



Human Error and Accidents: Why Do We Make Wrong Decisions That Cause Harm?

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Human error goals

Objectives

- Human error and adverse events
- Types of human error
- Causes of human error
- Prevention of human error

What could go wrong?



Human error perspective

Our perspective:

"Needs more training," "Be more aware," "Be careful."

"They should have known better; they had 8 hours of safety training on the day they were hired!"

Human error perspective:

- Rarely incompetence, lack of training, recklessness, extreme carelessness, bad luck
- Commonly interaction between vulnerable systems and fallible humans

What is human error?

An adverse event is caused by an unintentional failure between fallible human cognitive limitations and flawed systems.



What is human factors engineering?

History

- 1900's Frederick Taylor
- 1940's WWII aircraft design
- 1950's human factors and ergonomics invented

Goal

- Study how people interpret the environment around them.
- Find system errors that lead people to incorrect decisions.
- Increase safety, performance, and satisfaction
- Applications – aircraft, nuclear, vehicle design, iPhone



HUMAN ERROR

Classes of human error

1. **Decision errors**
2. **Execution errors**
3. **Perceptual errors**
4. **Violations**



1: Decision errors: Mistakes

1. **Decision errors:** wrong plan executed

Procedure error: a person misinterprets actions needed for a procedure.

- *The procedure is vague or poorly written; cues telling them what to do are confusing or misleading.*

Choice error: a person doesn't fully understand the situation and decides on a poor course of action without enough knowledge.

- *Examples: no procedures, too much information and/or too complex and nuanced; information to support choice is vague or abstract.*

What's the message?



<https://www.instagram.com/art101vandalay/p/C5XrKndNuDZ/>

Execution failures

2. Execution errors - the right plan and intention

Slip: something got mixed up in the execution

- *Example: I left my keys somewhere else when I came into the house; a person did one step wrong in a LOTO sequence; the employee hit the wrong button.*

Lapse: part of the plan was omitted

- *Example: A person was interrupted during LOTO and skipped an important step.*

Perceptual errors and violations

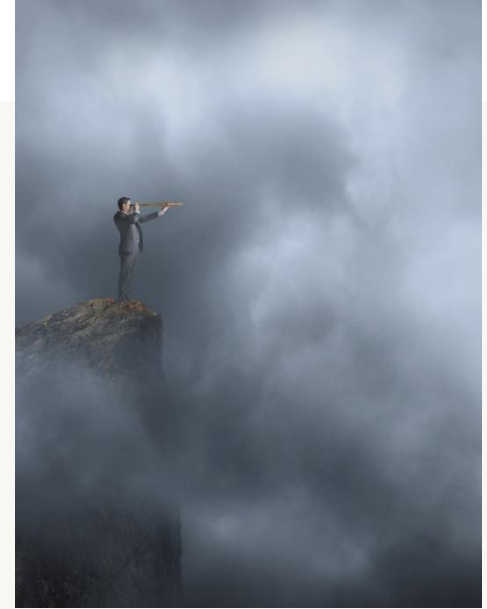
3. Perceptual errors

Sensory input is degraded or unusual

- *Example: driving at night in bad weather, inability to read text because it was too small or far away; objects look like something else*

4. Violations

- Willful disregard for rules and regulations (which is not really human error).
- Not to be confused with not understanding the rules (which is a decision error).

