Toward a DFT architecture of intentional agents

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Do the concepts of DFT reach all processes of the mind?

- so that DFT would provide a neural foundation for understanding the mind?
- … hinges on what we mean by the "mind"

Intentionality

- *Intentionality* = the capacity of organisms and their nervous systems to generate mental states that are *about things in the world*
  - *things* may include an organism's own body
  - *things* may ultimately also includes the nervous system's own states

Two *directions of fit* of intentional states (Searle)

- *world-to-mind*: the world must match the intentional state to fulfill that state's *condition-of-satisfaction* (CoS) => the "motor" flavor of intentionality
- *mind-to-world*: the intentional state must match the state of the world to fulfill the CoS => "perceptual" flavor of intentionality

Six *psychological modes* of intentional states (Searle)

- *mind-to-world*
  - *perception*
  - *memory*
  - *belief*
- *world-to-mind*
  - *intention-in-action*
  - *prior intention*
  - *desire*

The six modes reflect the sensory-motor grounding of cognition

- *world-to-mind*
  - *motor control*
  - *action plans, decisions, sequences*
  - *goals, motivations, emotions*

- *mind-to-world*
  - *attention, active, perception, working memory*
  - *scene memory, event memory*
  - *back-ground knowledge, learning from experience,*

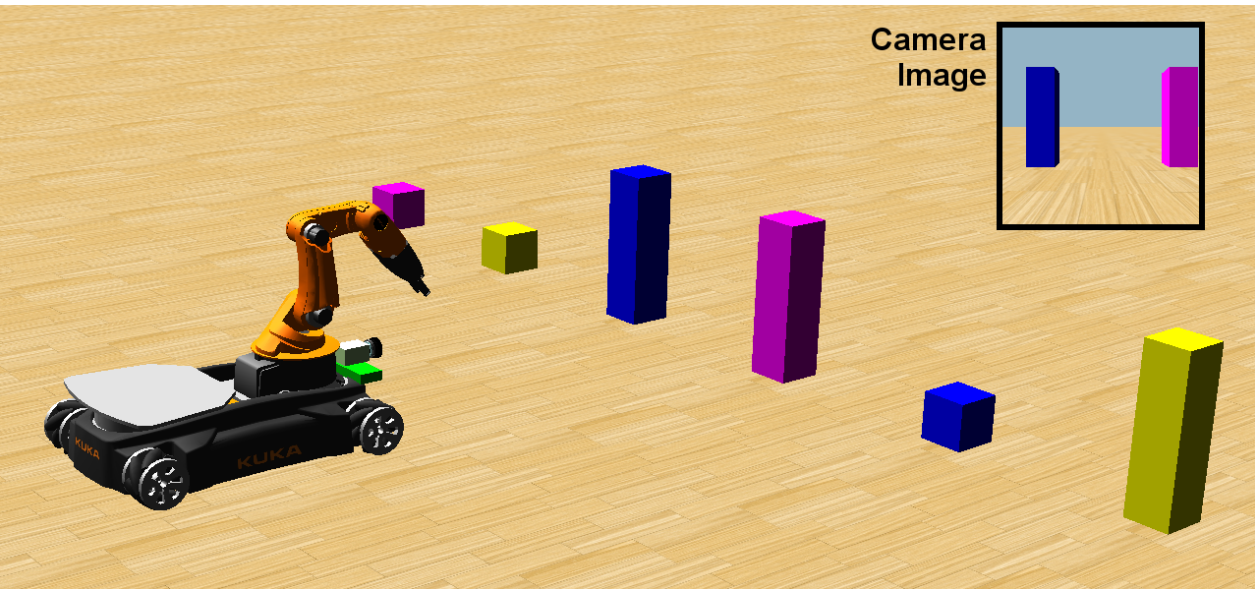
Six *psychological modes*

- Hypothesis: these psychological mode reach all of the mind

- *mind-to-world*
  - *perception*
  - *memory*
  - *belief*
- *world-to-mind*
  - *intention-in-action*
  - *prior intention*
  - *desire*

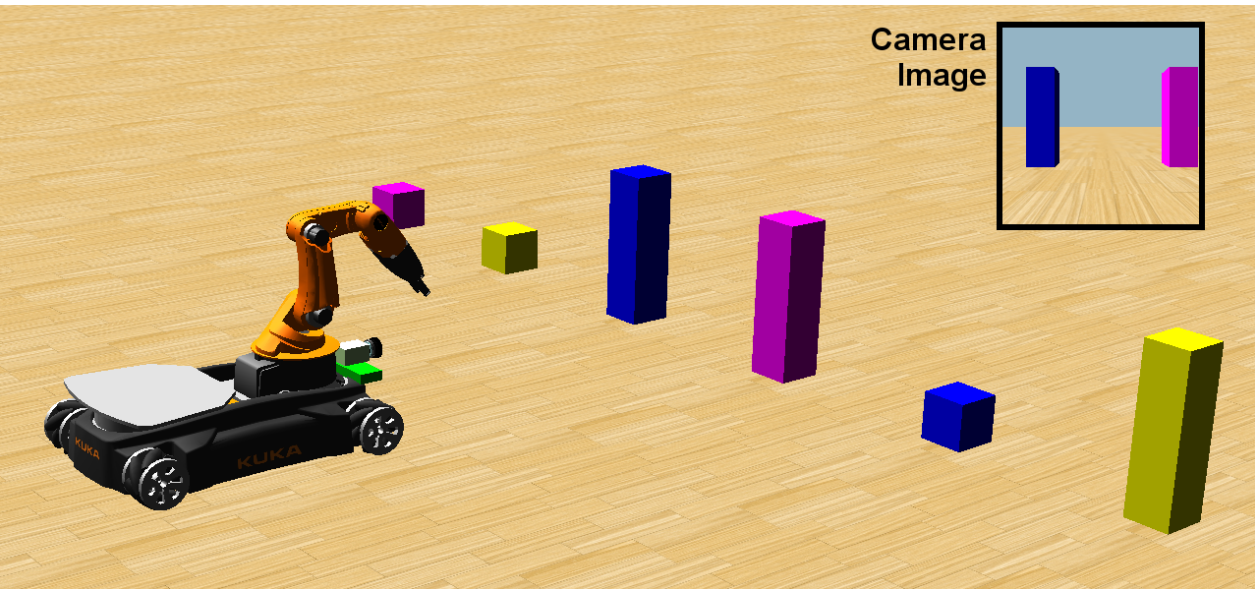
A first exploration into intentional systems

