We're Not in Kansas Anymore:

Human Reasoning and Diagnostic Safety

Children's Hospital Colorado

Affiliated with University of Colorado Anschutz Medical Campus

Joe Grubenhoff, MD, MSCS

Associate Professor of Pediatrics

Pediatric Emergency Medicine

University of Colorado School of Medicine

Medical Director, Diagnostic Safety Program

Children's Hospital Colorado

OBJECTIVES

- Compare the basic attributes of System 1 and System 2 thinking and describe their role in diagnostic reasoning
- Describe how theories of human reasoning inform our understanding of the development of clinical expertise
- List 3 techniques for promoting diagnostic safety during a clinical encounter

What's The Diagnosis?

7-month-old infant

Diffuse Crackles

Retractions

January

Bronchiolitis

RA Sats = 84%

1st time wheezing

CXR: peribronchial cuffing

Copious rhinorrhea

What's The Diagnosis?

December

9-year-old girl

New fever to 102 for 1 day

1 week of cough

Pneumonia

RA Sats = 84%

Tachypnea

CXR: RLL Opacity

Right base Crackles

What's The Diagnosis?

5-year-old boy

Diffuse Crackles

Chronic Sinusitis

RA Sats = 92%

Kartagener Syndrome

Multiple Episodes of AOM

Chronic Cough

CXR: Bronchiectasis and Situs Inversus

May

Decision Making in Everyday Life

NO GOOGLE ALLOWED
FOR THIS EXERCISE

Is the average height of a redwood tree greater or less than 600 feet?

Please Respond in CHAT

What is *your* estimate of the average height of redwood tree?

Decision Making in Everyday Life

Anchor: 180 ft

Avg Height: ___?

~250 ft

Anchor: 1200 ft

Avg Height: ___?

~800 ft

"Let's hold off making a decision until we have even more information we don't really need."

A trip to the sporting goods store

- GET READY to RESPOND in CHAT

- A bat and a ball together cost $1.10
- The bat costs $1 more than the ball
- What is the cost of the ball?

SUBSTITUTION

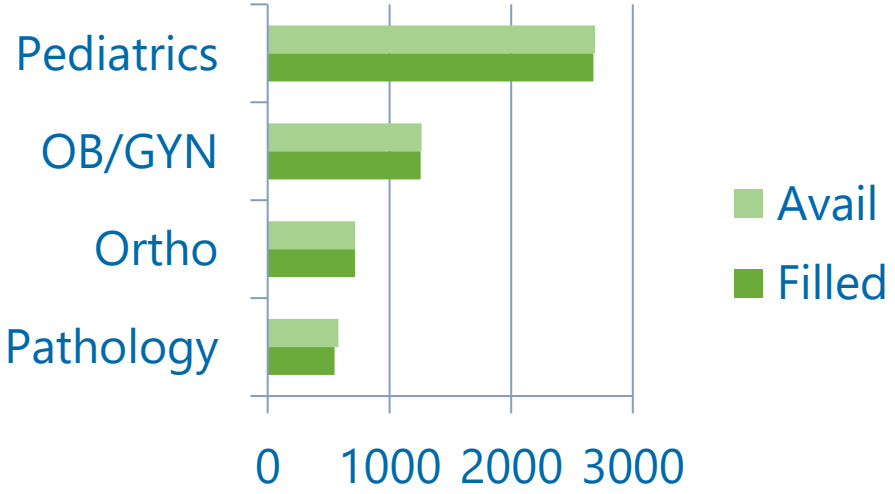
Simple Arithmetic → 1.10 - 1 = 0.10

Algebra → 1.10 = x + (x+1)

Hector's Specialty

- One more CHAT response…
- You're a med school dean preparing Dean's Letters
  - Hector scored an impressive 243 on Step 1 and 263 on Step 2
  - Hector wrestled in college and can bicep curl 120#
  - He enjoys woodworking in his spare time

- Hector is most likely to be entering which specialty?
  - Pediatrics
  - Pathology
  - Orthopedic Surgery
  - OB/GYN



The Brain is a Sense-making Organ

- System 1 attempts to reconcile available information into a coherent story
  - Uses any data available to inform a decision
  - WYSIATI: what you see is all there is
  - Represents categories as prototypical exemplars

Dual Process Theory – Oh Boy!

"The most coherent stories are not necessarily the most probable, but they are plausible and the notions of coherence, plausibility and probability are easily confused by the unwary"

- Daniel Kahneman,

Anchoring, the Associative Machine, & Narrative Coherence

- System 1 is insensitive to quality and quantity of evidence
  - Redwood tree example – non-informative anchor
- System 1 substitutes easier questions for harder ones
  - Bat-and-ball example – arithmetic for algebra
- System 1 manages narrative better than statistics
  - Hector – what makes sense
  - Relies on pattern recognition

The Cascade of Activated Ideas

Type in the CHAT the first thing that comes to mind when you see the picture.

