Reclaiming Rapid Cognition

Improving Decision-making in Command and Control Agencies by Understanding and Enabling Rapid Cognition

Presentation 206

Captain Elizabeth A. Cassleman, USMC
From Operation Enduring Freedom

- Austere, Mobile Environment
To Operation Iraqi Freedom

- Stationary, Data Heavy Environment
Effects of Technology

- Battlefield Picture in Real Time
- Can see individual units
- Faster Communications
- Demand for constant updates
- Demand for immediate response to senior’s requests
Overall Effect

• Micro-management
• Second-guessing subordinates
• Demand for explanations
• Disables Rapid Cognition Decision-Making
Reclaiming Rapid Cognition Overview

• What is Rapid Cognition?
• Training Rapid Cognition Decision-Makers
• Getting Back to Basics—Enabling the Executors
• Why it Matters What Our Architecture Looks Like
• Leadership as a Network Property
What is Rapid Cognition?

“I see only one move ahead, but it is the correct one.”-Jose Raul Capablanca, Chess Grandmaster
Deciding Advantageously Before Knowing the Advantageous Strategy (1997)
Deciding Advantageously Before Knowing the Advantageous Strategy (1997)

- Rigged Decks
- From cards 10-20, after few losses, anticipatory SCRs
- By card 50, subjects had hunch
- By card 80 subjects could verbalize strategy
- Subjects began to choose advantageously before they realized which strategy worked best
Decision-Making Cycle

Fig. 2. Diagram of the proposed steps involved in decision-making.
Rapid Cognition

• Takes place in unconscious
• Is a rational process
• Works at a faster rate than conscious thought
• Found in high-stress, quick reaction professions
Training Rapid Cognition Decision-Makers

“Yet this belief in the importance of innate talent, strongest perhaps among the experts themselves and their trainers, is strangely lacking in hard evidence to substantiate it . . . The preponderance of psychological evidence indicates that experts are made, not born.” –Philip E. Ross
Training the Components

• Knowledge Bank
  – Academic knowledge

• Experiential Knowledge
  – Allows the organization of knowledge

• Simulation Training
  – Identifies problems
  – Overcomes stress reactions
Experts don’t know significantly more, they just access it more efficiently

Figure 37.1. Activation of the brain, as a function of practice, in three periods of learning a motor tracking task. This is a maximum projection image, with white areas showing the activation of any cortical area either above or below the illustrated brain slice. The image is an axial (aerial) view of the head, where the top of the image corresponds to the front (nose) of the head and the bottom corresponds to the back of the head. The frontal areas (dashed ellipse) and parietal attention control areas (solid ellipse) show dramatic reductions in activation. The motor areas (middle of images) shows fairly preserved activation.
Figure 36.1. Model of Situation Awareness in Dynamic Decision Making (Endsley, 1995)
SA is demanding, frequently incomplete, and erroneous

- Limited attention
- Limited working memory

SA is fast, can be effortless, more complete, and greater comprehension, and projection

- Schema of prototypical situations
- Mental models of domain
- Automaticity of processes
- Learned skills (e.g., scan patterns, communications)

Figure 36.2. Factors effecting SA in Novices and Experts in a Domain
**Priming Problem Solving With Conceptual Processing of Relevant Objects (2004)**

**FIGURE 1.** Mean number of target solutions produced for object-relevance conditions with conceptual (Experiment 1) and lexical (Experiment 2) processing tasks, $n = 24$ per cell.

**FIGURE 2.** Mean difficulty ratings for object-relevance conditions with conceptual (Experiment 1) and lexical (Experiment 2) processing tasks, $n = 24$ per cell. The rating scale went from 1 = very easy to 5 = very difficult.
Priming Problem Solving With Conceptual Processing of Relevant Objects (2004)

1. Object: apple
Detective Jones arrived at the hospital to find that Al Franks, who had been in a coma, died moments ago while under police custody. Officer Bob Clark, who was assigned to guard the door, swore that no one had entered the room since a nurse last checked in on him some two hours earlier. Aside from an autopsy, Jones ordered that the hospital room be combed for clues. The only unusual thing found was a waste can containing crumpled pieces of paper, a tongue depressor, a half-eaten apple, and an empty cigarette pack. Other than that, everything seemed normal. After the search, Jones suggested to Officer Clark that he was lying, and that someone had indeed been in the room in the last half hour. What caused Jones to draw such a conclusion?

