Airborne Decision Making: Heuristics and Biases: should we be worried?

Al Baker; RNZAF HF Specialist

Three misconceptions about Heuristics

Heuristics are always a second best solution – one that you employ when you don't have enough time or skill to think through a problem completely

A quick and dirty way of problem solving that reflects that we have cognitive limitations; a view that prevails today in the form that we are cognitive misers;

More information, more computation and more time would always let us make better decisions.

PERFORMANCE = f (POTENTIAL) – (INTERFERENCE)

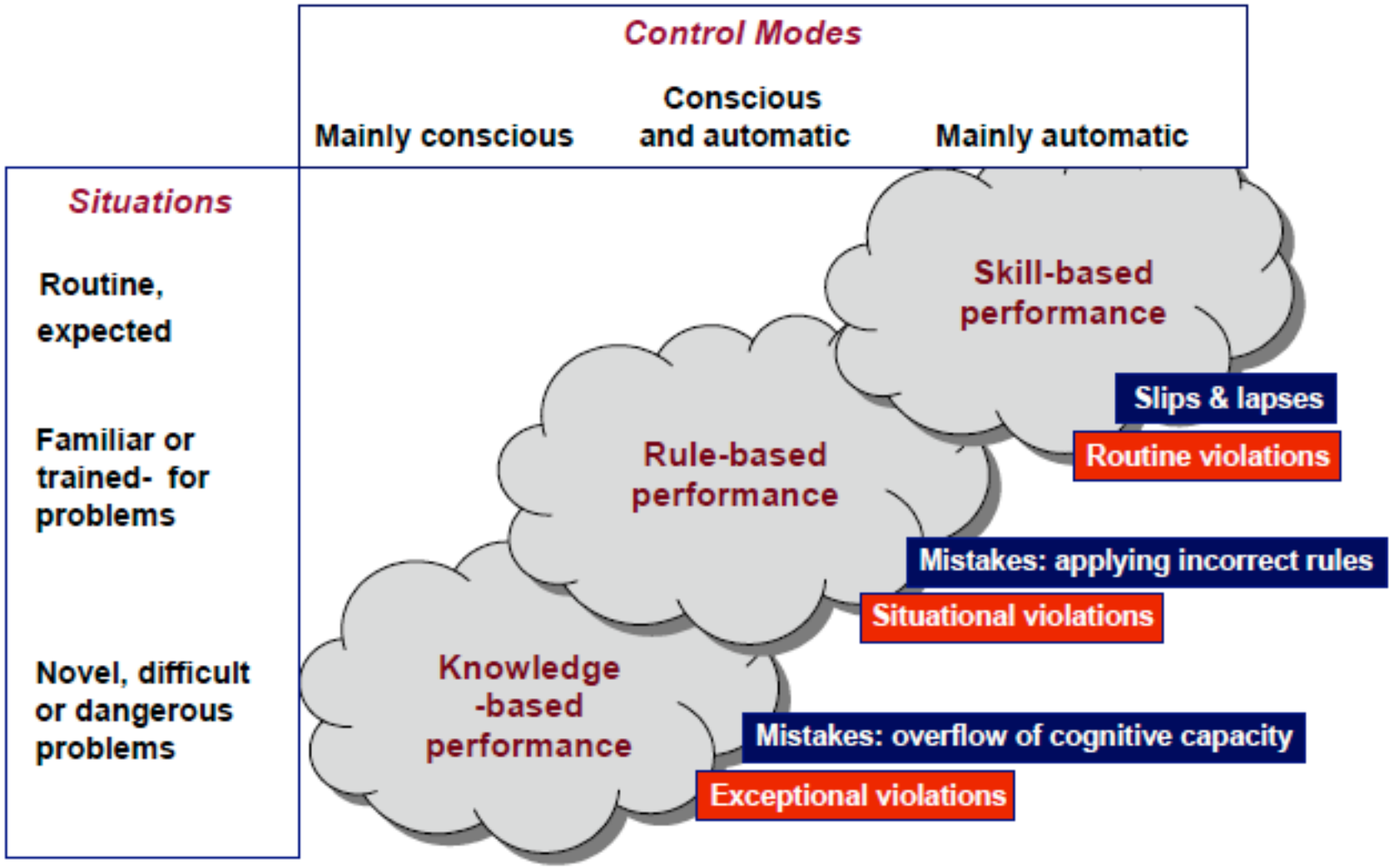

Figure 2

Performance Levels and Main Error and Violation Types (adapted from Rasmussen and Reason)

DECISION PROCESS

Influenced by:
-Ambiguity
- Understanding Risk
- Goal Conflicts
- Pressures

Situational Awareness

Error Types

Misinterpret cues
Misdiagnose cues
Ignore cues

Risk Levels miss assessed

Time issues miss assessed

Choosing a Course of Action

Inadequate Response – from a Rule-Based 'Error'
(i.e. not retrieved from memory & applied due to:
- not known, or
- some contextual factor mitigated against it).

