HDO Human Dimensions of Organizations
THE UNIVERSITY OF TEXAS AT AUSTIN

Risky Business:
Human Error & Organizational Resiliency

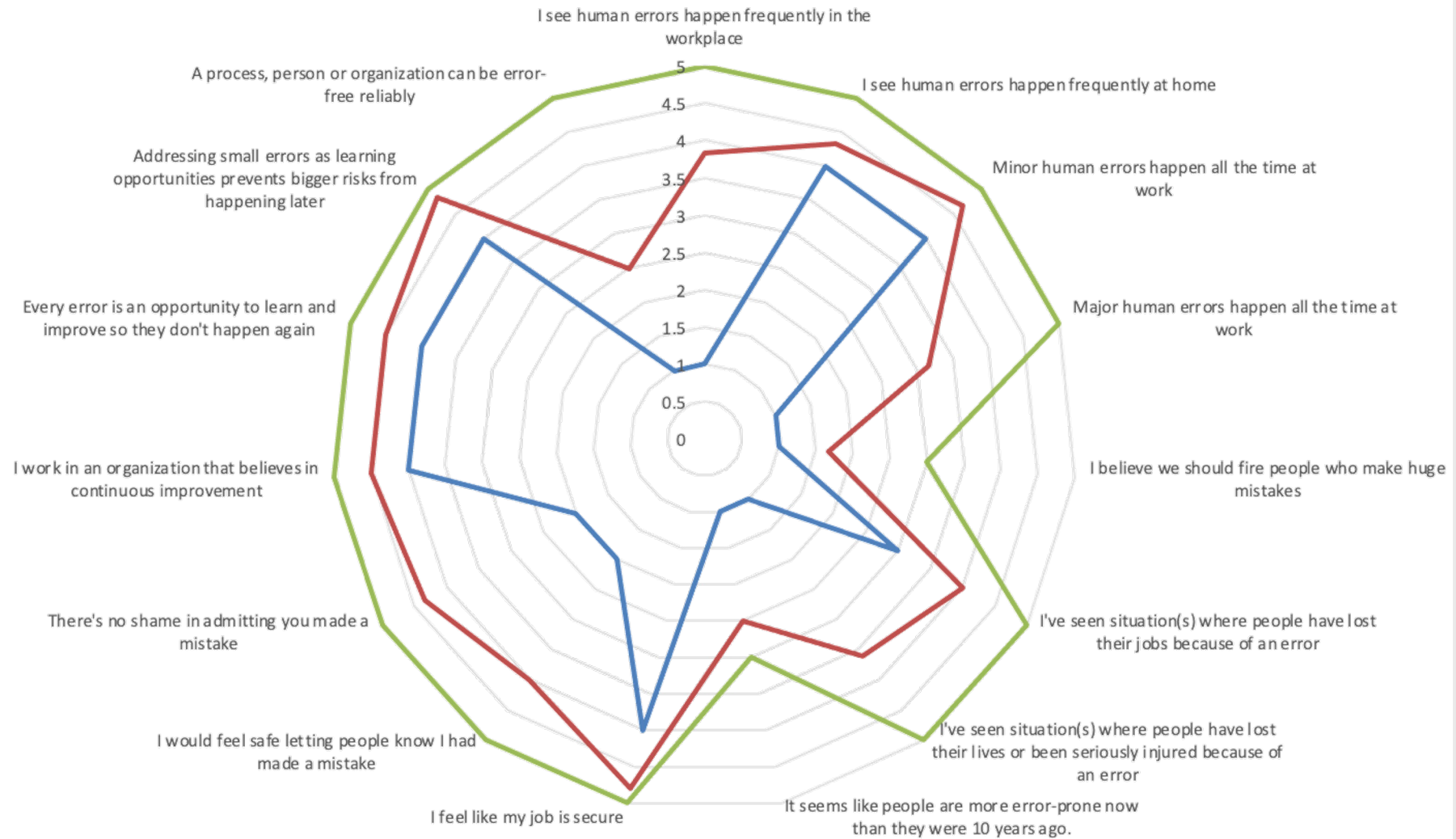Michael E. Legatt, Ph.D.

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March 2, 2023

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Introductions / Overview of Day

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Introductory Questions

Anything you'd like to cover?

- How to address errors made higher up the leadership chain

- How the subject overall is affected by the anxiety and pressure for results.

- My most recent employer held "blameless" post mortems on all projects; the tone and emphasis was on NOT placing blame, but learning and intentionally improving processes based on data, not blame. How can one cause a culture shift to this positive framework in companies where it's instead very much a "gotcha" mentality?

- I don't know if its related, but if possible, I'd like to see some mention of "just culture" safety approaches I'd also like to get information on how to change an organizational attitude to allow error reduction and a system that functions in the presence of error

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# What would make this course a success for you?

- Ability to be interactive and come away with ideas to apply strategies in my existing organization

- A friendly environment with good Knowledge sharing

- How best to shape the professional environment to accept risk and/or error.

- It would be excellent to learn new information that makes me reconsider my opinions and re-evalute "what I think I know" about human error and org resiliency, and I'd love leaving with a fresh perspective and new insights based on material and on robust discussion and exploration of ideas.

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What would make this course a success for you?

- To leave with a set of tools and further readings that can allow me to help management build a system that:
    - Reduces errors;
    - Prevents repeated errors
    - Adjusts to errors that, in spite of everything, still occur

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The Bulk Power System

- Presidential Policy Directive 21: Energy and communications infrastructure especially critical because of their enabling functions across all critical infrastructure areas

- DOE: "A resilient electric grid… is arguably the most complex and critical infrastructure."

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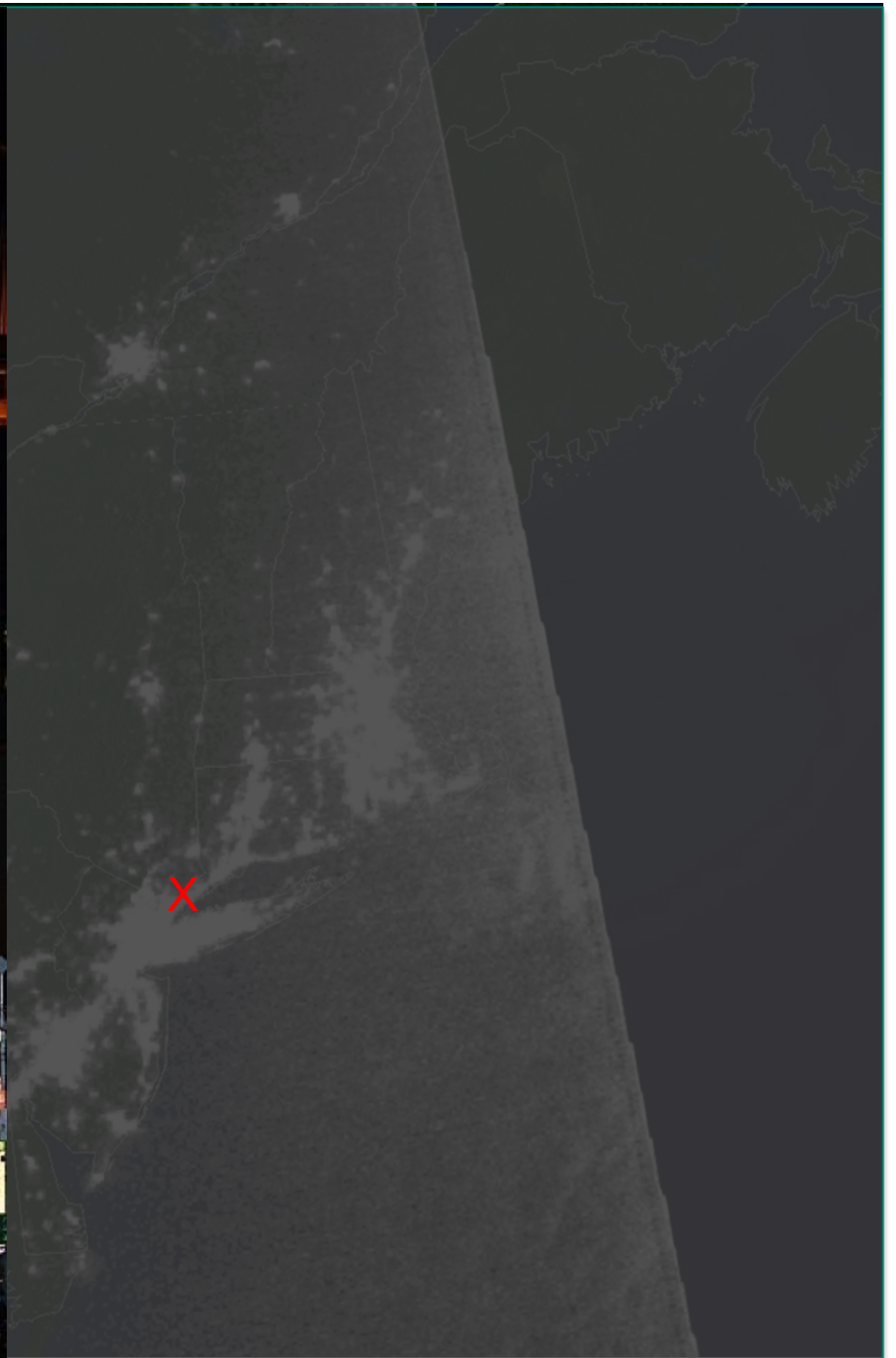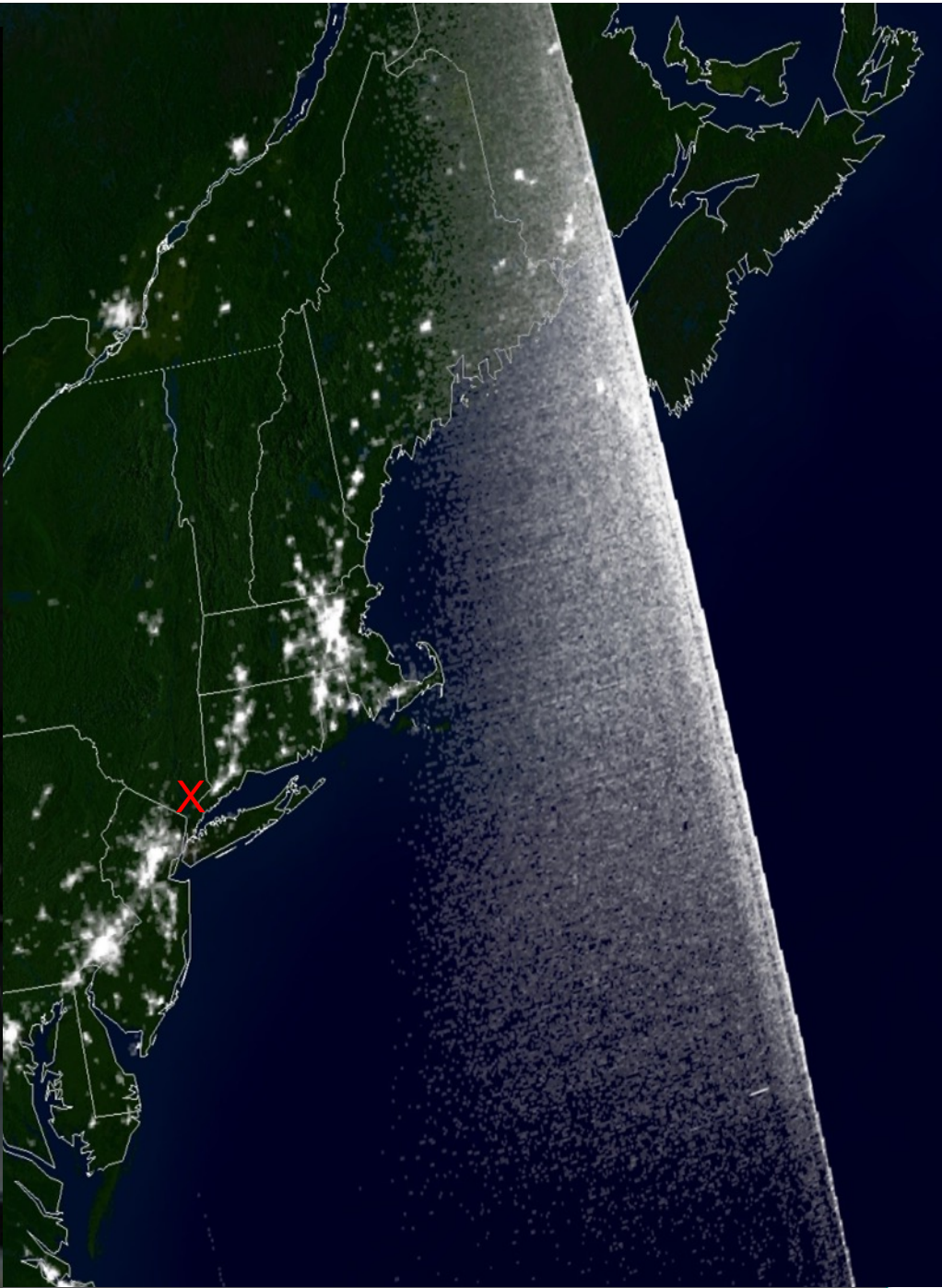
Core Philosophy:

"All organizations are perfectly aligned to get the results they get."
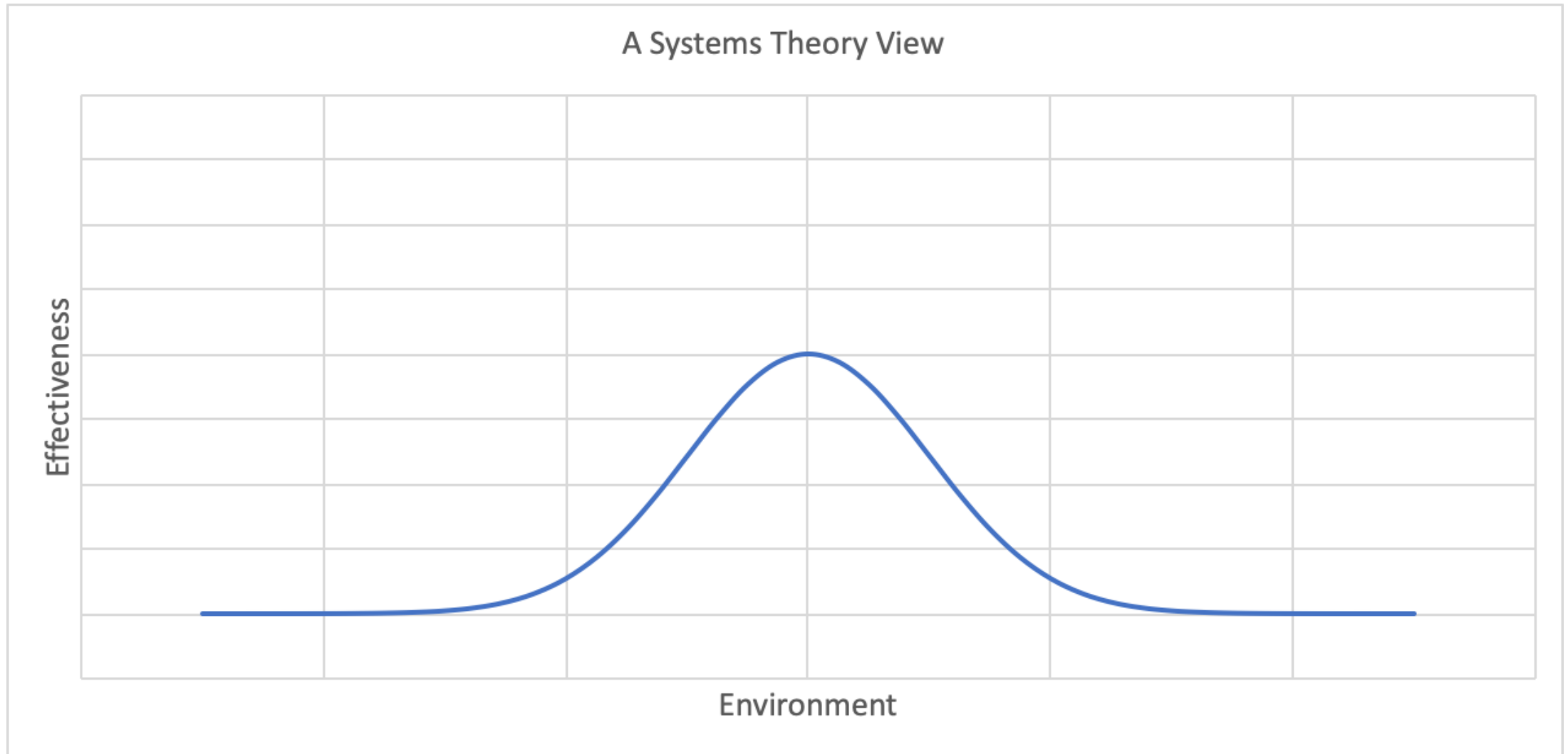
Arthur W. Jones

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Core Philosophy:

