LEARNING NOUNS AND ADJECTIVES IN BOLT

6/21/12

Aaron Mininger and John Laird

Introduction

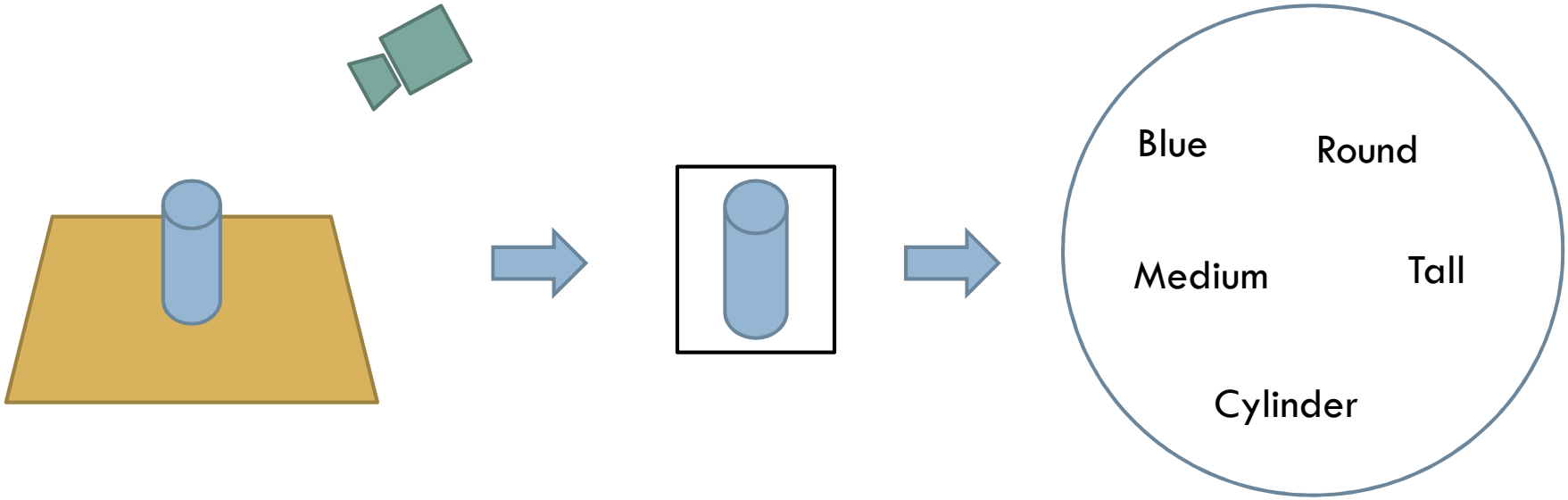
How can an agent learn to identify and refer to objects using descriptions in natural language?

Desired Characteristics:

- Utilize interaction to learn quickly
- Start with a minimum of initial knowledge
- Apply knowledge in novel situations

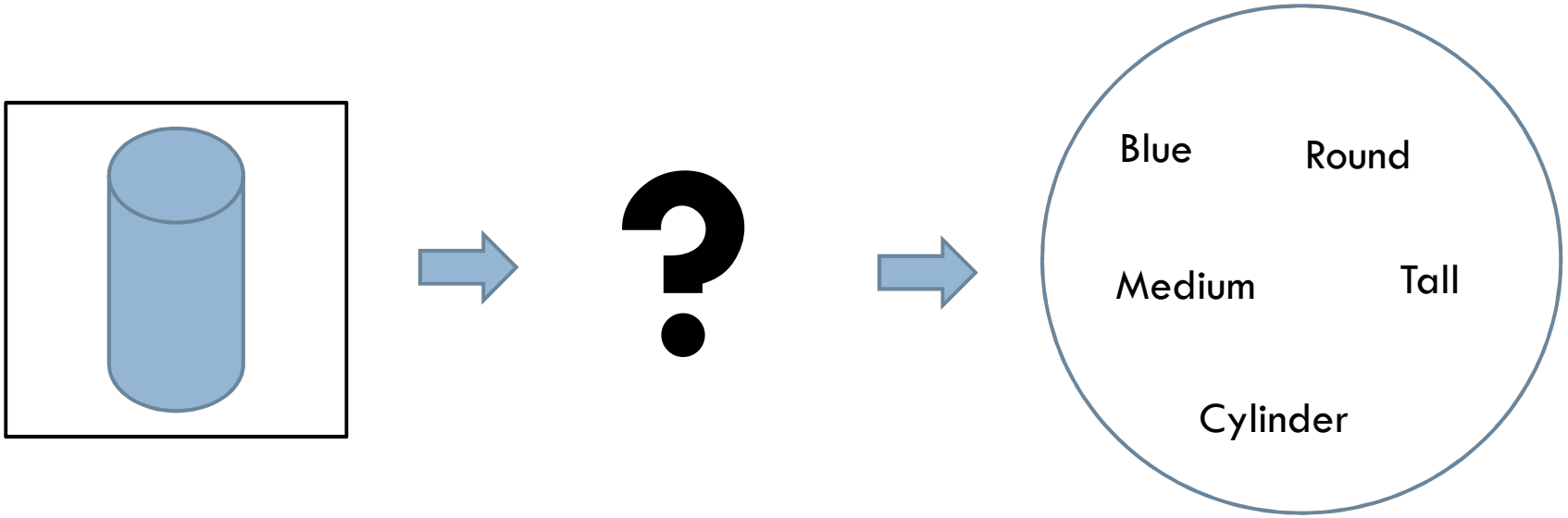
Vision → Description

How can an agent learn to describe an object?