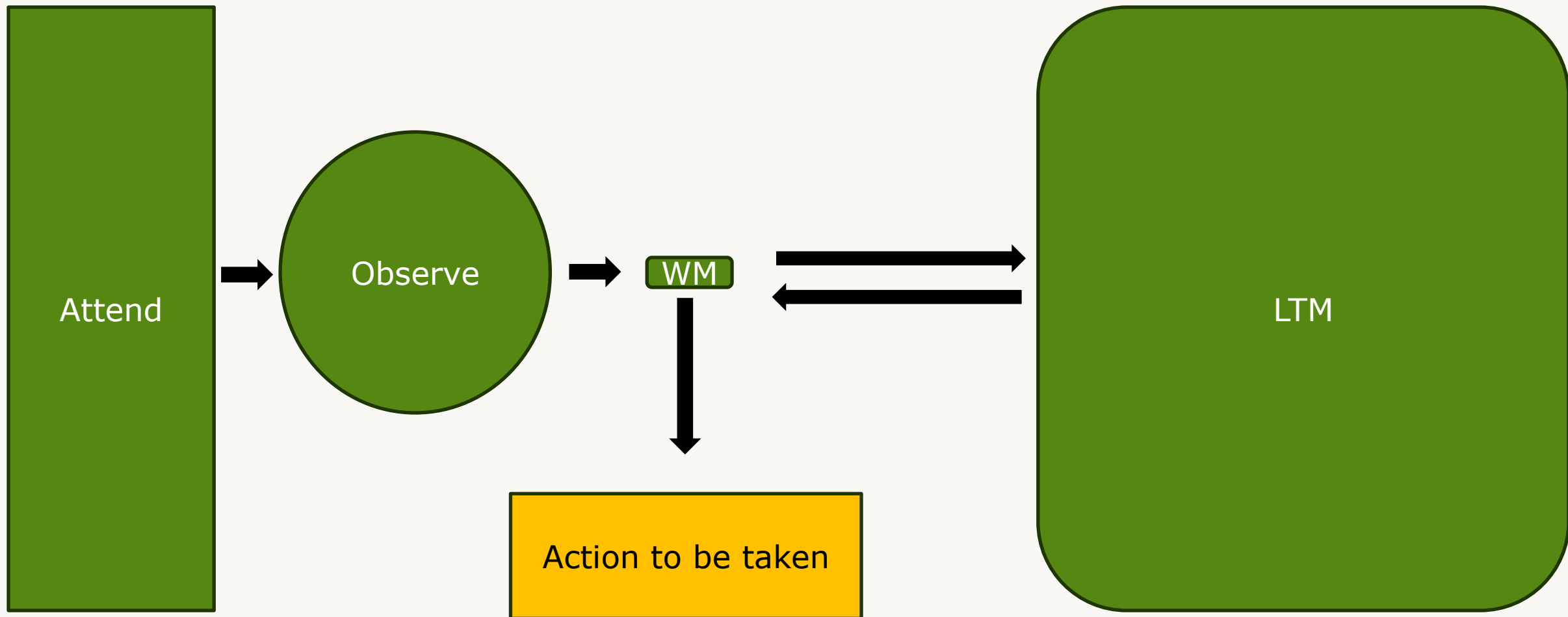


What could go wrong



How we process information

Information Processing Model



Funk, K.; Brace, T. "The Role of Human Error in Accidents: What Makes Us Do Things That Cause Injury?" Governors Occupational Safety and Health Conference. Portland, Oregon. 2 March, 2005.

ATTEND

Attention: our senses scan the environment and provide situational awareness.

- A filter that sorts what we need to respond to vs what we can ignore.
- Attention requires significant mental energy to support information processing

Attentional blindness: when people miss large features of the environment even when they look directly at them.

Selective attention: does not guarantee perception but is necessary for perception. We don't always perceive what our attention is focused on

- [Selective attention test](#)

Question

Q1 How many times did the player pass the ball?

