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Human Supervisory Control

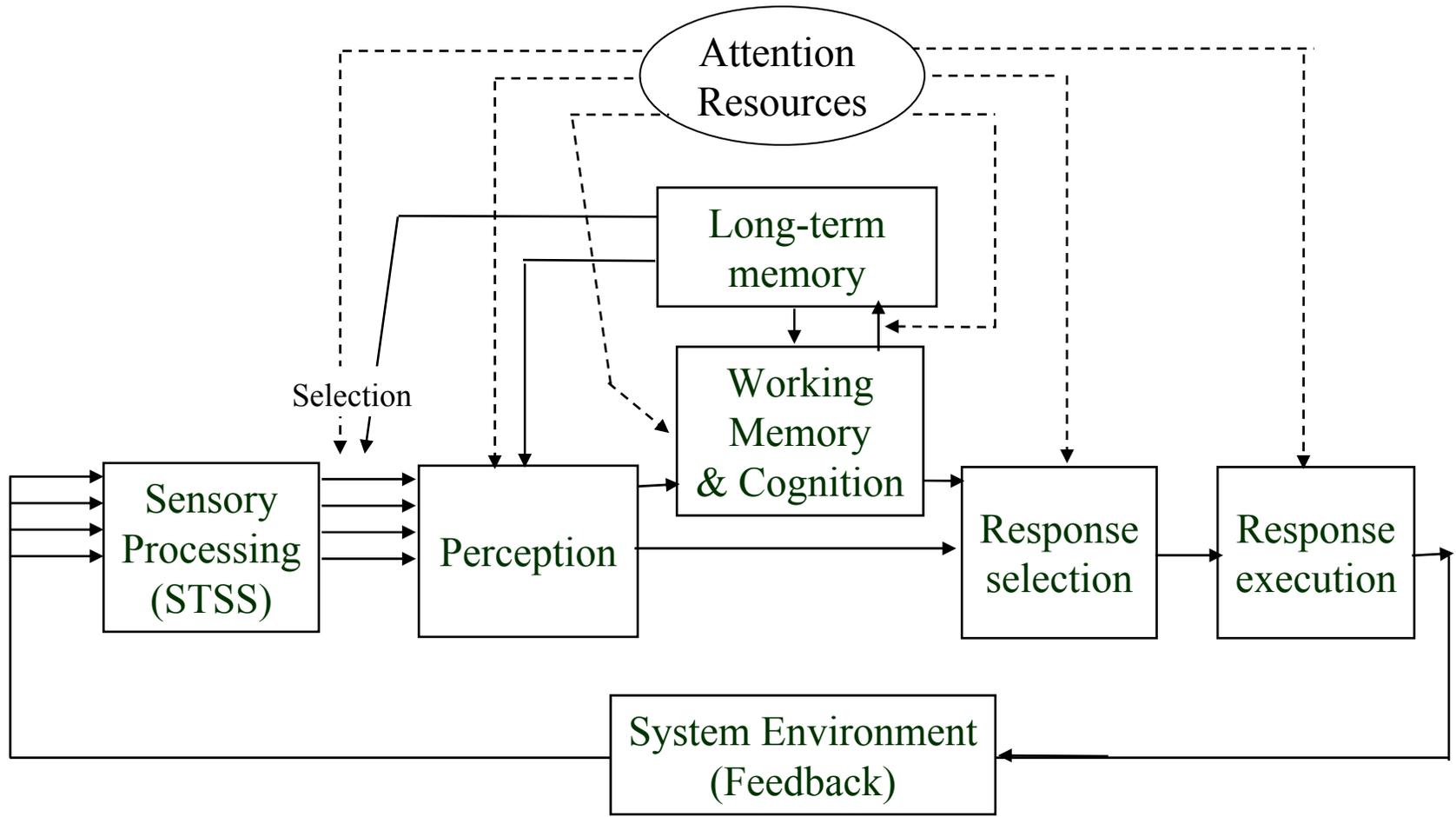
Memory & Attention



Massachusetts Institute of Technology

A Model of Human Information Processing

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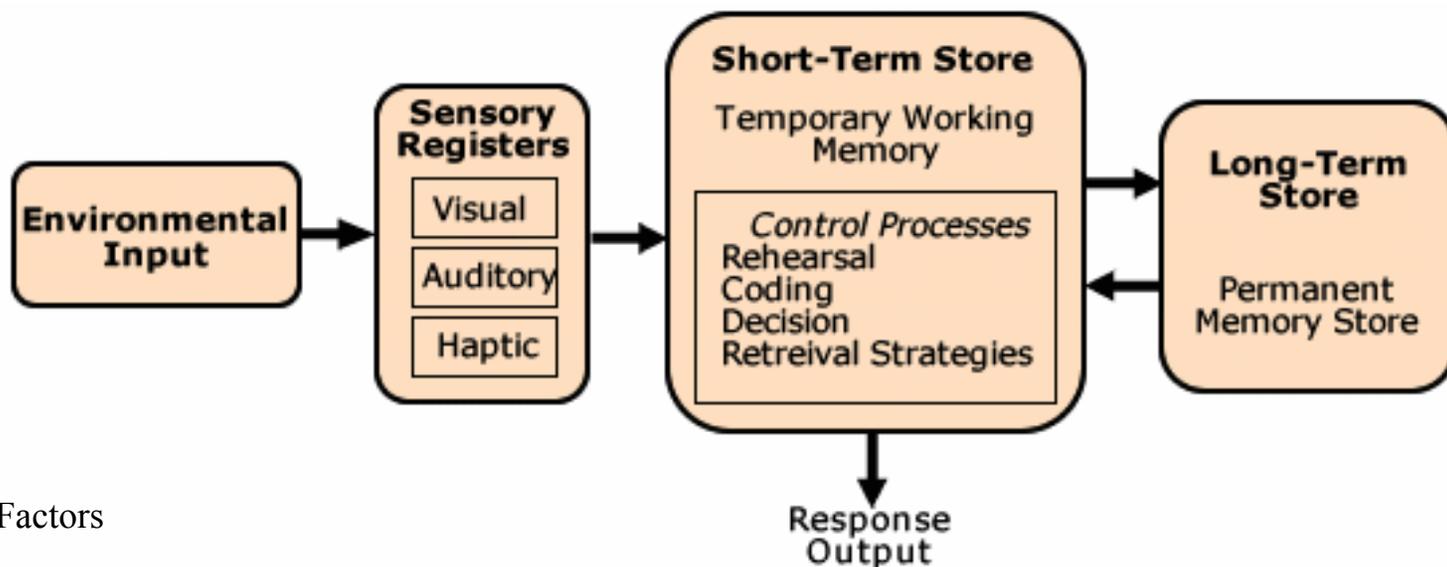
Wickens & Hollands, 2000

- STSS = short term sensory storage
- Perception drives bottoms-up processing while long term memory drives top-down processing

Working Memory

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- Also known as short term memory
- Three components
 - Verbal (phonological store & articulatory loop)
 - Visuospatial sketchpad
 - Central executive
- Temporary buffer



Working Memory Limitations

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- Limited capacity
 - Miller’s magic “7 +/- 2”
- Chunking & parsing
 - Skill & expertise
- Information will decay unless maintained in working memory through the articulatory loop (rehearsal) or stored in long term memory.
 - A fundamental component of learning
- Memory lost within 30 seconds unless rehearsed.