Inadequate Response – from a Choice-Based 'Error'
(i.e. not retrieved from memory – or only one option retrieved
when others are available and should be considered).

Inadequate Response – failure to come up with a workable
Creative solution

Modified from: Orasanu, J. & Martin, L. 1998. "Errors in Aviation Decision Making: A Factor in Accidents and Incidents".

Courses of Action

Rule Based: single prescribed action to take in response to a particular condition or situation

Choice Based: multiple options with legitimate trade-offs. Choices depend on prevailing goals and constraints

Creative: no suitable options are readily available and the decision maker must invent one to meet the demands of the situation.

AVIATION RESEARCH LABORATORY

INSTITUTE OF AVIATION
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

FINAL TECHNICAL REPORT

COMPONENTIAL ANALYSIS OF PILOT DECISION MAKING

Christopher D. Wickens, Alan Stokes, Barbara Barnett, and Tom Davis, Jr.

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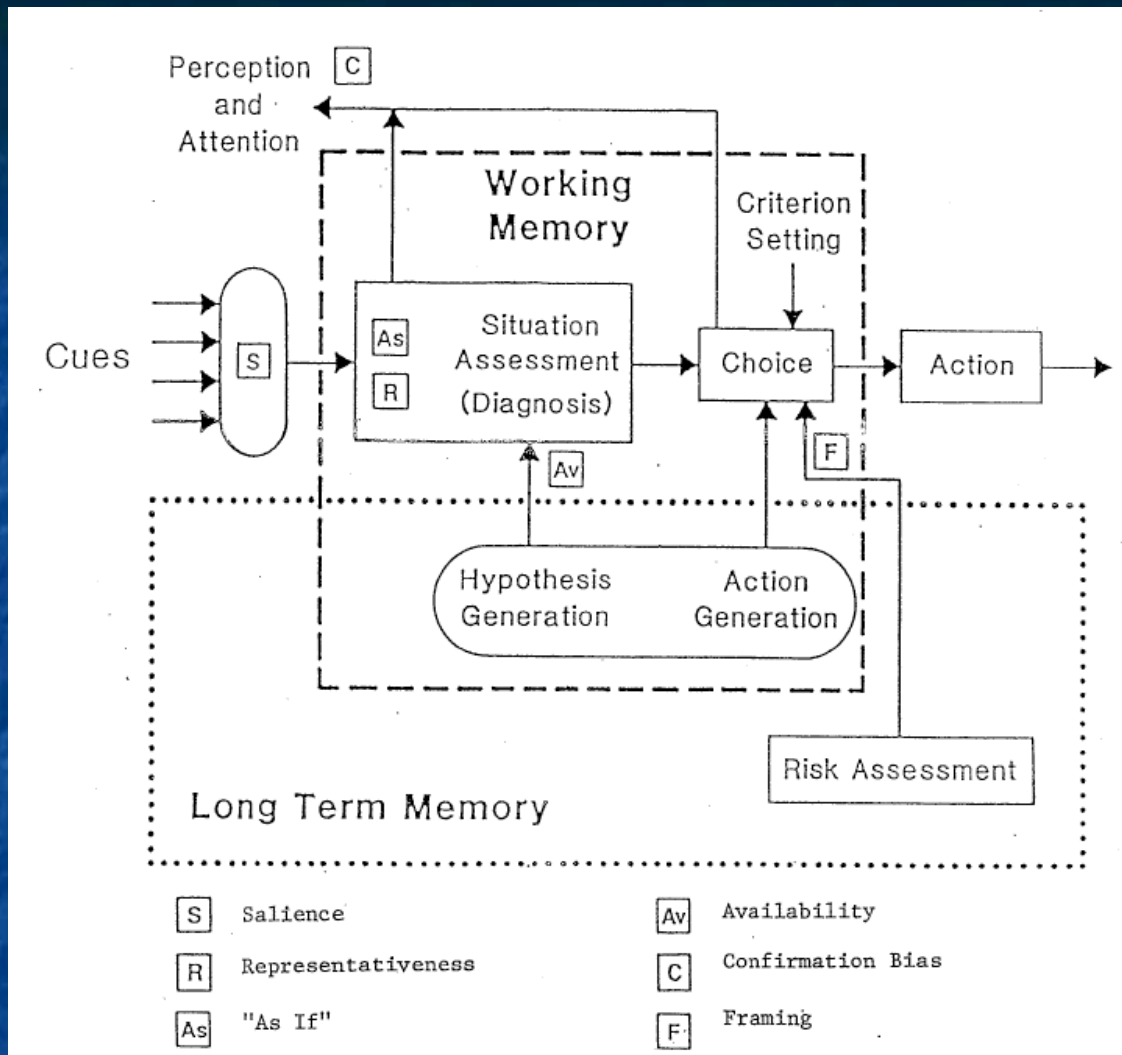