An intentional agent in environment



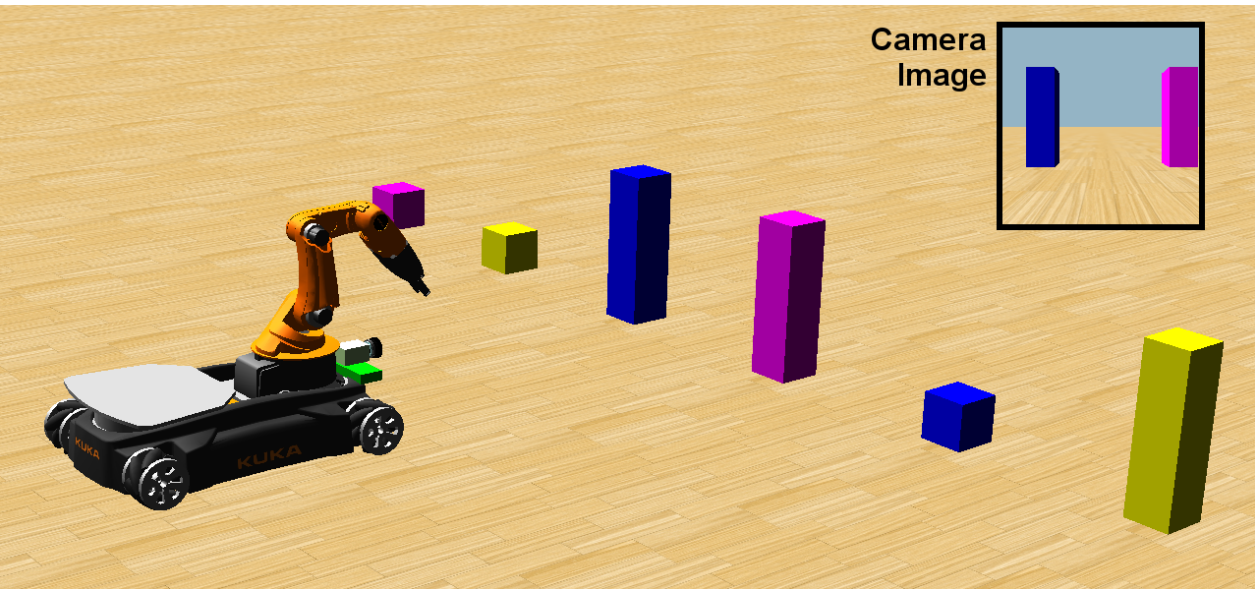
- environment
  - colored objects (small)
  - paint buckets (tall)
  - vehicle with arm
- perception
  - see color/feature
  - sense position, arm, paint in gripper
- intention in action
  - move in 1D
  - reach to take up paint
  - reach to apply a coat of paint

