

## Understanding & Minimizing Cognitive Limitations and Cognitive Error in Diagnosis

Medicine is the art of uncertainty and the science of probability.  
-Sir William Osler

Richard LeBlond, MD, MACP  
Billings Clinic

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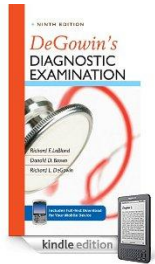
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## Disclosure



Royalties Received  
from McGraw-Hill

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## Objectives: You will ...

- Act like a human, *but with insight and understanding*
- Recognize our common cognitive limitations
- Think about your thinking: metacognition
- Consciously use system-1 and system-2 thinking
- Look for cognitive traps in patient care
- Identify common cognitive errors
- Mitigate common sources of error
- Record and classify your errors

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## Outline

- Cognitive Neuroscience
- Cognitive Diagnostic Process
- Cognitive Error
- Compensations for Cognitive Limitations

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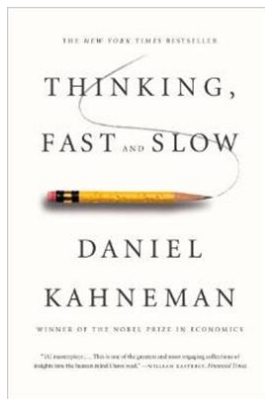
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## Cognition for Survival

- What separates animals from plants?
  - Locomotion, the ability to move in any direction
- What did animals need to move about non-randomly?
  - A means of locomotion
  - A means of making decisions, where to go
- The continuous everyday task of humans is making decisions.
  - The problem space is large
  - The decision time is short
  - Short, fast, generally accurate tools are needed

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### Bounded Rationality

Because of the limits on their computing speeds and power, intelligent systems must use approximate methods to handle most tasks. Their rationality is bounded.

Herbert A Simon, Invariants of Human Behavior. Annu Rev Psychol 1990;41:1-19

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### System-1 Decision Making

“...much of mental life is not the product of deliberate processing, but of quicker, more reflexive processes that are less available to conscious intervention.”

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### System 2 Processing

- Requires complete attention (impossible when delirious\*)
- Slow
- Laborious
- Avoided if possible
- Done as a last resort
- Often not done at all

\* 3 am on your 5<sup>th</sup> admission

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	PATTERN RECOGNITION	RATIONAL THINKING
<b>Cognitive Style</b>	<b>System-1 Intuitive, Heuristic</b>	<b>System-2 Analytic, Systematic</b>
Computational Principle	Associative	Rule Based
Responsiveness	Passive	Active
Capacity	High	Limited
Awareness & Control	Low	High
Automaticity	High	Low
Rate	Fast	Slow
Reliability	Low	High
Errors	Common	Rare
Effort	Low	High
Emotional Attachment	High	Low
Scientific Rigor	Low	High

Adapted from Crosky and Norman. Overconfidence in Clinical Decision Making. Am J Med 2007;121: S24-8

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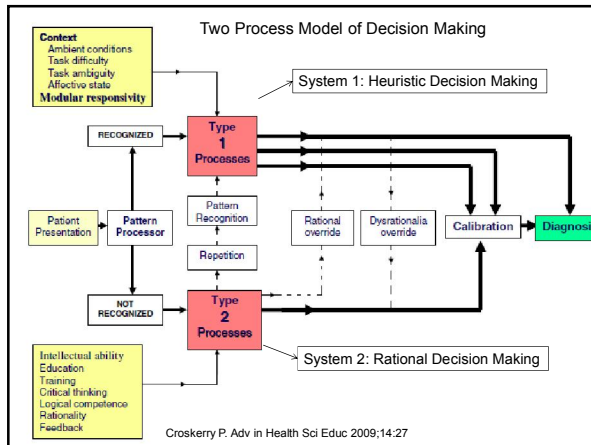
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### Limitations of Human Cognition

- System-1
- Processing power
- Attention
- Working memory
- System-2
- Computational skills
- Knowledge
- Experience
- Perception
- Judgment
- Understanding
- Time

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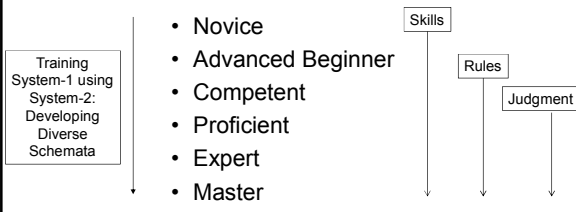
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### The Dreyfus Model of Skills Acquisition: Experiential Learning



Training system-1 cognition through experience & conscious learning using system-2 for calibration

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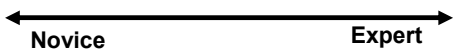
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Situation Awareness is demanding, frequently incomplete, and erroneous

Situation Awareness is fast, can be effortless, more complete, and greater comprehension and projection, **System-1**



- Limited attention
- Limited working memory
- Schema of prototypical situations
- Mental models of domain
- Automaticity of processes
- Learned skills (e.g. scan pattern, communications)

from The Cambridge Handbook of Expertise and Expert Performance

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## Osler on Experience

.. the problem is not that he doesn't know enough but that he has experienced too little.