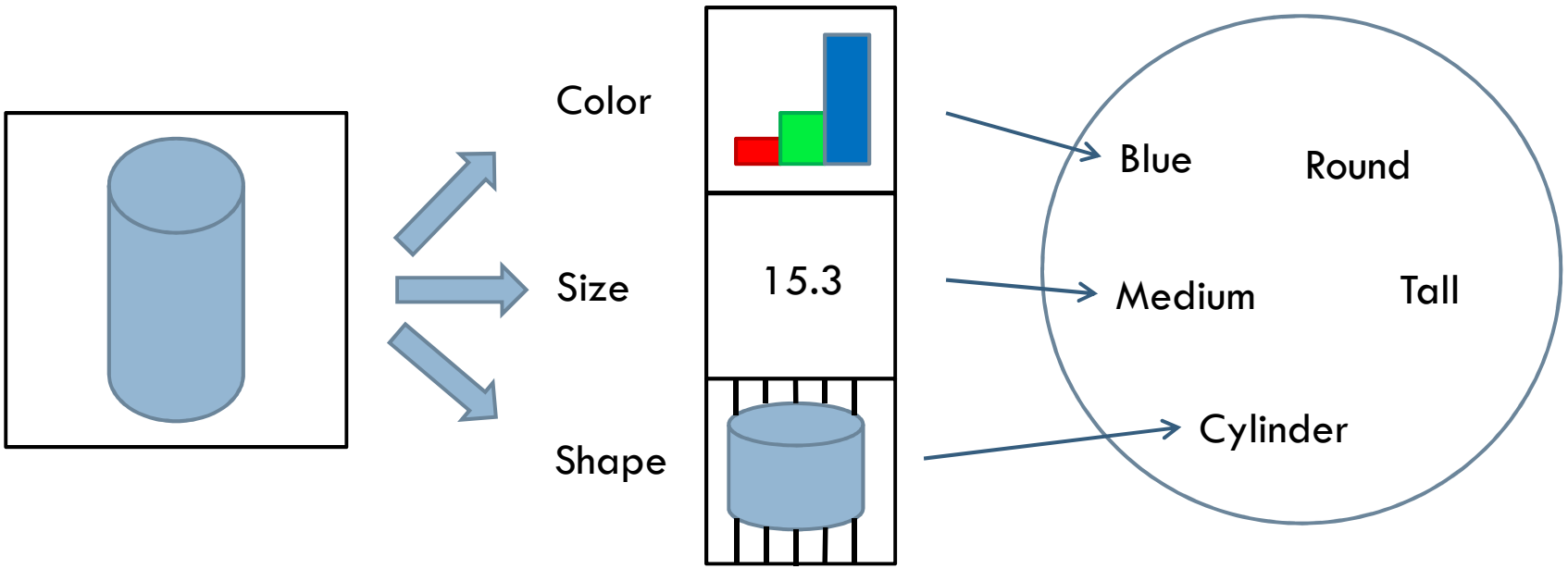
Vision → Description

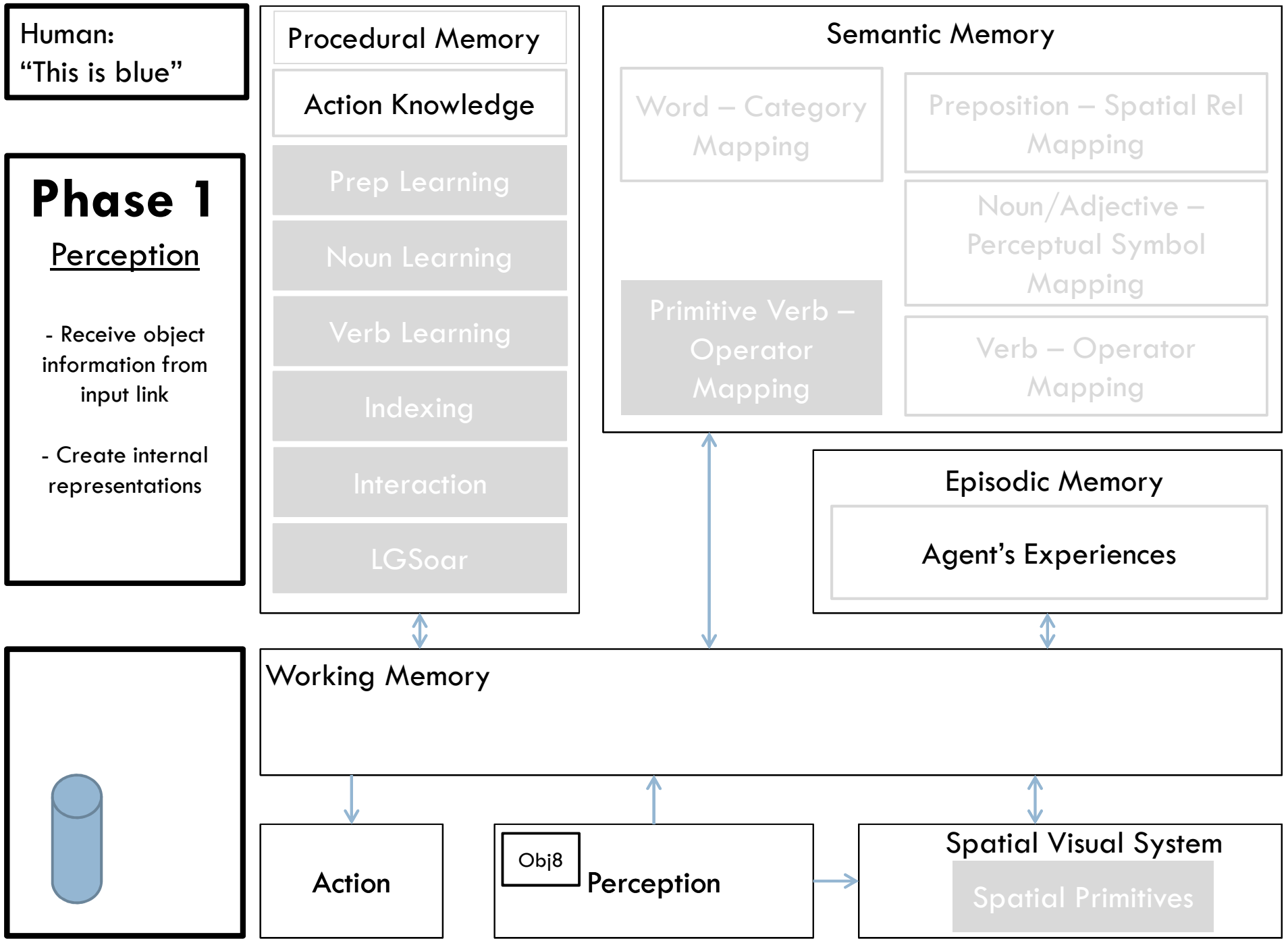
Large gap between raw image data and descriptions

