

# An Overview of Cognitive and Decision Making Models

***MV/OA-4655***

***March 8, 2001***

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# Outline

- *Definition of the decision maker*
- *Classical Decision Making*
- *Naturalistic Decision Making*
- *Computational Methods*
- *Military Applications*

## The Decision Maker

- *Defines the problem*
- *Identifies and analyzes possible courses of action*
- *Selects a course of action*

## Classical Decision Making

- *Makes the assumption that there is a “right” way to solve problems that can be applied to a variety of situations*
- *Prescriptive*
- *Narrow*
- *Does not transfer over to real-world scenarios*

# Classical Decision Making

## • *Normative Models*

- Focus on option generation and evaluation to choose course of action
- Can be used on specific types of problems
- Training effects
  - Unable to find proof that normative models transfer widely to real-world decisions
  - Didn't transfer in business management, financial analysis, or medical diagnosis

# Classical Decision Making

- ***Normative Models***

- Don't transfer because the circumstances under which they are taught, and the models' view of the decision-making task are inconsistent with the real world
  - Not usable under the time constraints that often occur
  - People see normative models as requiring too much effort

## Classical Decision Making

- *In mid-80's researchers working in more applied areas such as decision support, design, and training, found that CDM did not fit needs*
  - Led to Naturalistic Decision Making

# Naturalistic Decision Making (NDM)

- Focus on how people actually make decisions
- Emphasizes complex, real-world decision making
  - Ill-structured problems
  - Uncertain dynamic environments
  - Shifting, ill-defined, competing goals
  - Action/feedback loops
  - Time stress
  - High stakes
  - Multiple players

# Naturalistic Decision Making

- ***The expert-novice difference***
  - deGroot's chess players
    - Can look at a chessboard and parse it into chunks
    - Chunking is a result of previous experience
  - Also demonstrated in physics, statistics, computer programming, baseball, radiology, and basketball
  - As expertise grows, individuals come to know things differently

## **Naturalistic Decision Making**

- ***Decision making is not a task, but a means to an end***
- ***Requires flexibility because of the changing situation or knowledge***
- ***Multiple goals competing for attention***
- ***Time pressure and stress***
- ***Execution may involve multiple people***

## **NDM Models**

- ***Pennington & Hastie: Explanation-Based Decisions***
  - Example: how juries make decisions
- ***Montgomery: Search for Dominance Structure***
  - When many options are available (car or apartment buying)
  - Search for the dominant option

## NDM Models

- ***Many more models exist for NDM***
- ***Klein: Recognition-Primed Decisions (RPD)***
  - Most well-known of NDM models
  - Steps: situation recognition, serial option evaluation, mental simulation
  - Used by experts
  - Usually the first option generated is the “best”

# Recognition-Primed Decision Model

- ***Created to explain how experienced fireground commanders assess situation and choose course of action***
- ***Focuses on:***
  - Experienced decision makers in complex situations, who
  - Face personal consequences of decisions
  - Description rather than prescription
  - Situation awareness and problem solving are part of process