Tin Man

Glenda

Ruby Slippers

Wicked Witch

Emerald City

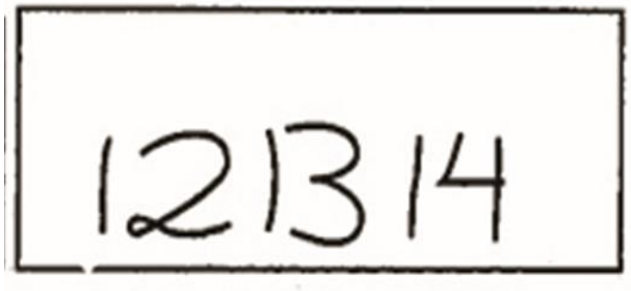
TOTO

OZ

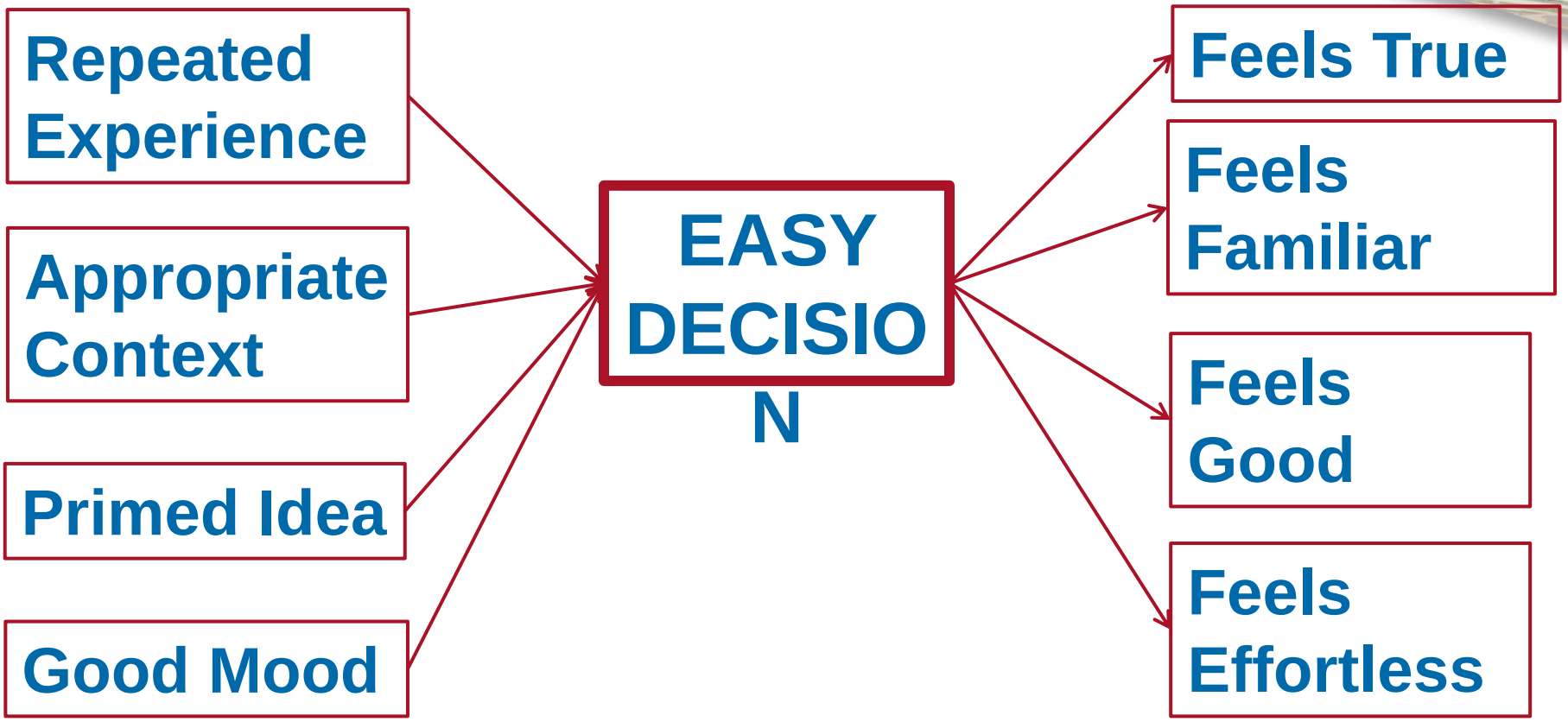
Flying Monkeys

Lion

Context Supply & Perspective



Cognitive Ease



System 1 Thinking: The System of Cognitive Ease

- Characteristics:
  - Fast, intuitive, subconscious = effortless
- Advantages:
  - Efficient, low cognitive load
  - Decisions in familiar situations typically correct
  - Analytic reasoning reserved for “tougher” problems
- Disadvantages:
  - Heuristics strongly influence conclusions
  - Insensitive to information quality/quantity
  - Generates context if not supplied

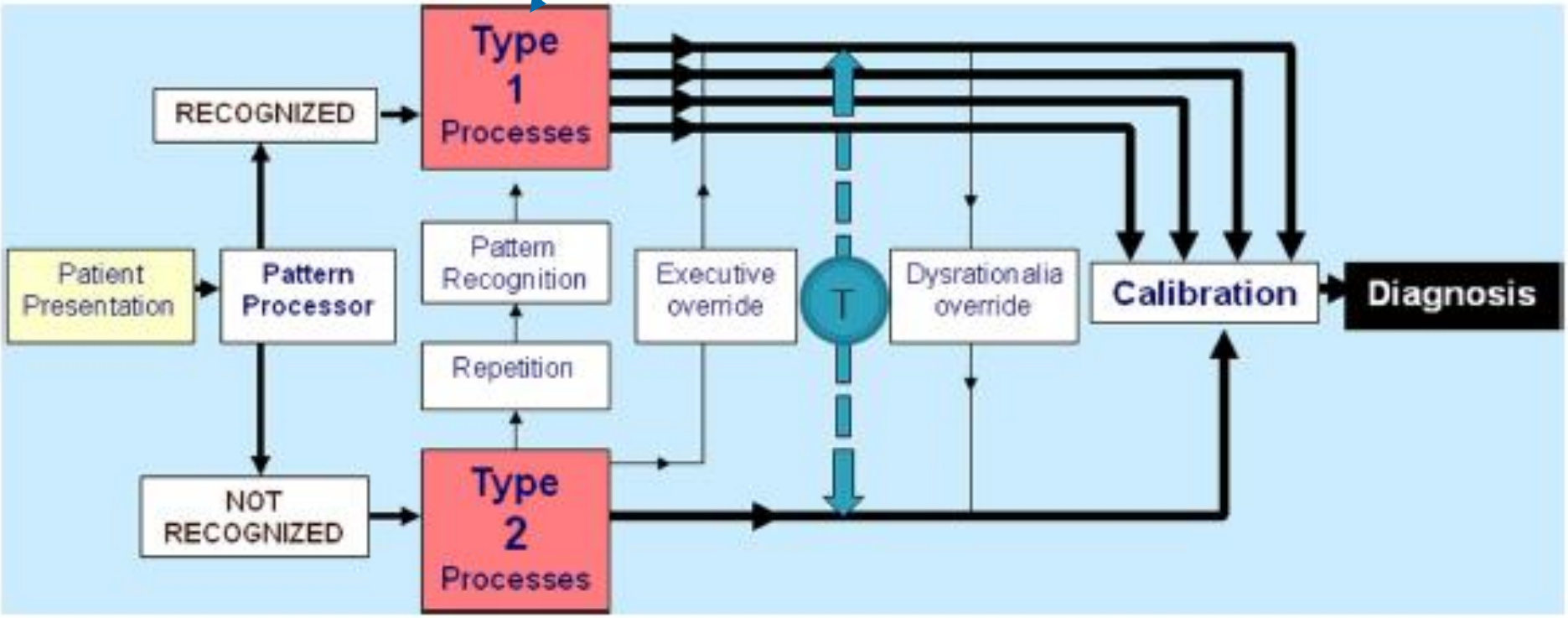
System 2 Thinking:
The System of Cognitive Strain

