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Human Factors and Medication Errors

Judy Smetzer, BSN, FISMP
Vice President
Institute for Safe Medication Practices
Jsmetzer@ismp.org

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Objectives

- Identify the differences between the automatic mode of cognition and the problem-solving mode of cognition
- List conditions that degrade human performance
- Review perceptual and cognitive biases and how to reduce their negative impact on patient safety
- Describe system design strategies that can prevent or detect human error or mitigate patient harm from errors

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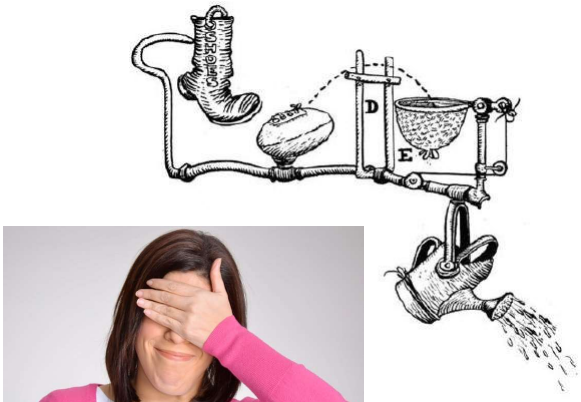
Medication Error Causes

- Systems
  - System design issues (latent failures)
- People
  - Human error
  - At-risk behavior
  - Reckless behavior (active failures)



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Human Error

A failure of a common sequence of psychological functions that are basic to human behavior:

- Perceive
  - Perception of all the senses
- Think
  - The way these stimuli are interpreted, the formulation of an action plan, and planning how the action should be carried out
- Behave
  - Execution of the planned actions

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Human Error Probabilities

Unfamiliar task performed at speed/no idea of consequences	50%
Task involving high stress levels	30%
Complex task requiring high comprehension/skill	15%
Select ambiguously labeled control/package	5%
Failure to perform a check correctly	5%
Error in routine operation when care required	1%
Well designed, familiar task under ideal conditions	0.04%
Human performance limit	0.01%
Team performance limit	0.001%

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Modes of Cognition

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Normal Cognition

Automatic → Problem Solving

- Apply a Rule
- Pattern Matching
- Analysis/Synthesis

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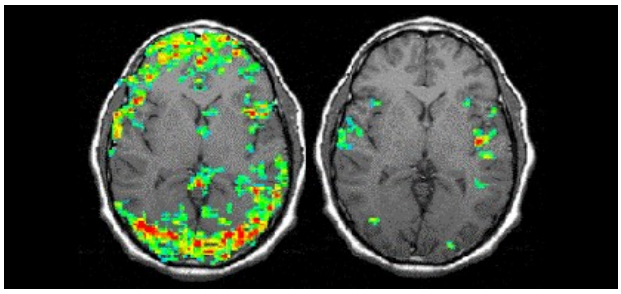
Skill Acquisition and Automaticity

- fMRI differences with transition from skill acquisition to automatic pilot
- Load on working memory reduced by 90%



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Schneider W. Automaticity in complex cognition. Center for Cognitive Brain Imaging at Carnegie Mellon University; 2003.

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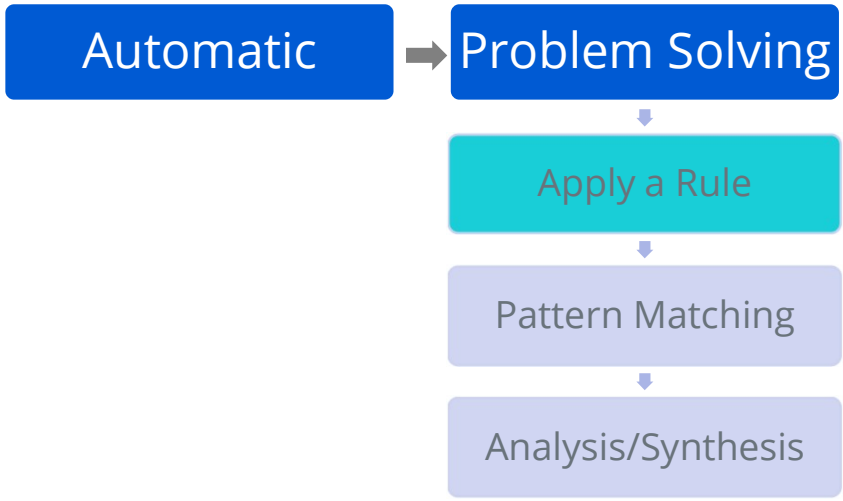
Normal Cognition