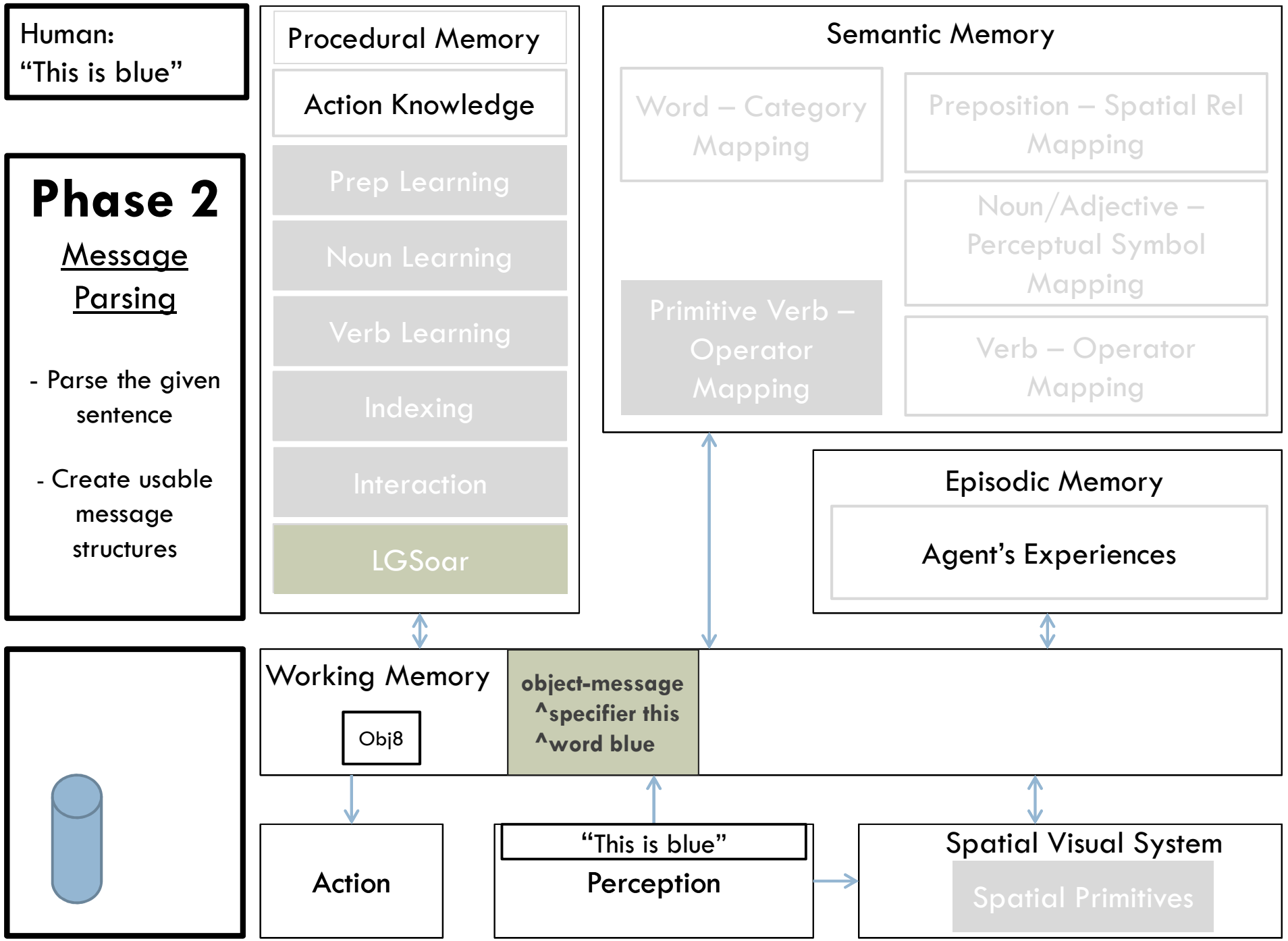


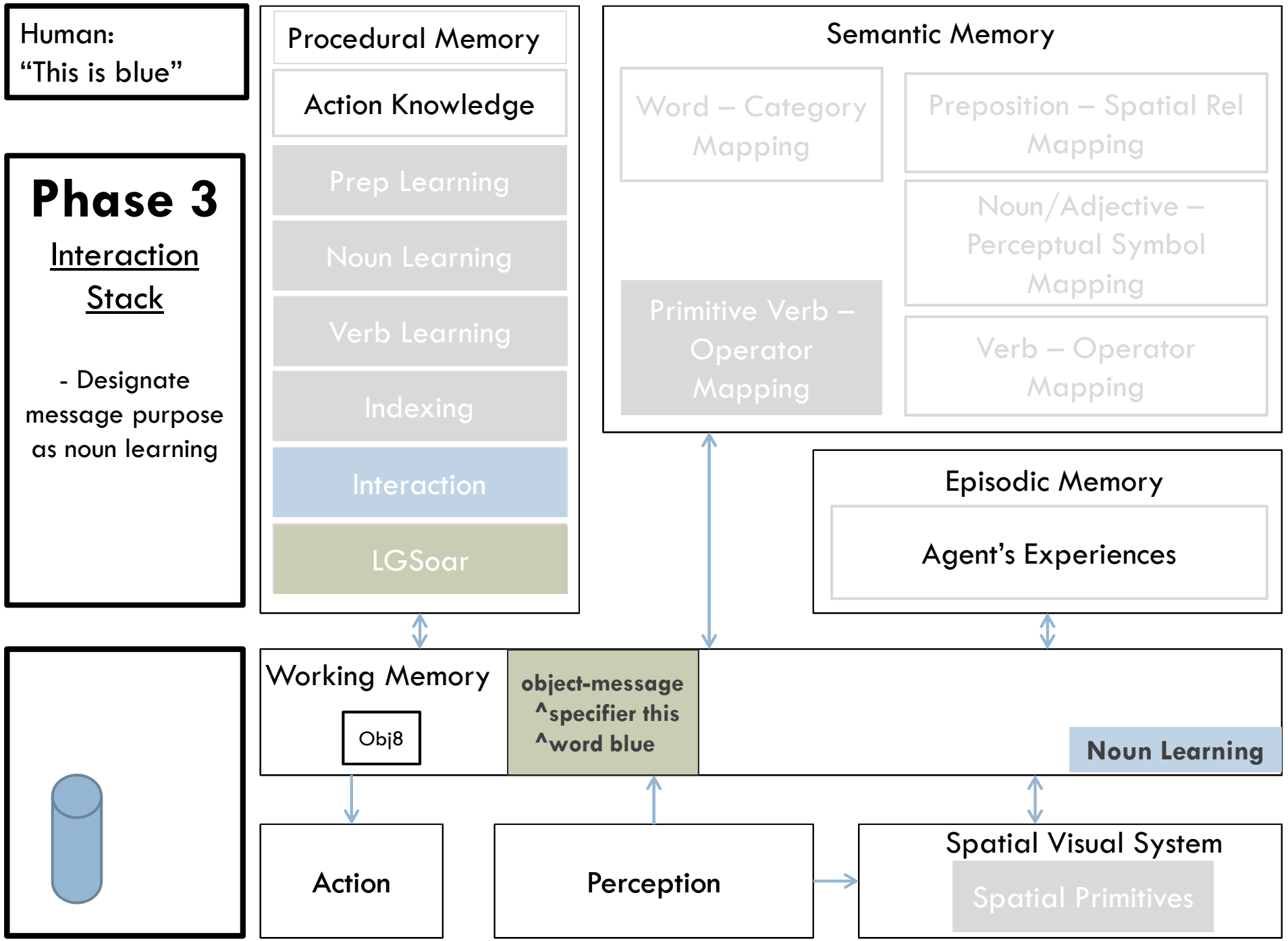
Vision → Description