- Characteristics:
  - Slow, analytical, deliberate = effortful
  - Less susceptible to cognitive biases
- Advantages:
  - Discretely considers each piece of data
  - Useful for unfamiliar decisions/options
  - Acknowledges data quality/quantity
- Disadvantages:
  - Inefficient, labor-intensive, exhausting
  - Requires "spare-capacity"
  - Needs to be "triggered"


Children's Hospital
Colorado

System 1 and System 2 in Diagnosis

a.k.a HEURISTICS



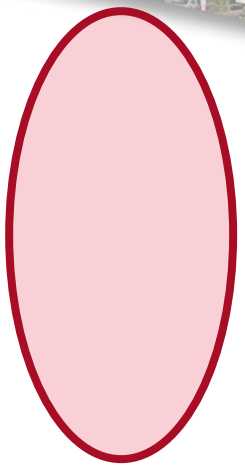
Croskerry P, *et al*. *BMJ Qual Saf* 2013;**22**:ii58–ii64. doi:10.1136/bmjqs-2012-001712

Naturalistic Decisions & Sense Making

System 1 is NOT an ENEMY

- When: November, 02:13
- Where: Your pediatric UC or ED
- Who: A 2 y/o M with CC of fever and SOB
- What (you see/hear):
  - Slightly pale, non-toxic, panicked toddler
  - Moderate respiratory distress
  - Barky cough and stridor
- In the CHAT: Dx and next *immediate steps*?

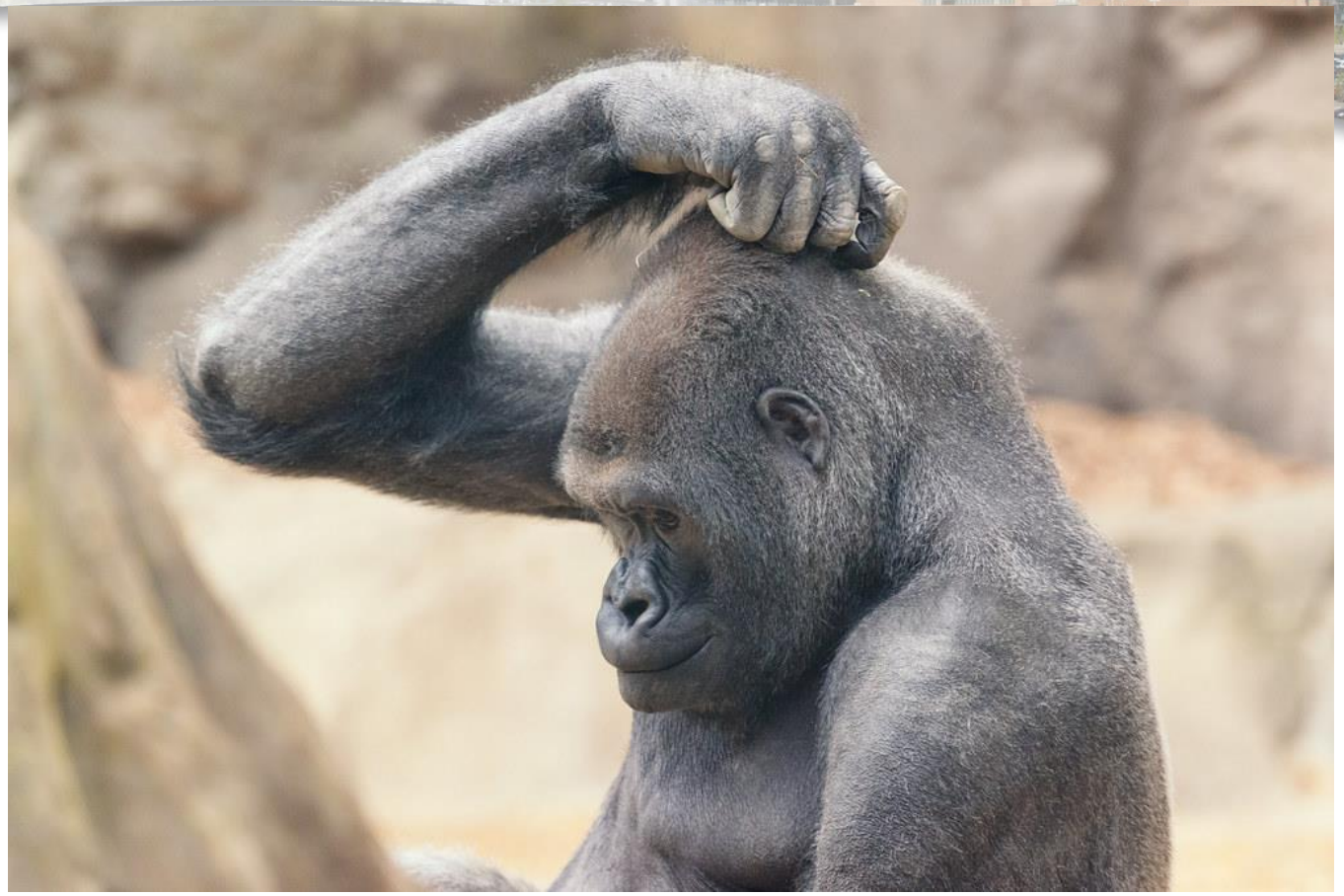
Detecting Inconsistencies



Find the inconsistencies
in the next frame.

Children's Hospital Colorado

Developing Clinical Expertise?

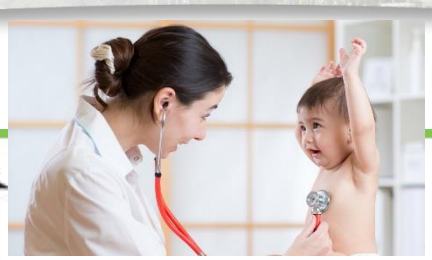


Can we learn to detect inconsistencies and avoid cognitive errors in clinical reasoning?

Experience Alone ≠ Expertise

What distinguishes the experienced clinician from the expert?