--Sir William Osler

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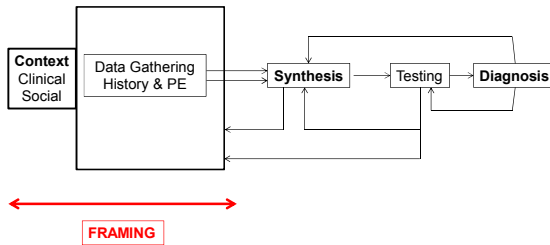
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## Diagnostic Process



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...the framing of hypotheses is the most difficult part of scientific work, and the part where great ability is indispensable. So far, no method has been found which would make it possible to invent hypotheses by rule. Usually some hypothesis is a necessary preliminary to the collection of facts, since the selection of facts demands some way of determining relevance. Without something of this kind, the multiplicity of facts is baffling.

-- Bertrand Russell  
"A History of Western Philosophy"

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### Diagnostic Error in Internal Medicine

Graber, Franklin, Gordon. Arch Intern Med 2005;165:1493

- 100 cases of diagnostic error
  - 3 Academic medical centers
  - Quality assurance n = 57
  - Self reported n = 33
  - Autopsy n = 10
- Taxonomy of Error
  - No Fault Errors
  - Systems Errors
  - Cognitive Errors

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### Diagnostic Error in Internal Medicine

Graber, Franklin, Gordon. Arch Intern Med 2005;165:1493

- Type: Systems (65%) and Cognitive (74%)
  - Systems 19%, Cognitive 28%, both 46%
- Delayed (28), Wrong (38), Missed (34)
  - Delayed Cognitive 36% System 89%
  - Wrong Cognitive 92% System 50%
- Errors by how they were discovered:
  - Quality Assurance: Cognitive 65% System 72%
  - Self Report: Cognitive 85% System 76%
  - Autopsy: Cognitive 90% System 10%

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### Types and Frequency of Cognitive Errors

Graber, Franklin, Gordon. Arch Intern Med 2005;165:1493

- Knowledge 11
- Data Gathering 45
- Synthesis 264

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### Cognitive Error

- Cognitive deficits leading to error
  - Attention
  - Perception
  - Communication
  - Knowledge
  - Data gathering
  - Clinical reasoning
  - Synthesis
  - Verification

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### Compensating for Cognitive Limitations

- Processing power
  
- Attention  
humans can only attend to one thing at a time
  
- Working memory  
humans can only hold about 3 - 5 items in working memory

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### Compensating for Cognitive Limitations

- Processing power      • Heuristics, probability
  
- Attention  
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**Heuristics**

“Rules of Thumb” to Assist Decision Making  
*Subconscious, Running in the Background*

- Anchoring and Adjustment
- Availability
- Fluency
- Ecological
- Prevalence
- Representativeness

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**Compensating for Cognitive Limitations**

- Computational power
- Attention  
humans can only attend to one thing at a time
  - A time for everything
  - Minimize interruptions
  - Minimize distractions
  - In the here-and-now
  - Active listening
  - Soft focus
- Working memory  
humans can only hold about 3 - 5 items in working memory

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**See with Beginner’s Eyes**

- Observe like a child
- Describe do not conclude
- Listen and record; no interpretation
- Nothing is irrelevant
- Anything is possible
- Ask lots of questions
- Don’t have expectations
- Practice

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## Compensating for Cognitive Limitations

- Computational power
- Attention  
humans can only attend to one thing at a time
- Working memory  
humans can only hold about 3 - 5 items in working memory
  - Problem lists
  - See the entire list
  - Don't chunk unless you are certain
  - Work the jigsaw puzzle

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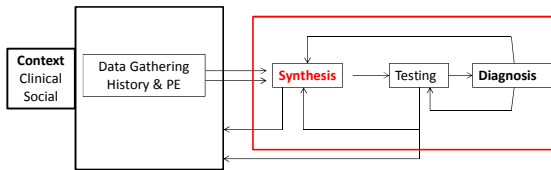
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## Diagnostic Process