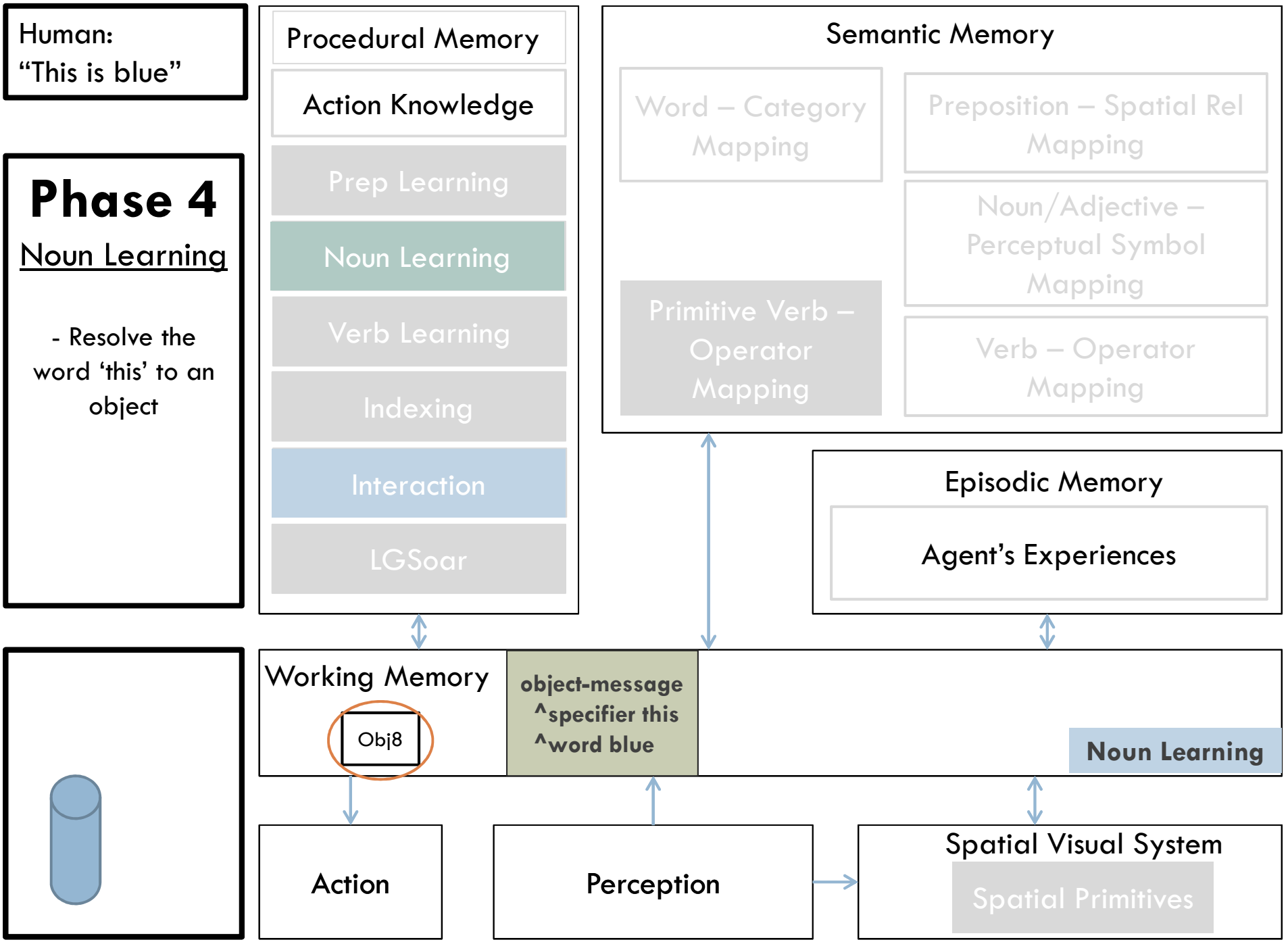
Explicitly define categories of visual properties