Long Term Memory

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- Semantic network of knowledge
 - Knowledge is procedural, declarative, and general
 - Encoded in terms of meaning and events
 - Not a random process
 - A loosely structured “database”
- Unlimited capacity
- Development of mental models
 - An abstract mental structure that allows understanding and insight into an event, problem, etc.
- How knowledge was encoded influences recall
- Perception vs. Long Term Memory
 - Recognition is much easier than recall

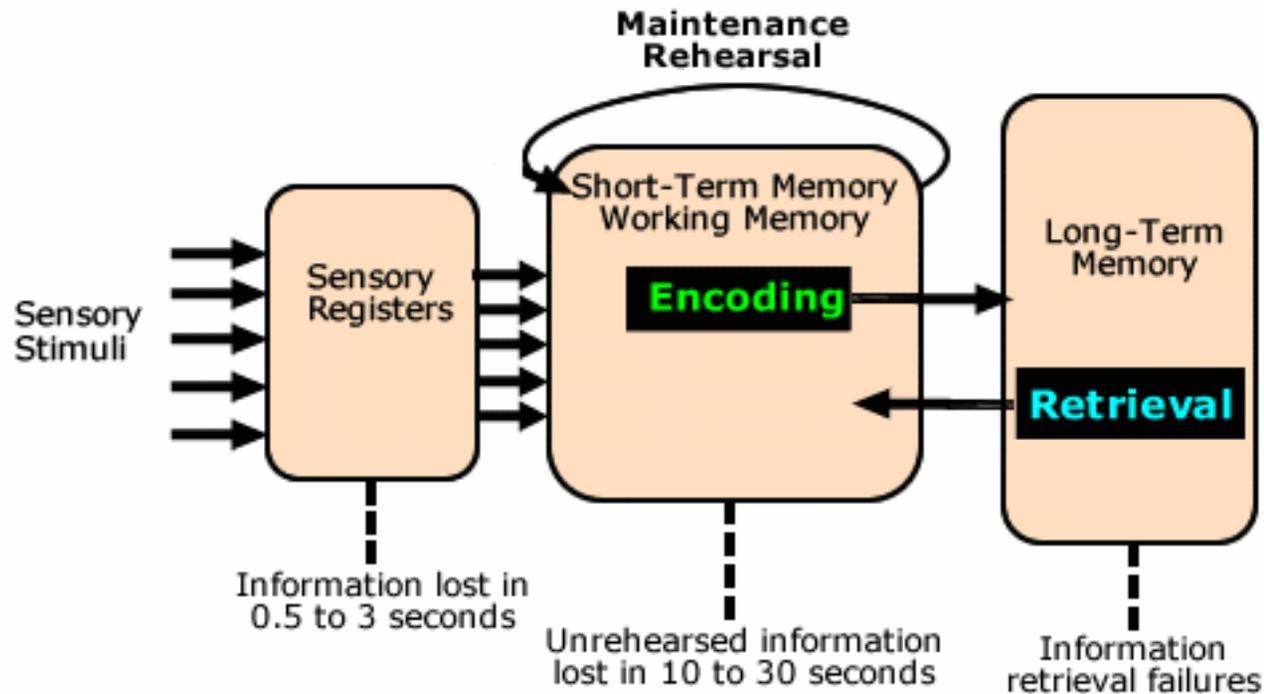
• Declarative – knowledge of facts

• We can identify thousands of different colors but in general can only name ~ 17.

Problems with Memory

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- Unreliable
- Recognition vs. recall
- Do we forget or does information decay?



More Problems with Memory

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- Retrieval and Inference
 - False memories
- Effect of Prior Knowledge
 - Memory reconstruction often uses general knowledge and expectations to fill in the gaps
- Memory can distort perception in systematic ways.
 - Tendency to overestimate colors, slow speeds (but underestimate high ones!), distances, etc.
- Eyewitness testimony
 - Framing effect
 - Subjects shown film of automobile accident. Subjects asked: Did you see a broken headlight? or Did you see the broken headlight? (There was actually none.)
 - Results: Subjects more likely to respond yes to the broken headlight.