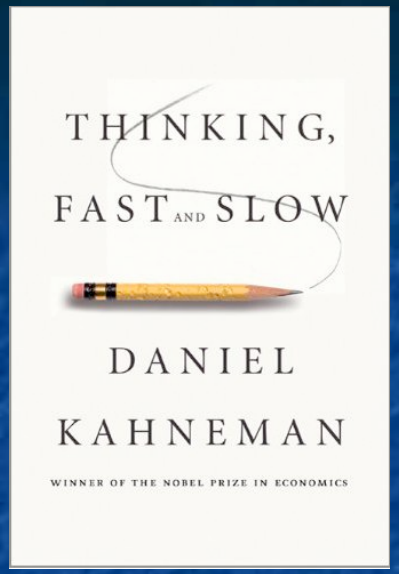
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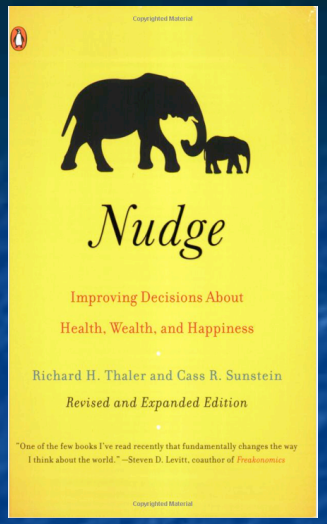
DANIEL KAHNEMAN
WINNER OF THE NOBEL PRIZE IN ECONOMICS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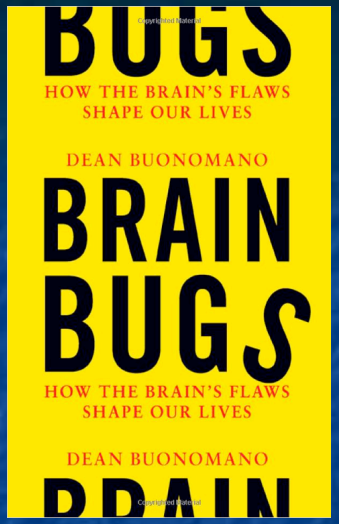
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HOW THE BRAIN'S FLAWS SHAPE OUR LIVES
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BRAIN BUGS
HOW THE BRAIN'S FLAWS SHAPE OUR LIVES
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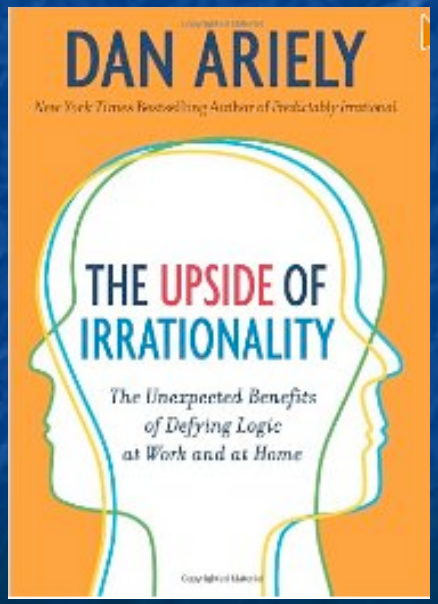