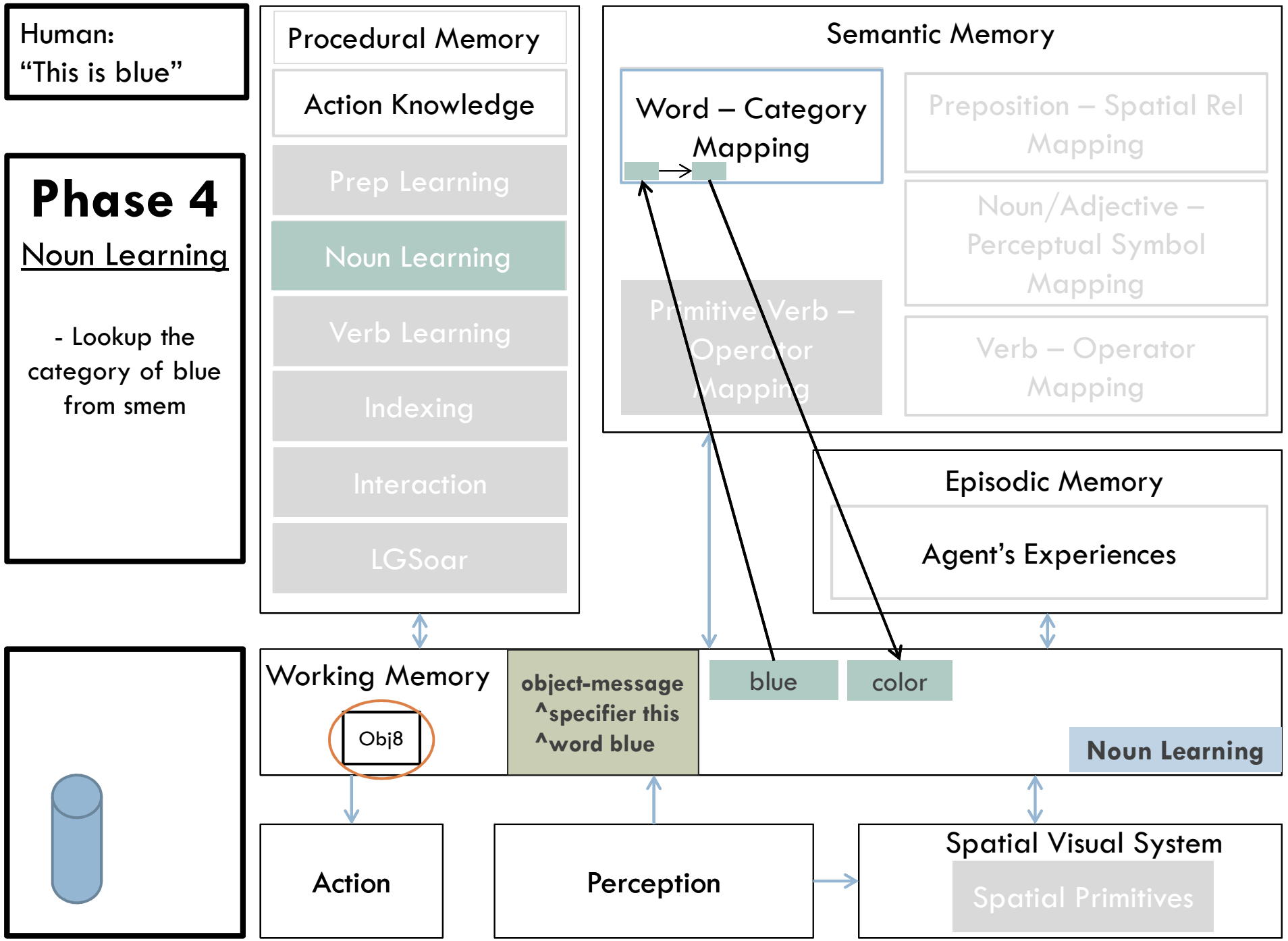


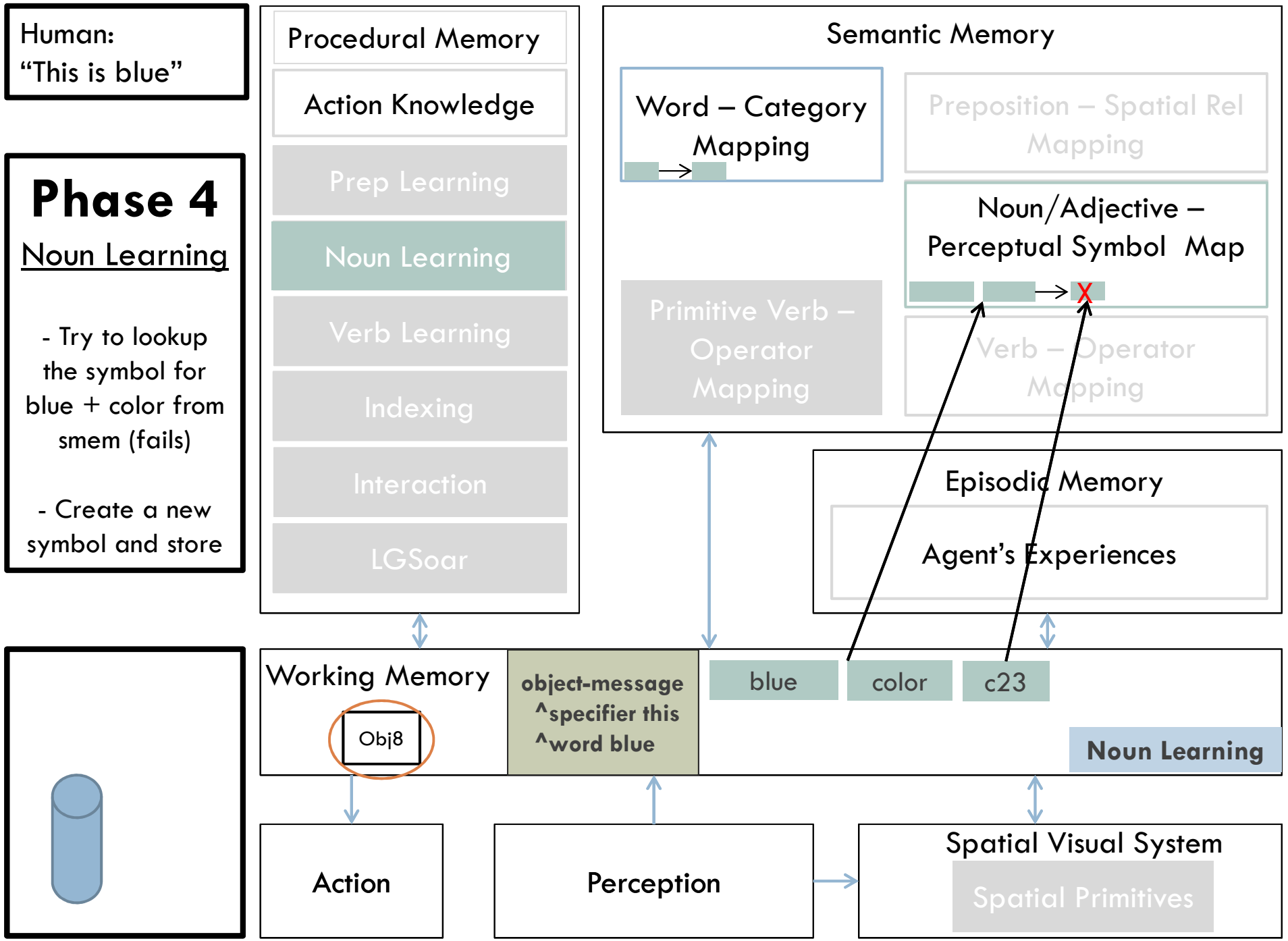

Human:
"This is blue"
Phase 1
Perception
- Receive object information from input link
- Create internal representations
Procedural Memory
Action Knowledge
Prep Learning
Noun Learning
Verb Learning
Indexing
Interaction
LGSoar
Semantic Memory
Word – Category Mapping
Preposition – Spatial Rel Mapping
Noun/Adjective – Perceptual Symbol Mapping
Primitive Verb – Operator Mapping
Verb – Operator Mapping
Episodic Memory
Agent's Experiences
Working Memory
Action
Obj8
Perception
Spatial Visual System
Spatial Primitives