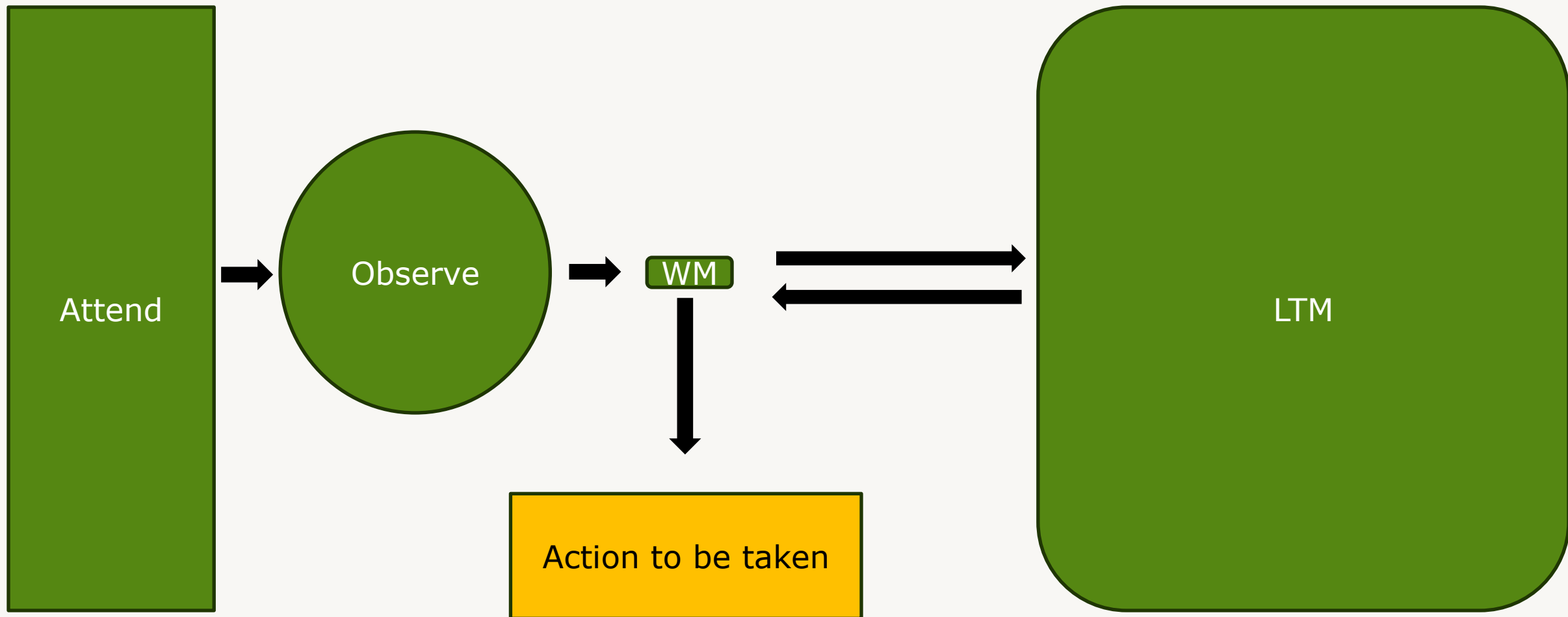
Q2 How many saw the gorilla?

ATTEND

Points where error can occur:

- **Bright cues:** the squeaky wheel gets our attention; it stands out
 - e.g., *High-vis vests, ringing phone*
- **High value vs low value:** attention focused on high-value things
- **Narrow focus:** attention focus is very narrow; we don't scan the entire clock face
- **Contrast:** low contrasts and low illumination make it less easy to see
- **Lack of chunking/bordering:** information flows together, making it hard to distinguish it from background noise. Remember the old MSDS?

Information Processing Model



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OBSERVE

Detected, noticed, or perceived.

Three types of *perceptual error* can stop this step from happening

1. Fail to observe/detect because:

- Stuff is too far away, poor contrast, poor lighting (sensory limitations)
- Sensory impairments (presbyopia, hearing loss, color blind)
- Fatigue from hypervigilance



OBSERVE

Detected, noticed, or perceived.