Humans are like components of the grid. Interconnect them well, and allow them to operate within their tolerance ranges, and you have an efficient system.
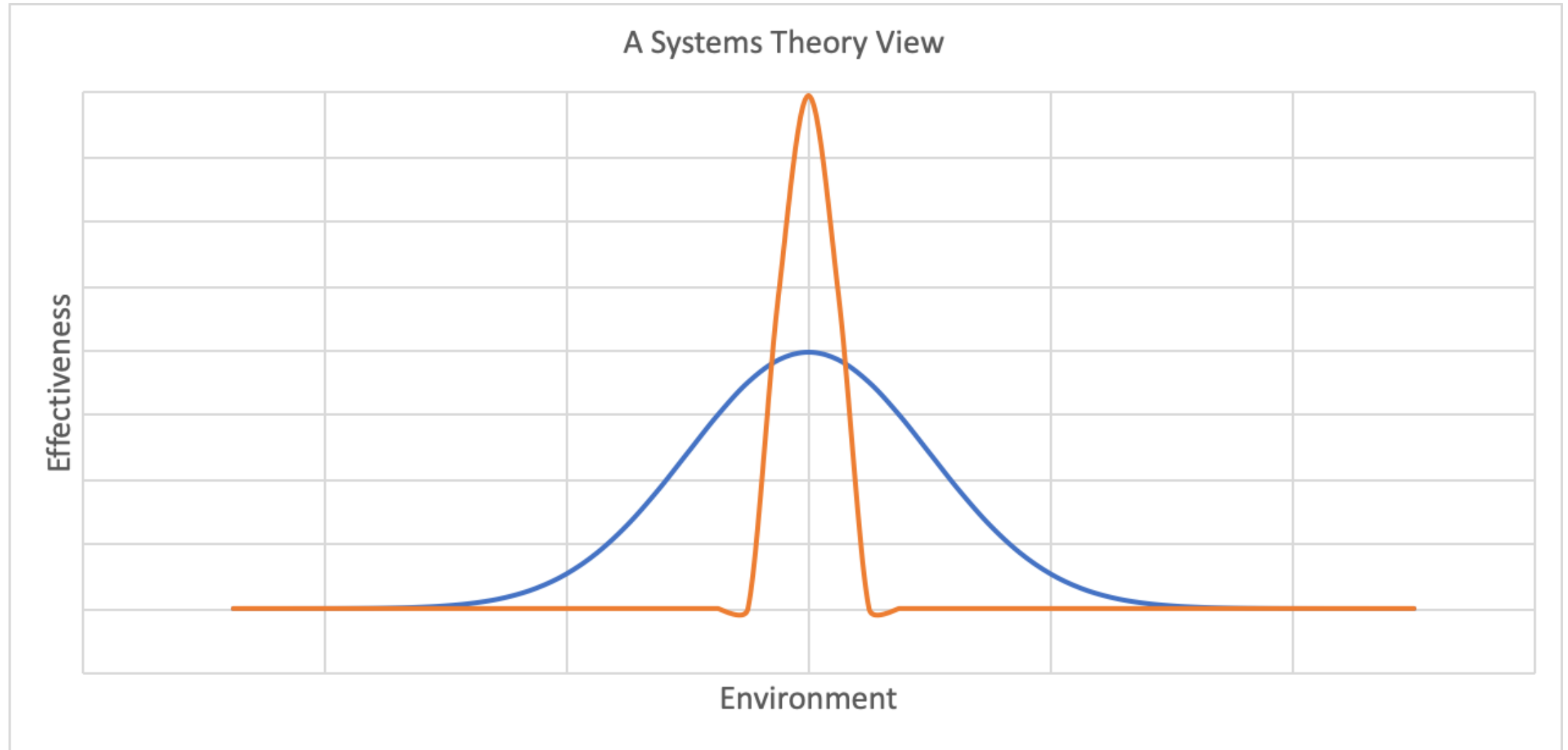
Interconnect them poorly or let them operate outside of tolerances, and you create inefficiency, heat, and the occasional explosion.

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A Changing World

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A Systems Theory View

Effectiveness

Environment

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A Systems Theory View

Flynn Effect (1987): An average increase of 3 FSIQ points every decade, concrete -> abstract thought

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Improving Safety

With Each Decade, U.S. Airline Safety Has Improved

Since Deregulation, < 0.5 Fatal Accidents per Million Departures

Legend: Fatal Accidents — Sched/Non Sched Depts — Fatal Accident Trendline

* Scheduled and Non-scheduled passenger and cargo operations of U.S. air carriers operating under 14 CFR 121; NTSB accident rates exclude incidents resulting from illegal acts

Source: National Transportation Safety Board (NTSB)

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With Each Decade, U.S. Airline Safety Has Improved

"We've learned that automation does not eliminate errors. Rather, it changes the nature of the errors that are made, and it makes possible new kinds of errors. The bottom line is this: Systems that integrate the best of human abilities and technology are the safest for all concerned."

Captain Sully Sullenberger, LinkedIn.com, "Technology Cannot Replace Pilots"

SULLY SULLENBERGER

* Scheduled and Non-scheduled passenger and cargo operations of U.S. air carriers operating under 14 CFR 121; NTSB accident rates exclude incidents resulting from illegal acts

Source: National Transportation Safety Board (NTSB)

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- **Complex:** Many interdependent components
  - Hard to get order, control, or predictably.

  - "Emergent system"

- **Complicated:** Many independent components
  - Once you can separate components, you can deal with each of them systematically

Human Performance Rooted in Psychology

Negative (Reinforcement / Punishment)

Pathology:

What's wrong?

How can we tell when it's wrong?

How can we predict when it's about to go wrong?

How to we minimize how bad things are?

Distress

Positive (Reinforcement)

Positive Psychology:

What's right?

How can we spread that right to other areas and strengthen it?

The belief that people want to lead meaningful and fulfilling lives, to continue to improve, and to enhance their experiences of love, work, and play.

Eustress

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- How well/quickly can a system bounce back/transform from an adverse event?
    - "Evaluating the ability of the system to reduce the magnitude and/or duration of disruptive events…depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event." (NIAC, 2009)
    - Essentials include "flexibility, coping with the unexpected and unplanned situations, and responding rapidly to events, with excellent communication and mobilization of resources to intervene at critical points." (Hollnagel, 2011)

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- Critical infrastructure resilience: both physical infrastructure, and the human components
  – Resilience Engineering: Humans are the primary source of resiliency for an infrastructure

- How do we foster resilience in humans?
  – Resilience is not genetic. If the environment supports growth, people thrive.

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- Modes of operation:
  - Compliance
  - Reliability
  - Resilience
- Stress?
  - Distress
  - Eustress
- Cascades in human error

What is Human Error?

Introductory Questions
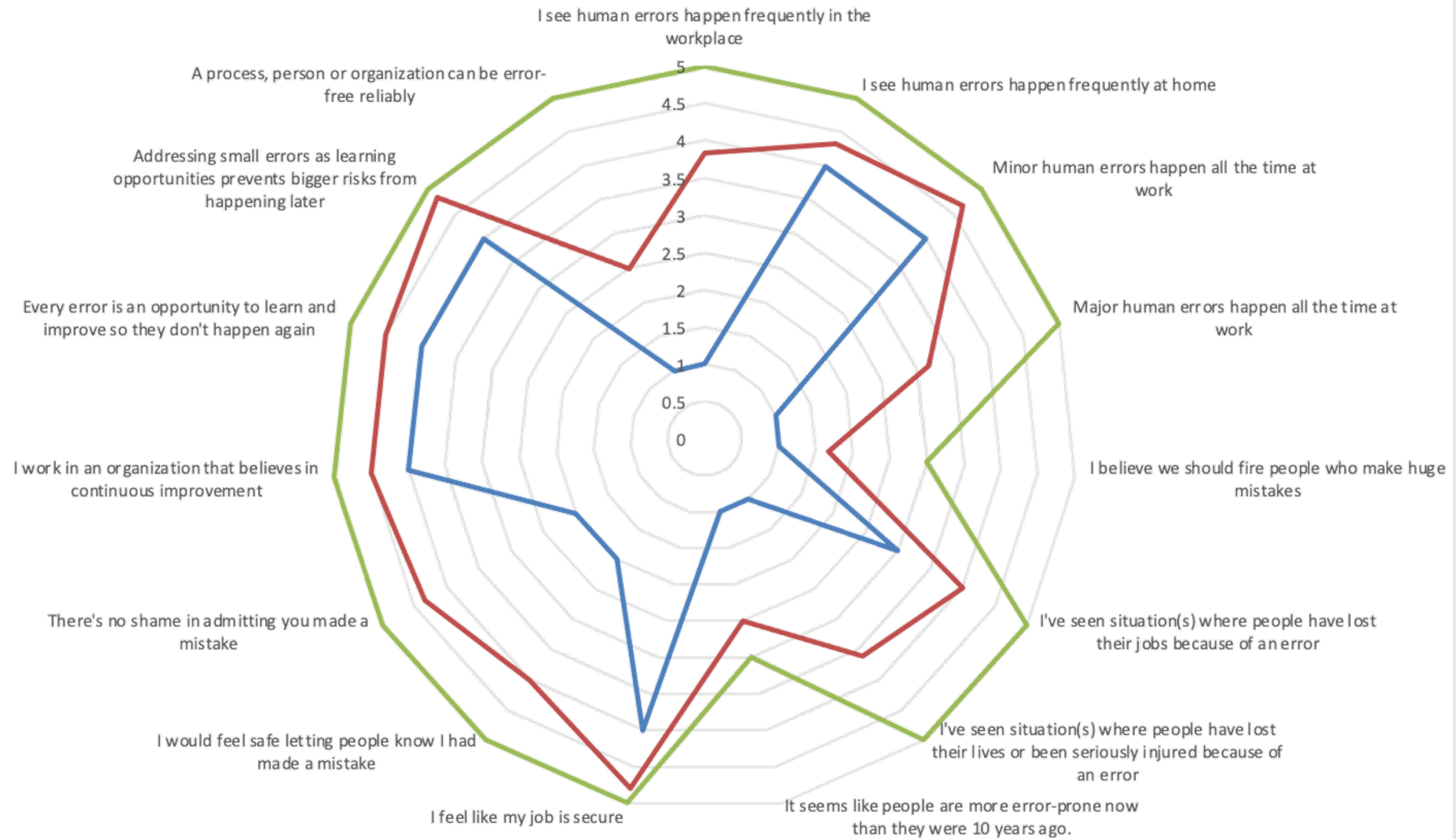
Example: Human error has had a major impact

- Incorrect medicine prescribed resulting in bleeding event

- Bridge collapses due to lack of engineering standards and cutting corners

- No equipment for protection while working in high places

- Publisher of state-level, bi-monthly industry magazine misspelled a prominent word on the cover of one issue; could have been career-altering, but was handled with humor, understanding, and "let's learn from this" attitude.

- There was one person who opened a test chamber without following process and lost his life because of it.

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New security flaws found in popular IoT baby monitors

Even internet-connected baby monitors aren't immune to hacking, including some flaws that are easy to exploit.

By Zack Whittaker for Zero Day | September 2, 2015 -- 13:54 GMT (06:54 PDT) | Topic: Security

A popular Fisher-Price 'smart bear' failed to properly authenticate the device's user.

Image credit: Amazon

Princeton researchers find security flaws in IoT devices engadget

Nest thermostats were leaking zip codes on the internet, for example.

Billy Steele , @wmsteele
01.21.16 in Home

Shares

It's Time to Pay Attention to Connected Car Cyber-Threats

By Wayne Rash | Posted 2016-03-20   Print

eWEEK

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Responding to Human Error

Outcome Bias

Over-Reaction	Under-Reaction
• Discipline of discrete error	• Turn a blind eye to risky choices
• Discipline person who didn't see risk	• Allow reckless people to go unchecked
• Over-reaction to singular events	• Pass over severe system design flaws

"The single greatest impediment to error prevention…
is that we punish people for making mistakes."
– Dr. Lucian Leape, Professor, Harvard School of Public Health,
1999 Testimony before Congress on Health Care Quality Improvement

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"Human error is a consequence, not a cause. Errors are shaped by upstream workplace and organizational factors… Only by understanding the context of the error can we hope to limit its reoccurrence"
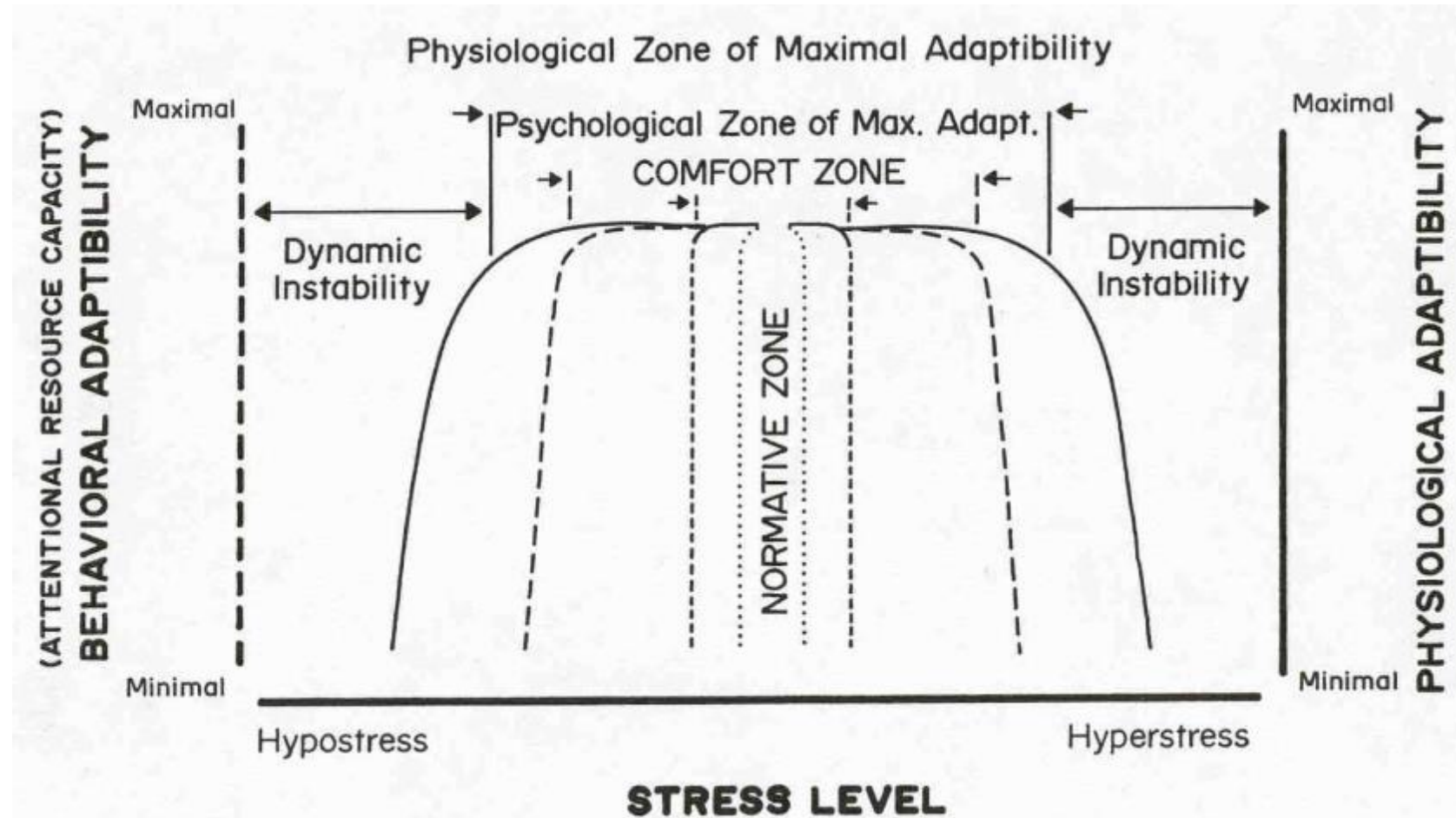
James Reason

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What Is a Human Error, Anyway?

- A generic term to encompass all those occasions in which a planned sequence of mental or physical activities fails to achieve its intended outcome, and when these failures cannot be attributed to some chance agency (Reason, 1990).

- [Human] error means that something has been done which was: not intended by the actor; not desired by a set of rules or an external observer; or that led the task or system outside its acceptable limits (Sender and Moray, 1991).

- An erroneous action can be defined as an action which fails to produce the expected result and/or which produces an unwanted consequence (Hollnagel, 1993).