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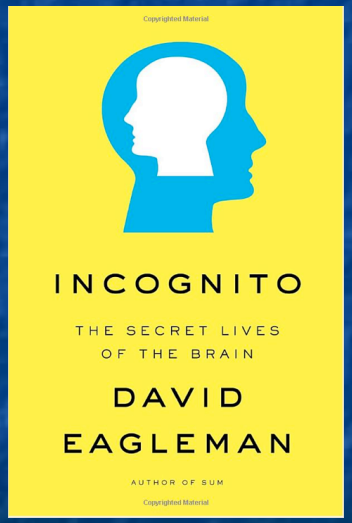
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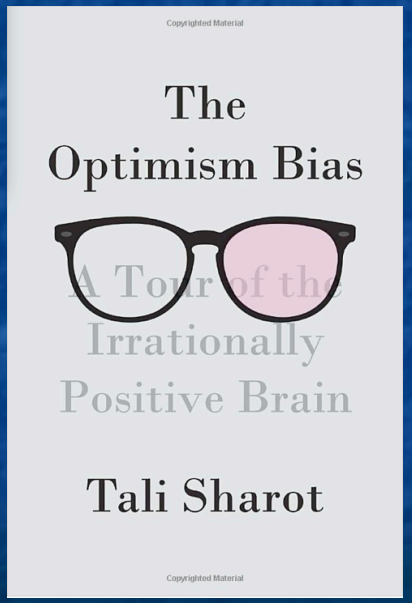
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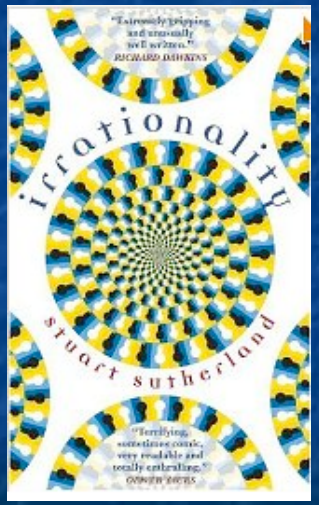
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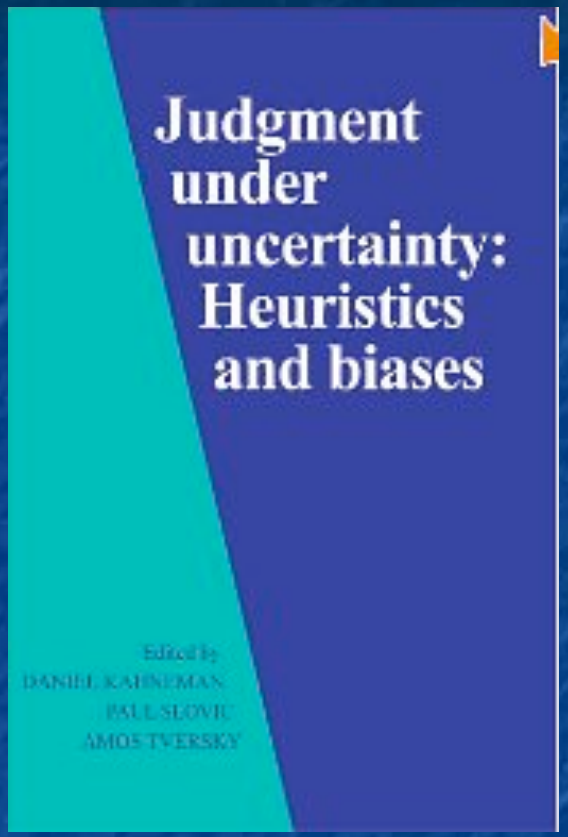
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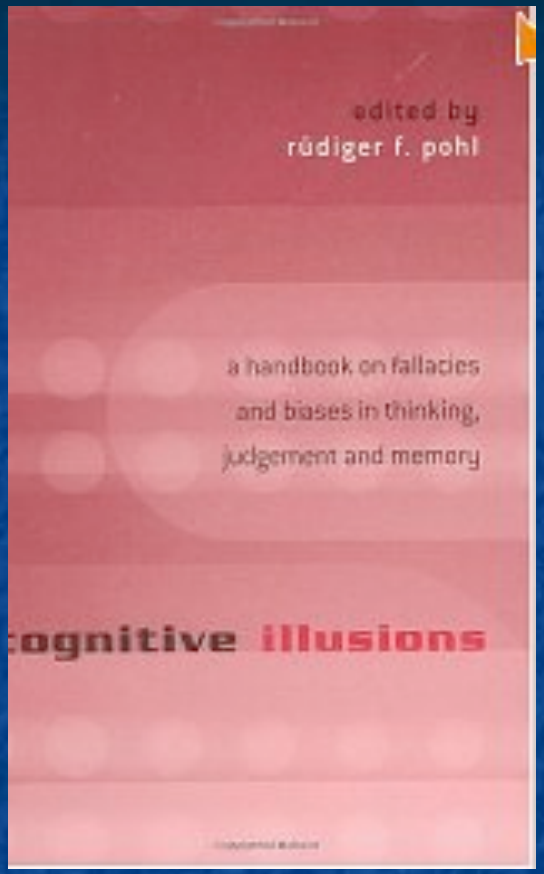
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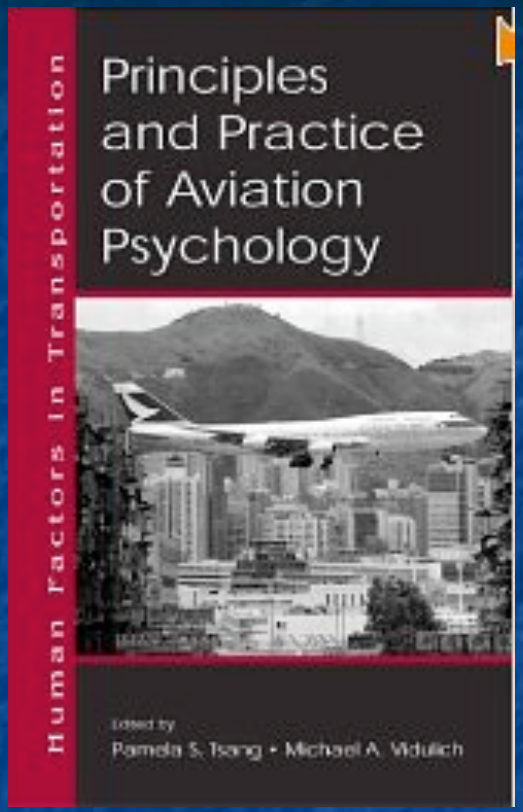