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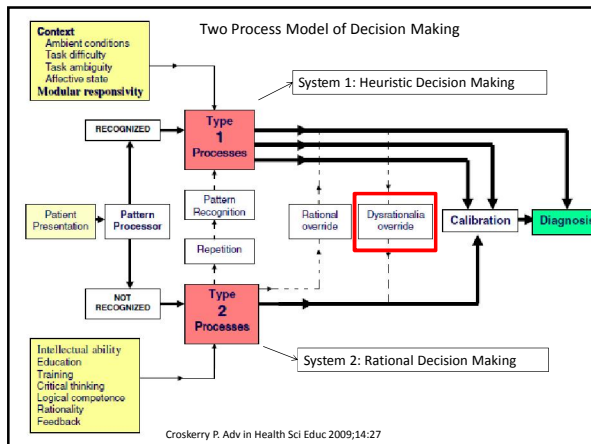
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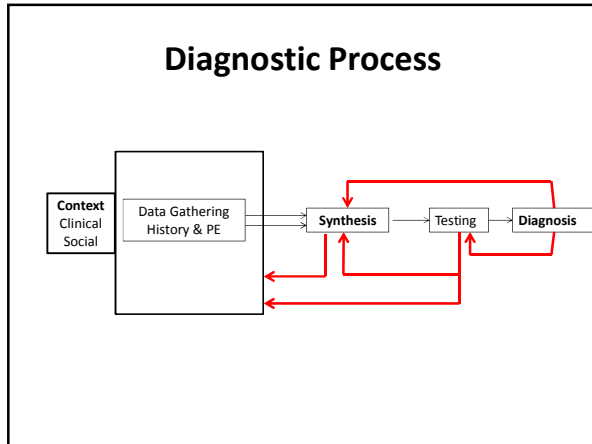
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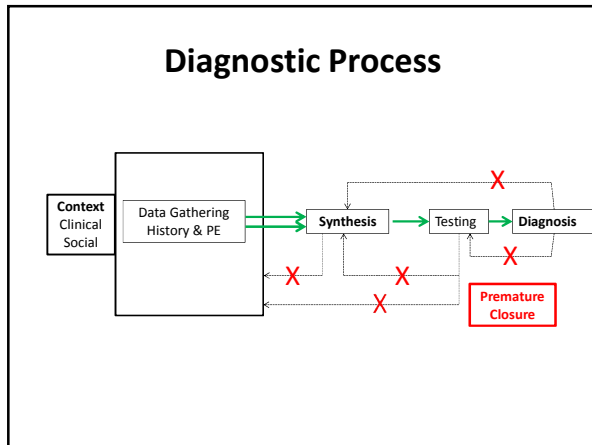
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### Spinoza on Anchoring

- Understanding and believing are single mental operation
- Humans believe assertions as part of understanding them
- They then “un-believe” those assertions that are at odds with other established facts

• From Daniel T. Gilbert, *Inferential Correction*. in *Heuristics and Biases*, the psychology of intuitive judgment. Cambridge 2002

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### Hypothesis Testing: Avoid Confirmation Bias

- Try to disprove your hypothesis
- Assume you are wrong (*prospective hindsight*): rethink context, knowledge, data gathering, synthesis, clinical reasoning, testing, judgment, experience
- Search for contradictory data
- Change Places: present the arguments for the alternative hypotheses and have someone else defend your hypothesis
- Affective heuristic: what is the consequence of being wrong?
- Make predictions: labs, course & response

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### Compensating for Limited Human Cognition:

*Assume You are Making a Mistake!*

- **Framing**
  - Change age, sex; avoid substitution of goals
- **Knowledge**
  - Study & Consults
- **Experience**
  - Consults, supervision, M&M, mentoring, case reports
- **Perception**
  - Beginner’s eyes: look & see, before looking *for*
- **Judgment**
  - Reflection, consults, autopsy, prove yourself wrong
- **Understanding**
  - Why, why, why, why, why?
- **Time**
  - Heuristics

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### Take-Aways

- Humans are imperfect decision makers
- Errors are a fundamental property of our cognitive processes
- Given our cognitive constraints, error free cognitive processing is incompatible with species survival
- You will make mistakes
- Assume you are making a mistake

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### Understanding Cognitive Limitations and Cognitive Error in Diagnosis

QUESTIONS?

Richard LeBlond, MD, MACP  
Billings Clinic

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