An intentional agent in environment



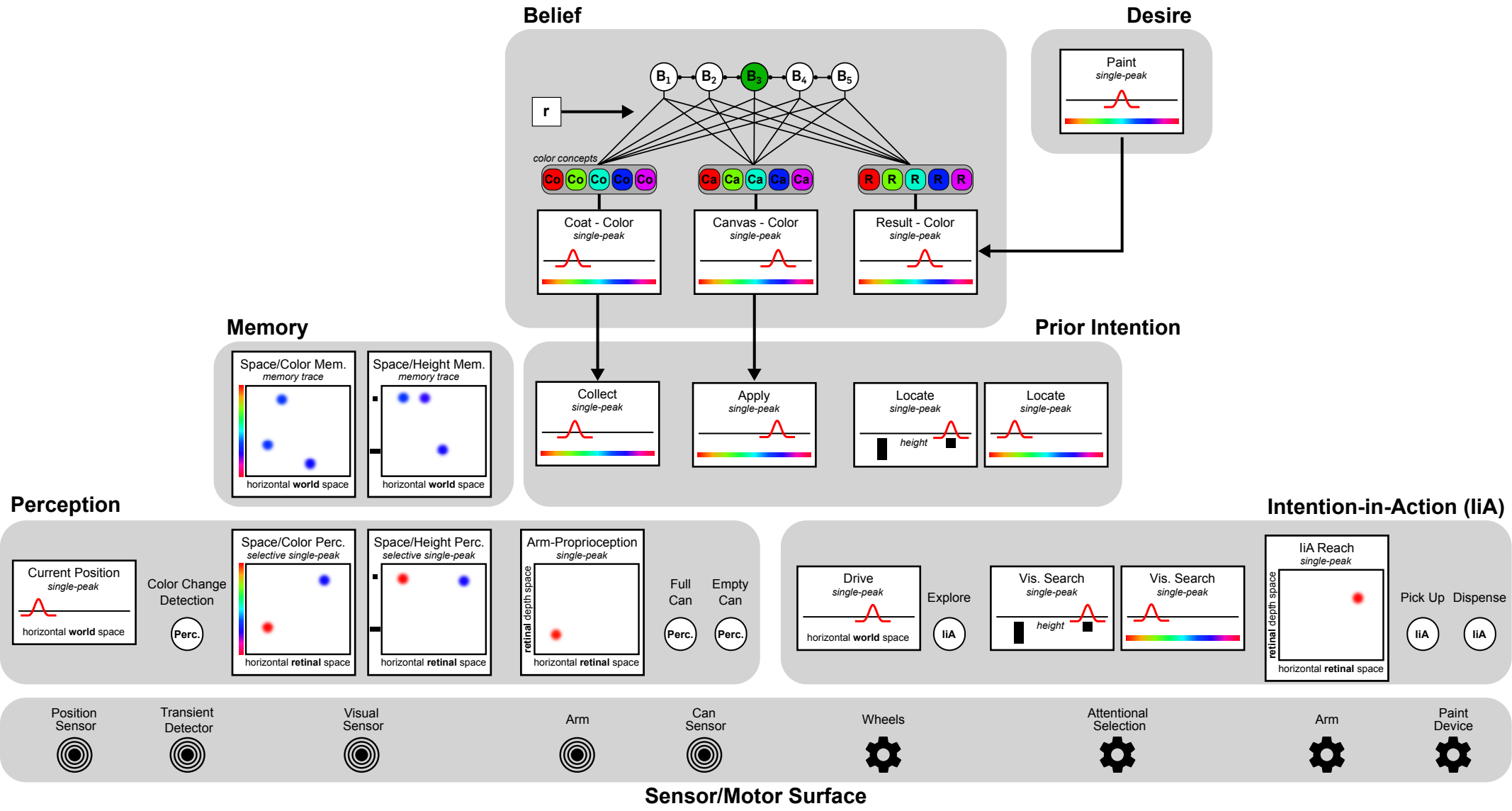
- memory
  - of visual scene
- prior intentions
  - search to paint
  - search to load paint
  - reach to apply paint
  - move to a recalled location …