The Dunning-Kruger Effect



HIGH

PEAK OF "MT. STUPID"

CONFIDENCE

LOW

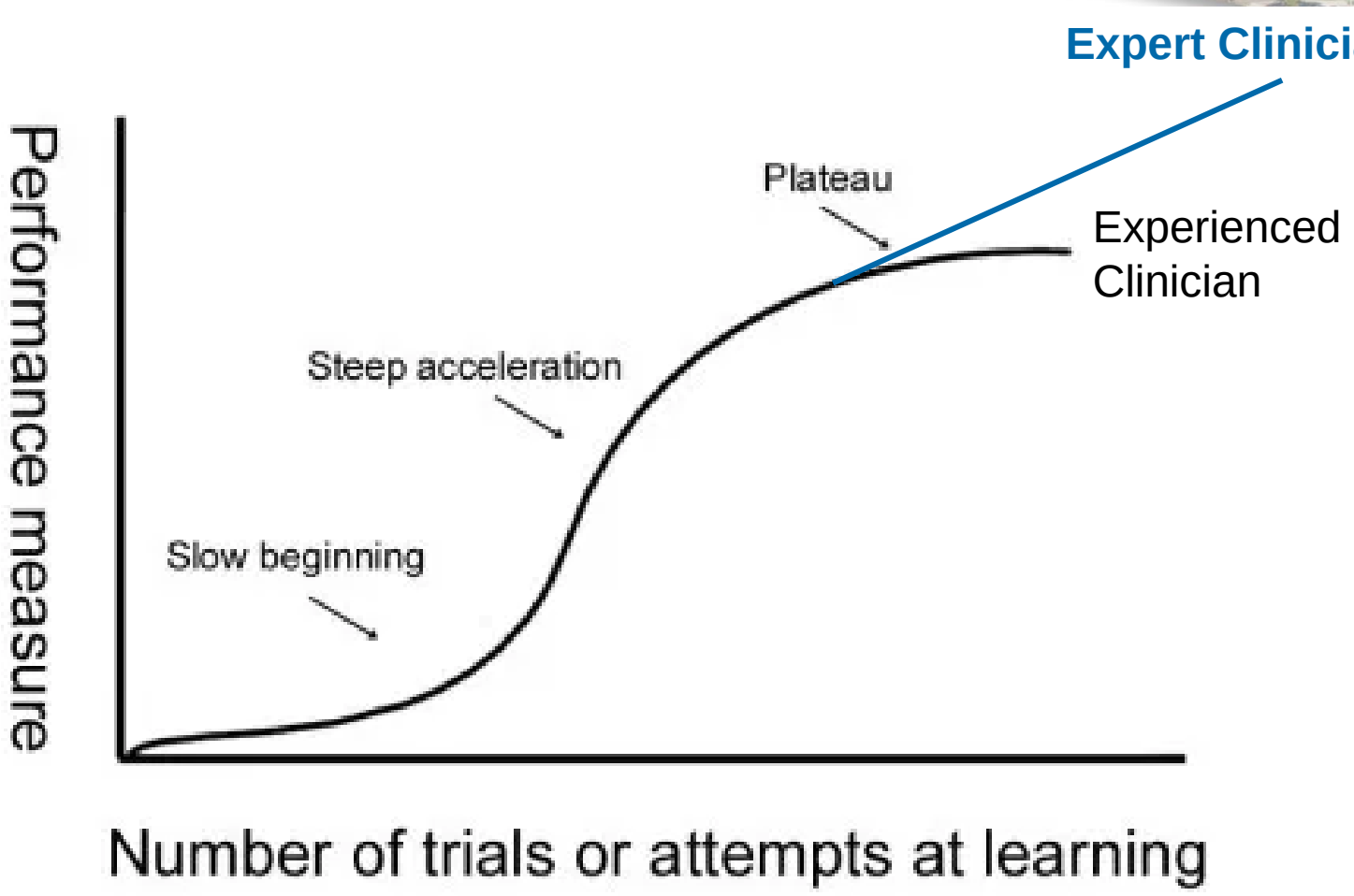
KNOW-NOTHING

EXPERT

WISDOM

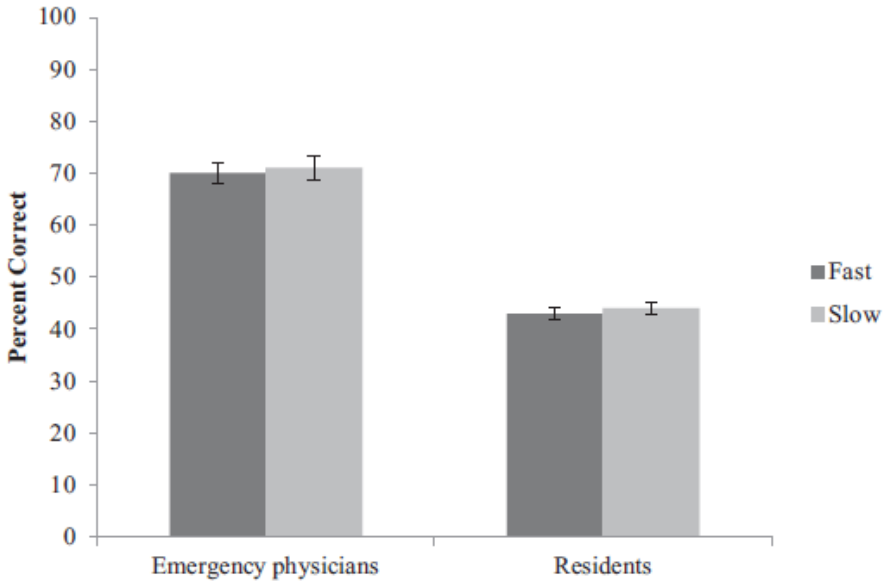
(KNOWLEDGE & EXPERIENCE)

The Performance Experience Curve



Experience matters

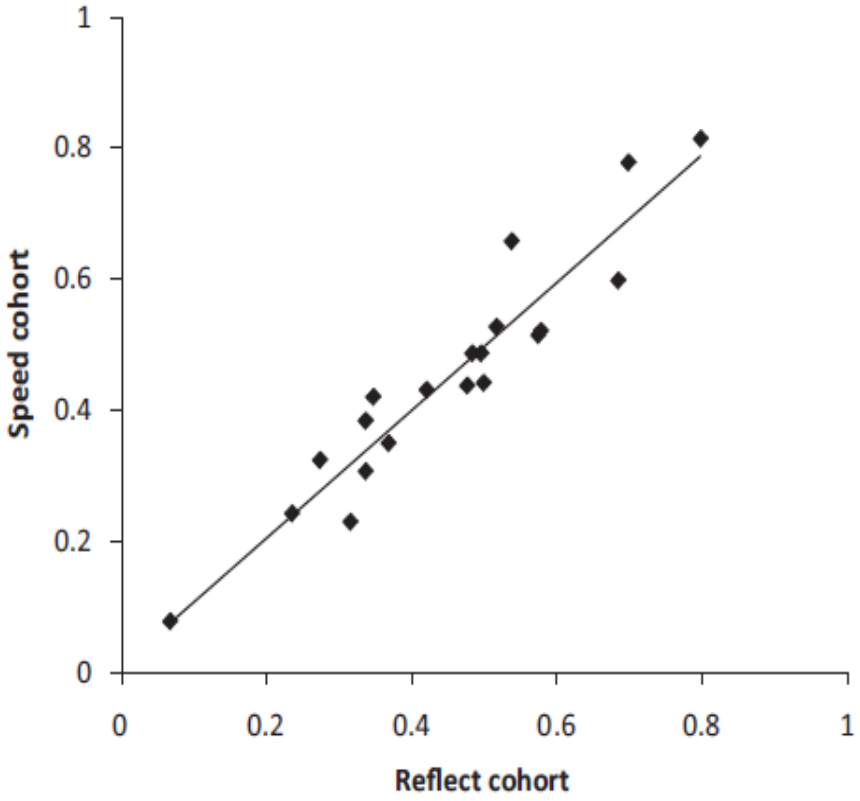
- Comparison of residents and emergency physicians (EPs) on dx accuracy
  - Half of all participants instructed to proceed quickly, other half received no instruction on speed
- EPs were generally much more accurate regardless of test condition