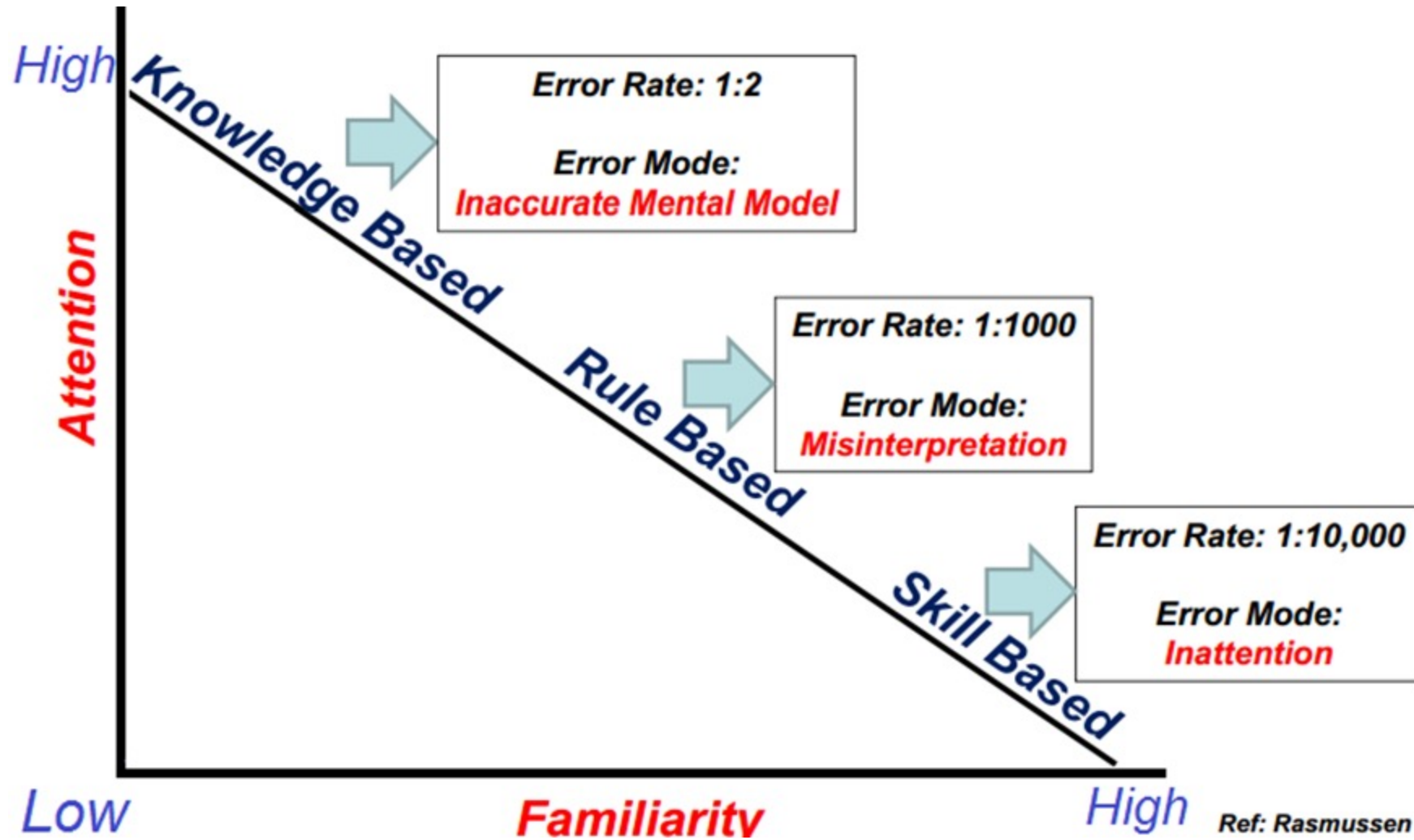- Many others (e.g., Dekker, Woods, NASA, Muschara, DOE)

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The Human Brain,Body, and Human Error

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Human Performance Under Stress

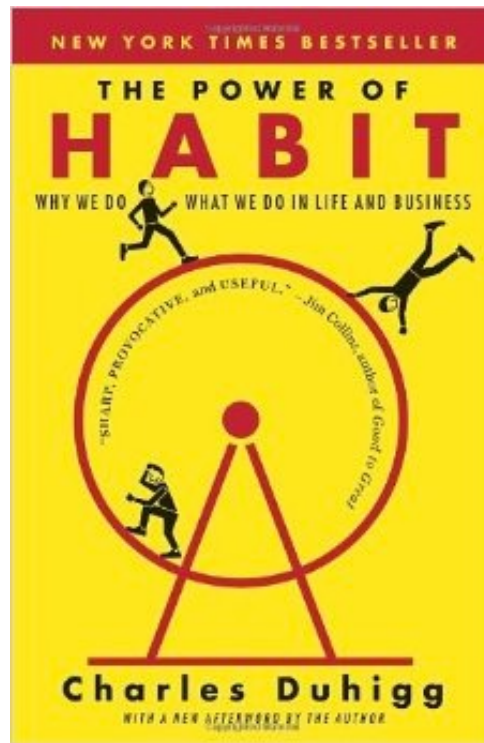A Dynamic Model of Stress and Attention, from Hancock & Warm (1989)

How we make mistakes

High

Attention

Knowledge Based

Error Rate: 1:2

Error Mode:
Inaccurate Mental Model

Rule Based

Error Rate: 1:1000

Error Mode:
Misinterpretation

Skill Based

Error Rate: 1:10,000

Error Mode:
Inattention

Low   **Familiarity**   High   Ref: Rasmussen

From: NERC Cause Analysis Methods

- Habit executors vs. JIT (just-in-time) performers

- Self-control is a limited resource, and like a muscle, it tires out (Baumeister et al, 1998)
- … or does it?

Triune Brain

- Neocortex
- Limbic System
- Reptilian Complex
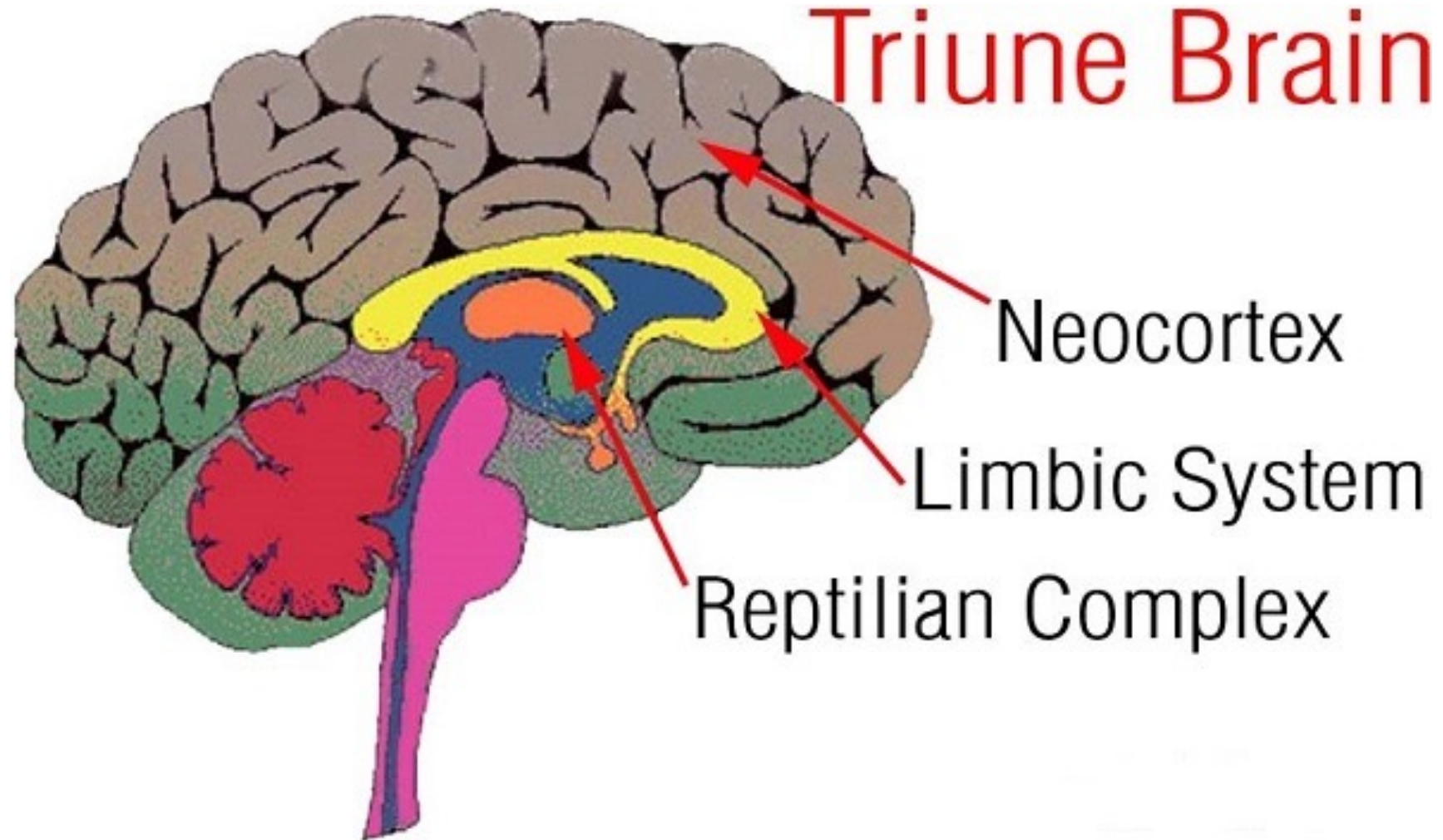
- Most difficult to process information under extreme stress

- Humans make 3 – 7 mistakes per hour awake, 11-17 under extreme stress.

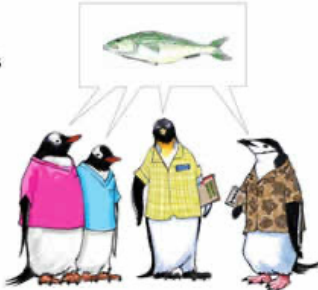- Working memory decreases under stress (7±2 => 3-5 or lower with long term damage)

- How people internally represent the task they are performing / situation they're in.

  - Schema – Representing and organizing information into interconnected chunks

    – Experts organize into larger, more effective, more accessible chunks

    – Novices struggle to organize schemata

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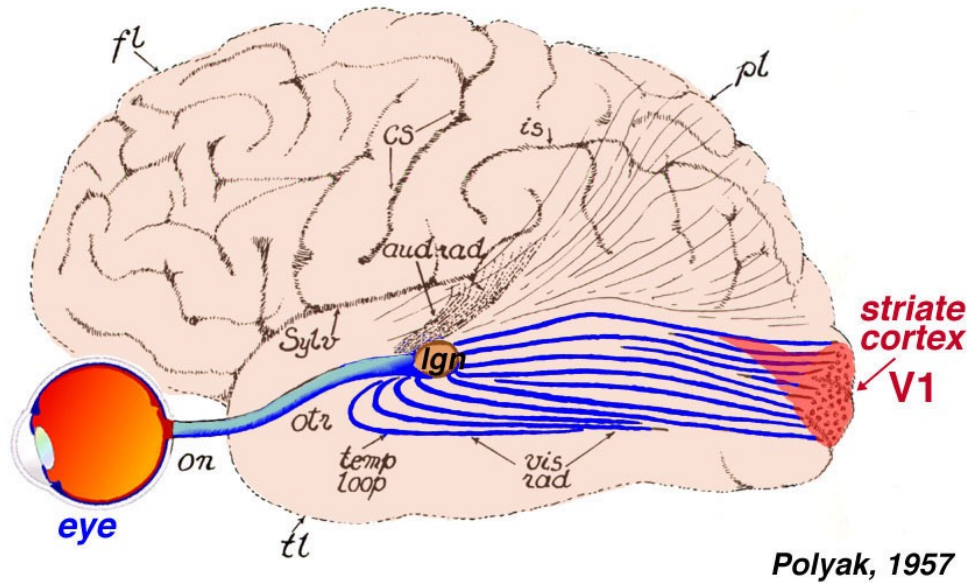
- Short-term / processing memory (7 ± 2; Miller, 1956)

- These 7±2 points can be "chunks", allowing for better storage and processing.

- Working memory decreases under stress (7±2 => 3-5, or even lower with long term damage)

747 cockpit
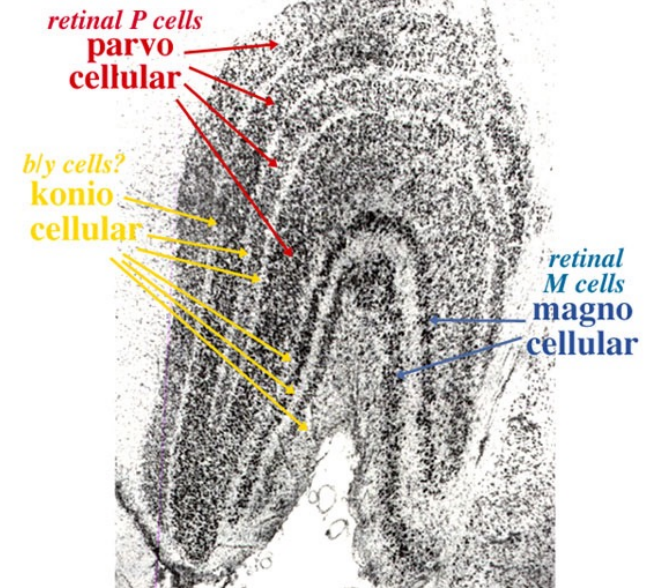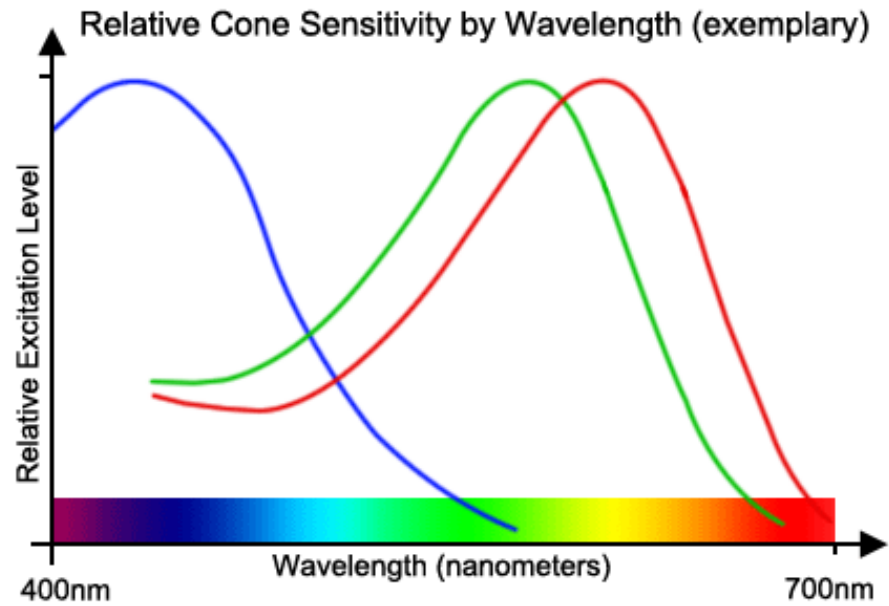
Polyak, 1957
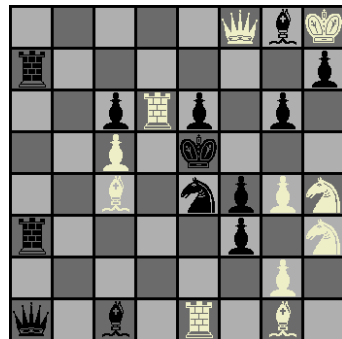
Layers of the LGN

Visual System

Relative Cone Sensitivity by Wavelength (exemplary)

Source: Chroma: A wearable augmented reality…
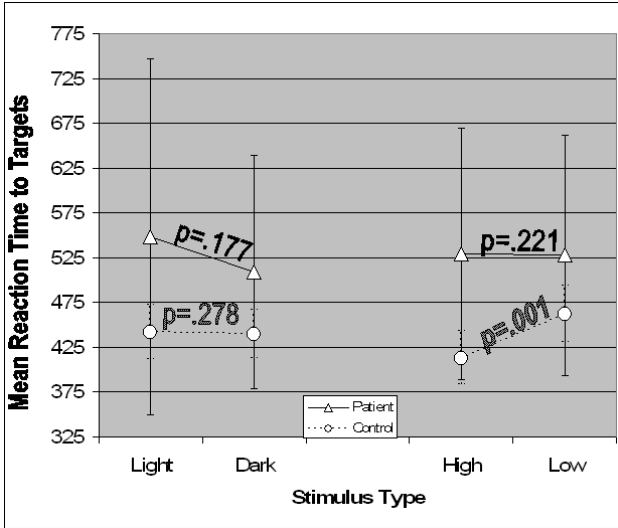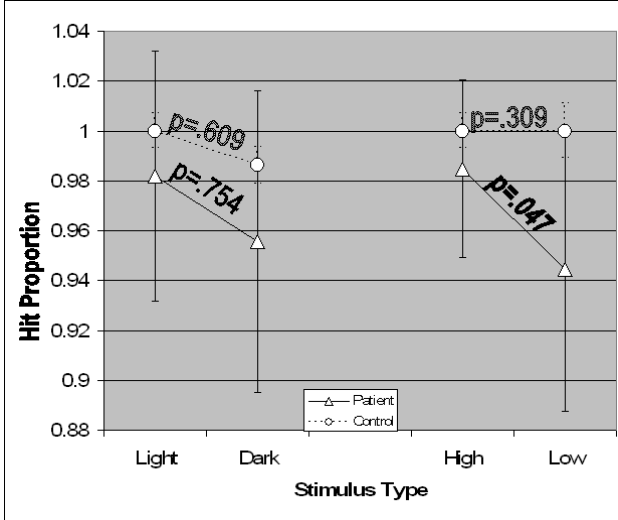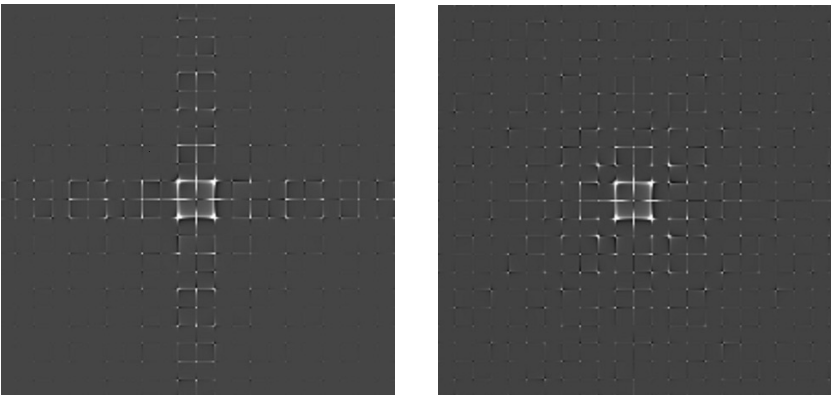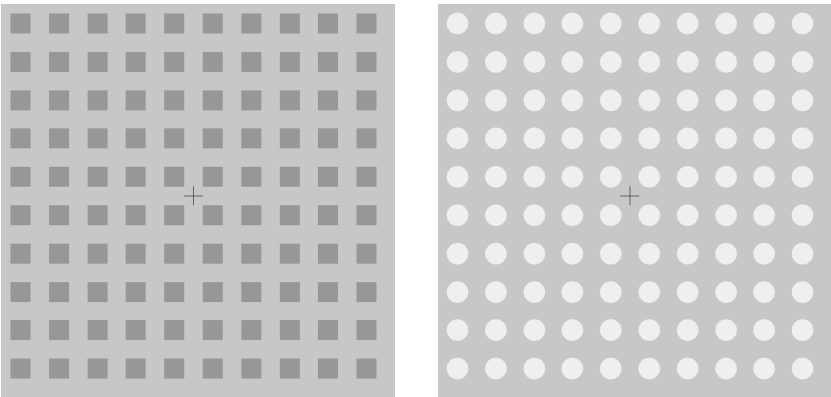
- Like much of power systems engineering involves applying knowledge from physics, so does human factors engineering apply knowledge from psychology, sociology & anthropology.