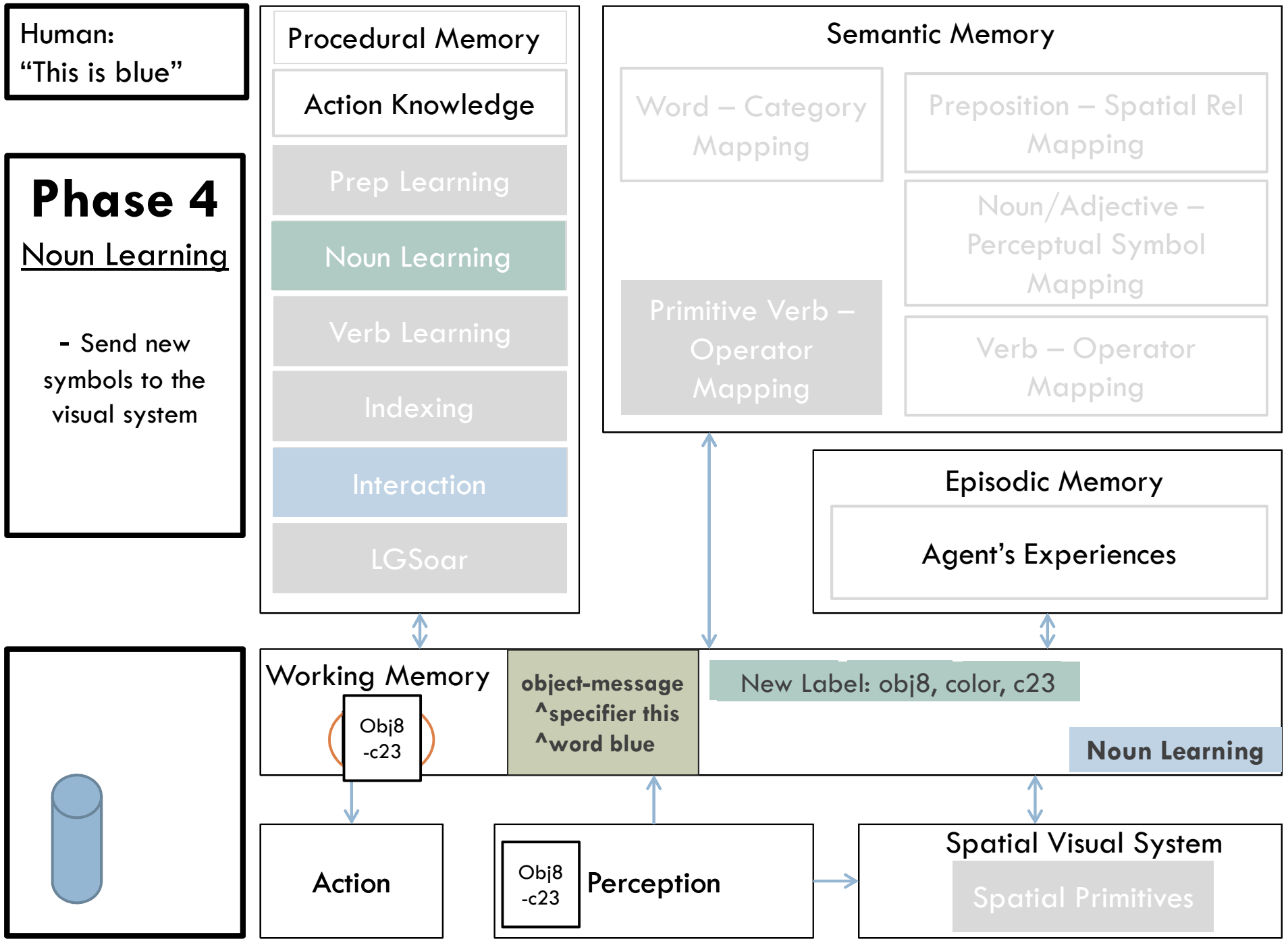

Human:
"This is blue"
Phase 2
Message Parsing
- Parse the given sentence
- Create usable message structures
Procedural Memory
Action Knowledge
Prep Learning
Noun Learning
Verb Learning
Indexing
Interaction
LGSoar
Semantic Memory
Word – Category Mapping
Preposition – Spatial Rel Mapping
Noun/Adjective – Perceptual Symbol Mapping
Primitive Verb – Operator Mapping
Verb – Operator Mapping
Episodic Memory
Agent's Experiences
Working Memory
Obj8
object-message
^specifier this
^word blue
Action
"This is blue"
Perception
Spatial Visual System
Spatial Primitives


Human:
"This is blue"
Phase 3
Interaction Stack
- Designate message purpose as noun learning
Procedural Memory
Action Knowledge
Prep Learning
Noun Learning
Verb Learning
Indexing
Interaction
LGSoar
Semantic Memory
Word – Category Mapping
Preposition – Spatial Rel Mapping
Noun/Adjective – Perceptual Symbol Mapping
Primitive Verb – Operator Mapping
Verb – Operator Mapping
Episodic Memory
Agent's Experiences
Working Memory
Obj8
object-message
^specifier this
^word blue
Noun Learning
Action
Perception
Spatial Visual System
Spatial Primitives


Human:
"This is blue"
Phase 4
Noun Learning
- Resolve the word 'this' to an object
Procedural Memory
Action Knowledge
Prep Learning
Noun Learning
Verb Learning
Indexing
Interaction
LGSoar
Semantic Memory
Word – Category Mapping
Preposition – Spatial Rel Mapping
Noun/Adjective – Perceptual Symbol Mapping
Primitive Verb – Operator Mapping
Verb – Operator Mapping
Episodic Memory
Agent's Experiences
Working Memory
Obj8
object-message
^specifier this
^word blue
Noun Learning
Action
Perception
Spatial Visual System
Spatial Primitives

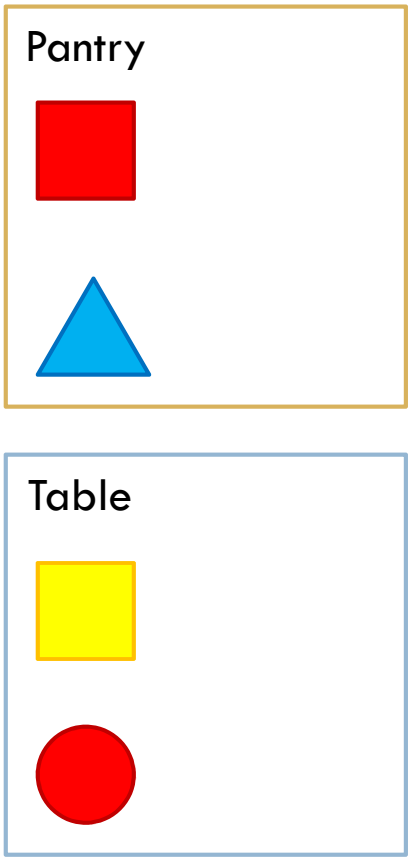

Human:
"This is blue"
Phase 4
Noun Learning
- Lookup the category of blue from smem
Procedural Memory
Action Knowledge
Prep Learning
Noun Learning
Verb Learning
Indexing
Interaction
LGSoar
Semantic Memory
Word – Category Mapping
Preposition – Spatial Rel Mapping
Noun/Adjective – Perceptual Symbol Mapping
Primitive Verb – Operator Mapping
Verb – Operator Mapping
Episodic Memory
Agent's Experiences
Working Memory
Obj8
object-message
^specifier this
^word blue
blue
color
Noun Learning
Action
Perception
Spatial Visual System
Spatial Primitives