Answer: The half eaten apple was still white, indicating recency of being bitten.

2. Object: camera
During a world fair a group of scientists were exhibiting their advances in genetic engineering. There were cross-breeds of various bulls, cows, and other domestic farm animals. Featured on the exhibit were several over-sized prize turkeys. One afternoon during the show, a woman walked up to the exhibit, shot the turkeys, and then ran out of the building. Although she was known to a number of people, nobody made any attempt to stop her. Why?

Answer: The woman shot the turkeys with a camera. She was a journalist with a deadline.

3. Object: chess set (in folded box)
Professor Charles was giving a lecture on “The Life of the Aristocracy in the 19th Century.” “It was during a large festive gathering of nobility,” began Charles, “when a fairly common occurrence took place. The Queen suddenly attacked and killed the King. The crowd watched the entire scene and then casually continued their party.” In what situation in the 19th century would a crowd be so casual about the Queen killing the King?

Answer: This would happen in a game of chess.
Priming Problem Solving With Conceptual Processing of Relevant Objects (2004)

- Insight Problems
- Cannot be solved by comprehensive analysis
- Successfully primed subjects to get correct answers by showing them objects that later came up in the problems

4. Object: Bicycle brand playing cards (in the original box)
A man is found inside a room dead, lying among 53 Bicycles. The only other objects in the room are a table and some chairs. What might have happened to cause this scene?

Answer: The man was playing cards with Bicycle brand playing cards, was caught with an extra card, and was killed by his opponent.
Priming Problem Solving With Conceptual Processing of Relevant Objects (2004)

**Figure 4.** Mean proportion correct for the Bicycle problem for control, cards, and bike objects conditions in Experiment 3. $n = 30$ per condition.

**Figure 5.** Mean difficulty and confidence ratings for the Bicycle problem for control, cards, and bike objects conditions in Experiment 3. $n = 30$ per condition. The rating scale went from 1 = *very easy* to 5 = *very difficult.*
Figure 38.3. An illustration of the gradual increases in expert performance as a function of age, in domains such as chess. The international level, which is attained after more than around ten years of involvement in the domain, is indicated by the horizontal dashed line. (From “Expertise,” by K. A. Ericsson and Andreas C. Lehmann, 1999, Encyclopedia of Creativity. Copyright by Academic Press.)
Getting Back to Basics—Enabling the Executors

“You’ve got to let people work out the situation, work out what’s happening. The danger in calling is that they’ll tell you anything to get you off their backs, and if you act on that and take it at face value, you could make a mistake. Plus, you are diverting them. Now they are looking upward instead of downward. You’re preventing them from resolving the situation.” –Paul VanRiper
Thinking Too Much: Introspection Can Reduce the Quality of Preferences and Decisions (1991)

- Novices differed from expert jam ratings when asked to explain why they liked the jam they liked.

Table 1

<table>
<thead>
<tr>
<th>Condition</th>
<th>Jam 1</th>
<th>Jam 2</th>
<th>Jam 3</th>
<th>Jam 4</th>
<th>Jam 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>6.52</td>
<td>7.64</td>
<td>6.12</td>
<td>2.72</td>
<td>4.68</td>
</tr>
<tr>
<td>SD</td>
<td>2.22</td>
<td>1.66</td>
<td>2.05</td>
<td>2.26</td>
<td>2.66</td>
</tr>
<tr>
<td>Reasons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>4.54</td>
<td>6.25</td>
<td>5.42</td>
<td>2.88</td>
<td>4.92</td>
</tr>
<tr>
<td>SD</td>
<td>2.00</td>
<td>2.38</td>
<td>2.70</td>
<td>2.13</td>
<td>2.89</td>
</tr>
</tbody>
</table>

Note. The jams are listed in order of their rankings by the Consumer Reports experts; Jam 1 was the highest ranked jam, Jam 2 was the second highest, and so on. The liking ratings were made on 9-point scales that ranged from disliked (1) to liked (9).
Thinking Too Much: Introspection Can Reduce the Quality of Preferences and Decisions (1991)

- Introspecting about decisions to take psych courses caused students to weight information in a less than optimal way and to make less optimal choices.