- New view of a power system: humans and technology intertwined into a larger system.

- Humans enhance (not threaten) reliability.

- Thus, co-optimizing both each part and their interaction is a key goal -- engineering for success.

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- A great many human factors influence the overall reliability of the system, for example:

Exercise	Visual system function
Sleep	Cognitive biases
Corporate culture	Mood
Genetic factors	Training
Self-monitoring	Abstract reasoning, empathy
Diet	Self-actualization
Stress & fear	Positive thinking

- For this discussion, we'll focus on one area:
  – Diet, fatigue, stress and human error

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- "After more than 100 years of research on fatigue, we do not really know very much about it" - Hockley
- "A lack of sufficient steady-state energy to power physical and/or cognitive work" – Hancock, Desmond & Matthews
- "Fatigue makes cowards of us all" – Vince Lombardi

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Fatigue

- Stark & Ash (1917): "When an error occurs it is followed immediately by other errors and more and more frequently as the period of work continues"

- Fatigue is not boredom!

- Every hour awake after 10 hours, the equivalent of .004% BAL decrease in reaction time (Dawson & Reid, 1997).

- Increased error risk, lowered self-monitoring.

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- Maintaining a fairly constant blood sugar level helps maintain energy levels
- Eat within an hour of waking, snack every 2-4 hours
- Make sure strong fiber (soluble and insoluble) in diet, especially at breakfast
- Fruits and vegetables good, but some are better than others
- Broccoli, kale, brussel sprouts, cauliflower
- Less processed generally better

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Source: Schartz, H. (2013)

Circadian Rhythms
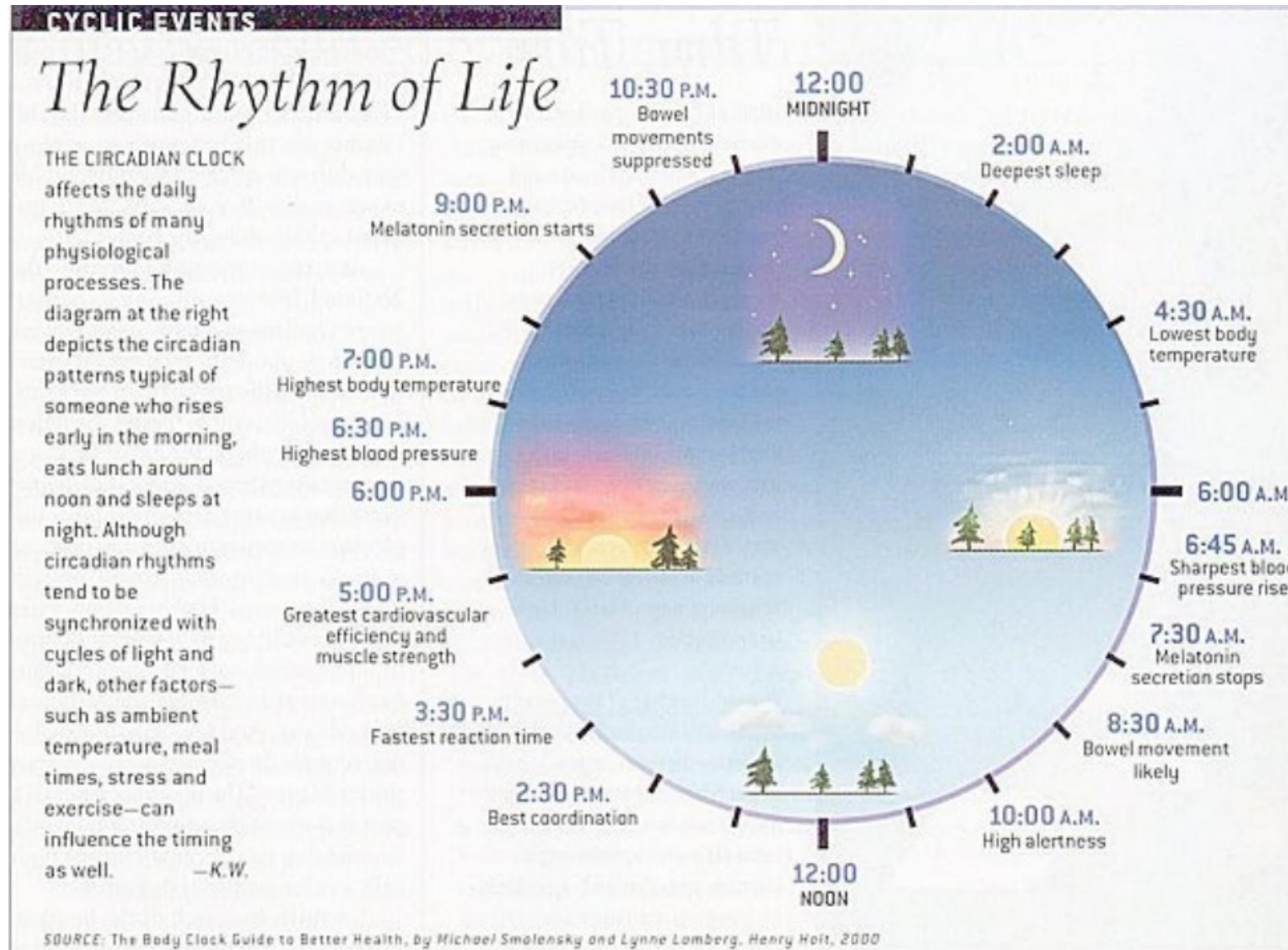
Source: Neuroscience Education Institute

- Serotonin is a neurotransmitter (traveling between nerve cells)
- Low serotonin levels lead to clinical depression
- Excessive serotonin leads to extreme feelings of well-being and happiness
  - Serotonin syndrome
  - Serotonergic neurotoxicity

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Image Sources: Wikipedia
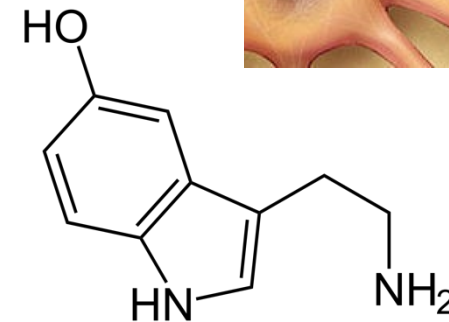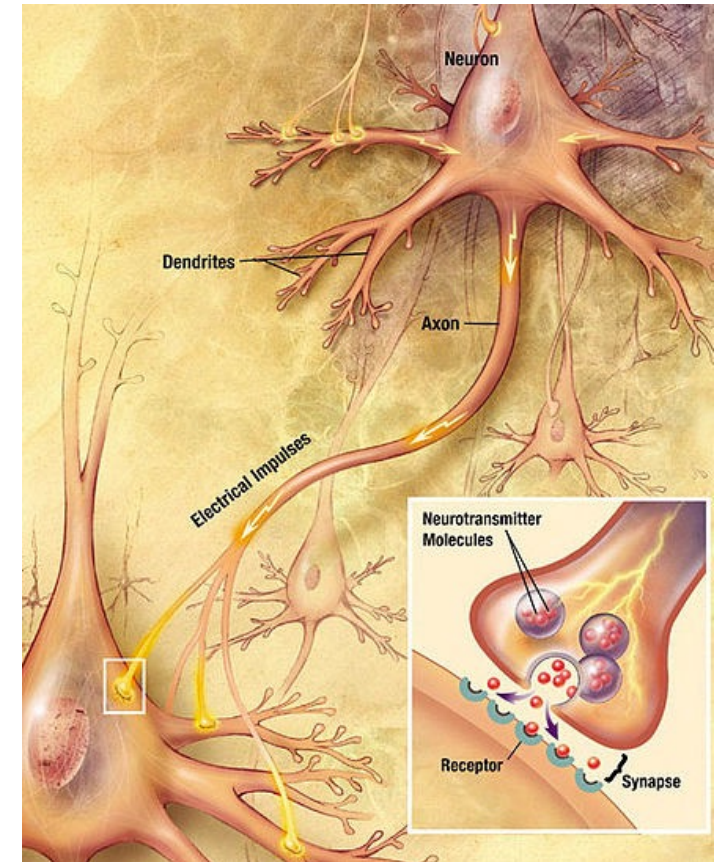
Carbohydrates

- Digesting carbohydrates increases blood sugar, and the body in turn produces more insulin.

- Type 2 diabetes begins when muscle and other cells stop responding to insulin, and eventually insufficient insulin is produced and blood sugar levels
stay too high.

Image Source: Harvard School of Public Health

- Vigilance is: The ability to maintain attention over long periods of time
- Vigilance can decrease due to:
  - Memory load
  - Event rate
  - Adverse environmental factors
  - Changes in motivation
- Maintaining vigilance is stressful, and exhausting (ego depleting), especially under high stress

- Ford Motor Company (1917) found two 10-minute breaks every day produced greater worker output over the whole day.

- Fatigue is not "one size fits all":
  - Fatigued extroverts perform better in stimulating environments around people, worse in quiet steady-state environments
  - The opposite effect is observed for introverts

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- Chances of getting acquitted in a criminal trial is higher right after lunch, lower right before (Danziger, Levav & Avnaim-Pesso, 2011).

- Some cultures incorporate early afternoon / post-lunch rest / nap (siesta) to insulate against heat & fatigue.

- In the medical field, a higher probability of human error in the early afternoon (often on long shifts) as opposed to the beginning of a shift.

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- Many drugs used to treat depression are SSRIs – they lead to more serotonin in the brain

- 95% of serotonin is secreted in the gut in response to food

- Under stress, most people tend to increase "snack food" intake, reduce "meal food" intake (Oliver & Wardle, 1998).

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- Experimentally, stress tends to shift people towards higher saturated fat, sugar and calorie foods (Zellner et al, 2006).
  - After eating these foods, participants reported feeling better for a short while.
  - People already dieting reported much higher levels of stress during these times.
  - Suppressing the impulse to eat fatty foods, especially under stress, may increase the risk of ego depletion!

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- There is a well-known relationship between what you eat and how tired you feel.

- Eating high-carbohydrate foods can lead to hyperinsulemia (excessive insulin)

- For people engaged in strenuous exercise, high-carbohydrate foods 3-4 hours prior lead to reduced fatigue.

- For people not engaged in strenuous exercise, high carbohydrate foods are associated with lightheadedness, fatigue, and occasional fainting.

- Fatigue is not just physical; people can also become fatigued mentally.

- The brain uses sugar as a fuel source.

- Complex mental problems (including vigilance and self-control) require increased use of sugar in the brain.

- People given complex mental puzzles tend to also search out high fat / sugar / calorie snacks, compared to people given simple mental puzzles.

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- Large food intake requires more blood flow to the gut, in order to support digestion & absorption.

- Carbohydrate intake also leads to decreases in blood pressure.

- Central fatigue hypothesis: Increased serotonin in the brain can lead to decreased sport/exercise performance (Davis, 1996).

- Take out a paper and pen

- When you see the next slide, write down exactly what you see on the slide.

- As soon as you're done, raise your hand.

Jewelry is shiny

1 2 3 4 5 6 7 8 9 10 11 12 13 14

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- How fast was that?

- How hard was it?
  - Did any of you make any errors?
  - Did any of you have any near misses?

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- Now, let's try that again, but this time do it differently.

- We'll write out the same lines,

- Except we'll take turns, going between letters and numbers. For example:

J

_____

- How fast was that?

- How hard was it?
  - Did any of you make any errors?
  - Did any of you have any near misses?

- So, wait a minute… what just happened here?

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- **Change Blindness** – Sometimes we don't see changes in a scene or some critical detail

Source: NOVA
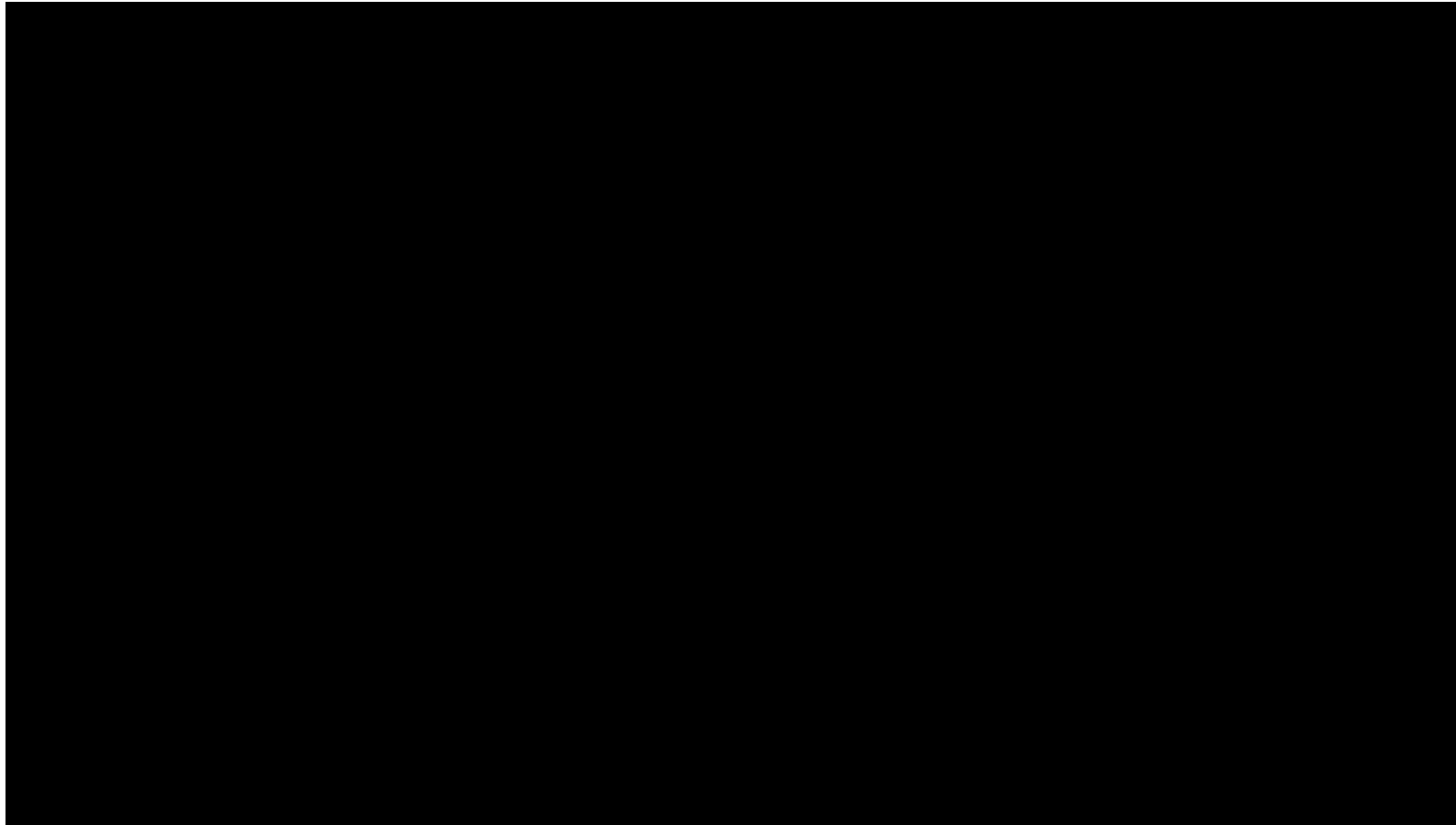
- "Multitasking" is the attempt to carry on two or more tasks or activities at the same time.

