “Metaphors”

- Interpreting the Results
  - Metaphors bridge between verbatim and gist
    - Metaphors cue verbatim memory
    - Their interpretation cues gist memory
  - Stimuli (“effect of materials”) can affect memory
    - “The woman was an **aspirin...**”
    - “The woman was **cough syrup...**”

# Reyna, “Metaphors”

- Implications
  - Continuum stretches from literal to metaphorical interpretation
  - Appropriate interpretation requires pragmatic knowledge
  - Do we over-rely on metaphors to describe complex socio-technical systems?
  - When using metaphors, are there ways to mitigate problems with interpretation?

# ES Implications

- Are there ES lessons to be gleaned by Todd's and Reyna's questions, methodologies, and reporting?
- How should ES view humans' penchant for cognitive shortcuts?
  - Modeling systems
  - Designing systems

# Janis, Groupthink

- Central Theme: “The more amiability and *esprit de corps* among the members of a policy-making in-group, the greater the danger that independent critical thinking will be replaced by groupthink, which is likely to result in irrational and dehumanizing actions directed against out-groups.”
- Groupthink – A deterioration of mental efficiency, reality testing, and moral judgment that results from in-group pressures.

# Janis, Groupthink

- Seven Defects in Decision-Making
  1. Discussions limited to a few alternative course of actions
  2. No survey of the objectives to be fulfilled and th value implications
  3. Failure to reexamine the initially preferred course of action
  4. Neglect courses of action initially judge unsatisfactory
  5. No attempt to solicit information from experts
  6. Selective bias distorts factual information
  7. No discussion of contingency plans

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