<table>
<thead>
<tr>
<th>Course Preregistered for and Actually Taken</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>Control</td>
</tr>
<tr>
<td>Preregistration</td>
<td></td>
</tr>
<tr>
<td>Highly rated courses</td>
<td>.41</td>
</tr>
<tr>
<td>Poorly rated courses</td>
<td>.04</td>
</tr>
<tr>
<td>Actual enrollment</td>
<td></td>
</tr>
<tr>
<td>Highly rated courses</td>
<td>.37</td>
</tr>
<tr>
<td>Poorly rated courses</td>
<td>.03</td>
</tr>
</tbody>
</table>

*Note. Subjects were assigned a 1 if they registered for or actually took a course and a 0 if they did not register or take a course.*
<table>
<thead>
<tr>
<th>Experiential System</th>
<th>Rational System</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Holistic</td>
<td>1. Analytic</td>
</tr>
<tr>
<td>2. Automatic, effortless</td>
<td>2. Intentional, effortful</td>
</tr>
<tr>
<td>3. Affective: pleasure-pain oriented (what feels good)</td>
<td>3. Logical: reason oriented (what is rational)</td>
</tr>
<tr>
<td>4. Associationistic connections</td>
<td>4. Logical connections</td>
</tr>
<tr>
<td>5. Behavior mediated by “vibes” from Past events</td>
<td>5. Behavior mediated by conscious appraisal of events</td>
</tr>
<tr>
<td>6. Encodes reality in concrete images, metaphors, and narratives</td>
<td>6. Encodes reality in abstract symbols, words, and numbers</td>
</tr>
<tr>
<td>7. More rapid processing: oriented toward immediate action</td>
<td>7. Slower processing: oriented toward delayed action</td>
</tr>
<tr>
<td>8. Slower and more resistant to change: change with repetitive or intense experience</td>
<td>8. Changes more rapidly and easily: changes with strength of argument and new evidence</td>
</tr>
<tr>
<td>11. Experienced passively and preconsciously: we are seized by our emotions</td>
<td>11. Experienced actively and consciously: we are in control of our thoughts</td>
</tr>
<tr>
<td>12. Self-evidently valid: “experiencing is believing”</td>
<td>12. Requires justification via logic and evidence</td>
</tr>
</tbody>
</table>
### TABLE II Characteristics of Analysis and Intuition (From Dunwoody et al., 2000)

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Intuition</th>
</tr>
</thead>
<tbody>
<tr>
<td>High insight into judgment process, and hence, publicly retraceable</td>
<td>Low insight into judgment process, and hence, difficult to retrace and defend</td>
</tr>
<tr>
<td>Low confidence in outcome, high confidence in method</td>
<td>High confidence in outcome, low confidence in method</td>
</tr>
<tr>
<td>Cues are objectively evaluated</td>
<td>Cues are perceptually evaluated</td>
</tr>
<tr>
<td>Slow rate of processing</td>
<td>Fast rate of processing</td>
</tr>
<tr>
<td>Errors few, but large when they occur</td>
<td>Errors normally distributed</td>
</tr>
<tr>
<td>High cognitive consistency</td>
<td>Low cognitive consistency</td>
</tr>
</tbody>
</table>

### TABLE III Task Characteristics That Induce Analysis and Intuition (From Dunwoody et al., 2000)

<table>
<thead>
<tr>
<th>Analysis-inducing Task Characteristics</th>
<th>Intuition-inducing Task Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than five cues</td>
<td>More than five cues</td>
</tr>
<tr>
<td>Successively presented cues</td>
<td>Simultaneously presented cues</td>
</tr>
<tr>
<td>Low cue redundancy</td>
<td>High cue redundancy</td>
</tr>
<tr>
<td>Unequal weighting of cues in ecology</td>
<td>Equal weighting of cues in ecology</td>
</tr>
<tr>
<td>Cues objectively measured</td>
<td>Cues perceptually measured</td>
</tr>
<tr>
<td>Nonlinear cue functions</td>
<td>Linear cue functions</td>
</tr>
<tr>
<td>Organizing formula available</td>
<td>No organizing formula available</td>
</tr>
<tr>
<td>Task outcome available</td>
<td>Task outcome unavailable</td>
</tr>
</tbody>
</table>
Rapid Cognition

• Uses a different part of the brain than Comprehensive Analysis
• Can be “switched off” by asking for an explanation
• Fragile Process
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• Can be “switched off” by asking for an explanation
• Fragile Process
The Verbal Overshadowing Effect: Why Descriptions Impair Face Recognition (1997)