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Question

Solve this equation: **5 + 3 + 2 ÷ 2 = ?**

A. 5

B. 9

C. 12

D. None of the above

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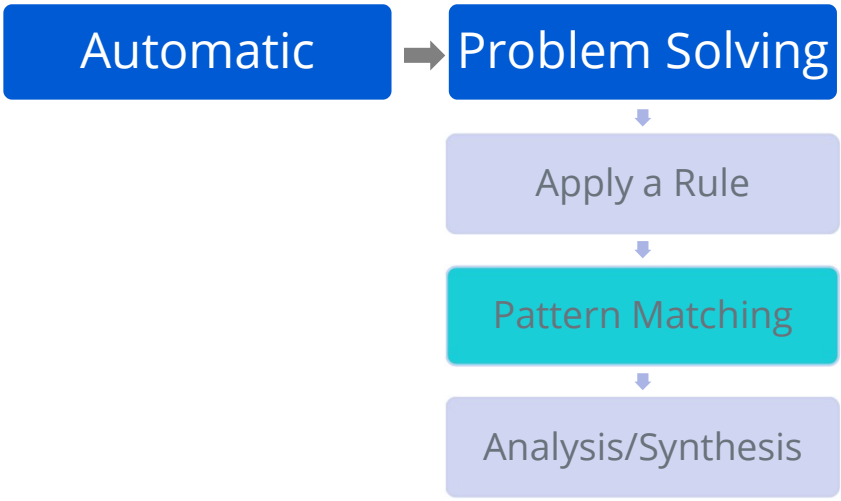
Normal Cognition



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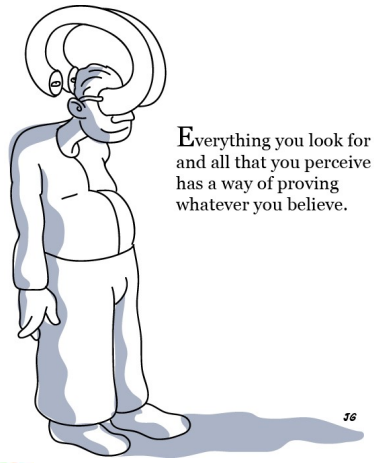
Confirmation Bias

Selectively search for information that confirms one's beliefs, reject information that does not



- Judge likelihood by how easily the idea sprang to mind (**availability heuristic**)
- Stick to our initial assumptions (**anchoring heuristic**)
- Downplay contrary evidence, reluctant to pursue alternatives (**premature closure**)
- When we look "here", we risk missing "there"

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Jim Gill: www.cognitiveBiasParade.com

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Confirmation Bias

May not be a big deal when you confuse two different cereal products…

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Confirmation Bias

But it is a big deal if you confuse these…

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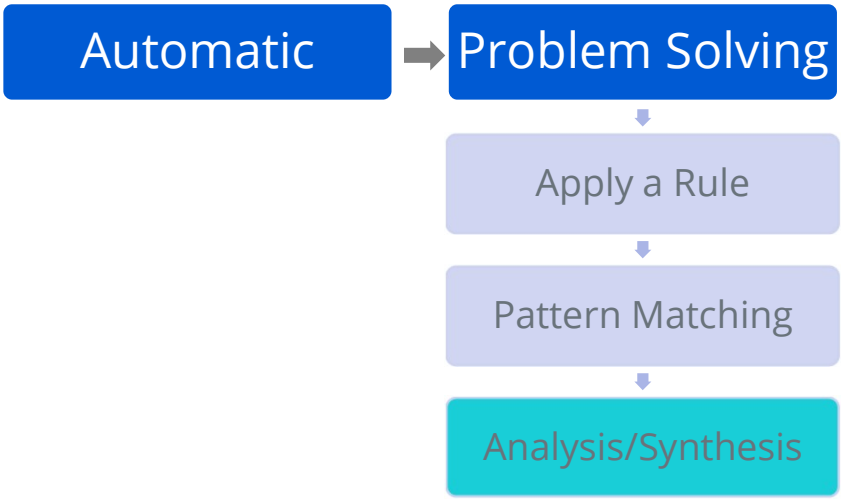
Normal Cognition