- But, really what is happening is both

  - Habit / automation – learned behaviors being repeated with little thought

  - Frequent "mental set shifting" / "context switching" which is computationally intensive and risky.

  - Should something (e.g., driving a car) need a jump in attention, there may be insufficient resources available to help.

- ## Generally, we can do more than one thing, as long as:
  - **Only** one thing requires our conscious attention – and the other tasks can be processed automatically
    - e.g., Sending an email while chewing gum
  - The task that is requiring our conscious attention **can be immediately stopped without consequence** and there is time to re-orient
    - e.g., we can pause writing out the email when we start to choke on our gum, knowing we can pick up the email later.

- A circuit from Motivation -> Attention -> Memory.
  - Therefore, weaknesses in attention mean we have weaknesses storing, holding on to, and recalling memories
  - Ever find you had a conversation while driving and a critical detail you knew you needed to know, but couldn't recall?
- Abilities to multitask not significantly different by sex or generation.
- It has been estimated $650 billion a year is wasted in the US business sector due to multitasking: errors and loss of productivity

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- When we're mental set shifting,
  - We need extra time every time we move from one task to another, to readjust.
  - We lower our performance speed (tasks take between 1½ and 3 times as long
  - Our chances of making a mistake grow significantly
  - Our IQ temporarily drops by about 10-15 points (worse than a night of no sleep, alcohol, marijuana, or a stroke)
  - Our bodies show signs of stress: increased blood pressure, salivary cortisol, heart rate
  - We are more likely to cut corners on a task

http://business.tutsplus.com/tutorials/how-to-do-one-thing-at-a-time-and-stop-multitasking--cms-25159

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- However, this also may feel exciting, and even have addictive components

  – More dopamine is released in the brain when we're trying to multitask

- High prolonged multitaskers tend to have smaller anterior cingulate cortex

  – A region of the brain responsible for empathy, and mental/emotional control.

- Multitasking in meetings and other social settings tends to relate to lower self- and social-awareness / lower EQ.

http://www.forbes.com/sites/travisbradberry/2014/10/08/multitasking-damages-your-brain-and-career-new-studies-suggest/2/

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"Multitasking" or switchtasking: Cell Phones while Driving

- Drivers trying to talk and drive at the same time are both:
  - Worse drivers
    - 4x more likely to be in a vehicle accident
    - Reacted more slowly to brake lights and stop signs
    - Involved in more rear-end collisions
    - Sped up and braked more slowly than intoxicated drivers (BAL = .08)
  - Worse conversationalists
    - More forgetful about what discussed
    - Struggled to maintain the conversation – especially when it was complex
- Whether a handsfree device was used or no effect.
- Listening to audio books did not have a negative effect on driving performance
- New infotainment systems, GPS devices, etc., seem to have similar distracting properties

http://www.apa.org/research/action/drive.aspx

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- "Super-taskers"
  - About 2 – 3% of the population can perform better when multi-tasking than when uni-tasking. There is likely a genetic influence – they're born with it, and you can only learn to improve slightly.
  - However, people's ability to gauge their own multitasking abilities is usually inaccurate.

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"Multitasking Makes You Stupid" – (Shellenbarger, 2003)

Organizational Culture, Fear, and Human Error

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– Most positive (in order)

- Being a good coach
- Empowering / not micromanaging
- Being interested in direct reports, success & well-being
- Being productive and results-oriented
- Being a good communicator and listener
- Helping employees with career development
- Having a clear vision and strategy for the team
- Having technical skills that could help advise the team

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Google Oxygen / What Makes a Poor Leader?

– Most negative (in order)

- Having trouble making a transition to management/leadership

- Lacking a consistent approach to performance management

- Spending too little time managing (servant leadership) and communicating.

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– No significant relationships between team members' distribution of IQ, friendship, diversity alone.

– Significant relationship: Group norms

• Most important: habits of how team members treat each other

• Not important: dynamics of one/few leaders vs. distributed leadership. As long as everyone agreed.

- Retiring workforce, millennials and workplace diversity.
- Greater dependence on expertise and reliance on humans to understand "the big picture"
- Loss of "tribal knowledge"
- Mixed mental models: Theoretical and hands-on

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- Fredrick Winslow Taylor
  - Mechanical engineer who sought to improve industrial efficiency
  - One of the first management consultants
  - Wrote <u>The Principles of Scientific Management</u>:
    - Replace "rule-of-thumb" methods with those based on scientific study
    - Actively select, train, and develop each employee
    - Provide detailed instruction and supervision of each worker in the performance of that worker's discrete task
    - Divide work between managers and workers: managers **plan/think**, workers **do**.

Source: McChrystal, S. (2015). Team of Teams.

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- # Fredrick Winslow Taylor
  - Moved from skilled individuals doing many things to less skilled individuals, each doing one thing over and over
  - Motivating them simple: financial awards can make them work faster

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- ## Taylor efficiencies not working in today's world
  - Much of what we do is now on **thought** not repetitive, automatic actions.
  - Financial bonuses now **decrease** performance and **increase** error rates.
  - Many employees now searching for more **meaning** in their work; cultural and short term KPI misalignments abound.

Sources:
McChrystal, S. (2015). Team of Teams.
Duhigg, C. (2016). Smarter, Faster, Better.

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Approaches to Management

- "What you can measure you can manage"

- "If you can't measure it you can't manage it"

W. Edwards Deming
(1900-1993)

Source: deming.org

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"It is wrong to suppose that if you can't measure it, you can't manage it – a costly myth…

It is the relationship with people, the development of mutual confidence, the identification of people, the creation of a community.

This is something only you can do. It cannot be measured or easily defined.

But it is not only a key function. It is one only you can perform."
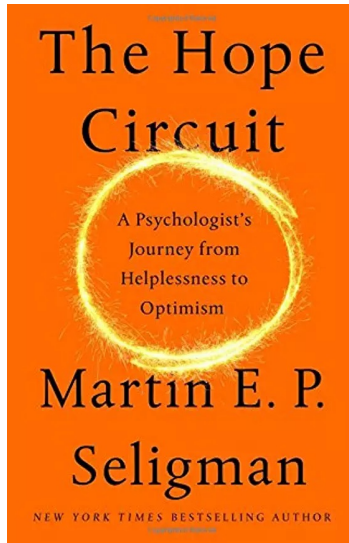
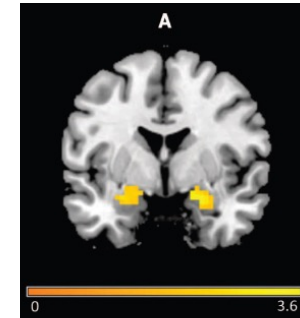

W. Edwards Deming
(1900-1993)

Source: deming.org

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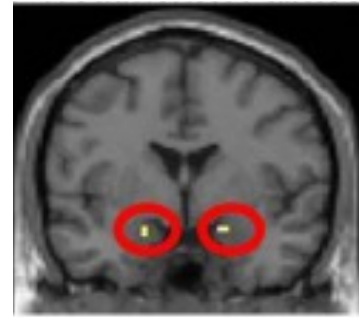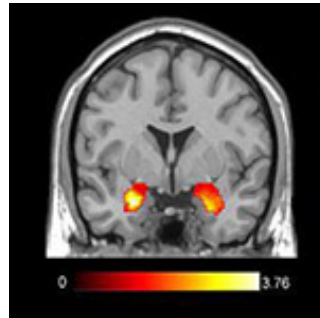
- "Losada Line" / "Critical positivity ratio"

- Use a positive psychology principle:
- Critical Positivity Ratio
- Ratio of positive to negative > 2.901 to 1
- > Linked to higher performance, lower anxiety
- > 7:1 for "superstar" teams
- < associated with punitive / fear-based cultures.
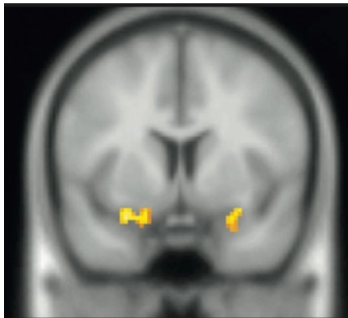
Continuous Improvement, After-Action Review and Learning Teams

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- Complex sociotechnical system with constant change:
  - New attacks and threats
  - New optimizations and goals
  - New technologies
  - Changing culture
  - Changing pattern recognition
- Therefore, a focus on continuous improvement supports continuous growth, in current and changing circumstances

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- The power of stories
- Safety I vs Safety II
- Resilience Engineering
- The role of After Action Reviews
- Learning Teams and Root Cause Analysis

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- Humans are the <u>primary</u> source of resilience for an infrastructure
  - o This is especially true as growing infrastructure nexus challenges occur (e.g., electric-natural gas)

- Therefore, to strengthen an organization's resiliency, you need:
  - o Right-sized tools
  - o Strong measurements
  - o Strong habits
  - o Strong learning
  - o Ideally, time and support to anticipate and prepare ("antifragility")

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- Provide opportunities to improve collaboration and communication

  o Shared tabletops / thought exercises

  o Shared drills / training

  o Group interactions / getting to know each other

o Shared situational awareness / Common Relevant Operational Picture (CROP)

High Reliability Organizations and High Performing Teams

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An example…

- # Rhode Island Hospital
  - ## A top medical institution
  - ## Deep tensions between doctors and nurses
    - "This place can be awful. The doctors can make you feel like you're worthless, like you're disposable. Like you should be thankful to pick up after them." (A nurse interviewed by a reported in 2000)
  - ## "Time-out" procedure called by a nurse
    - Surgeon stormed out, saying "If I want your damn opinion, I'll ask for it. Don't ever question my authority again. If you can't do your job, get the hell out of my OR". (Duhigg, 156)

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- Compensatory techniques informally developed
  - Doctors names written on whiteboards – different colors depending on their abrasiveness
  - Nurses would communicate ad-hoc when a doctor made a mistake; nurses tended to check up on more error prone doctors

- July 30, 2007
- Neurosurgeon J. Frederick Harrington Jr., asked to perform an emergency surgery on an 86 year-old patient with a subdural hematoma on the left side
- At the time, Dr. Harrington was in the midst of a lumbar laminectomy – quickly reviewed the slides but didn't write down the side of the hematoma; his nurse failed to note it as well

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- In the surgical suite..

- A nurse noted that the consent form lacked a side, and asked for a time out

- Harrington snapped "we have no time for this!" and encouraged the nurse she could log into a computer and check the CT scans, but he would have her terminated if she did.

- He misremembered the side of the hematoma, and operated on the wrong side of the patient's skull.

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- When Harrington realized the mistake, sealed up the skull and skin, turned the patient over and operated on the correct side, a great deal of time was lost. The patient died two weeks later.

- State board fined the hospital $50k

- A few months earlier, a doctor and nurse both admitted they weren't trained to use a checklist, having failed to mark the spot of another neurosurgery.

- A few months later, a doctor and nursing staff discussed a surgery (identifying the correct side), then proceeded to operate on the wrong side of an elderly woman.

  - "I don't know if [the nurse] even knows why she didn't speak up"

Setting the stage…

- A year and a half later, a surgeon operated on the wrong part of a child's mouth during cleft palate surgery

- Ten months after that, a drill bit was left inside a patient ($450k fine)

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Photo Montage, Rizwan Shah, Department of Energy

- "Fishbowl" industries – exceptionally strong social and/or political pressure crashing down in a failure event.

- Complicated systems/fields with a high probability of error.

- Major mistakes are so severe, you can't afford to learn by trial and error.

  – Human Error rates typically (3-7 errors per hour, 11-15 under high stress, fatigue, etc.)

- An organization with relatively error free operations over a long period of time.

- An organization that again and again accomplishes a high hazard mission while avoiding catastrophic events.

- An organization in a field in which failures are so severe, they should be avoided at almost any cost.

- # Five principles:
  1. ## Preoccupation with failure
     - Everyone within the organization focuses on how their processes can break down and fail
     - Focus on both small and large inefficiencies and risks
     - Destigmatization of human errors
     - Focus on near-misses as a path to resilience
       - Ever near miss is both a success and a learning opportunity

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- # Five principles:

  2. Reluctance to simplify

      - Not quick to jump into simple explanations for why something occurred.

      - Root cause analysis to determine both deep causes of problems, and track latent organizational weaknesses.

      - An avoidance of long-held beliefs – challenging attitude around assumptions

- # Five principles:
  - 3. Sensitivity to operations
    - An awareness by leaders and staff on how processes and systems affect the organization.
    - A strong focus on what is and isn't working – data, not assumptions.
    - "Rounding" – managerial walkthroughs, to ensure a correct understanding of a group that would be affected by a change.

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- Five principles:
    4. Commitment to resilience
        - A steadfastness to identifying causes, and continual improvement
        - Swift identification – both of errors and near-misses, and commitment to continue improving.
        - Strong and reliable evaluation tools – measurable goals, well-engineered KPIs, etc.

- Five principles:

  5. Deference to expertise

     - Reaching out to SMEs on their issues – regardless of their seniority
     - Ideas can come from anywhere – and are encouraged from everywhere
     - Key decisions being made at the work areas and in the work environment, not in conference rooms and meetings.
     - Some HROs adapt "no meeting time zones" – so managers can make rounds and observe, get feedback from employees, etc.

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- Constant training / learning growth of management and employees

- Matching of technical competence and high performance

- Oversight includes little close supervision

- Personnel never content – "search continually to improve their operations"(Rochlin, 1993) through actively soliciting feedback

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- Not "error free", but "not disabled by an error"
- Physical, social and external facets combine in complex operations
- Formal and informal expectations for peak performance
- Ability to decentralize in an agile fashion in emergencies. **TRUST**.
- Redundancy in people, roles, training

How are HROs different?

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- Human errors
  - A cause
  - A mismatch of human capabilities and environment
- Reporting
  - Based on past events
  - Focused on conditions and future outcomes
- Workarounds
  - It's how we get things done
  - For only unexpected outcomes

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- Accountability
  - Solves problems
  - A byproduct of participation
- System designs
  - Design to be successful
  - Design to be failure-tolerant and recovering
- Management
  - Producing short-term outcomes
  - Creating conditions and cultures that set people up to excel

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- Mistakes
  - A source of stress, infighting, self-protection, and fear
  - An opportunity to learn and improve
- Error risks
  - Good people don't make mistakes
  - A systems approach needed – no one can have a perfect day every day

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- Culture
  - Not a strong focus; or a culture of safety.
  - A strong culture, not only focused on safety, but also looking for signals of weakness; searching for potential problems before they challenge the organization.

- Readiness
  - An organization is "ready" if nothing bad happened.
  - An organization is constantly trying to anticipate next problems but understands non-anticipatable problems may come up.

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"As they strive for high reliability, organizations shift away from having outside bodies solely determine their quality agenda to developing an agenda that incorporates the organization's most important goals."

Mark R. Chassin, M.D., F.A.C.P.

The Joint Commission & Joint Commission Center for Transforming Healthcare

"Human error is a consequence, not a cause. Errors are shaped by upstream workplace and organizational factors… Only by understanding the context of the error can we hope to limit its reoccurrence"

James Reason

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- A group of "reliability professionals"
- Anticipation vs. resilience?
- Recovery – a new performance mode
- Robustness – a threat to reliability?
- "Just-in-time performance" – pull and push

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- Design <u>and</u> management of a system

- Focus on keeping many processes within acceptable bandwidths. Don't focus on just one metric.

- Centralization and interdependence among system components can help managers ensure reliability

What are the benefits of being a part of an HRO?

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- Higher job satisfaction, lower turnover, greater willingness to share learning (Egan & Bartlett, 2004)

- Better at interviewing and selecting candidates who fit in well with HRO mission (Ericksen & Dyer, 2007)

- Less losses due to lost wages, training, severance, sick days, etc.