David O' Hare' s Decision Making Analogies

* Pilot as Faulty Computer

* Pilot as Rational Computer

* Pilot as an Enquiring Expert

* Pilot as Character Defective

The seduction of pseudo explanations.

Moliere's parody of the Aristotelian doctrine of substantial forms: Why does opium make you sleepy?

Because of its dormative properties.

"Models of heuristic cognition focus on situations in which people need to act fast, the probabilities or utilities are unknown, and multiple goals and ill-defined problems prevent logic or probability theory from finding the optimal solution."

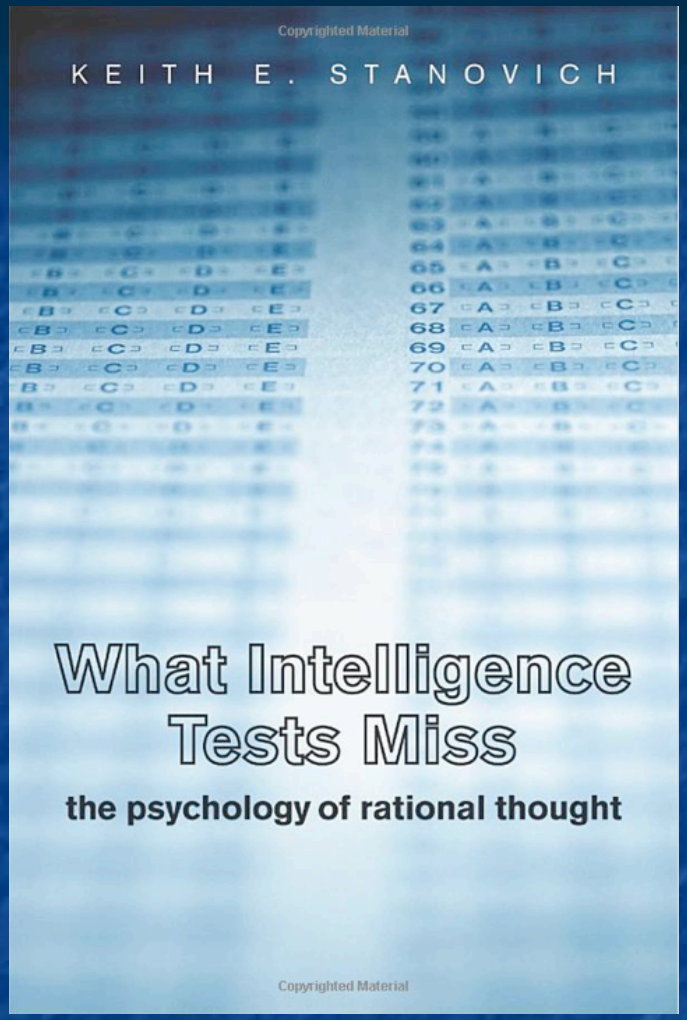
A glove and ball cost $1.10 in total. The glove costs $1 more than the ball. How much does the ball cost?

Jack
(Married)

Anne

George
Unmarried

Question:
Is a married person looking at an unmarried person?
a)Yes
b)No
c)Cannot be determined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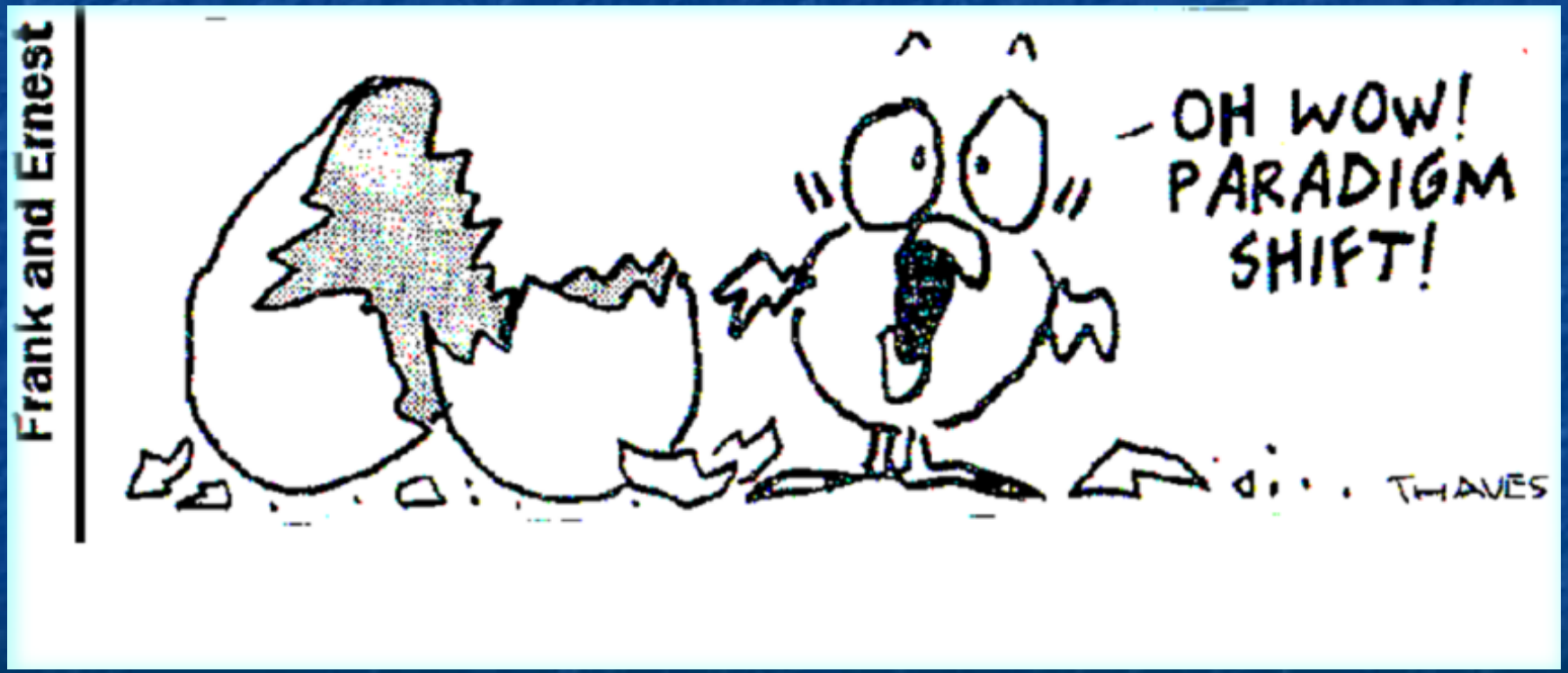
Frank and Ernest
OH WOW! PARADIGM SHIFT!
THAVES