Montiero, et al. Academic Medicine, Vol. 90, No. 4 / April 2015

System 1 vs. System 2: A Trial

- Compared 2 groups of residents
  - Group 1 – Speed
  - Group 2 – Reflect
- Measured response time and accuracy of dx to case vignettes

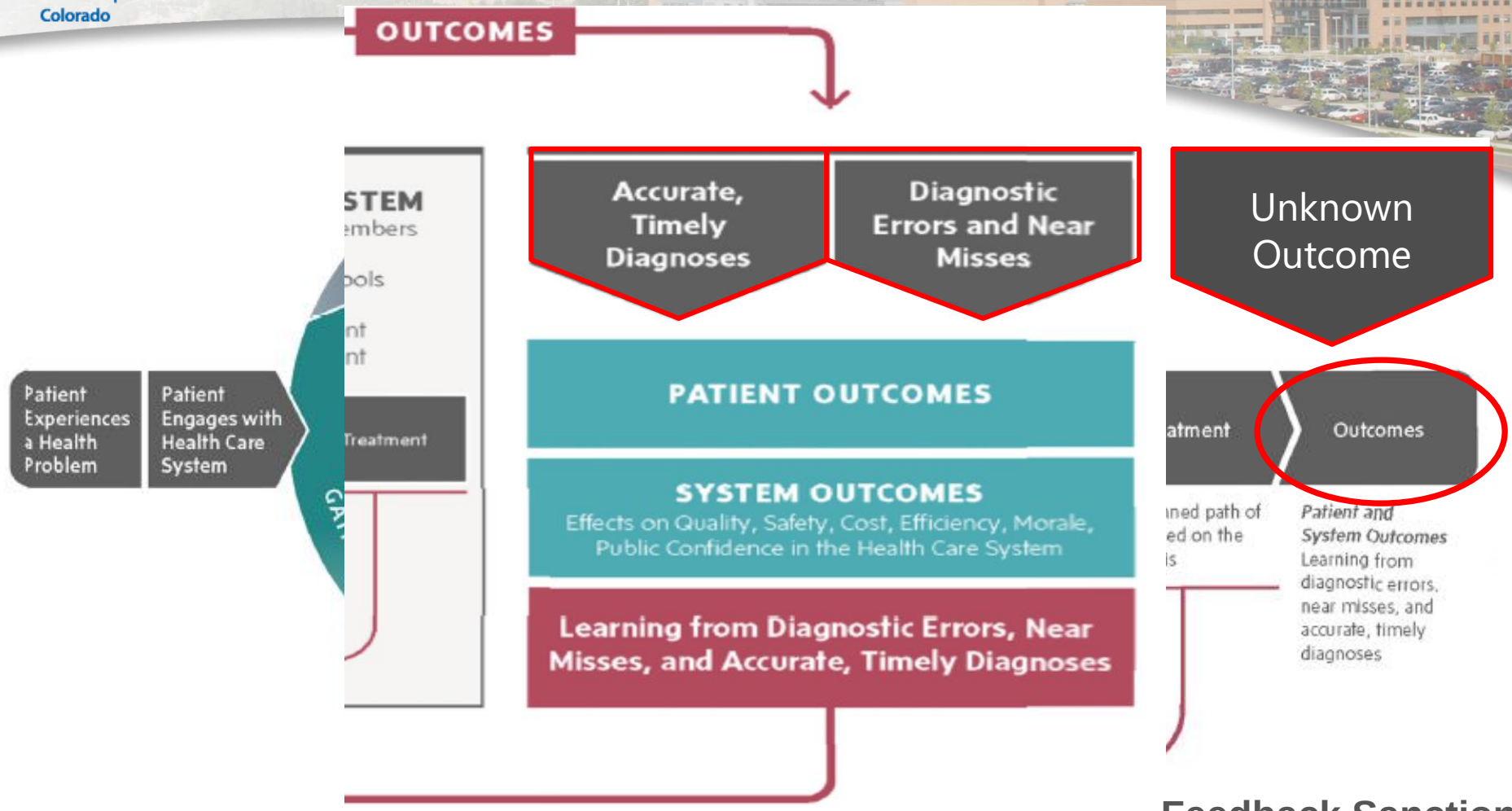


Norman, et al. Academic Medicine, Vol. 89, No. 2 / February 2014

Expertise aka Intuition : how do you get it?

- Expertise develops when a professional has:
  - Environment sufficiently regular as to be predictable
  - Regularities learned through prolonged practice
  - Receive feedback on decisions (calibration)

CALIBRATION



Feedback Loop:
Is the patient responding to treatment?