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Levels of Human Performance

Situations	Control Modes		
	Problem Solving	*Mixed*	*Automatic*
Routine			skills-based
Trained-for problems		rules-based	
Novel problems	knowledge-based		

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Components of Human Cognition

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Three Components of Cognitive Systems

- Sensory register
  - Keyboard
  - Perceive
- Working memory
  - Operating system (workbench)
  - Think
  - Behave
- Long-term memory
  - Hard drive

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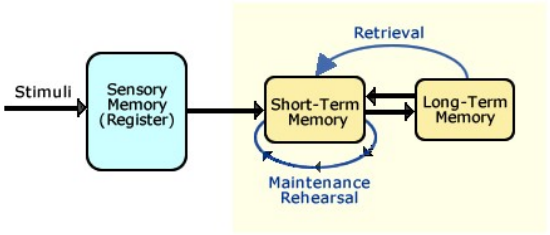
Three Processes of Cognitive Systems

- Encoding
  - "Attended to" information encoded
- Maintenance
  - Limited storage capacity
  - Information "decays" unless "rehearsed"
- Retrieval
  - Long-term memory decays over time OR
  - Retrieval mechanisms lost



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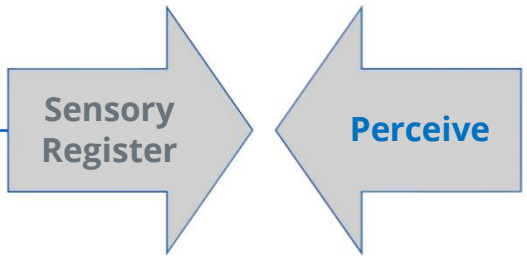
Encoding



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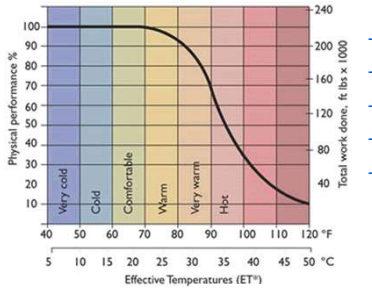
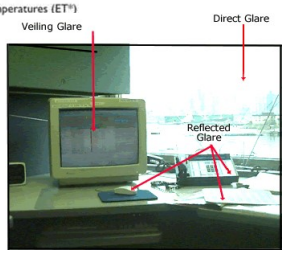
What Can Degrade Sensory Register?

System PSFs



- Physical distractions
- Light
- Noise
- Climate
- Humidity



Personal PSFs

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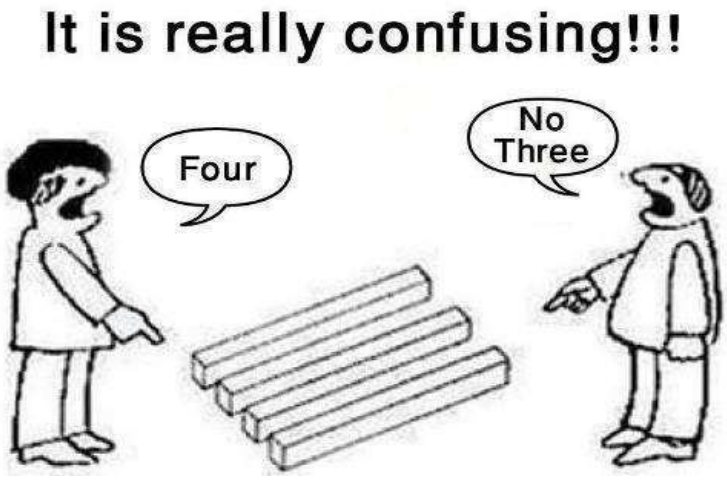
Perceptual Biases