Three types of *perceptual error* can stop this step from happening

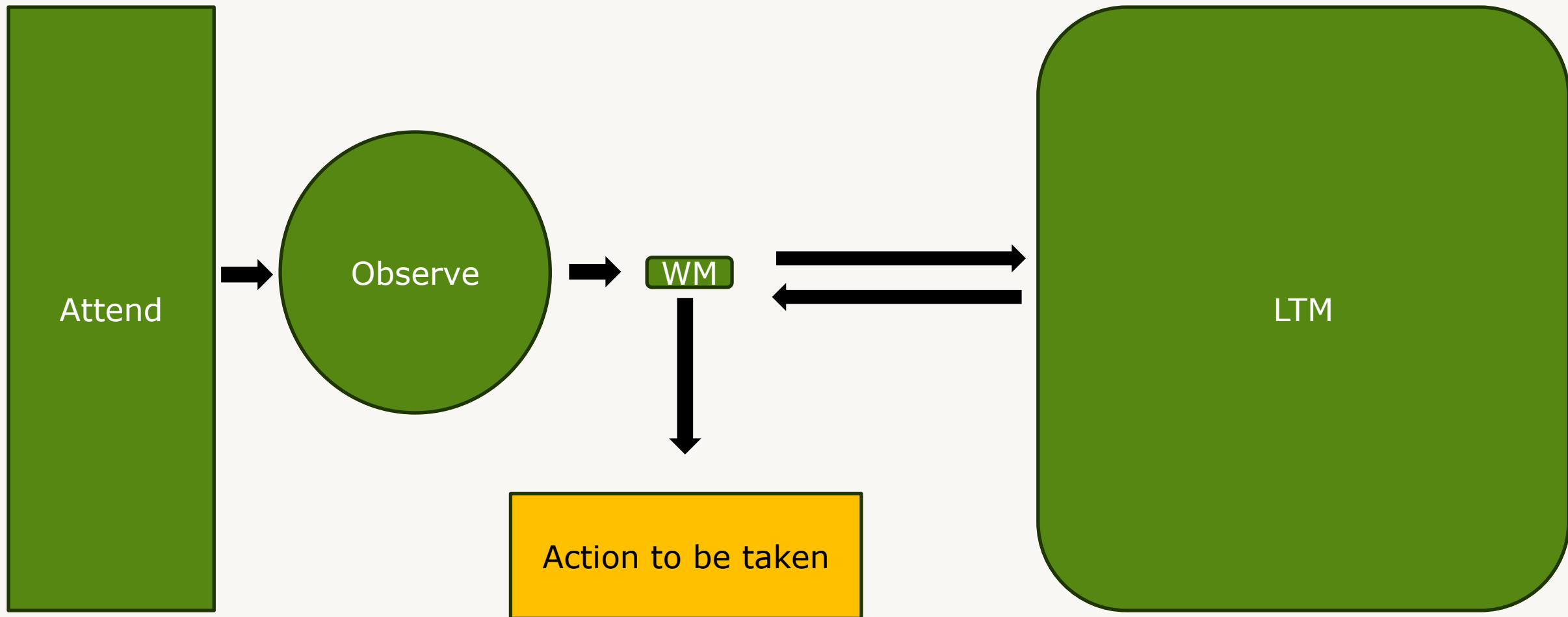
2. Fail to discriminate between important things

- Masking - competing things are similar in kind, color, size, shape, font, or sound

3. Fail to identify or recognize

- Too much information and clutter to wade through
- Perceptual errors

Information Processing Model



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REMEMBER – Working memory

Working memory: a temporary storehouse that keeps the information available while we are using it or until it gets stored in long-term memory

- A bottleneck that requires more mental resources
- Limited storage capacity, with a very short half-life
- Holds ~5 chunks of data at a time

8-0-0-2-8-5-8-5-2-5

vs.