Feedback Sanction

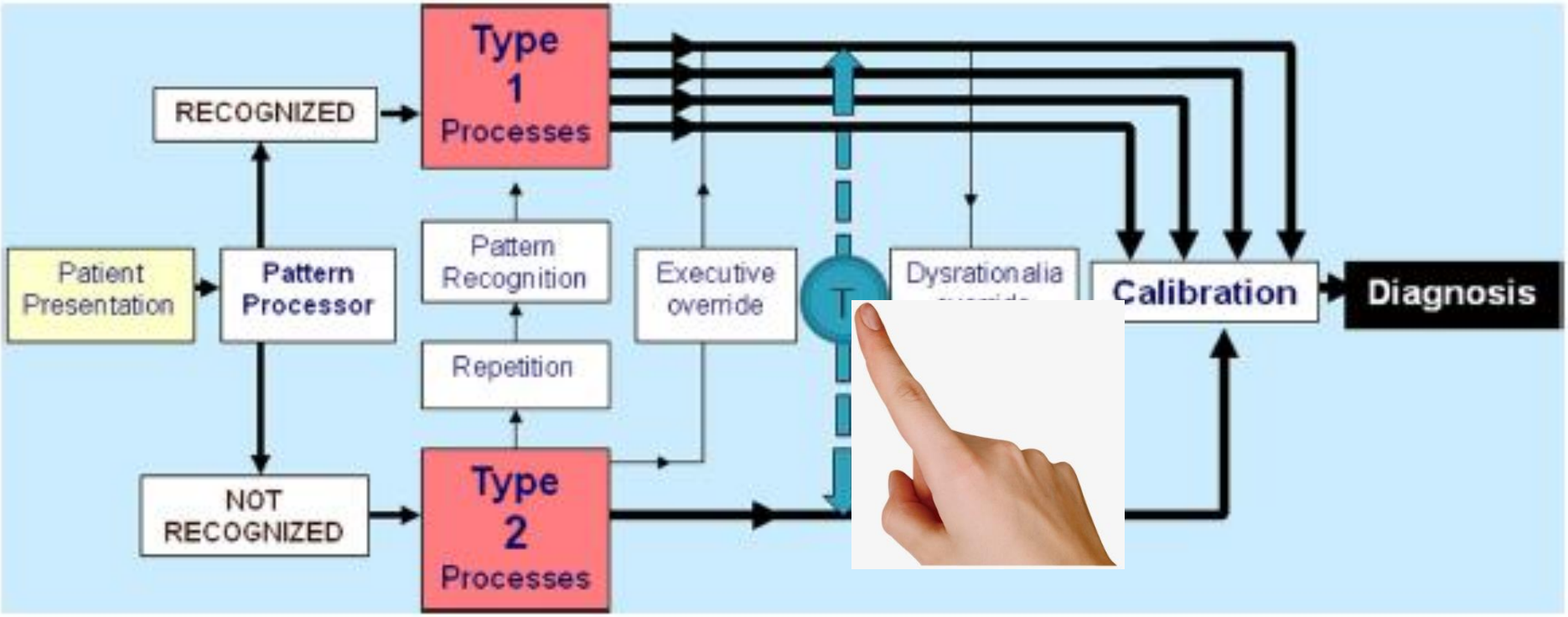
Children's Hospital Colorado

NO NEWS
IS ~~GOOD~~
NO NEWS

Whadda we gonna do?!

- Increase sensitivity to quality/quantity of data
- Recognize missing info
  - WYSIATI
- Interrupt the cascade of activated ideas
- Detect inconsistencies in our frame
  - What doesn't fit the illness script
- Improve our intuitive decisions

Children's Hospital Colorado



The Brain is a Sense-making Organ

- System 1 attempts to reconcile available information into a coherent story
  - WYSIATI: what you see is all there is
  - Narrative takes shape in the cascade of activated ideas
  - Represents categories as prototypical exemplars

- Information Distortion, Confirmation Bias and Search Satisfying
  - The Case of June Bueno

The Case of June Bueno

- June is a previously healthy 16-year-old F who presents with sudden onset RLQ pain today. No fever, no dysuria, good appetite. No vomiting, no diarrhea. LMP 1 week ago. Denies sexual activity.

- VS: 36.8, 82, 18, 112/70

- PE: Focal RLQ TTP with mild guarding, no rebound

- In the CHAT – what are you thinking and what next?

June gives way to July

- US: Visualization: Partially visualized.
  - Solid heterogeneous mass-like opacity in the RLQ with the central tubular structure. May represent a ruptured appendix but needs clinical clarification & potentially CT.
  - CBC obtained with WBC of 8.8 and 42% PMNs

- Surgery Consulted – not convinced it's an appy – repeat CBC and serial exams overnight – will re-evaluate in AM

- WBC falls to 6.9 (39% PMNs) and tenderness resolves

- In the CHAT – what do you do now?

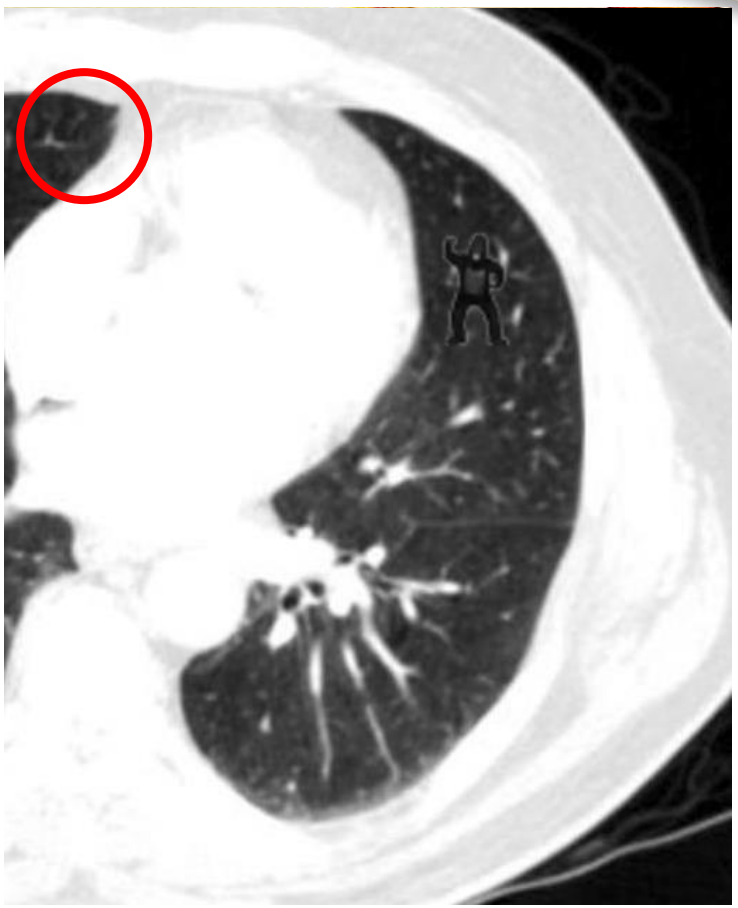
Information Distortion, Confirmation Bias and Search Satisfying

- Information Distortion Bias
  - DDx: appendicitis, torsion, cyst, stone (heme - UA), UTI, ectopic (UPT neg)
  - Appy leading consideration
    - No↑WBC or left shift: "that can happen in appy"
    - U/S fitted to explain findings (maybe an abscess)

- Confirmation Bias
  - The appendix partially visualized & abnormal
- Search Satisfying
  - The WBC is better – see we told you it's not an appy!