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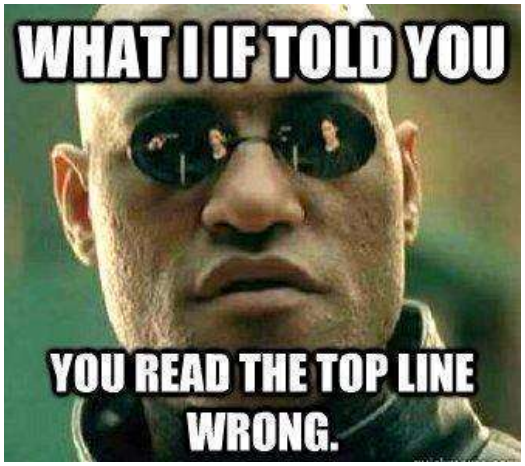
Inattentional Blindness

Why do intelligent, diligent, thorough people fail to see the obvious?



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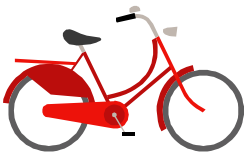
Inattentional Blindness

- Consider what we see to be true representation of external world
- Brain, working with eyes, constructs the outside world inside our heads using memories and knowledge we carry around
- We see only what the brain tells us to see
- Inattentionally blind to rest of information since bever reaches consciousness
- "The Grand Illusion"- Gill in the gaps



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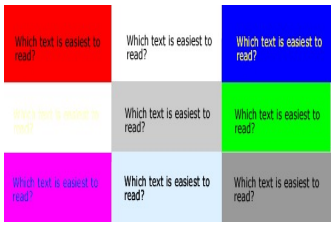
Design Strategies

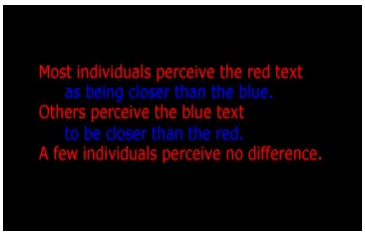
Inattentional Blindness

— Conspicuity (physical properties)

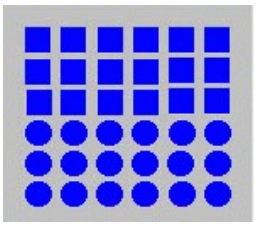
Avoid Conflicts



1) Contrast



2) Color



3) Shape

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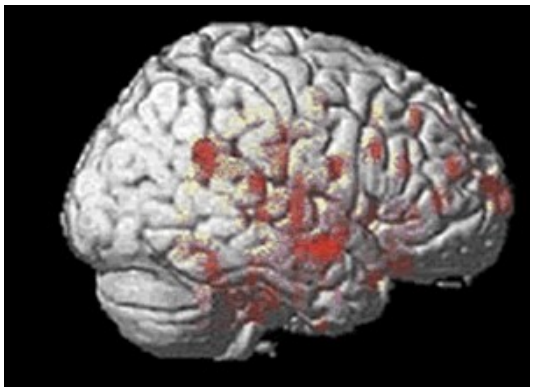
Design Strategies

Inattentional Blindness

— Conspicuity (cognitive properties)



Relevance: The Cocktail Party Effect

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Treisman AW. Contextual clues in selective listening. Qual J Experim Psychol. 1960;77:533-46.
Graphic from the University of Tohoku, Japan.

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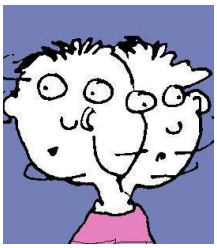
Design Strategies

Inattentional Blindness

- Mental workload and task
  - Steady workload, no multitasking
- Attention capacity
  - Variable
  - Fit person to job



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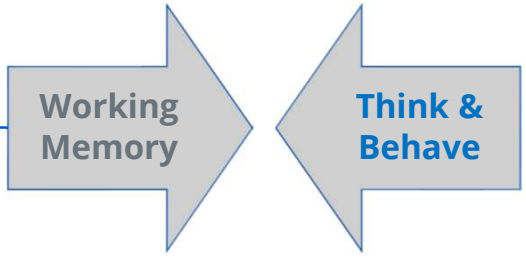
Maintenance