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Why Heuristics Work

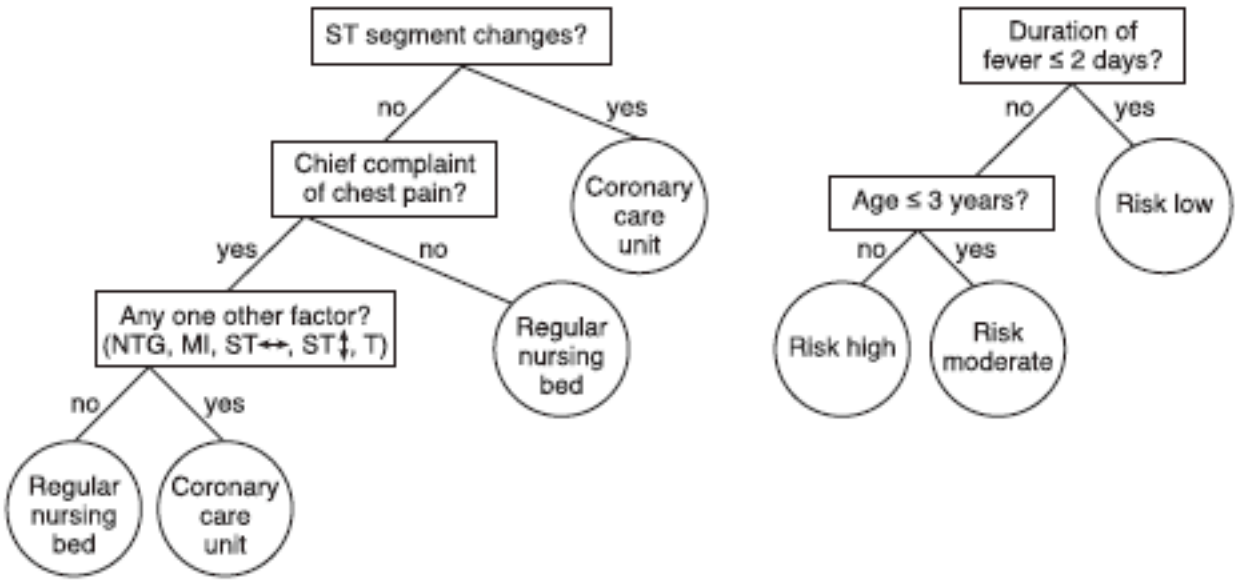


Fig. 1. Fast-and-frugal trees for coronary care unit allocation (left; based on Green & Mehr, 1997) and for macrolide prescription for children (right; based on Fischer et al. 2002). The former assists emergency unit physicians in deciding whether a patient with severe chest pain should be sent to the coronary care unit or a regular nursing bed; the latter assists pediatricians in diagnosing whether children are infected with *Mycoplasma pneumoniae* and should be treated with first-line antibiotic treatments (macrolides). A fast-and-frugal tree is a classification tree that has $M + 1$ exits (M is the number of cues) and allows for a classification after each question (cue). In contrast, the number of end nodes of a complete tree (2^M) increases exponentially, which makes complete trees computationally intractable for large numbers of cues.