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Just Culture

The Case for Just Culture

- Traditional management styles lagging research & employee expectations
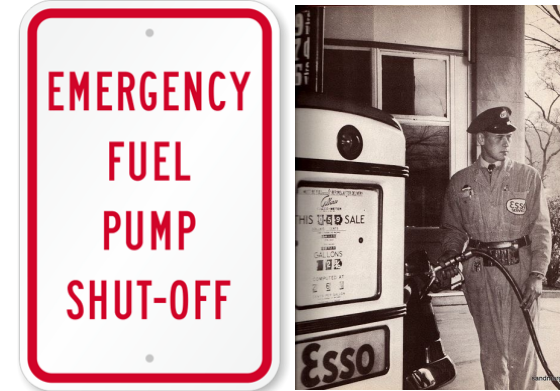- Vast amount of work frustration due to inequity and ambiguous signals

Capuchins reject unequal pay
w/ Dr. Sarah Brosnan
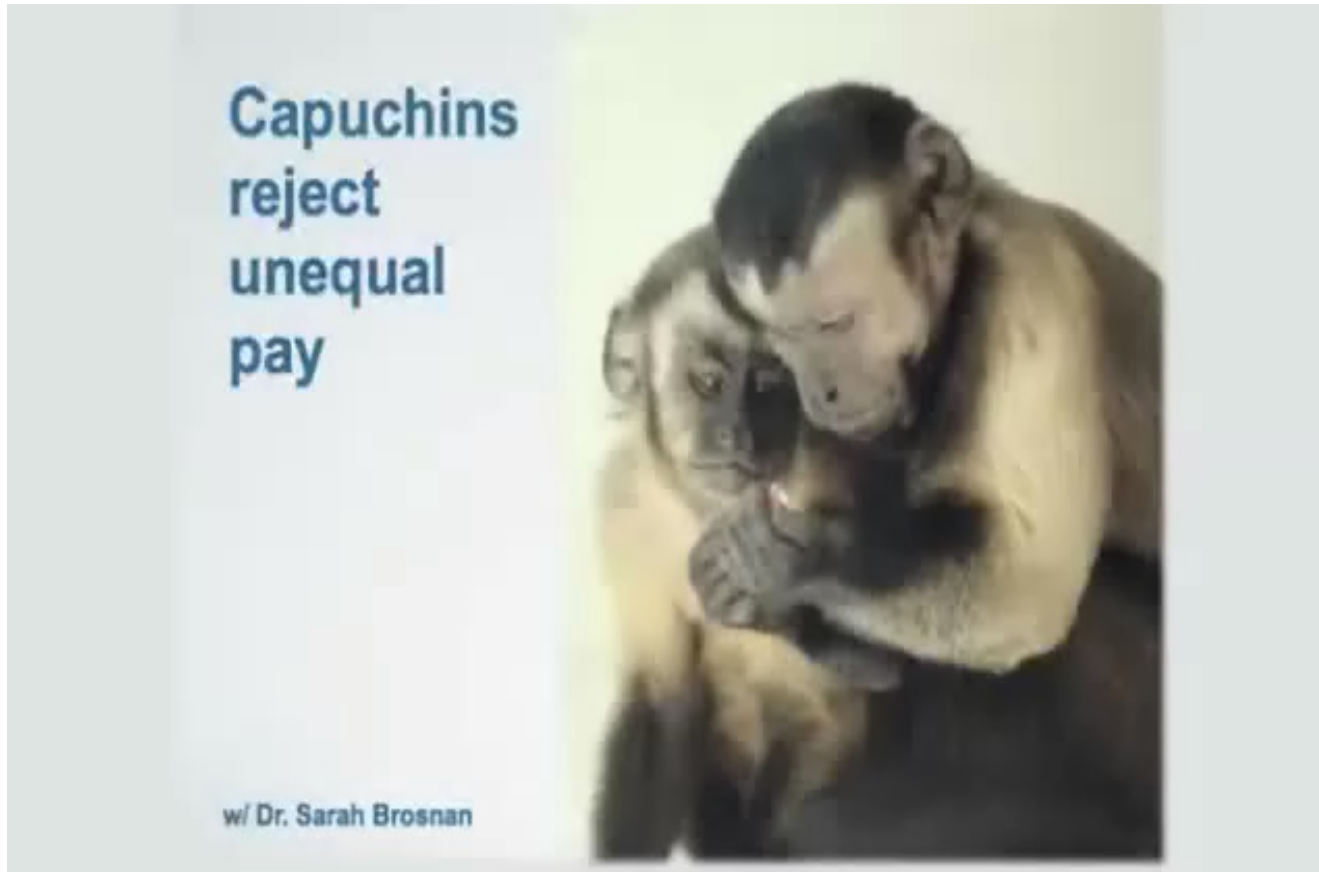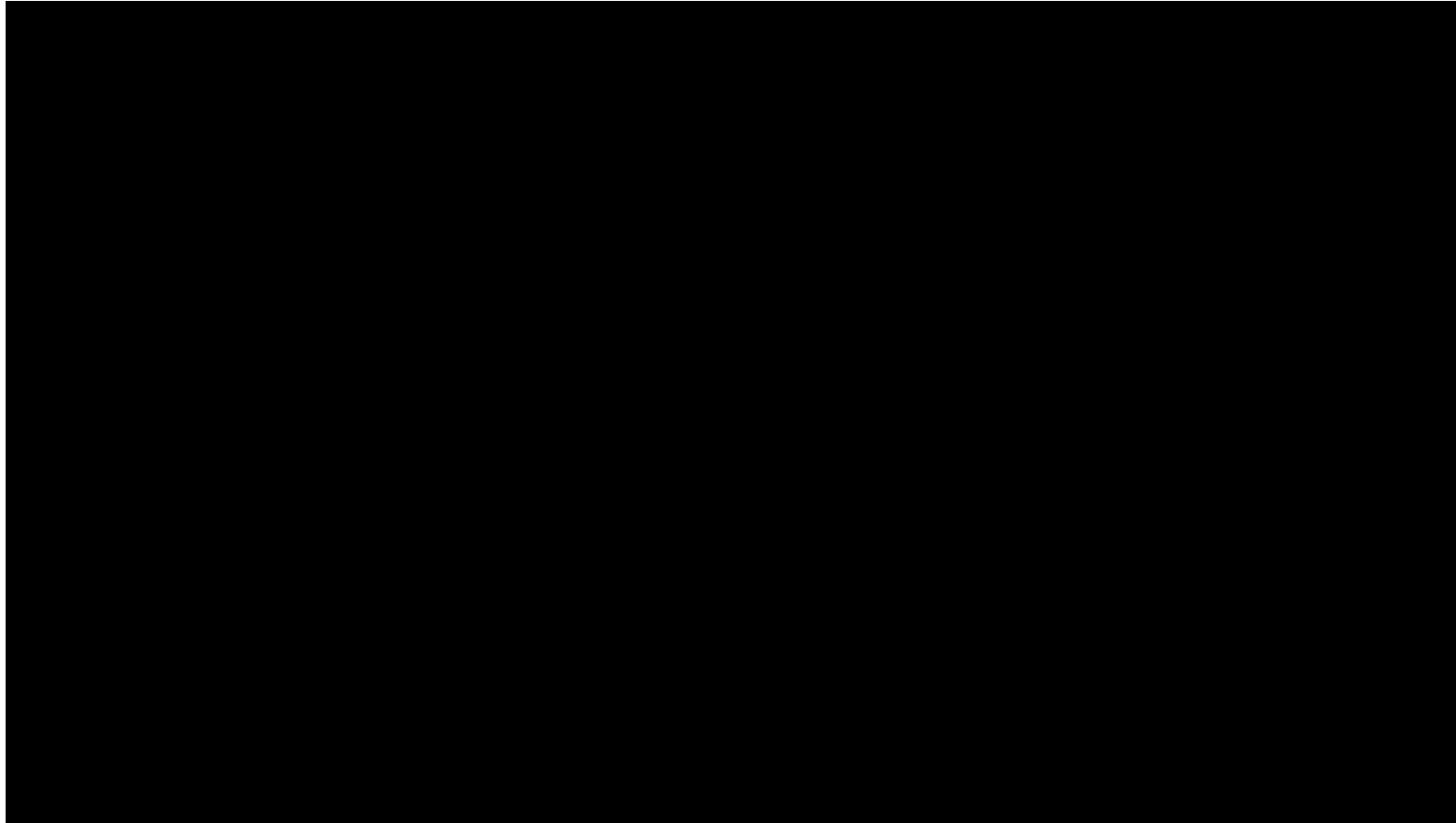
Ways of addressing events

Barriers

Recovery

Redundancy

First, we must first identify At-Risk Behavior Types

Types of Risk Behavior

Human Error (3-7 to 11-15 errors per hour; Muschara, 2012)

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Types of Risk Behavior

At-Risk Behavior (The better we are, the harder it is to perceive our drift)

Types of Risk Behavior

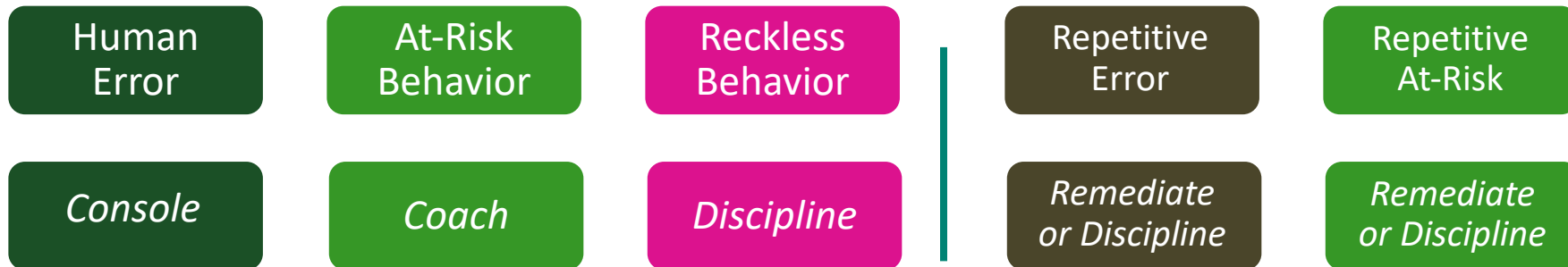At-Risk Behavior (The better we are, the harder it is to perceive our drift)

Types of Risk Behavior

Reckless Behavior (< 2% but extremely dangerous)

Just Culture Approach

- ## Managing Risk, Fairly and Consistently
  - One approach that works across all values
  - One approach that works both pre- and post-incident
  - One approach that applies to everyone at all levels

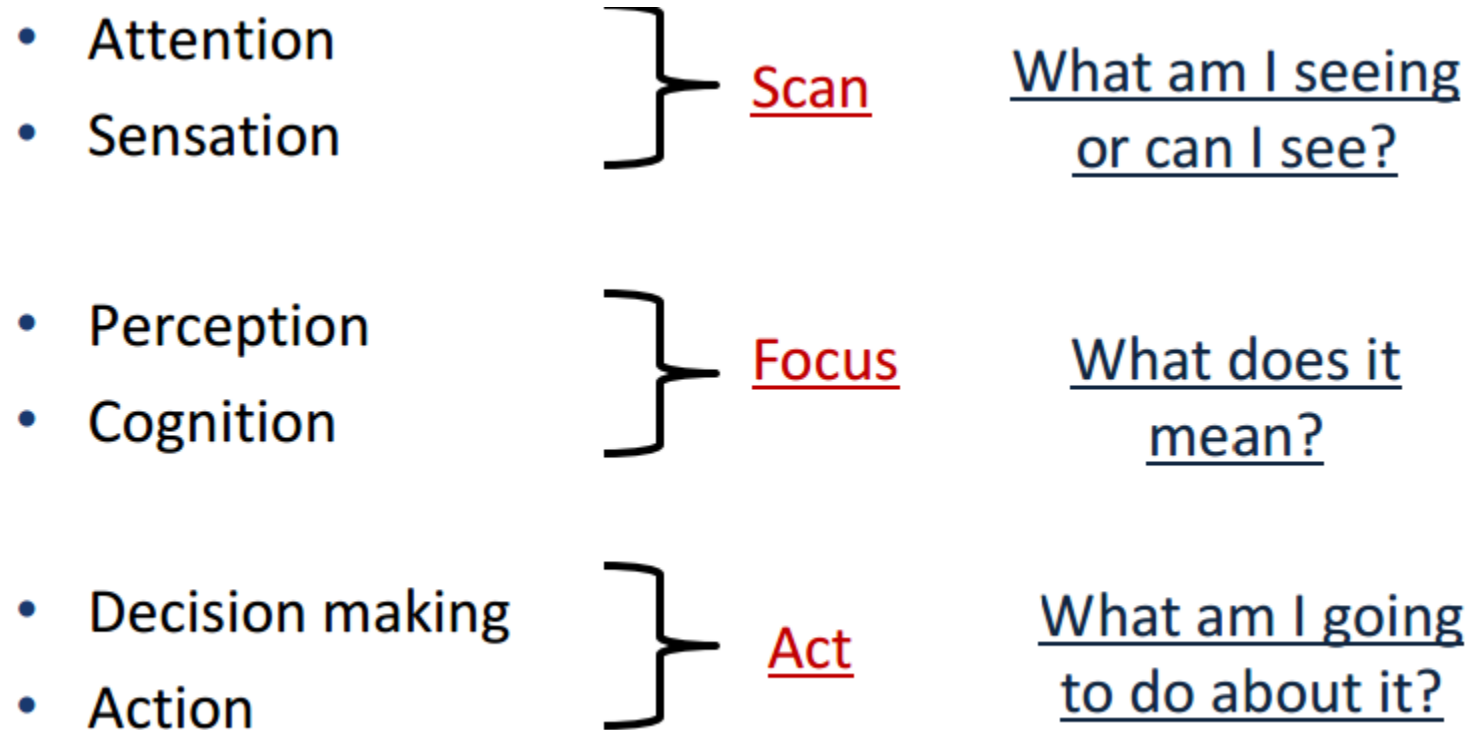| Human Error	At-Risk Behavior	Reckless Behavior		Repetitive Error	Repetitive At-Risk
Console	*Coach*	*Discipline*		*Remediate or Discipline*	*Remediate or Discipline*

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Situational Awareness

- "The perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status into the near future" (Endsley, 1988).

- "Continuous extraction of environmental information, integration of this information with previous knowledge to form a coherent mental picture, and the use of that picture in directing further perception and anticipating future events" (Dominguez, 1994).
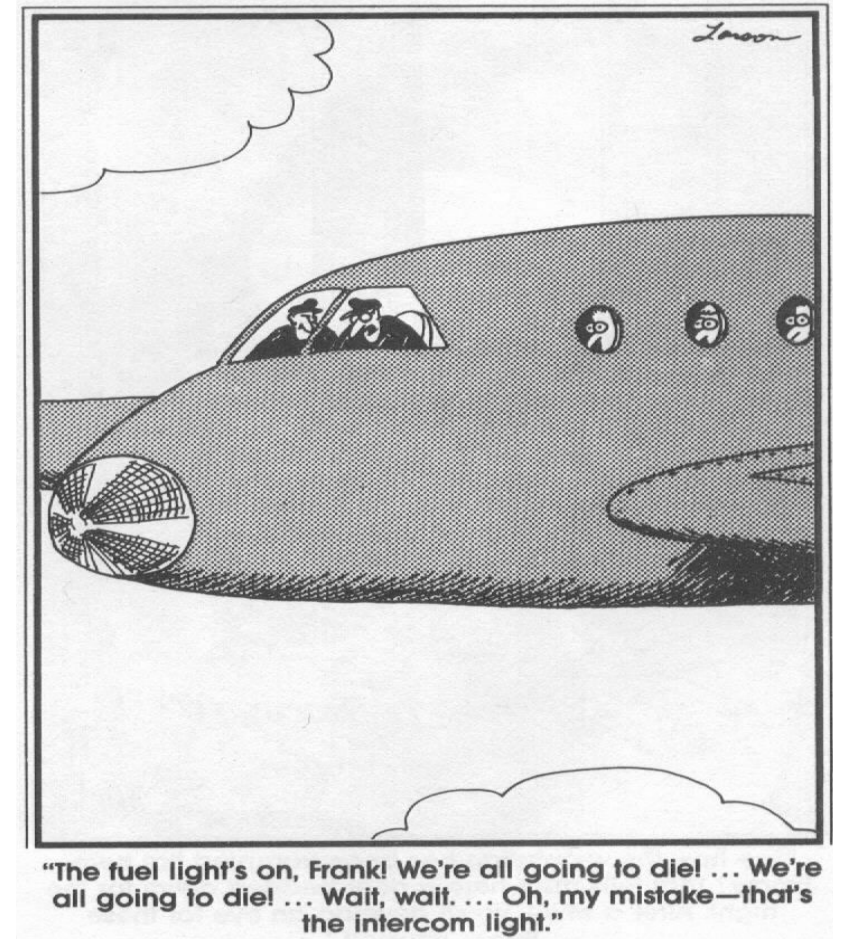
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- "Loss Of Situational Awareness" is NOT:
  - One of many phrases to represent individual human error, leading to punishment of that individual.
  - Instead, it is one of several lenses into human performance that helps to understand why a mismatch between environment and human capabilities occurred.

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Situational Awareness

- Attention
- Sensation

} **Scan** <u>What am I seeing or can I see?</u>

- Perception
- Cognition

} **Focus** <u>What does it mean?</u>

- Decision making
- Action

} **Act** <u>What am I going to do about it?</u>

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- # Three levels of situation awareness:
  - ## Level 1: Perception
    - ### What is going on?
  - ## Level 2: Comprehension
    - ### What does it mean?
  - ## Level 3: Projection
    - ### Where is it going? What am I going to do about it?
- # Situational awareness is necessary both in individuals and within teams.

"The fuel light's on, Frank! We're all going to die! … We're all going to die! … Wait, wait. … Oh, my mistake—that's the intercom light."