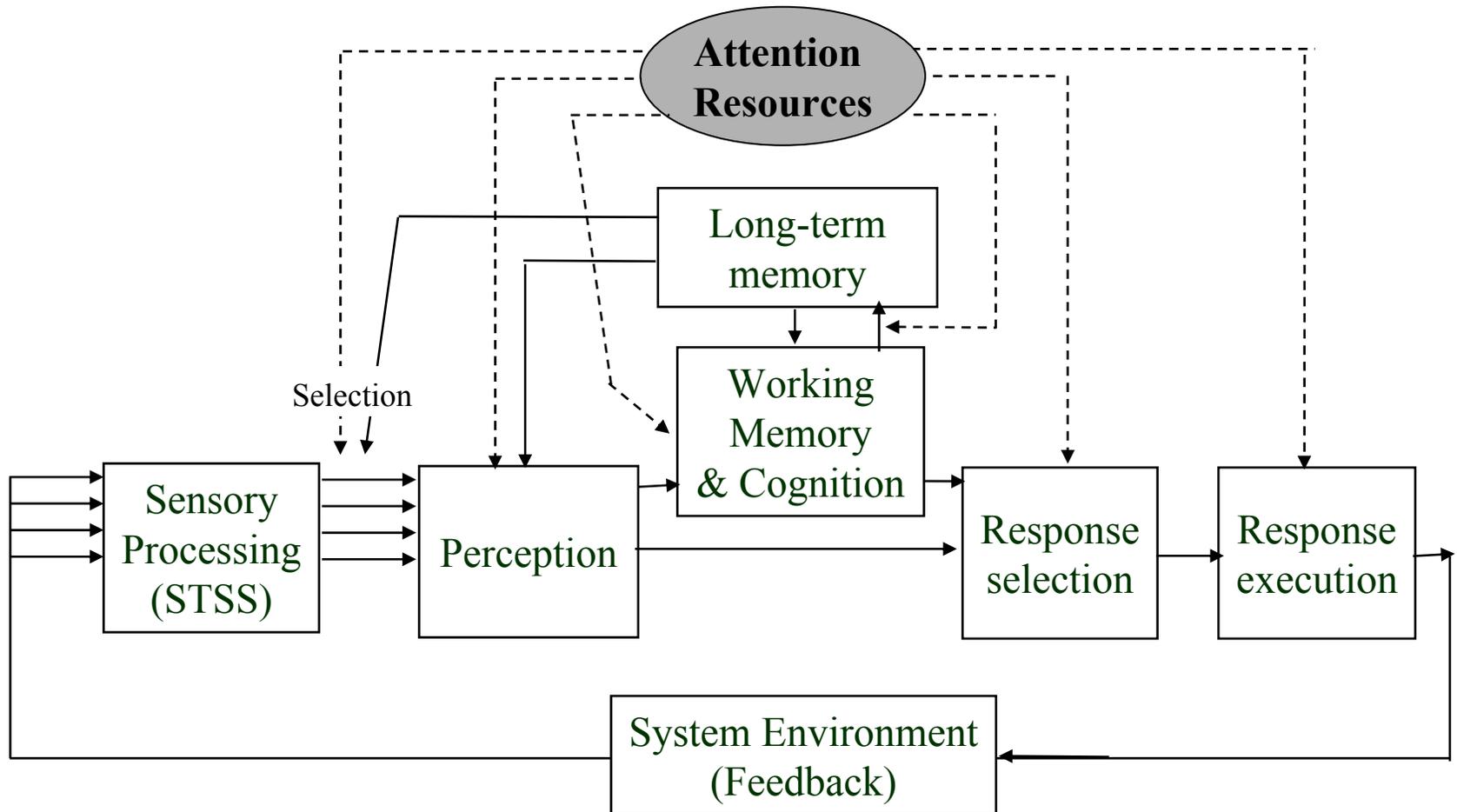
Memory & Automated System Design

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- Calculations, comparisons, and workspace navigation tasks which require extensive use of working memory increases the mental workload for that task.
 - Also increases likelihood of error.
- Can increase working memory capacity by using two senses instead of one
- Promote consistent mapping
 - Negative transfer
- Mental model support
 - Training strategies
 - Part task