Perfect replication (of past)

Unique situation

Need for perfect memory

No need for any memory

Where we need to know what is noise and what is valid information

Anesthetists Problem Solving

2 were identified as Stalled. They couldn't find any pattern or choose a C of A; neither figured out the problem.

11 were identified as Fixated. They jumped to the obvious diagnosis and rarely considered other hypotheses; none of the 11 figured it out.

17 were identified as Open-minded (or diagnostic Vagabonds). They wouldn't commit to any diagnosis and treated all possibilities as tentative. They never engaged in a course of treatment that let them probe more deeply; none figured it out.

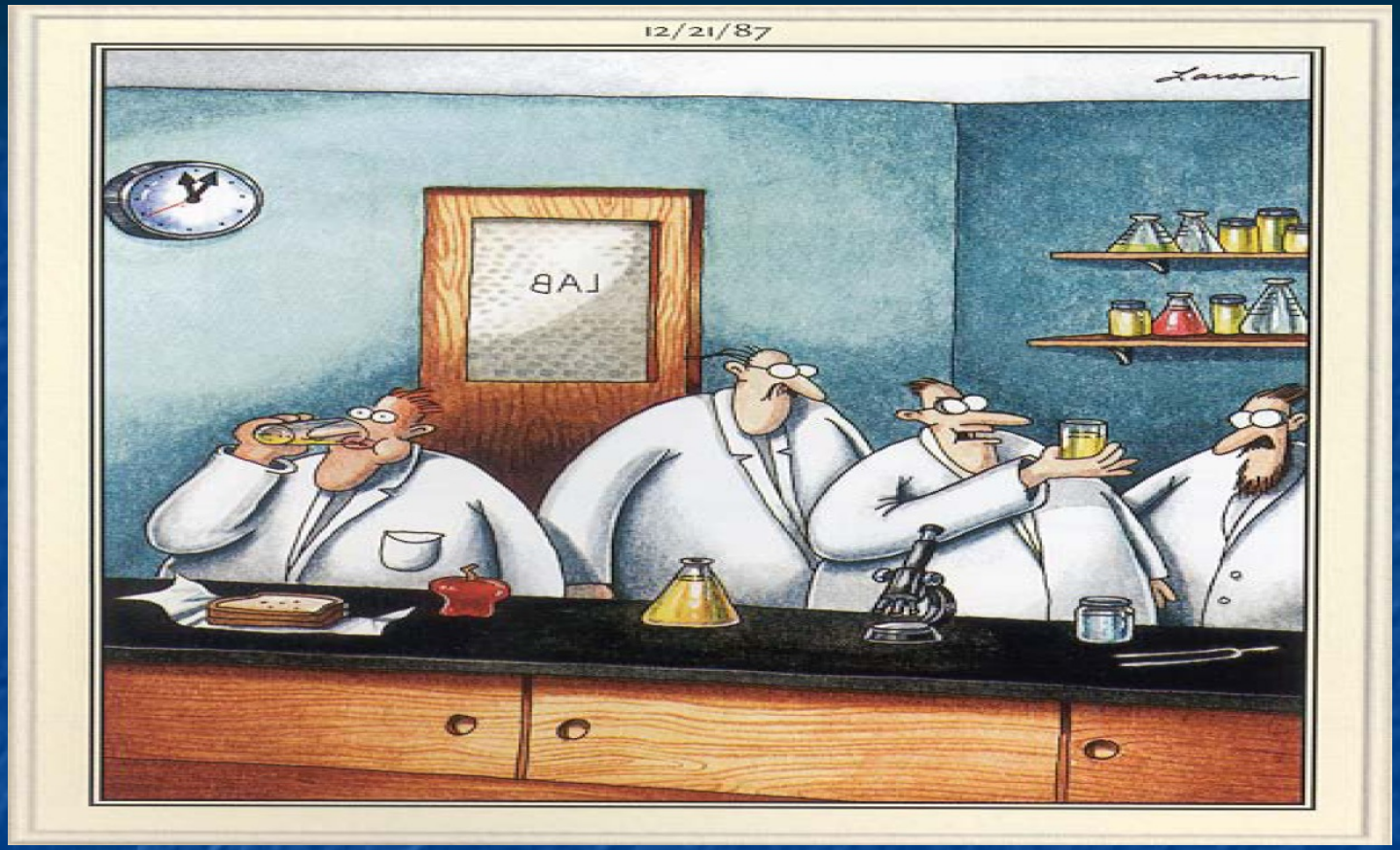
9 were identified as Adaptive Problem Solvers. Like the fixated they identified the most likely cause right off the bat. But when the treatment didn't work they turned to other diagnoses as launching pads for conducting tests and treatments. 7 of the 9 got there.

Randolph & Raemer (2004)


OK CHILDREN, WHAT SOUNDS DID WE HEAR ON OUR TRIP TO THE FARM YESTERDAY
MOOOO!
BAAAA!
QUACK QUACK!
GET OFF THAT FUCKIN' TRACTOR !