Source: The Far Side

- Three components of situational awareness:
  - Spatial awareness - where you and other objects are in space, orientation to location.
  - System awareness – understanding about the state of the system(s)
 - Task awareness – understanding about the tasks being engaged in
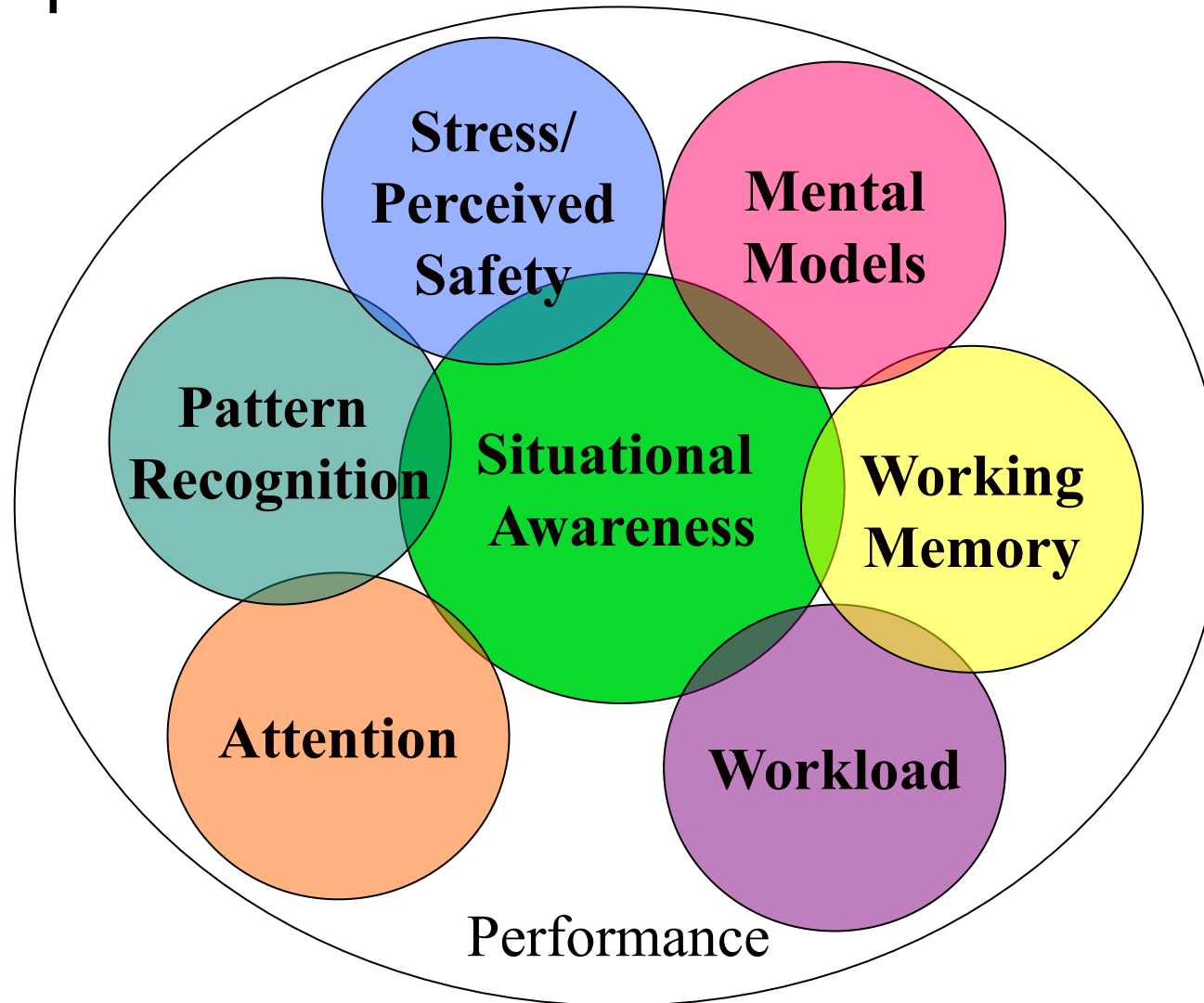
• Components of situational awareness

- **Mental Models -** How individuals internally represent the task they're performing, situation they're in, or technology they're using

- **Shared Mental Models** – team members having same understanding of

  o Team activities and task at hand

  o Team goals

  o Changing roles and responsibilities as events unfold

  o Procedures and processes

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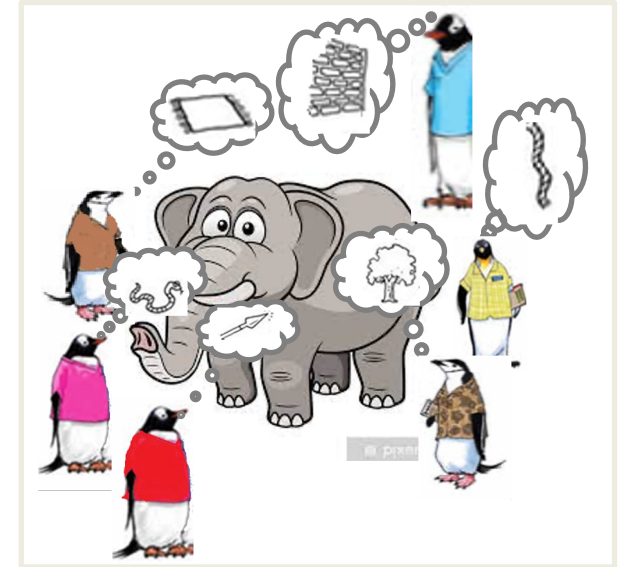
Scaling Beyond Silos in the Organization

- Blended events will cross multiple silos, and probably organizations

- Experts may struggle to communicate across silos effectively

- Lack of shared training may lead to a lack of habits

- Key information for one group may be available, but not obvious to those in other groups

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Gaps Contributing to Challenges for Intra-Organizational Teams

- ## Ineffective communication across teams, due to
  - o Lack of shared vocabulary
  - o Lack of understanding of relevant information and data
  - o Lack of system-wide understanding and mental models
- ## Unshared relevant information and knowledge due to not knowing it is 'unshared'
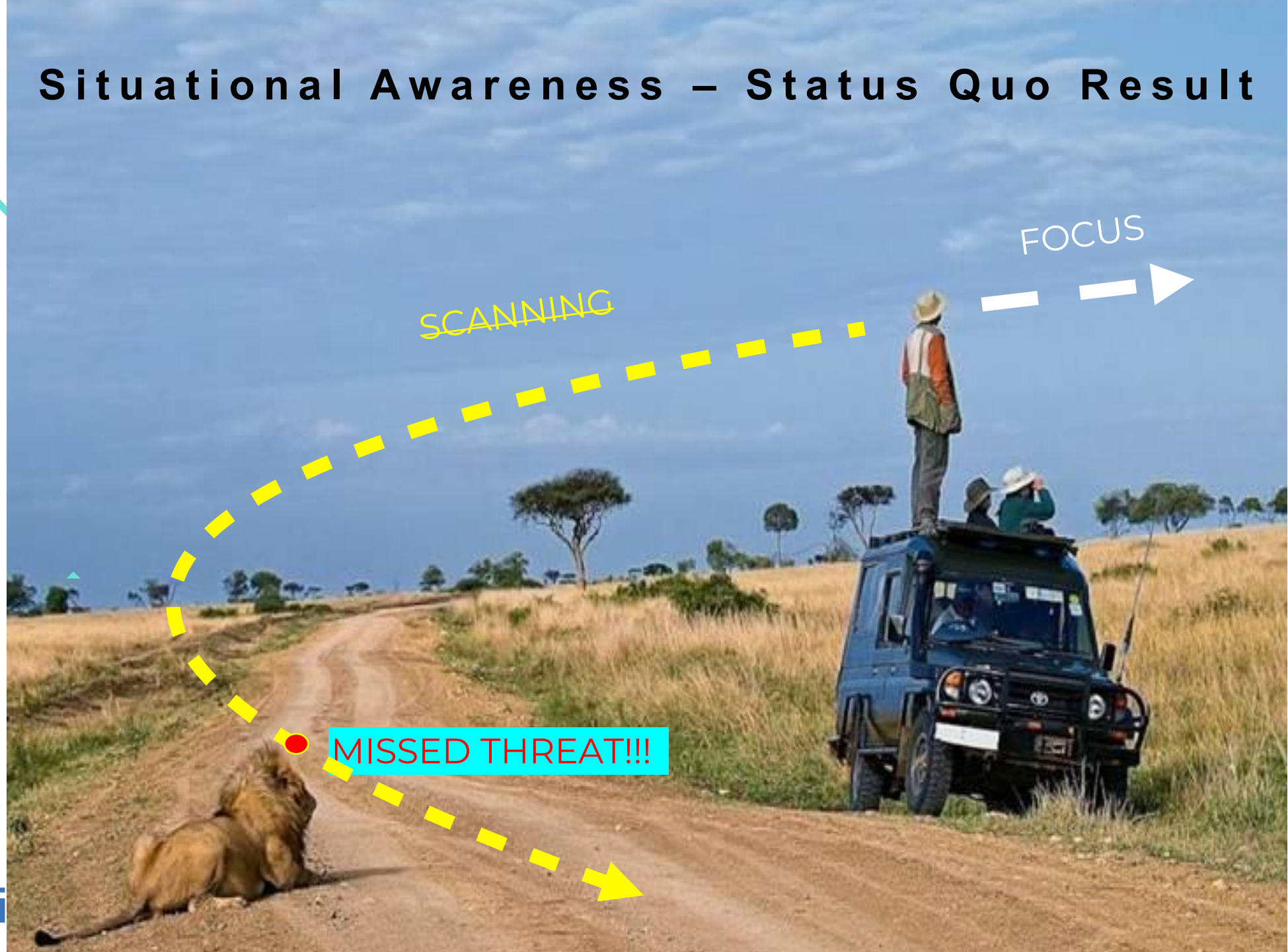- ## Insufficient Intra-organizational, intra-team training

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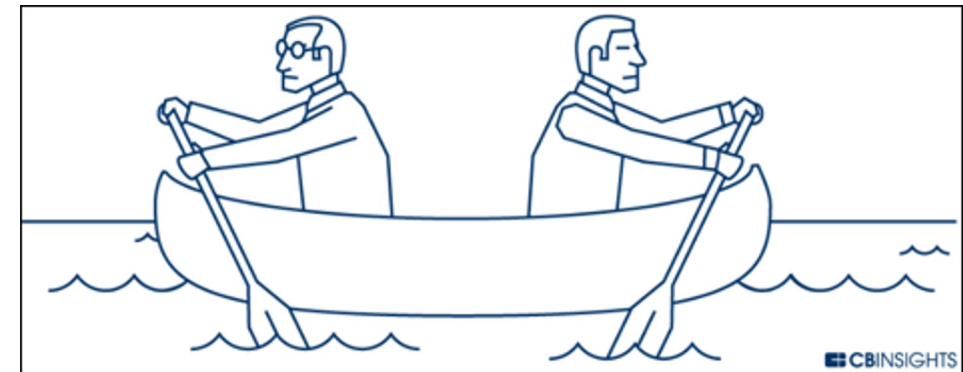
Strengthening Resilience for Collaborating across Teams

- Anticipate and prepare to be unprepared
- Increase adaptive capacity to changing demands
- Synchronize team activities
- Engage in proactive/continuous learning
  - Organizational knowledge, e.g., rules, procedures, policies
  - Individual knowledge and skills
  - Team training to develop shared mental models
  - Create habits

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Strengthening Resilience to Enhance Team Readiness

- Provide opportunities to improve collaboration and communication
    - Shared tabletops / thought exercises
    - Shared drills / training
    - Group interactions / getting to know each other

Situational Awareness – Status Quo Result

MISSED THREAT!!!

SCANNING

FOCUS

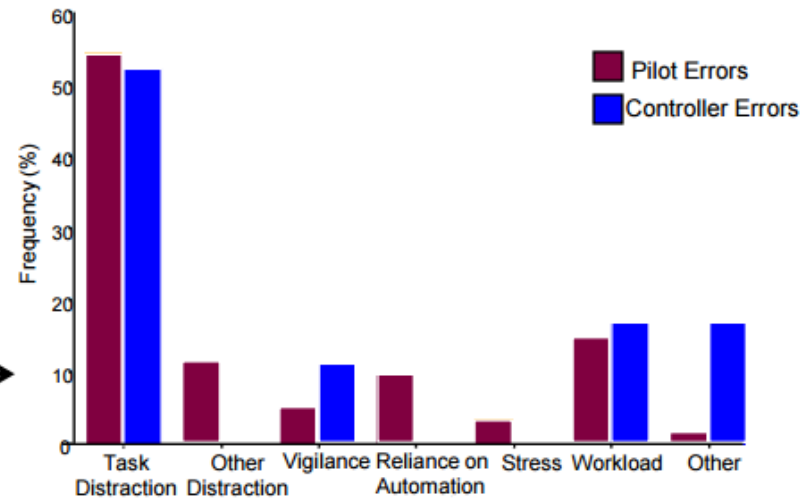© Independent Electricity System Operator, CA

Situation Awareness Errors
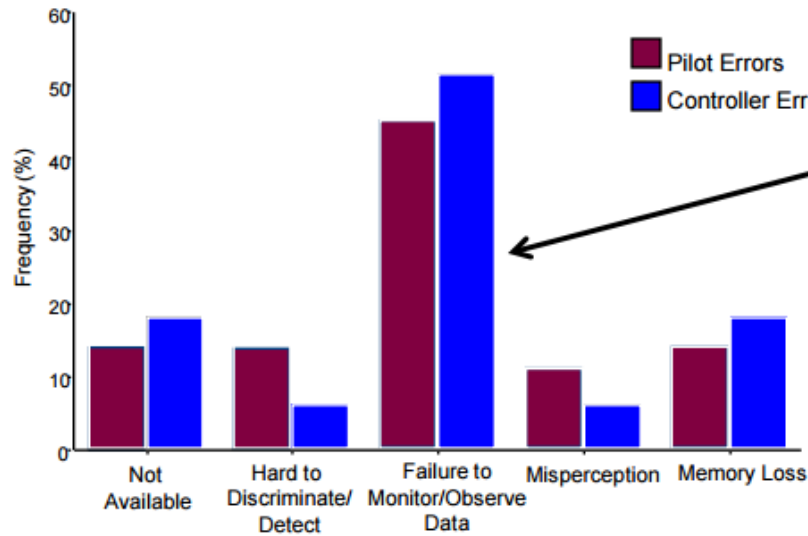
Majority of Level 1 Errors Due to failure to Monitor or Observe Data That is Present (50%)
  Highest single cause of all SA error (30%)
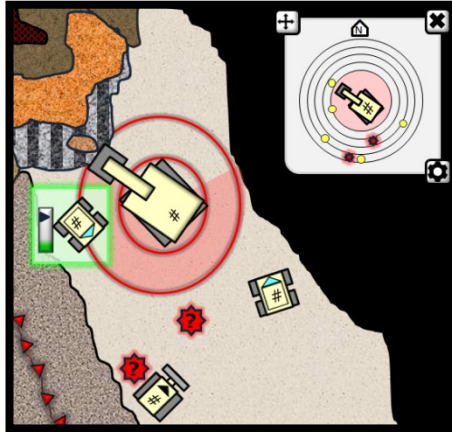
Biggest Single Cause is "Task Distraction"

Source: SATechnologies

- Attentional narrowing
  - Attention grabbed, drawing focus away from critical information
- Data overload
  - More/faster information presented than a human can process
- Misplaced salience
  - The wrong things standing and catching your attention
- "Out of the loop"
  - Uncertainty in data and system status not represented to users
- Short-term memory over-reliance
  - Holding too many chunks, or for too long (> 30 sec)

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- Complexity Creep
  - Additions to a UI or procedure may affect far more than one screen
- Low operator confidence in systems
- Workload, anxiety, fatigue, loss of perceived safety
- Incorrect mental models
- Inattention

- Alarm screens
  - "Alarm storms" – critical information scrolling off the screen due to other important alarms
  - "Dust storms" – critical information scrolling off the screen due to unimportant alarms
  - Alarm accuracy – False Alarms, percent correct
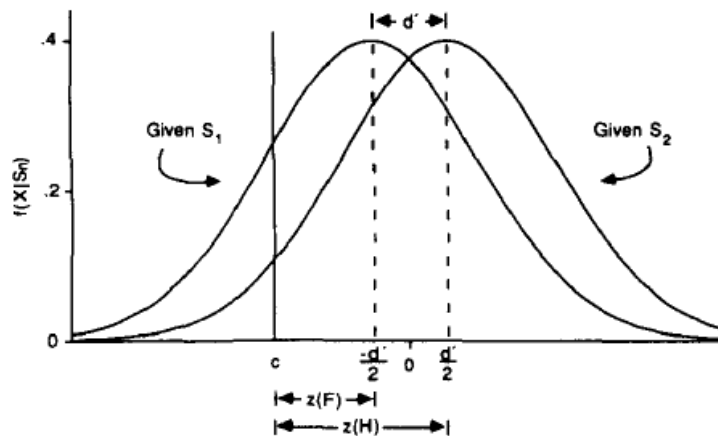
	Target	Noise
Response	Hit	False Alarm
No Response	Miss	Correct Rejection

Cognitive Bias

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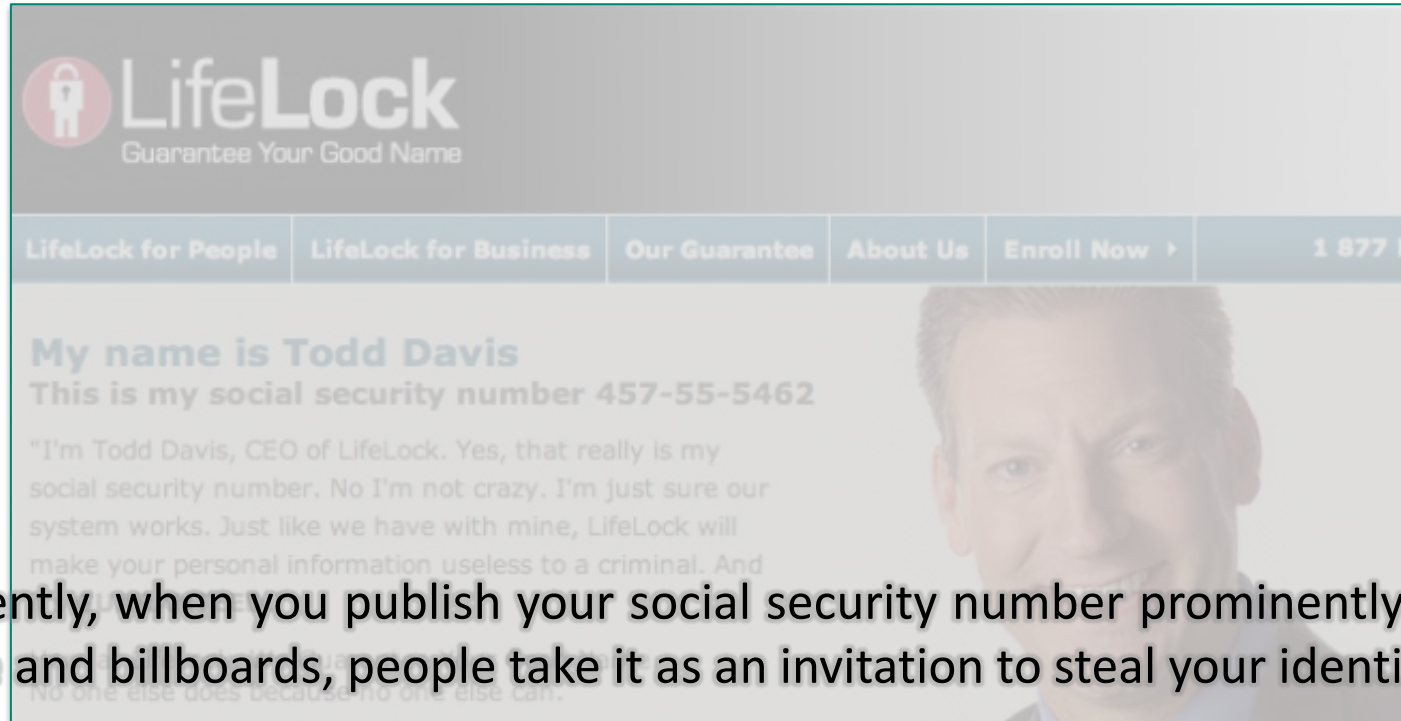
A Quick Thought Exercise

- A baseball and bat together cost $11. The bat costs $10 more than the ball. How much does the ball cost?