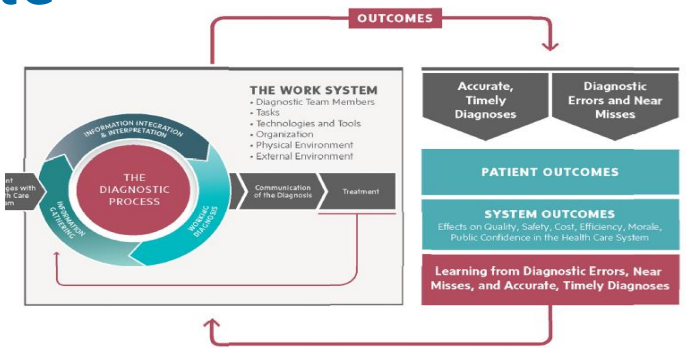
Increasing Awareness of the Quality and Quantity of Data

- Acknowledge the Cascade of Activated Ideas
- Search for the Surprises
  - Some will be subtle
- Articulate New Thoughts
  - Synthesis



#1 - Deliberate Practice & Feedback

- Assess
- Analyze
  - What do I know?
  - What don't I know?
  - What do I need to know?
- Articulate
- Adapt



#1 – Deliberate Practice & Feedback

Referral: ***7*** *m/o F, fussy after fall down 4 carpeted stairs, PCP obtained femur and tib/fib films, no fracture but still fussy.*

Your exam: pain with ROM of the right knee, no swelling but tender around knee

Workup Requested: *evaluate for other injury*

In the CHAT: what next?

Diagnostic Checklist:

1) Is there data I haven't obtained or reviewed?
2) Did I (we) view the image myself?
3) Was the diagnosis suggested to me (us) by another provider/nurse/parent without verification?

#1 – Deliberate Practice and Feedback

- Specifically request follow-up information:
  - From those receiving hand-off
  - From the inpatient or EDteam
  - ***From the Patient***
- Select cases to follow-up:
  - "Obvious" or "certain" diagnoses
  - Ambiguous diagnoses
- Read Operative, Pathology, Radiology Reports
- Set small learning assignments based on missed diagnoses
  - What didn't I know that I needed to know?
  - Was what I thought I knew about this diagnosis accurate?

#2 – Diagnostic Checklist

- Diagnosis – synthesizing all available patient data with relevant knowledge of diseases
  - Gestalt vs. deliberate consideration

- Memory and cognition have LIMITS
  - Checklist may prompt new dx considerations or investigation
  - Assists with the “analyze” phase of deliberate practice

#2 – Diagnostic Checklist

Clinical Indication for Exam: *10 y/o M, right forearm pain and swelling after FOOSH, mid-forearm tender on exam*

Information Requested: *sign of radius / ulna fracture*

Interp: *mildy displaced ulna fracture*

- Assess
- Analyze
  - What do I know?
  - What don't I know?
  - What do I need to know?
- Articulate
- Adapt

#2 – Diagnostic Checklist

- Have I ruled out must-not-mis… diagnoses?
- Did I just accept th… came to mind?
- Was the diagn… me by the pati… another provi… verification?
- Did I consider … systems besides …
- Is there data I haven … and/or reviewed?

…iew the image myself?

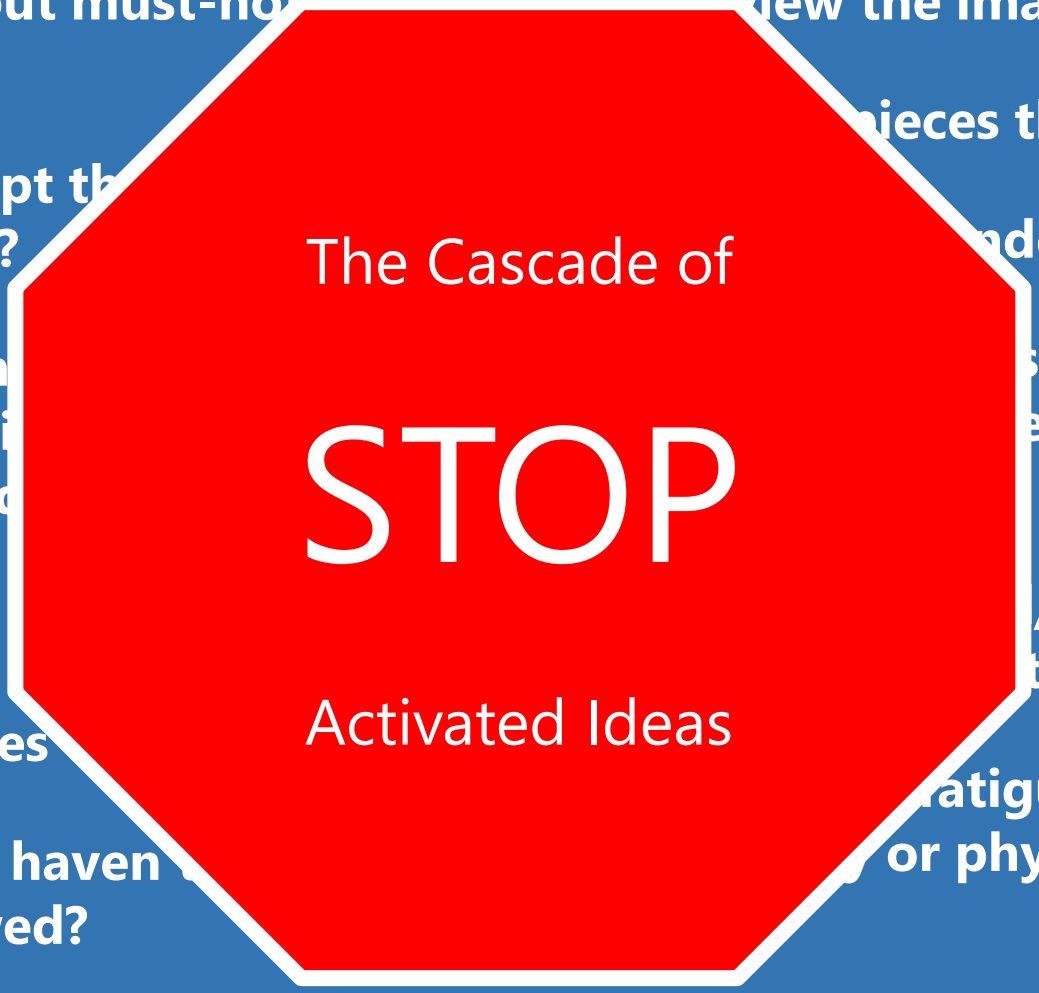
…ieces that don't fit?

…nded off to me?

…seen in …ecently for the …

…/distracted …this patient?