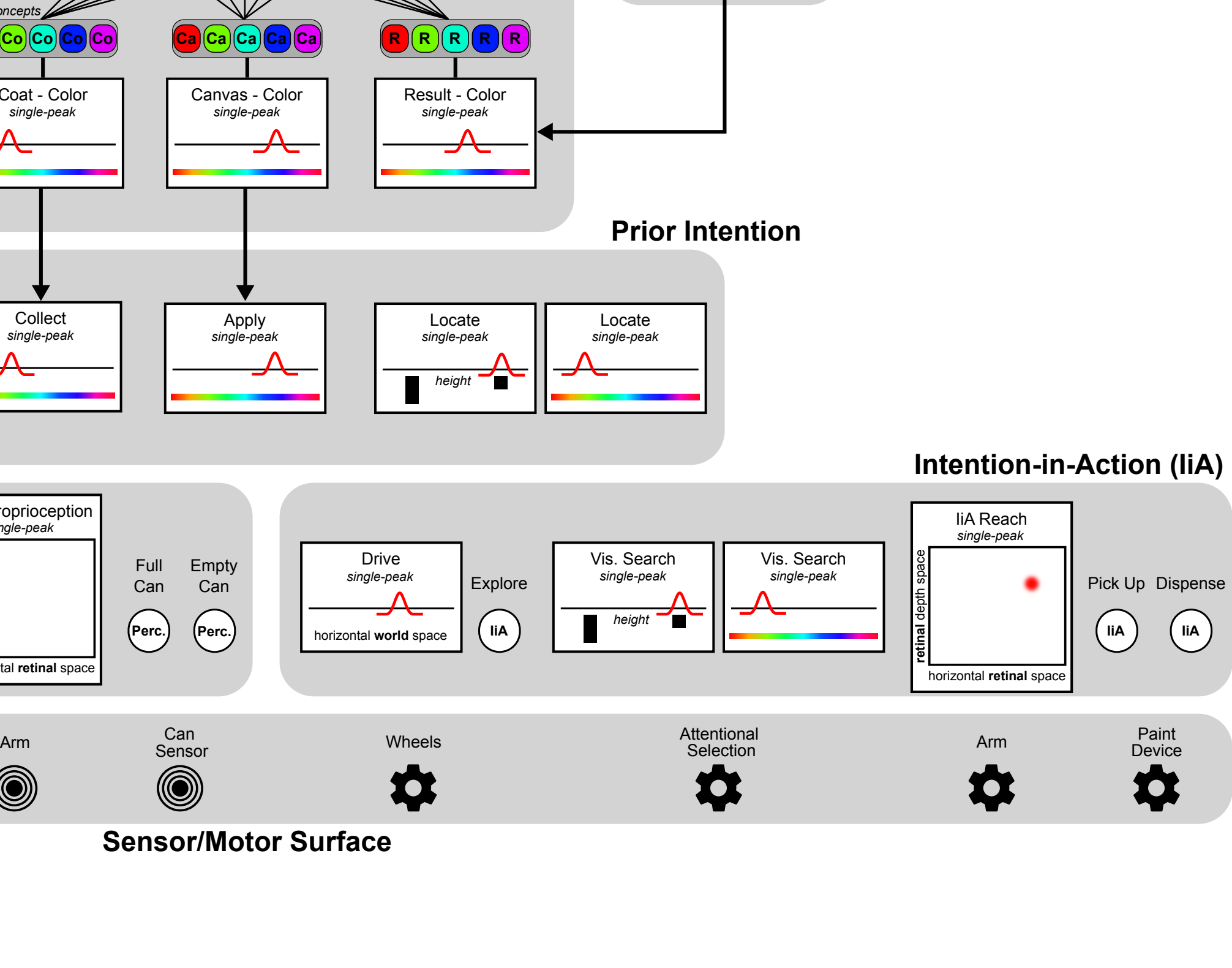
An intentional agent in environment



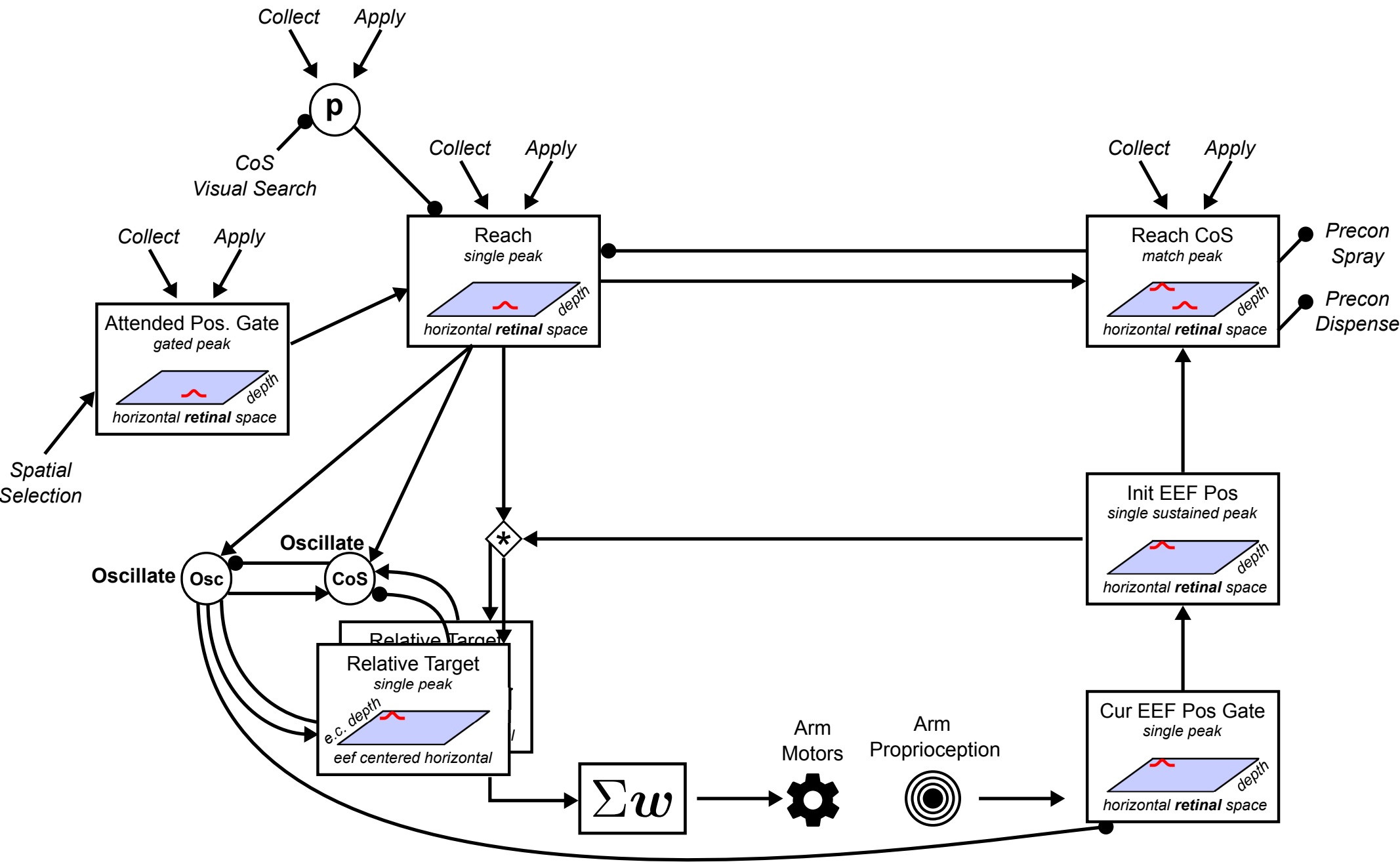
- beliefs
  - (propositional)
  - rules linking color concepts: which paint on which canvas generates which new color
  - learn these beliefs
- desires
  - to point cubes in a particular color