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Cognitive Biases

- **Endowment effect**
  - Place greater value on something after acquiring it
- **Framing effect**
  - Drawing different conclusions from the same information, depending on how or by whom that information is presented
- **Frequency illusion**
  - Thing recently come to one's attention appears with improbable frequency
- **Hindsight bias**
  - Tendency to see past events as being predictable
- **Normalcy bias**
  - Will never happen here

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Cognitive Biases

- **Identifiable victim effect**
  - Tendency to respond more strongly to person at risk than groups
- **Status quo bias**
  - Disfavor change and keep what have
- **Cognitive dissonance**
  - Rationalization that comes from discomfort caused by conflicting values
- **Current moment bias**
  - Stronger preference for immediate rewards
- **Outcome bias**
  - Severity of response based on outcome

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What Can Degrade the Working Memory?

Personal PSFs

- Mental and physical hardiness
- Cognitive capacity
- Confidence
- Attention span
- Anxiety, stress, fatigue, moods
- Task interest, motivation

System PSFs

- **Environmental distractions**
- Workload
- Physical environment

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Distractions and Interruptions

- Anything that disturbs or diverts attention away from current task, forcing attention on another task
  - **Chloral hydrate liquid**
- Nurses/pharmacists interrupted once every 2 minutes
- Physicians interrupted once 5-10 minutes
- Risk of medication error
  - **Increases 12.7% per interruption**
- Risk of a **harmful** medication error
  - **Doubled when interrupted 4 times**
  - **Tripled when interrupted 6 times**

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Question

Which of the following represents the greatest source(s) of interruptions and distractions of nurses during drug administration?

A. Telephone calls

B. Patients

C. Self-induced interruptions during which health professionals themselves initiate conversations

D. A and B

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Distraction and Interruptions

- No interruption zone (NIZ)
- "Do not disturb" signs
- Best times for necessary interruptions during transitions, between subtasks
- Use checklists during critical tasks so remember where left off
- Prepare: Gather all needed supplies
- System improvements (e.g. missing medications)
- Mobile device management strategies
- Reduce invalid alerts, alarms, noise

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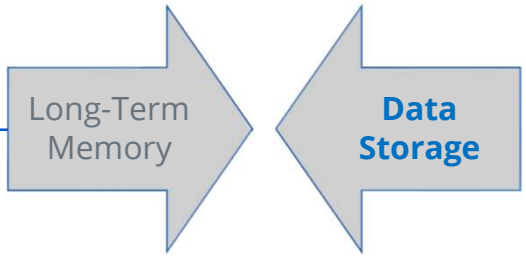
Retrieval



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What Can Degrade Long-Term Memory?

- Interference
- Education, training, and experience
- Distractions that interfere with retrieval
- Rarely accessed memories decay
- Stress and emotional at time of learning
- Intelligence/aptitude for task
- Motivation to recall
- Memories can change as you retrieve them
- False memories

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Memory Enhancement: Storytelling

Expose dilemmas
Enhance attentiveness
Incite questions
Challenge assumptions
Memorable

Open to new ways of thinking
Contemplation
Reflection
Empathy
Inspire change

- No matter how powerful the data, no better way to inspire and sustain change that through the simple craft of telling stories that move listeners to action
- Lessons without stories rarely lead to learning and change

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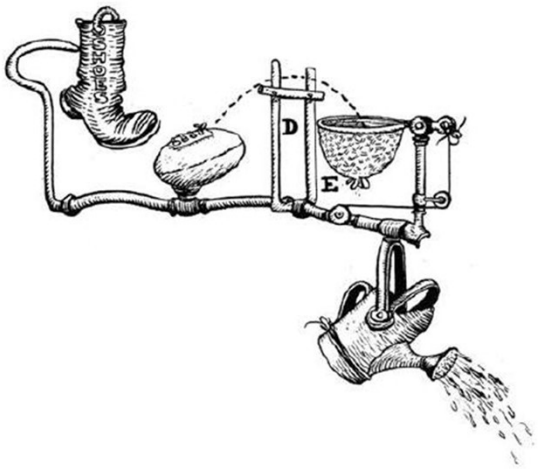
Human Factors and System Design