### Table 1

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage Correct Recognition</th>
<th>Recognition × Confidence Scores</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-paced test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>80</td>
<td>4.95</td>
<td>.39</td>
</tr>
<tr>
<td>Verbal</td>
<td>65</td>
<td>4.20</td>
<td>.51</td>
</tr>
<tr>
<td>Speeded test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>70</td>
<td>4.30</td>
<td>.38</td>
</tr>
<tr>
<td>Verbal</td>
<td>35</td>
<td>3.20</td>
<td>.37</td>
</tr>
<tr>
<td>Two-choice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>65</td>
<td>4.25</td>
<td>.51</td>
</tr>
<tr>
<td>Verbal</td>
<td>55</td>
<td>3.85</td>
<td>.49</td>
</tr>
<tr>
<td>Ignore</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal</td>
<td>45</td>
<td>3.30</td>
<td>.45</td>
</tr>
</tbody>
</table>

### Table 2

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage Correct Recognition</th>
<th>Recognition × Confidence Scores</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>65</td>
<td>4.38</td>
<td>.35</td>
</tr>
<tr>
<td>Describe parent</td>
<td>53</td>
<td>3.63</td>
<td>.34</td>
</tr>
<tr>
<td>Verbal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-paced</td>
<td>53</td>
<td>3.72</td>
<td>.33</td>
</tr>
<tr>
<td>Ignore</td>
<td>38</td>
<td>3.23</td>
<td>.30</td>
</tr>
<tr>
<td>Provide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-paced</td>
<td>45</td>
<td>3.48</td>
<td>.31</td>
</tr>
<tr>
<td>Ignore</td>
<td>63</td>
<td>4.15</td>
<td>.30</td>
</tr>
</tbody>
</table>
Why It Matters What Our Architecture Looks Like

“Networks have properties hidden in their construction, that limit or enhance our ability to do things with them.” –Albert-Laszlo Barabasi
Koenisburg Bridge Problem
Genesis of Graph Theory

• There was a definitive answer: No
• There was a formula to support it: No unbroken non-repetitive path will exist between the nodes when there are an odd number of links
• Networks have Properties
AOL users to sites

SLOPE = -2.07

Proportion of sites

Number of users

Cumulative number of sites vs. x (number of visitors)

- Usage data
- Pareto CDF with k = 1.16 (α = 2.16)
- Pareto CDF with k = 1.87 (α = 2.07)
Distributed
FIG. 1 — Centralized, Decentralized and Distributed Networks
All Scale-Free have similar topologies, regardless of the character of the network
Practical Uses

• Command and Control Systems are generally Scale Free
• C2 have hubs-defining trait
• Are the bottleneck for information and decisions
• Are actually fractals
Leadership as a Network Property

“This is not to say that individual qualities are not important, but rather that sustainable and replicable qualities of leadership treated here as a network property, made possible by the combination of the social network and the individuals themselves.” - Dr. John H. Clippinger
Leadership

• Sustainable and replicable
• Supported by architecture
• Cognitive Continuum Theory
  – Neither type of decision-making is “wrong”
  – Free to choose most appropriate type of decision-making
Practical Example

• MACCS - Marine Aviation Command and Control System
• TACC - Tactical Air Command Center (Senior Agency)
• DASC - Direct Air Support Center
• TAOC - Tactical Air Operations Center
• FSCC - Fire Support Coordination Center
• ASLT - Air Support Liaison Team
Current MACCS

TACP

ASLT

TAOC

TACC

DASC

Joint C2

MMT

Airboss

POS

ATC

Airboss

Divert

Launch

POS

TACP

POS

REG AO

Div AO

PROC

POS

ATC

Airboss
Request Process Internal Procedures

- TAR/HR takes Request
- Crew Chief for Filing
- TAR/HR Mission Data
- TAD/HD To A/C
- Plotter Plots
- Crew Chief Quality Check
- SAD for Tasking
• It is a profoundly erroneous truism, repeated by all copybooks and by eminent people when they are making speeches, that we should cultivate the habit of thinking about what we are doing. The precise opposite is the case. Civilization advances by extending the numbers of important operations which we can perform without thinking about them. Operations of thought are like cavalry charges in battle--they are strictly limited in number, they require fresh horses, and must only be made at decisive moments.

•  
  - *Alfred North Whitehead*

• When making a decision of minor importance, I have always found it advantageous to consider all the pros and cons. In vital matters, however, such as the choice of a mate or a profession, the decision should come from the unconscious, from somewhere within ourselves. In the important decisions of personal life, we should be governed, I think, by the deep inner needs of our nature."

•  
  - *Sigmund Freud*