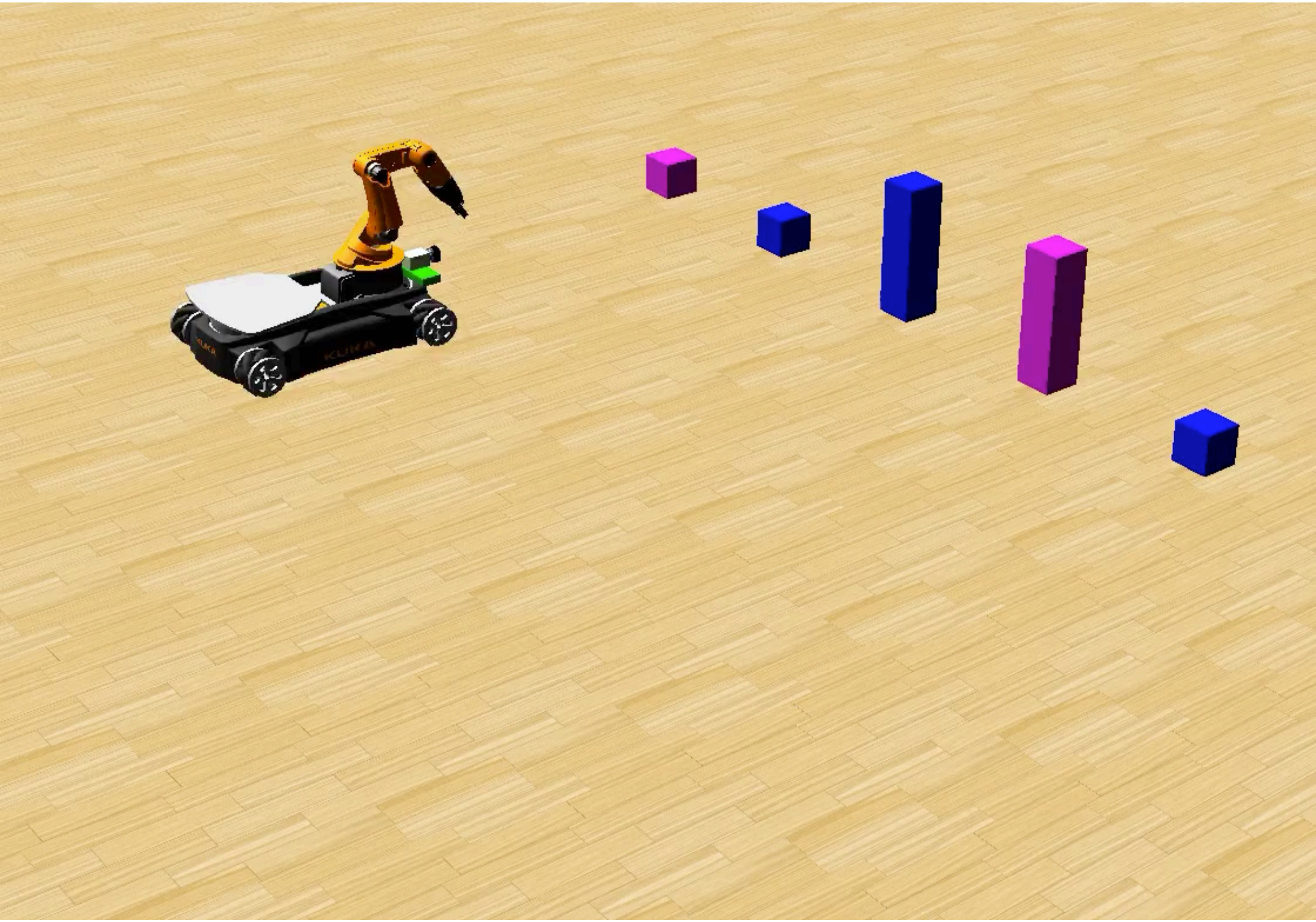
Neural dynamic architecture

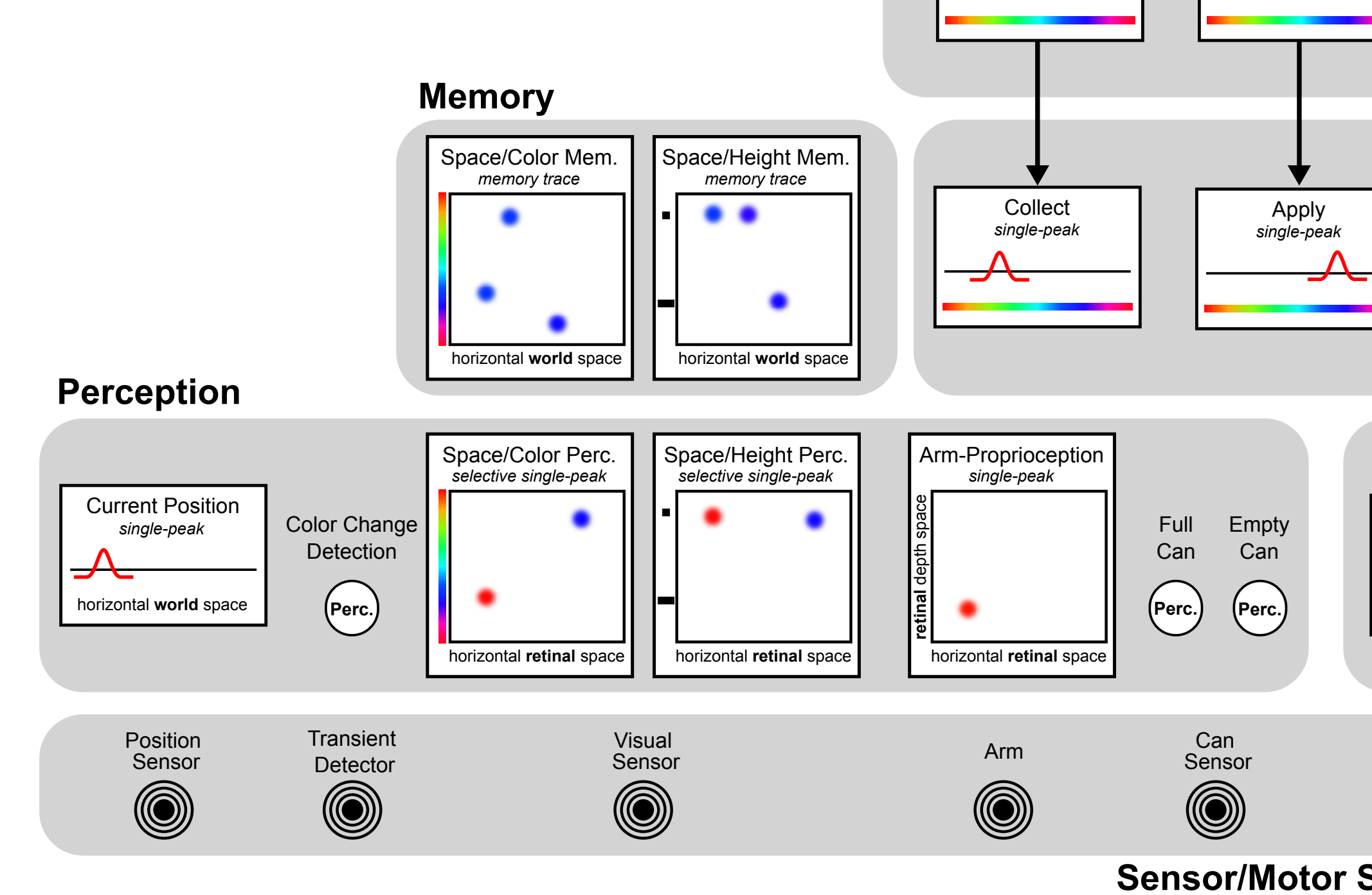



oncepts
Co Co Co Co
Ca Ca Ca Ca Ca
R R R R R
Coat - Color
single-peak
Canvas - Color
single-peak
Result - Color
single-peak
Prior Intention
Collect
single-peak
Apply
single-peak
Locate
single-peak
height
Locate
single-peak
Intention-in-Action (liA)
roprioception
ngle-peak
tal retinal space
Full Can
Empty Can
Perc.
Perc.
Drive
single-peak
horizontal world space
Explore
liA
Vis. Search
single-peak
height
Vis. Search
single-peak
liA Reach
single-peak
retinal depth space
horizontal retinal space
Pick Up
Dispense
liA
liA
Arm
Can Sensor
Wheels
Attentional Selection
Arm
Paint Device
Sensor/Motor Surface