…atigued … or physically ?

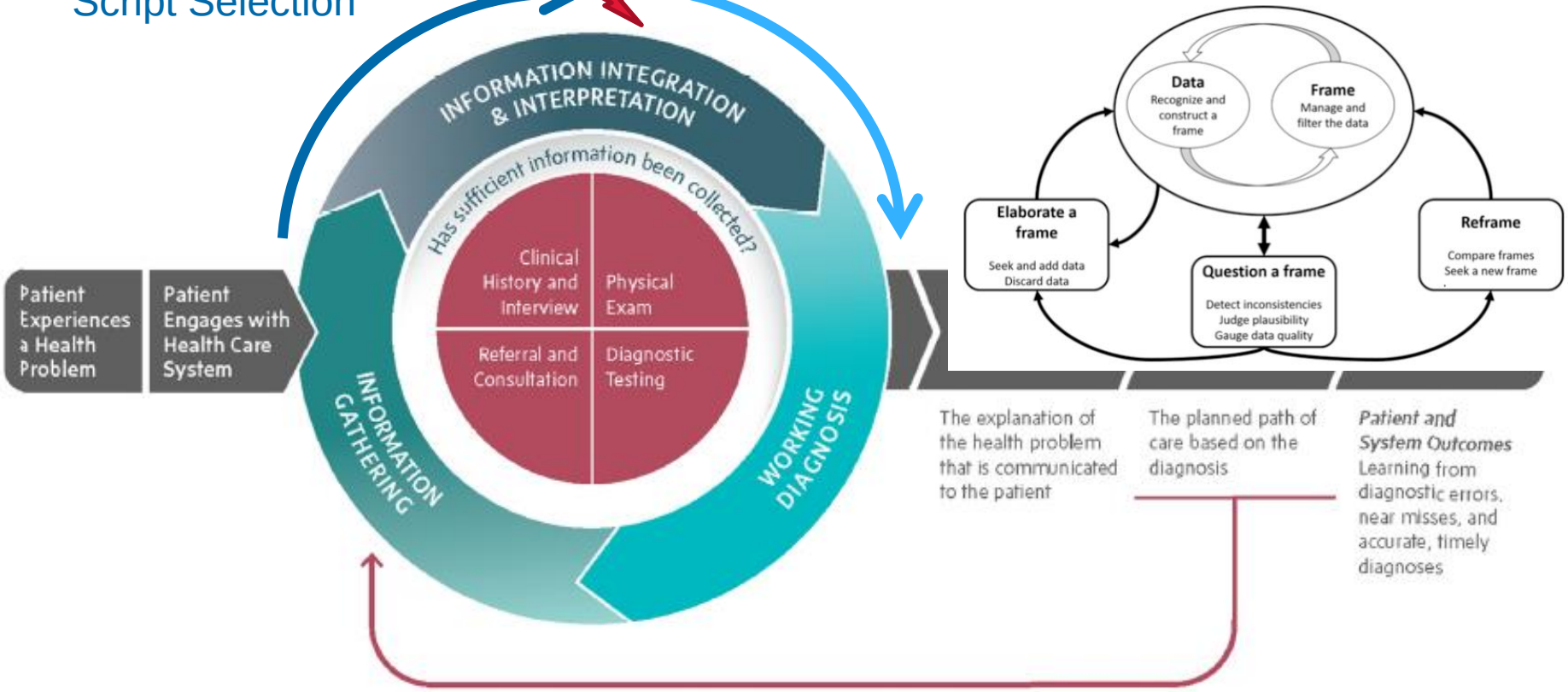


#3 – Hypothesis Driven Physical Exam

HEURISTICS
Information Distortion
Confirmation Bias
Search Satisficing
Anchoring

PATTERN RECOGNITION
Script Search & Script Selection

PATTERN CONFIRMATION
Script Verification



#3 – Hypothesis Driven Physical Exam

- If this is 'X' then I should expect A, B, and C on exam
- However, if this is 'Y' then I would expect A and B but not C
  - Instead, I should find D
- If A and B are both absent but I see C, what else might this be?

#3 – Hypothesis Driven Physical Exam

Referral: *23 d/o M, fussy, no fever, cellulitis on face*

Workup Requested: eval for cellulitis, admit for IV abx

In the CHAT: does this look cellulitic?

If so, what do you expect on *exam?*

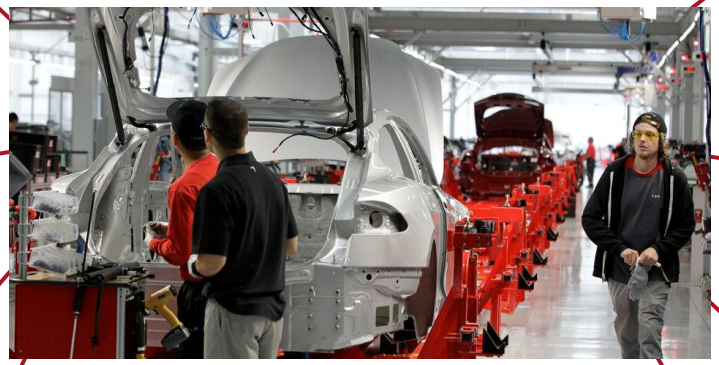
What about Herpes SEM dz?

- If this is cellulitis I expect:
  - Warmth, uniform redness, tenderness, firm skin, ?fever
- If this is Herpes SEM disease:
  - Redness, tenderness, vesicles, mucous findings
- Let's Look

Cognitive dis-Ease

Children's Hospital Colorado

- Atypical of Experience
- Unusual Context
- Interrupted Idea
- Inquisitive Mood



- Feels Suspicious
- Feels Unfamiliar
- Feels Wrong
- Feels Effortful

Take Home Points

- Intuitive (system 1) diagnostic reasoning leads to errors when:
  - The quality and quantity of data is poor and not recognized as such
  - Clinicians are unaware of data that has not been obtained/analyzed
  - The diagnosis appears plausible (“good story”) even if not probable

- Clinical expertise requires:
  - A regular practice environment
  - Sufficient opportunity to learn regularities
  - Feedback on decisions within the practice environment (calibration)

- Toggling from System 1 to System 2 reasoning requires acknowledgement of subtle surprises

Other Resources to Improve Clinical Reasoning

SOCIETY to IMPROVE DIAGNOSIS in MEDICINE

Improvediagnosis.org

NSW GOVERNMENT | CLINICAL EXCELLENCE COMMISSION

Take 2, Think, Do

isabel

Isabelhealthcare.com

visualDx.

VisualDx.com

Children's Hospital Colorado

Feedback & Questions