A Model of Human Information Processing

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Attention

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- Three general categories
 - Selective
 - Cognitive tunneling
 - Focused
 - Environmental distractions
 - Divided
 - Time-sharing
- Attention is perceptually driven
 - We tend to notice significant changes in light, motion, temperature, sound, color, novelty, or information complexity
 - Cocktail Party Phenomenon

Attention & Visual Perception

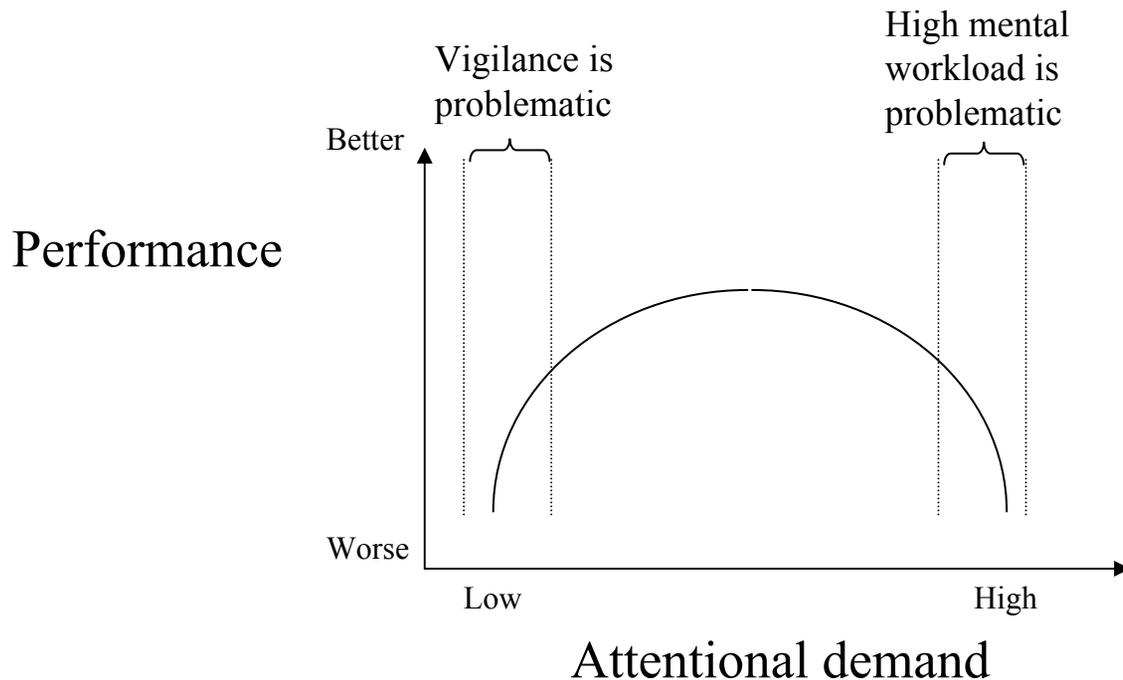
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- Peripheral vision (rods)
 - Helps to see movement, change
 - Poor acuity and brightness
- Foveal vision
 - Focused perception (cones)
 - Helps to see details, color
 - Pursuit & saccadic movements
- Saccades
 - Eye “jumps” from one spot to next
 - Dwell times
- Scanning versus target search
 - Both occur in supervisory control

Vigilance & Attention

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- Vigilance – Monitoring for signal detection over extended periods of time (e.g. radar watch, airport security, etc.)
- People cannot maintain vigilance past 30 minutes in low workload monitoring conditions .



Designing to Direct Attention

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- Spatial Proximity
 - Promotes divided attention
 - Heads-up display
 - Conformal symbology
- Salience of visual cues
 - Intelligent cueing
- Proximity Compatibility Principle
 - Display v. processing proximity
 - Configural displays
 - Emergent features & pattern recognition
- What about auditory attention?