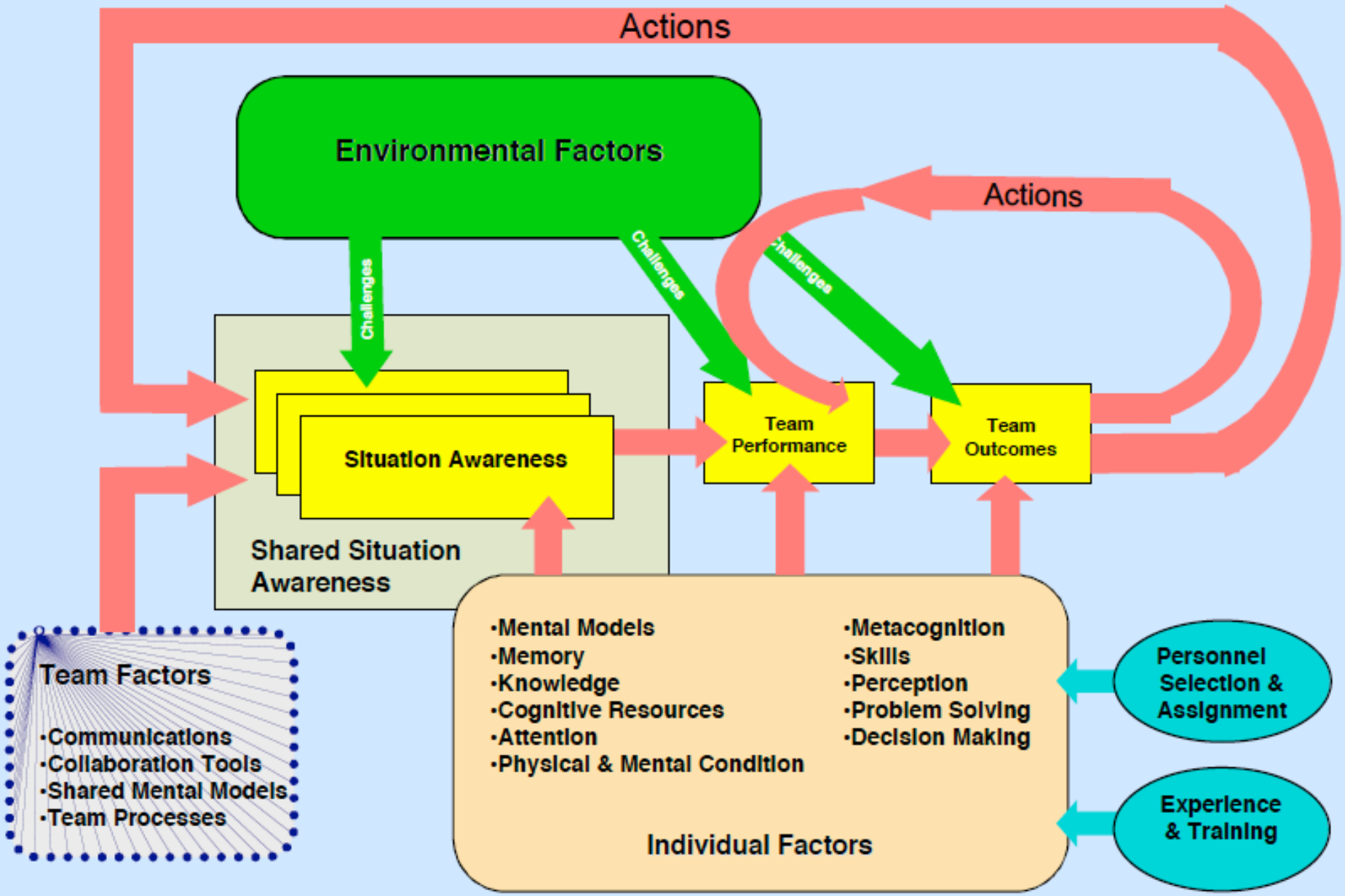
When Crews Err:
% of Errors by Phase of Flight

- **Pre-departure/taxi** **26%**
- **Take-off** **20%**
- **Cruise** **6%**
- **Descent/approach/landing** **42%**
- **Taxi in** **6%**



"This tastes like lemonade; now where's my culture of aomebic dysentry?"

Model of SA


Actions
Environmental Factors
Challenges
Challenges
Actions
Challenges
Situation Awareness
Shared Situation Awareness
Team Performance
Team Outcomes
Team Factors
·Communications
·Collaboration Tools
·Shared Mental Models
·Team Processes
·Mental Models
·Memory
·Knowledge
·Cognitive Resources
·Attention
·Physical & Mental Condition
·Metacognition
·Skills
·Perception
·Problem Solving
·Decision Making
Individual Factors
Personnel Selection & Assignment
Experience & Training