Human:
"This is blue"
Phase 4
Noun Learning
- Try to lookup the symbol for blue + color from smem (fails)
- Create a new symbol and store
Procedural Memory
Action Knowledge
Prep Learning
Noun Learning
Verb Learning
Indexing
Interaction
LGSoar
Semantic Memory
Word – Category Mapping
Preposition – Spatial Rel Mapping
Noun/Adjective – Perceptual Symbol Map
X
Primitive Verb – Operator Mapping
Verb – Operator Mapping
Episodic Memory
Agent's Experiences
Working Memory
Obj8
object-message
^specifier this
^word blue
blue
color
c23
Noun Learning
Action
Perception
Spatial Visual System
Spatial Primitives


Human:
"This is blue"
Phase 4
Noun Learning
- Send new symbols to the visual system
Procedural Memory
Action Knowledge
Prep Learning
Noun Learning
Verb Learning
Indexing
Interaction
LGSoar
Semantic Memory
Word – Category Mapping
Preposition – Spatial Rel Mapping
Noun/Adjective – Perceptual Symbol Mapping
Primitive Verb – Operator Mapping
Verb – Operator Mapping
Episodic Memory
Agent's Experiences
Working Memory
Obj8 -c23
object-message ^specifier this ^word blue
New Label: obj8, color, c23
Noun Learning
Action
Obj8 -c23
Perception
Spatial Visual System
Spatial Primitives

Indexing

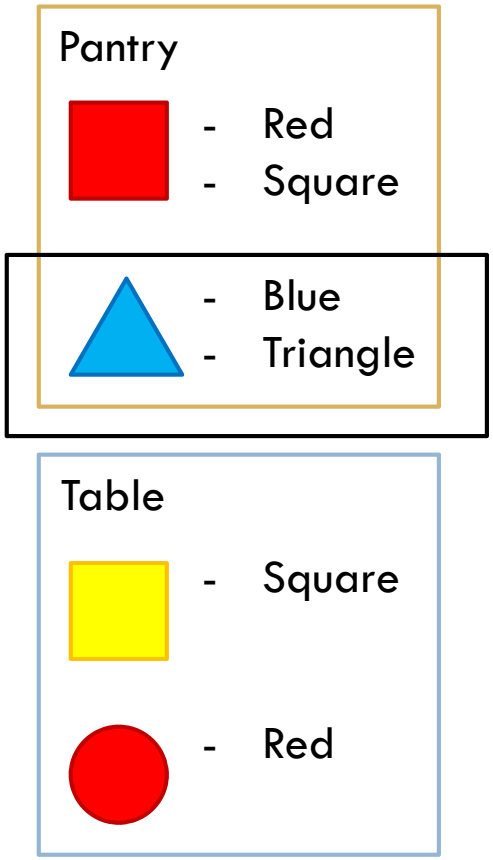
How can the agent identify an object from a description?



"Pick up the blue object."

Indexing

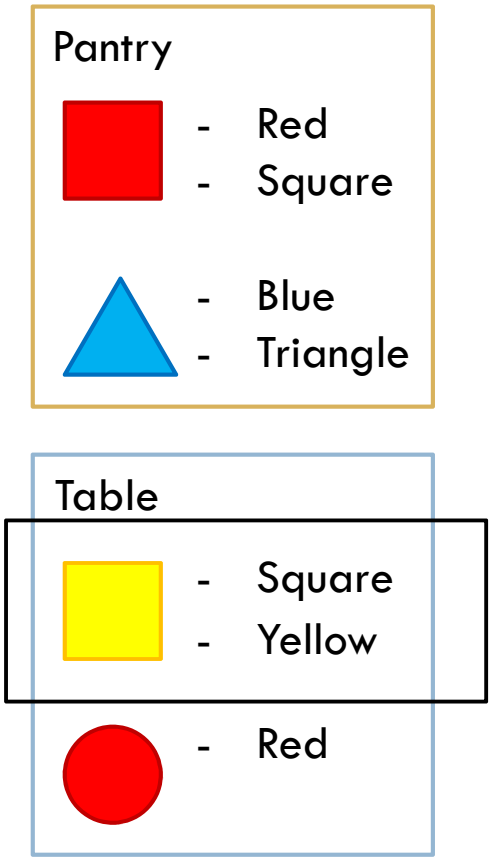
- Case 1: Unambiguous Match



"Move the blue object to the table."

Indexing

- Case 2: No Match (Insufficient Knowledge)



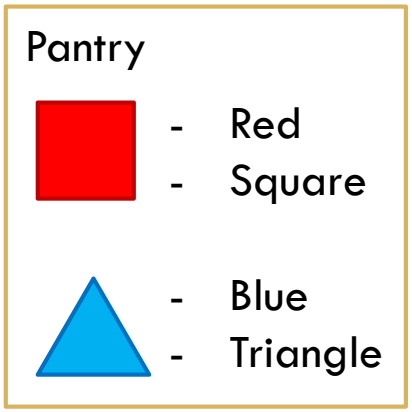
"Which is the yellow square?"

The agent can initiate a new interaction

Requests more teaching examples

Indexing

- Case 3: Multiple Matches



"Pick up the red object."

The agent can initiate a new interaction

Requests more information ("*Which red object?*")

- Point to an object ("This one")
- Give further description ("The square")
- Use spatial relations ("The one in the pantry")

Evaluation

Nuggets:

- Learns new adjectives with few training examples
- Leverages interaction to learn incrementally

Coal:

- Limited to predefined categories

Questions?