- Bad designs
- Better system design strategies



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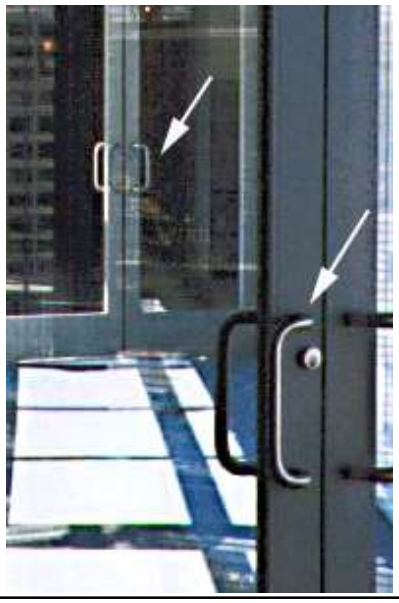
Things That Don't Work The Way You Expect



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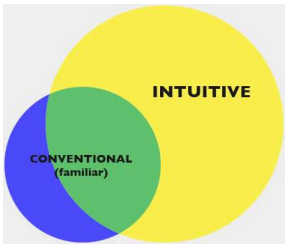
System Design Strategies

Use affordances

– Human-centered design



System Function	Control Movement
On	Up, right, forward, pull
Off	Down, left, rearward, push
Right	Clockwise, left
Left	Counterclockwise, left
Up	Up, rearward
Down	Down, forward
Increase	Up, right, forward, clockwise
Decrease	Down, left, rearward, counterclockwise

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Things That Are Hard To Remember

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Things With Too Many Choices

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System Design Strategies

Simplify and Standardize

- Reduces risk and variation in work
- Examples:
  - Use commercially prepared products
  - Use evidence-based standard order sets
  - Standardize concentrations, container sizes, drugs
  - Dispense unit doses
  - Utilize dosing charts

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Unlimited Access

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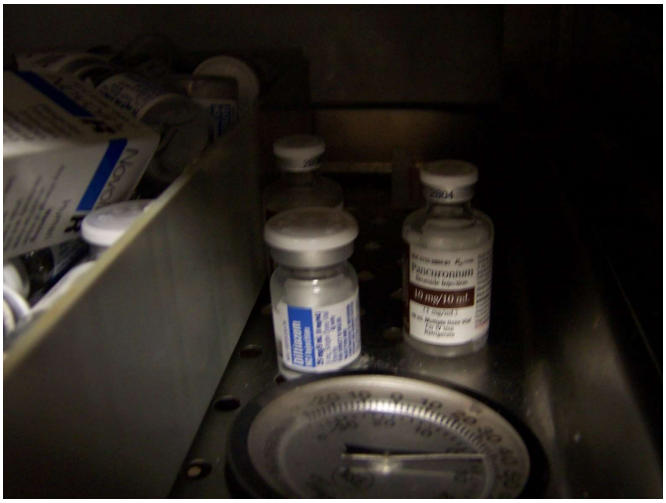
Too Easy to Grab by Mistake?



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System Design Strategies

Limit Access, Externalize, Centralize

- Reduce opportunities for errors
- Examples:
  - Sequester neuromuscular blocking agents
  - Prepare all chemotherapy in a central location
  - Require special training for access to prescribing, preparation, dispensing, administration of high-alert medications
  - Restrict concentrated oral liquid opioids
  - Carefully select drugs, concentrations, quantities in floor stock/ADCs

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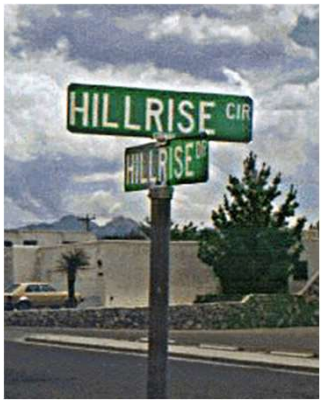
Different Things/Names That Are Too Similar