10 chunks

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800-285-8525

10 chunks

3 chunks

REMEMBER

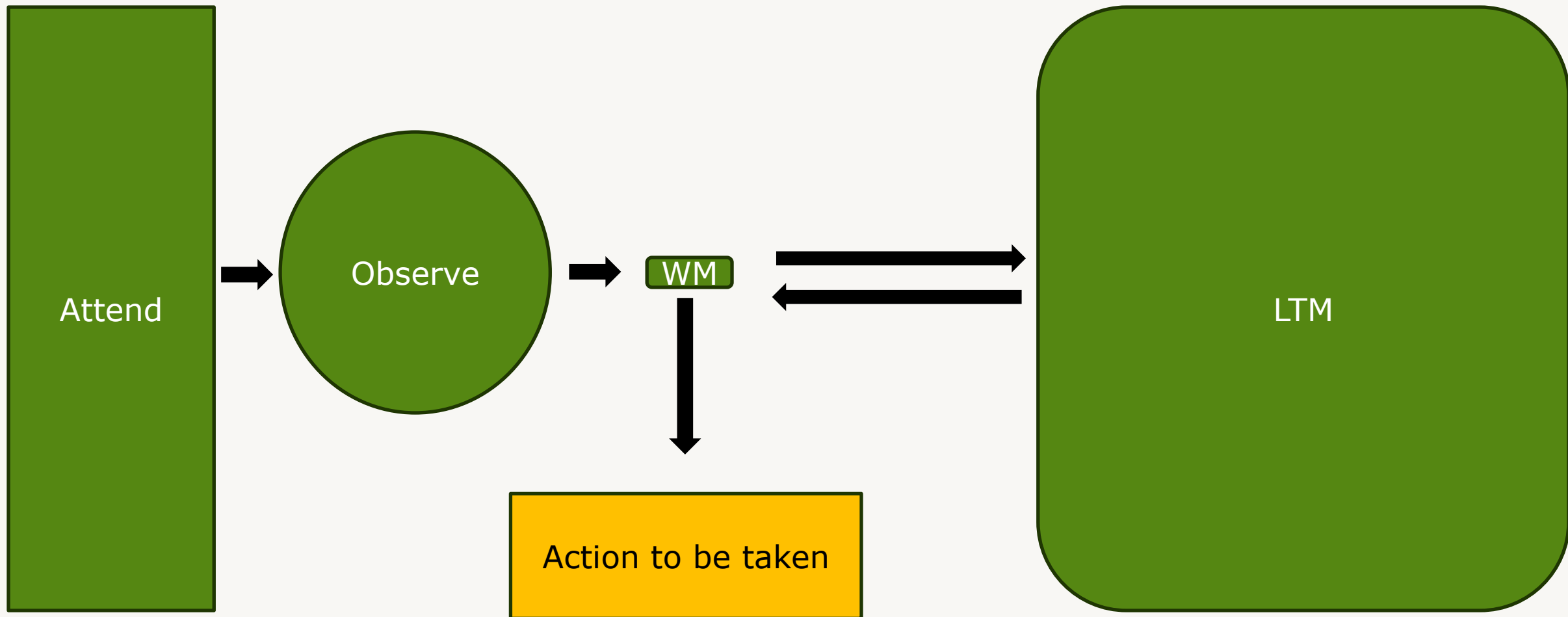
Working memory errors

Decision and execution errors occur at this point.

Fail to recall

- Limited WM capacity (>4 chunks)
- Limited WM time duration (<20 seconds)
- Wordy, long narratives; too much information
- Overly technical language
- Lack of icons, imagery, discrete use of color
- Insufficient chunking

Information Processing Model



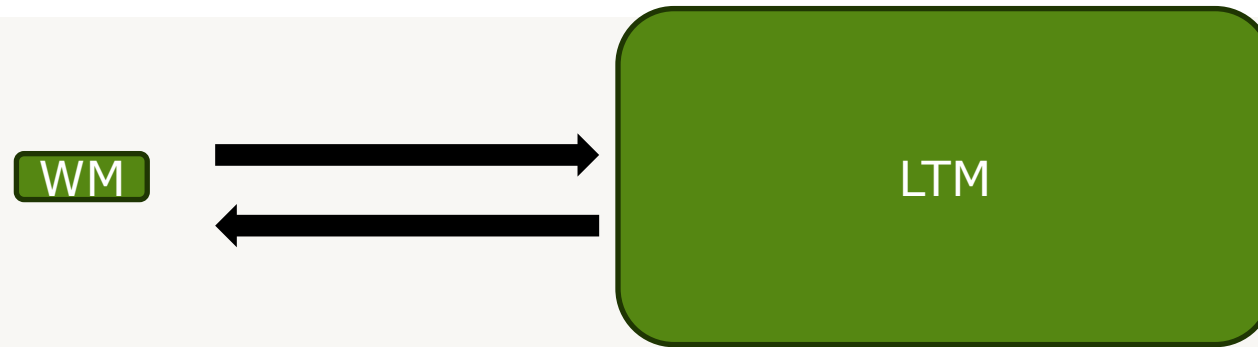
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THINK – Long-term memory