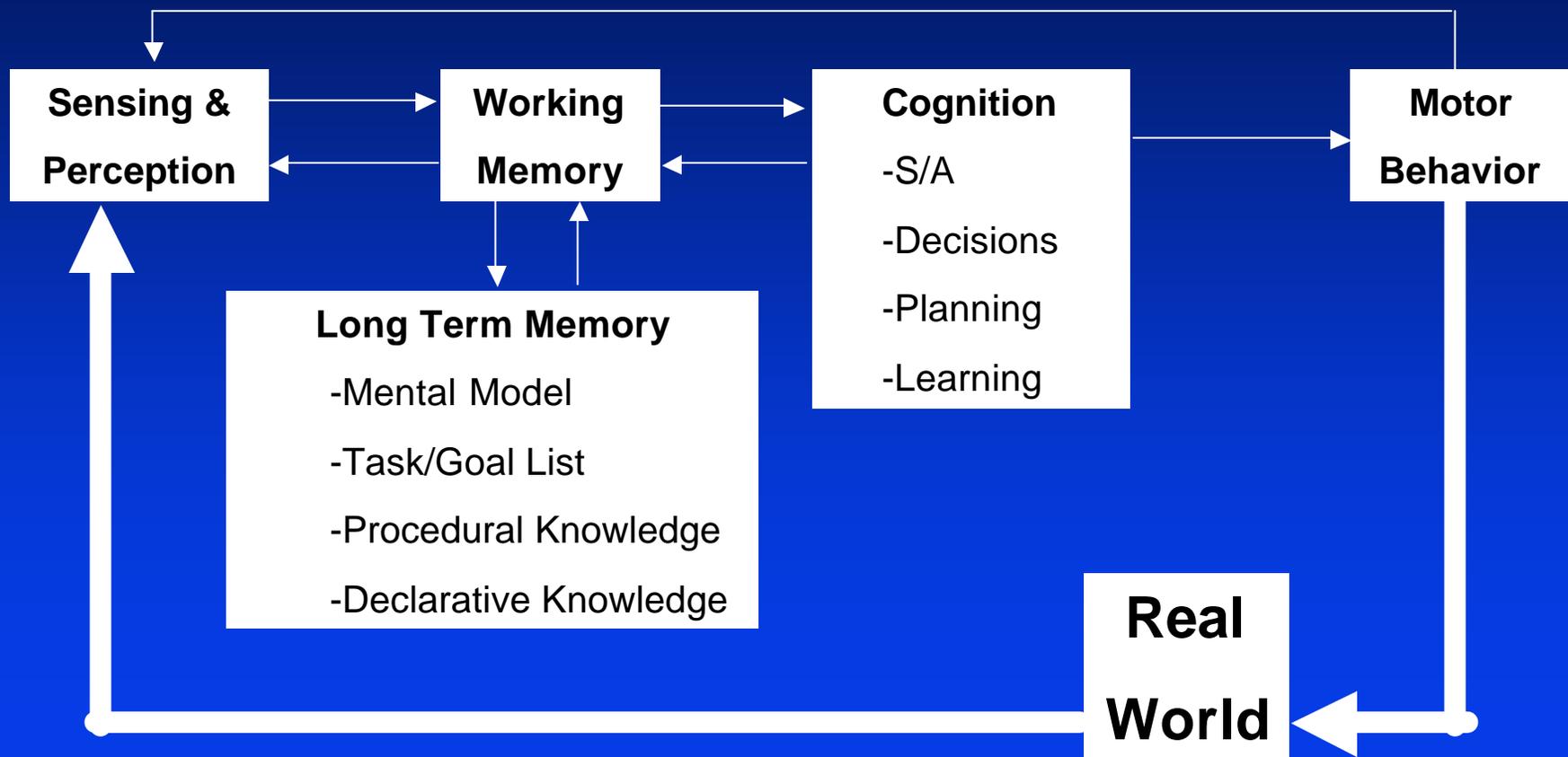
# Recognition-Primed Decision Model

- *Has been observed in a variety of situations:*
  - Firefighting
  - Military: Army tank platoon operations, Navy command and control in AEGIS cruisers
  - Hardware/software design
  - Flight control in commercial airliners
  - Chess tournaments
  - Nursing in ICU's

# Cognitive Task Analysis

- ***Klein Associates developed CTA using the Critical Decision Method***
  - Experts are interviewed and questioned about key events (critical decisions) and their responses
  - Can be difficult – experts don't necessarily consciously think about responses

# Basic Cognitive Model



# General Computational Methods

## • *Rule-based systems*

- Adaptive Control of Thought (ACT-R)
- COGNition as a NETWORK of Tasks (COGNET)
- Operator MOdel Architecture (OMAR)
- System Analysis of Integrated Networks of Tasks (SAINT)
- Soar

# General Computational Methods

- ***Typical rule-based system execution cycle***
  - Input – new sensory data into working memory
  - Proposal – interpret data, propose & compare operators
  - Decision – new operator is selected
  - Application – apply new operator to define next state
  - Output – pass to external environments

# General Computational Methods

- ***Other programming approaches***
  - Agent-based systems
    - Goal selection
    - Rule selection
    - Rule generation (genetic algorithms)
  - Neural networks (also called connectionistic networks or parallel distributed processing systems)

# General Computational Methods

## • *Shortcomings of Current Models*

- Traditionally based on Rational Choice Theory - leading to computational models that don't make decisions like humans do
- Rule-based models require coding responses for every possible input condition – not realistic in complex dynamic environments
- Many applications require the model to explain why it made the decisions (ITS, decision support, training summaries)
- Most models are very good at certain aspects of human cognition in specific situations, but . . .

# General Computational Methods

## • ***Behavioral Validity***

- How well the responses and actions match reality
- User only cares that the actions taken are human-like

## • ***Cognitive Validity***

- How well the entire cognitive process matches reality
- User requires that the actual decision making process, not just the resultant action, is human-like

# Military Simulation Applications

- ***Computer Generated Forces (opposition)***
- ***Intelligent Tutoring Systems***
- ***Tactical Decision Support***
- ***Distributed Training (friendly CGF's)***
- ***Information Warfare***

## Questions (& Answers)

- ***What are the two theories of decision making?***
  - Classical & Naturalistic
- ***List characteristics of situations in which NDM is applicable (hint: there were 7 mentioned in this brief)***
  - Ill-structure problems, dynamic environments, competing goals, feedback loops, time stress, high stakes, multiple players

## Questions (& Answers)

- ***What is the difference between behavioral and cognitive validity?***
  - Behavioral = how well the responses & actions match reality
  - Cognitive = how well the entire cognitive process of the model matches reality
- ***List military simulation applications that require a decision making model***
  - Computer generated forces (CGF's), intelligent tutoring systems, tactical decision support, distributed training (friendly CGF's), information warfare

**Questions?**