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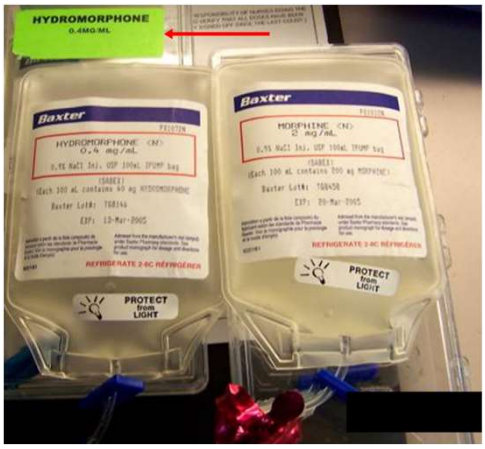
System Design Strategies

Differentiate, Affix Warnings

- Reduces opportunities for errors
- Examples:
  - Auxiliary labels for chemotherapy, Neuromuscular blocking agents, powerful opioids
  - Use color to draw out warning labels (double strength, epidural)
  - Use tall man letters (HumaLOG, HumuLIN)
  - Purchase look-alike medications from different manufacturers



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New Equipment with Unexpected Functions

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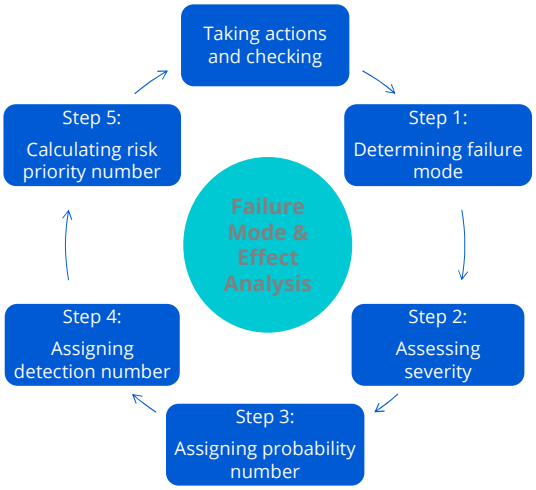
System Design Strategy

Proactive risk assessment before purchase or use

- User testing
- Failure mode and effects analysis (FMEA)



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Machines That Do What You Don't Want

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System Design Strategies

Barriers, Forcing Functions, Fail-Safes

- Prevents hazard from touching target
- Examples:
  - Personal protective equipment
  - Needleless system
  - Different medical gas connectors
  - Oral syringes
  - Safe defaults, required fields
  - Free-flow protection with infusion pumps

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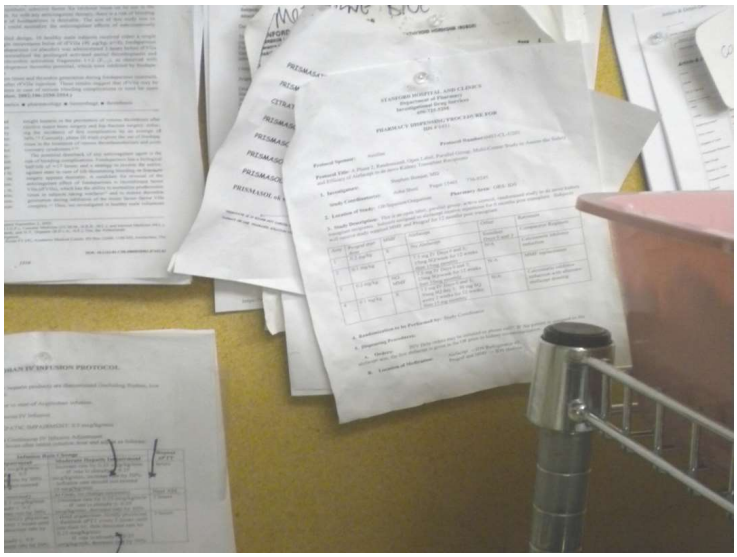
Conditions That Make It Hard To Find Information



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System Design Strategies

Maximize Access to Information,
Automation with Decision Support

- Examples:
  - Clinical pharmacists
  - Dosing charts
  - Smart pumps
  - Barcode scanning
  - CPOE
  - EHR
  - Data monitoring software

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Single-Pathway To Serious Harm