Long term memory storage

- **Semantic or declarative:** Memory for general knowledge
- **Episodic memory:** Memory for things gained from experience and visual imagery
- **Procedural memory:** How to do things like tie your shoes or ride a bike

THINK – WM and LTM integration



Getting stuff to stick in LTM

- **Chunking:** Stores more information in LTM and reduces WM demand
- **Mental model:** Sticks in better LTM when connected with something meaningful
(e.g., duct tape and jelly donuts)
- **Mnemonics or visual imagery:** Better than text or rote repetition. Rote repetition is rapidly forgotten in LTM when not practiced
- **Experience:** Sticks better than classroom memorization; easier load on WM

THINK

LTM Errors are decision errors

Fail to recall

- Weak associations
- Insufficient chunking

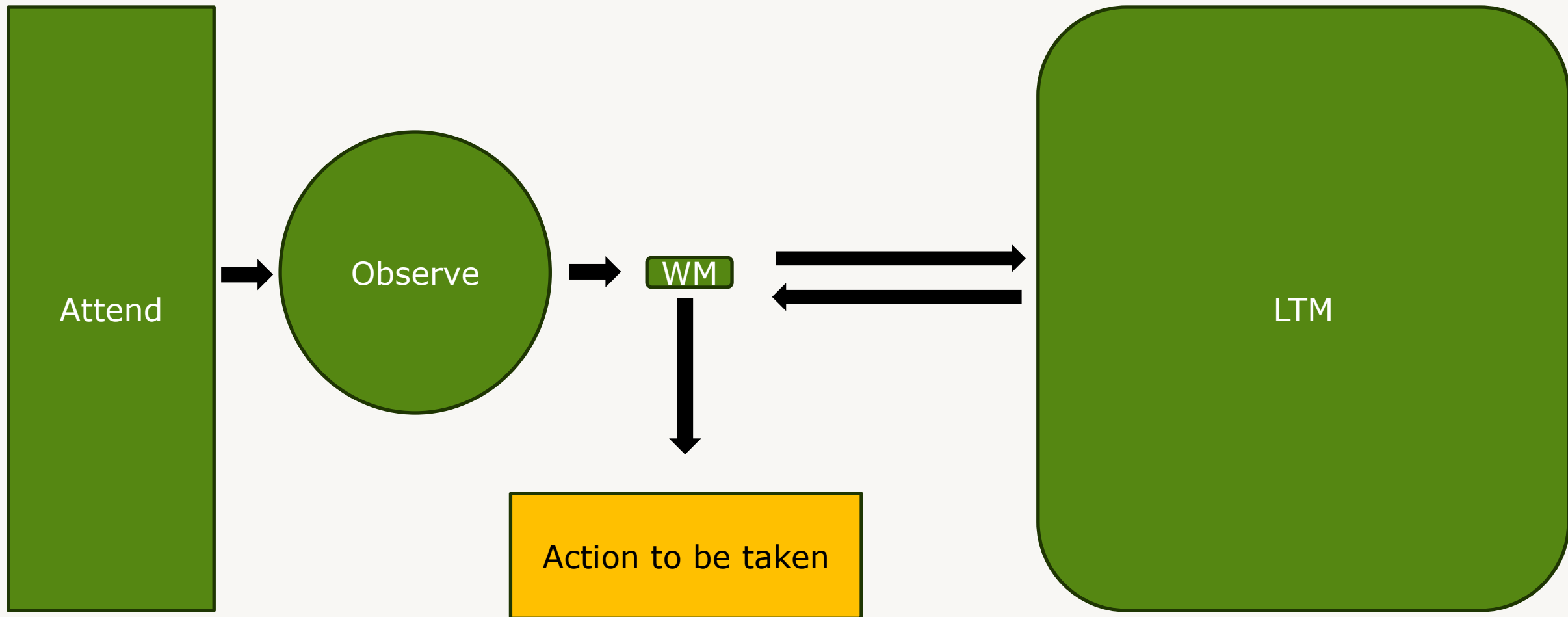
Mental model

- Poor mental model

Bias and heuristics

- Decision errors based on internal biases

Information Processing Model



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THINK - Decide

Working memory now makes decision

Strategies for action are now pulled from LTM, WM now decides which action to take

Normative decision making: People look for the ideal situation where the correct decision can be made by calculating the optimal choice – “what people should do.”

Satisficing: Most decisions involve shortcuts relative to the normative approach. People do not follow the goal of making the best or optimal decision due to lack of time and resources; they opt for a choice that is “good enough.”

THINK - Decide

Bias and heuristics: short cuts made in thinking because of limits of reasoning

- Shortcuts that save time and mental energy
- Developed from experience and applied until a change is needed
- Works well for experienced people in familiar settings; new people not so much
- Inaccurate B&H can lead to wrong choices (mistakes)

THINK – Bias and heuristics

- **Anchoring:** stuck on one thing, can't see anything else
- **Recency:** what is most recently recalled is most available
- **Consultant fallacy:** internal SME dismissed
- **Cognitive tunneling:** new evidence disregarded after decision made



THINK – Bias and heuristics

- **Overconfidence:** belief too strong in one's own abilities
- **Confirmational bias:** “confirming what I already believe”
- **Hindsight bias:** Monday morning quarterbacking