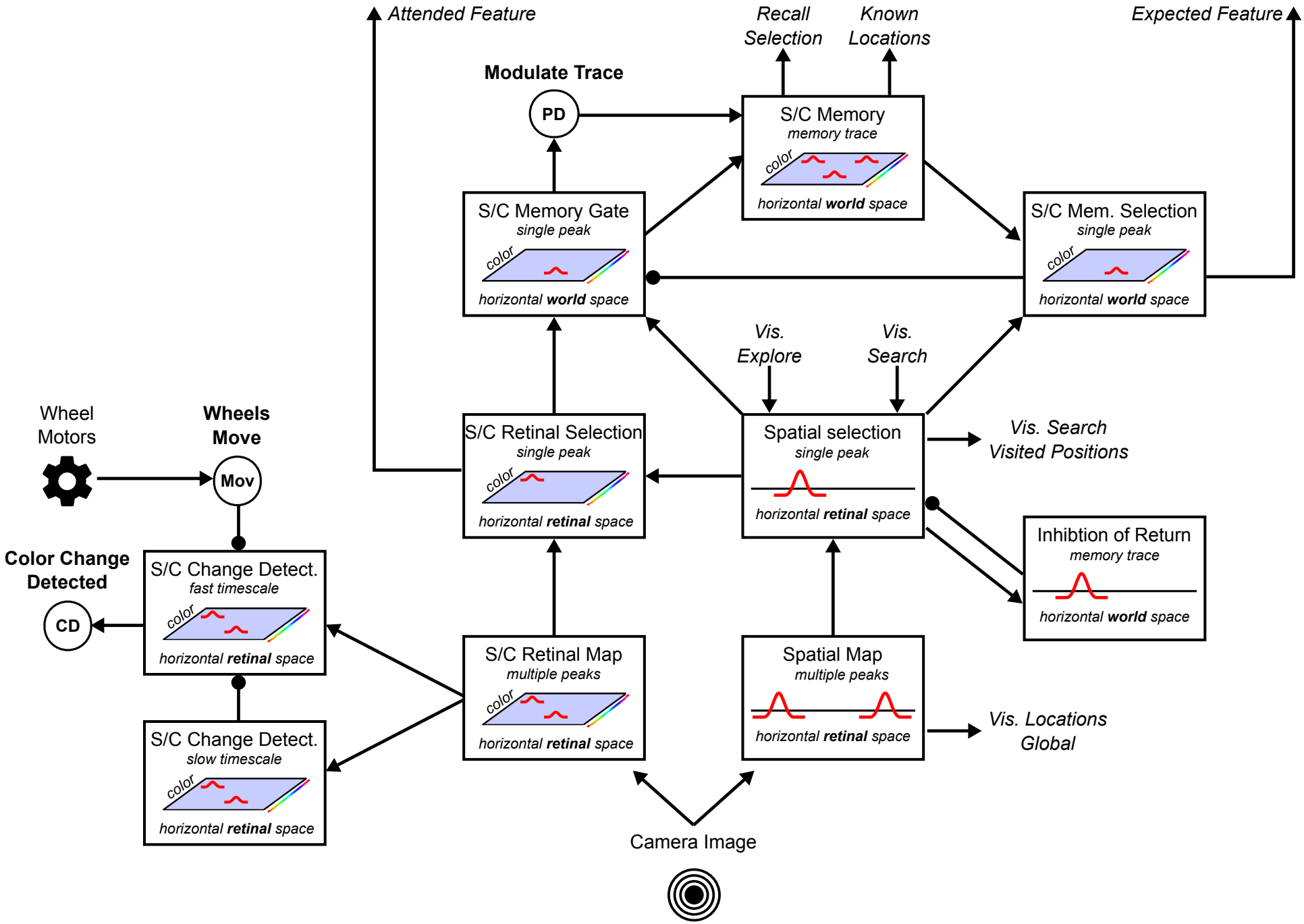
Intention in action: reach






Memory
Space/Color Mem.
memory trace
horizontal world space
Space/Height Mem.
memory trace
horizontal world space
Collect
single-peak
Apply
single-peak
Perception
Current Position
single-peak
horizontal world space
Color Change Detection
Perc.
Space/Color Perc.
selective single-peak
horizontal retinal space
Space/Height Perc.
selective single-peak
horizontal retinal space
Arm-Proprioception
single-peak
retinal depth space
horizontal retinal space
Full Can
Perc.
Empty Can
Perc.
Position Sensor
Transient Detector
Visual Sensor
Arm
Can Sensor
Sensor/Motor S

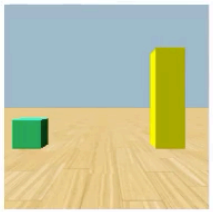
Perception and memory



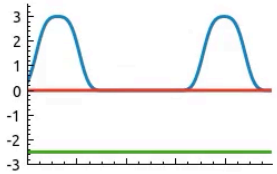
From perception to scene memory

[memory initially empty, then sequentially built]