- Did you say $1 for the ball?
  - Most people do, but:
  - The correct answer is $0.50:
  - $10.50 - $0.50 = $10.00

- Why do many of us make these kinds of mistakes?
  - Mental shortcuts tend to shorten the amount of time it takes us to come up with an answer, but doesn't necessarily work in all situations.

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LifeLock
Guarantee Your Good Name

LifeLock for People | LifeLock for Business | Our Guarantee | About Us | Enroll Now ▸ | 1 877 LI

My name is Todd Davis
This is my social security number 457-55-5462

"I'm Todd Davis, CEO of LifeLock. Yes, that really is my social security number. No I'm not crazy. I'm just sure our system works. Just like we have with mine, LifeLock will make your personal information useless to a criminal. And No one else does because no one else can."

"Apparently, when you publish your social security number prominently on your website and billboards, people take it as an invitation to steal your identity."

LifeLock CEO's Identity Stolen 13 Times
–K. Zetter, Wired.com, April 2010

- How we respond in ambiguity
- A deviation in judgment – non-logical functioning
- Predictable, but not rational
- May be adaptive (e.g., speeding up decisions)
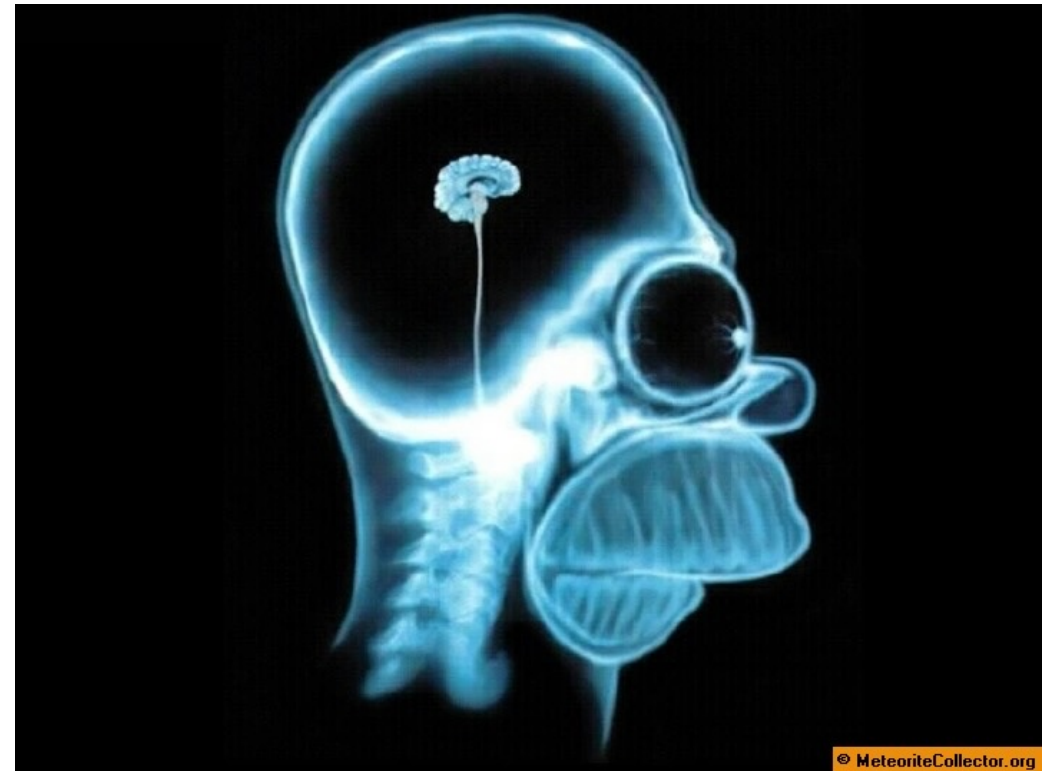- Some biases prejudicial
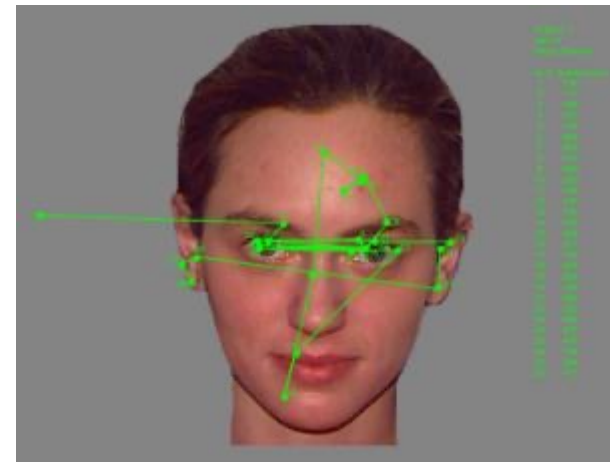
90% of inputs to the brain are visual

The brain adapts constantly: learning new skills, acquiring power, being bullied

The brain makes up approximately 2% of a human's weight, and uses over 20% of its calories, oxygen and blood (newborns 50%)

© MeteoriteCollector.org

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- Brain's limited processing capabilities
  - Heuristics (mental short-cuts)
  - Distractions, stress, pace
- Emotional, moral, and social sources
- Physiological arousal
- How we feel (e.g., hungry, tired)

ResilientGrid
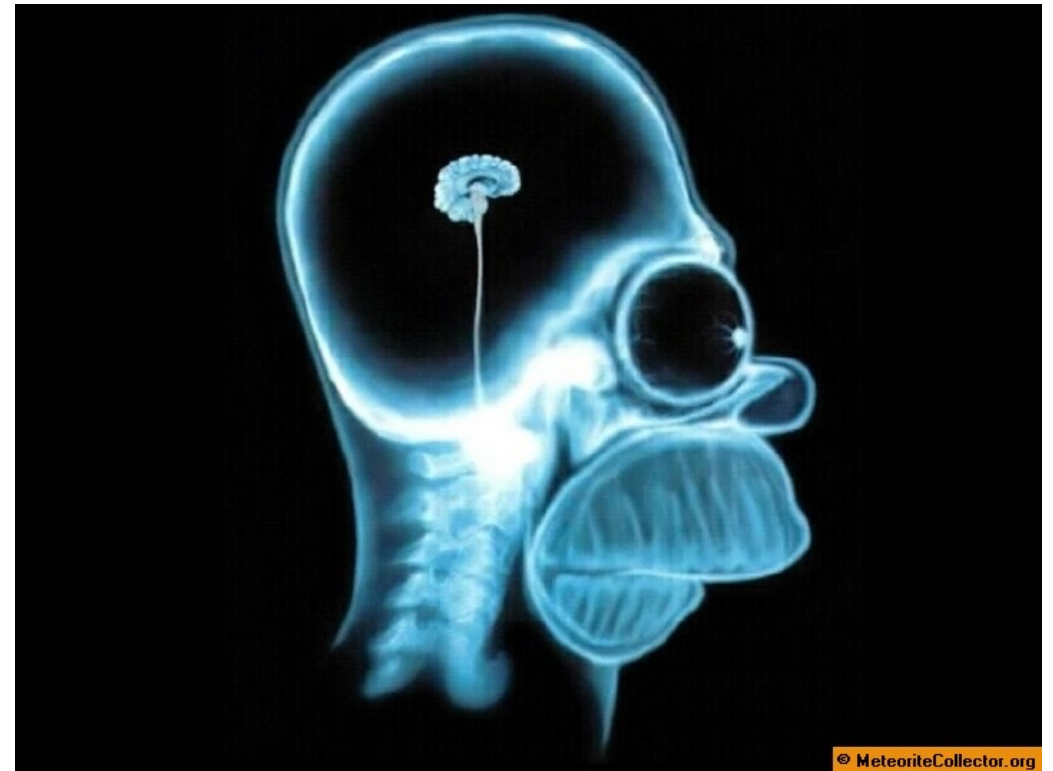
Cognitive Bias Examples

- Money-Related
  - Anchoring
  - Endowment Effect
  - IKEA Effect
- Information-Related
  - Attentional bias
  - Confirmation bias
  - Semmelweis Reflex
  - Stovepiping
  - Out-of-sample error
  - Target fixation

- Opinion-Related
  - Attitude Polarization
  - Belief Bias
  - Cognitive Dissonance
  - Dunning-Kruger Effect
  - Framing Effect
  - Fundamental Attribution Error
  - Groupthink
  - Halo effect

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Cognitive Bias Examples

- ## Memory-Related
  - Availability Heuristic
  - Context effect
  - Google effect
  - Recency & Primary effects
  - Von Restorff effect
  - Zeigarnik effect

- ## Risk-related
  - Critical positivity ratio
  - Loss aversion
  - Outcome / severity bias
  - Status quo bias
  - Sunk cost fallacy
  - Zero-risk bias

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Cognitive Bias Examples

- ## Self-Related
  - Diffusion of responsibility
  - Illusion of skill
  - Self-serving bias

- ## Others
  - Hindsight bias
  - Illusion of transparency
  - Mirror-imaging
  - Organizational bias
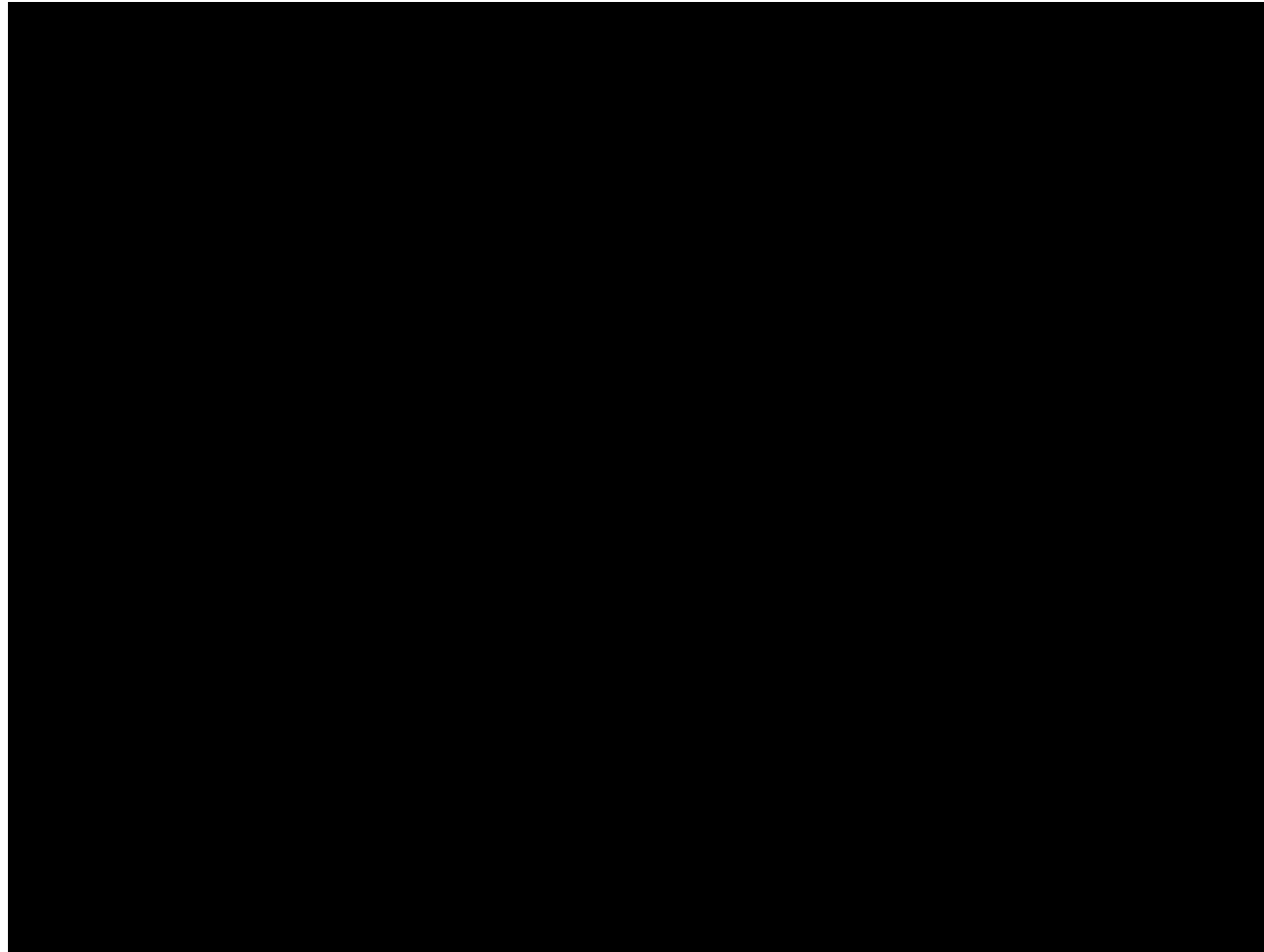 - Outgroup homogeneity
  - Rational actor hypothesis

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The Cobra Effect: Unintended Consequences

Selective Attention

Simons & Chabris: Selective Attention Test (1999)

http://youtu.be/vJG698U2Mvo

- **People often overestimate their ability to explain mechanical, natural, and social processes** (Alter, Oppenheimer, & Zelma, 2010; Keil, 2003)
  - You likely know that a zipper closes because teeth somehow interlock. But do you know how the teeth actually interlock to enable the bridging mechanism?
  - You probably have a vague notion that an earthquake occurs because two geological plates collide and move relative to one another. But do you know more about the mechanism that initially produces these collisions?
  - You may think you know your preferred political candidate's stance on a policy, but do you really know the intricacies of what they belief on an issue?

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- You look at a checklist or procedure, and think you understand the intent of the writers and that they anticipated all possible risks.

- You understand how a piece of equipment works in normal operations (> 95% of the time). Can you accurately anticipate how it will work in an abnormal condition?

- You think may think you know your coworkers' or employees' knowledge level and skill set, but do you actually know how they would respond to an emergency or crisis?

- Setting up a projector or conference call is simple… or not.

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- People are better calibrated when assessing their knowledge for declarative facts and trivia (Rozenblit & Keil, 2002)

  – E.g., country capitals

- Hints at why IOED occurs – awareness of our lack of *specific* knowledge in these domains

- People know generally *why* manmade objects, natural events, and social events occur, but lack insight on specifically *how* they work or happen

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- Confusion occurs between why and how, and people end up believing they understand complicated manmade, natural, or social concepts **quite deeply**

- Further, people are often surprised by the shallowness of their own explanations when prompted to describe the concepts thoroughly

- People understand certain concepts at an abstract level quite well

- But, they only superficially understand their more concrete characteristics

- So, when people mistake their mastery of abstract for concrete characteristics, IOED will emerge.

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- Find a way to focus on the information that illuminates the depth of your understanding

- Steer away from focusing on uninformative cues

- Focus on concrete rather than abstract knowledge and you should realize your ignorance and <u>hopefully take steps to remedy it</u>

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Recap, AAR, Close out

Guiding Principles

"All organizations are perfectly aligned to get the results they get."

Arthur W. Jones

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Thank you!

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