- **Sunk cost/gamblers fallacy** – “too big to fail”



Best practices

ATTEND & OBSERVE – Best practices

- **Improve contrast:** black-on-white lettering instead of black-on-black; better lighting
- **Bottom-up cues:** use color, size, brightness, or make the signal dynamic (motion) to draw attention (*e.g., “orange vests”; “blue lights”; motorcycle flashing headlamp*)
- **Reduce clutter and wordiness:** too much information search difficult
- **Color:** careful use of color and intensity to draw attention

- **Chunking**

Information:
Step one
Step one
Step one
Problem:
Problem one
Problem one
Problem one

VS

Information

- Step 1
- Step 2
- Step 3

Problems

- Prob 1
- Prob 2
- Prob 3

ATTEND & OBSERVE – Best practices

- **Familiarity:** use familiar fonts and lower-case text
- **Icons:** use meaningful icons or images
- **Smaller vocabulary:** short words rather than abbreviations
- **Avoid competing signals:** avoid two signals that look or sound similar
- **Redundancy:** visual and auditory alarms (*e.g., forklift horns AND blue lights*)

REMEMBER & THINK – Best practices

- **Practice:** regular experiential practice to increase “muscle memory”
- **Verbalize learning:** encourage active verbalization of info to be recalled
- **Standardization:** standardize forms, procedures
- **Mnemonics:** e.g., *GUMPS before landing (Gas, Undercarriage, Mixture, Props, Systems)*
- **Meaningful:** information presented as a story that would resonate with little technical jargon and as few words as possible (e.g., duct tape and donuts)

REMEMBER & THINK – Best practices

- **Limit options:** instead of 20 options, how about 3?
- **Checklists vs. a novel:** use bullets & checklists to make decisions more consistent
- **Pre-task planning:** helps with situational awareness, problem-solving, decision-making, teamwork, and task management
- **FEMA's:** what can go wrong?

REMEMBER & THINK – Best practices

- **Training on biases and heuristics:** a mixed record of success
- **Immediate feedback:** provide feedback to show how better outcomes are produced when training strategy is followed and worse outcomes when it is not
- **Training aides:** build experiential “muscle memory” knowledge
- **Simulations:** get people out of the classroom doing hands-on experience
- **Contingency plans:** create fallback plans and plan to re-plan

Questions?

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