National Geographic photo

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System Design Strategies

Redundancy

- Multiple pathways so if first fails, second successful
- No single failure can cause accident
- Examples:
  - Independent double-checks
  - Back-up supplies and power
  - Time-out process
  - Marking surgical site
  - Patient identification
  - Listing brand and generic names
  - Read-back
  - Automated redundancies

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System Design Strategies

Recovery

- Allows the error to occur
- Relies on ability to detect initiating event and correct before the critical undesired outcome
- Examples:
  - **Downstream checks and tests**
    - Order review
  - **Making the error visible through feedback**
    - Review screen on pump
  - **Patient monitoring**
    - Labs, capnography, timely assessments
  - **Surgical sponge count**
    - Can also be redundancy
  - **Capture of prescribing, dispensing, administration errors**

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Rank Order of Strategies

	Strategy	Leverage	
System	• Forcing functions • Barriers and fail-safes • Automation and computerization • Standardization • Redundancies		High ("Blunt end")
			Medium
Human	• Reminders and checklists • Rules and policies • Education and information • Suggestions to "be more vigilant"		Low ("Sharp end")

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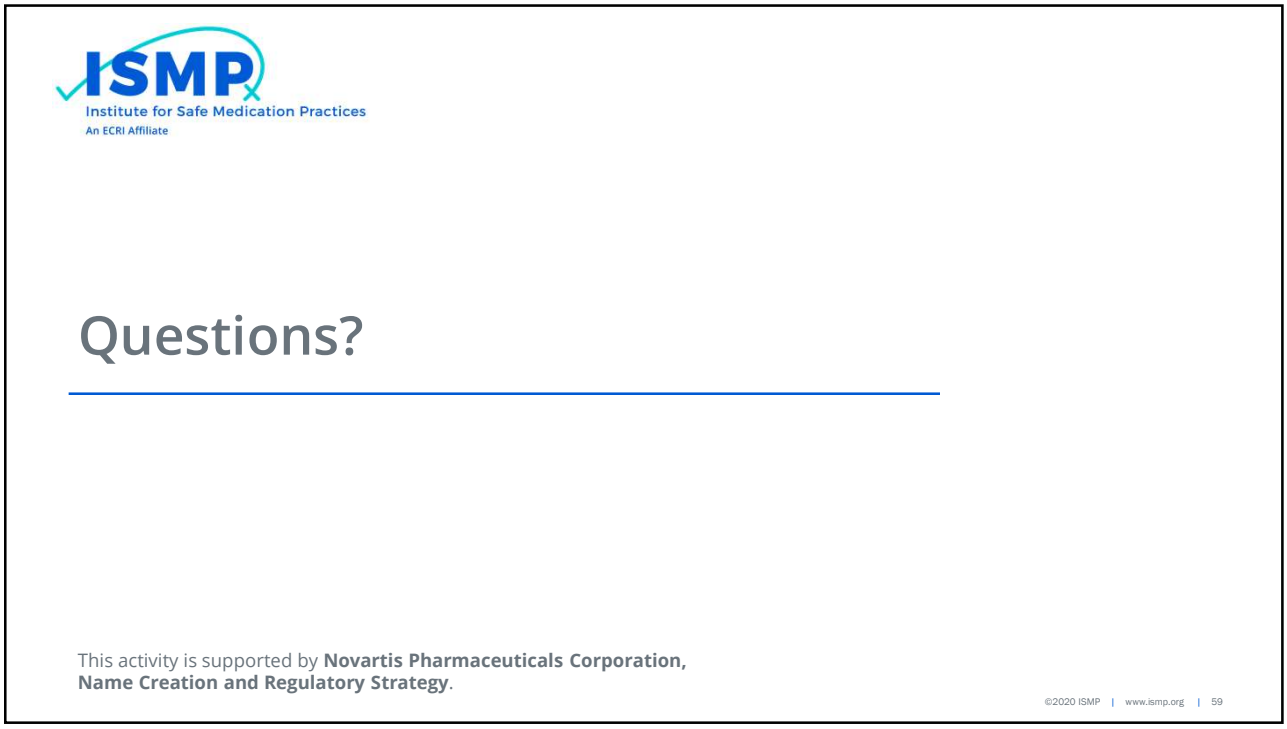
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