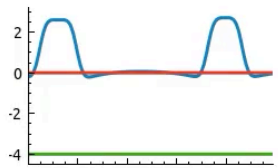
Camera



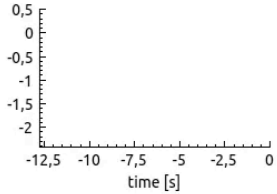
Saliency



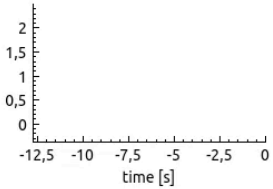
Saliency Selection



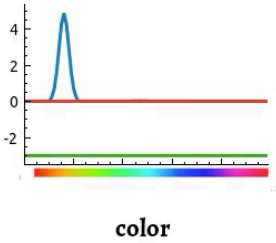
Intention Vis. Explore



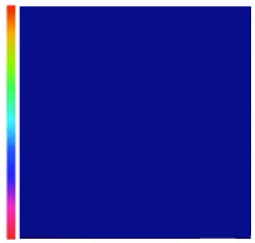
CoS Vis. Explore



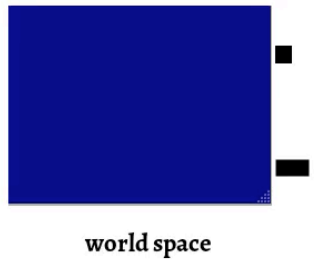
Attended Color



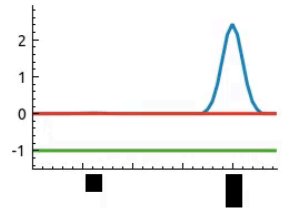
S/C Memory



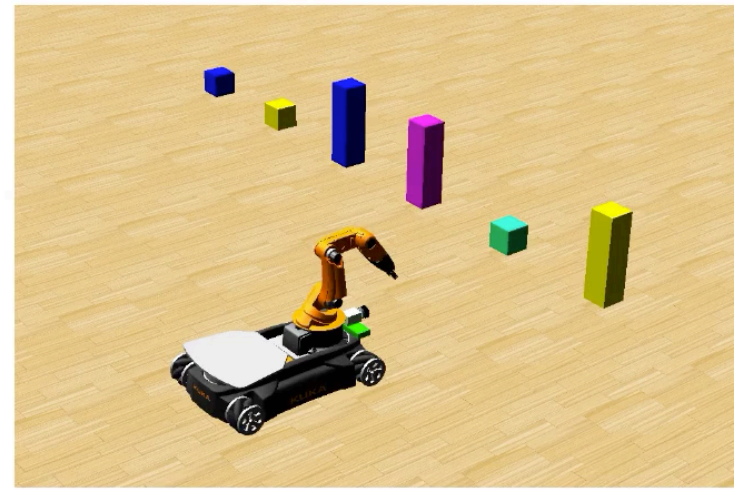
S/H Memory



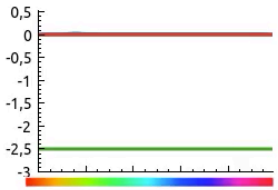
Attended Height



Scene

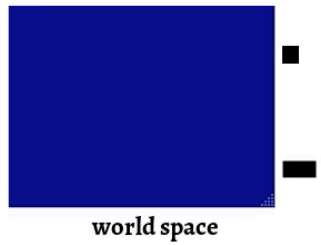


Expected Color

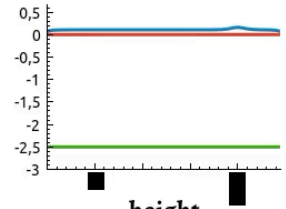


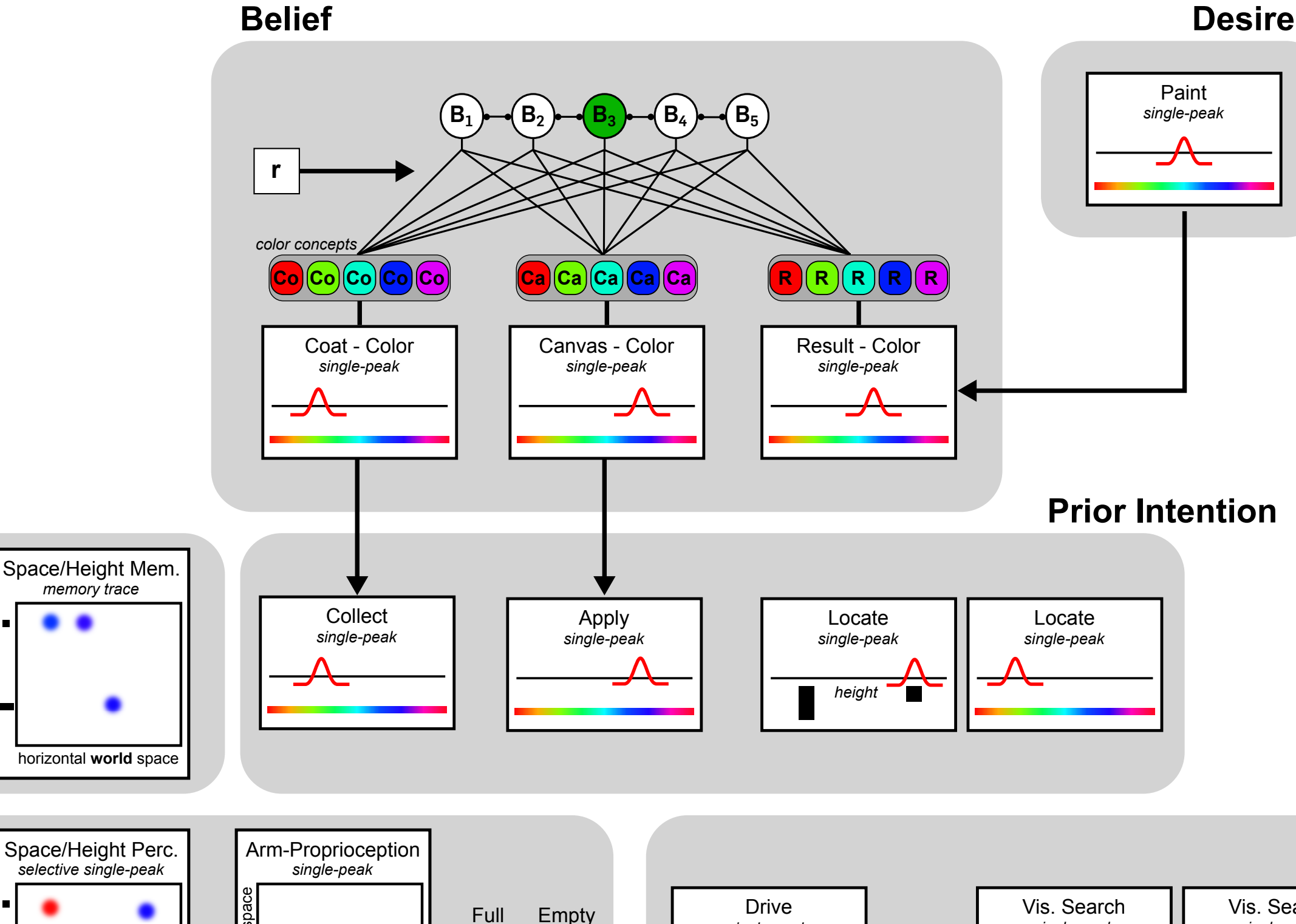
S/C Mem. Selection

S/H Mem. Selection

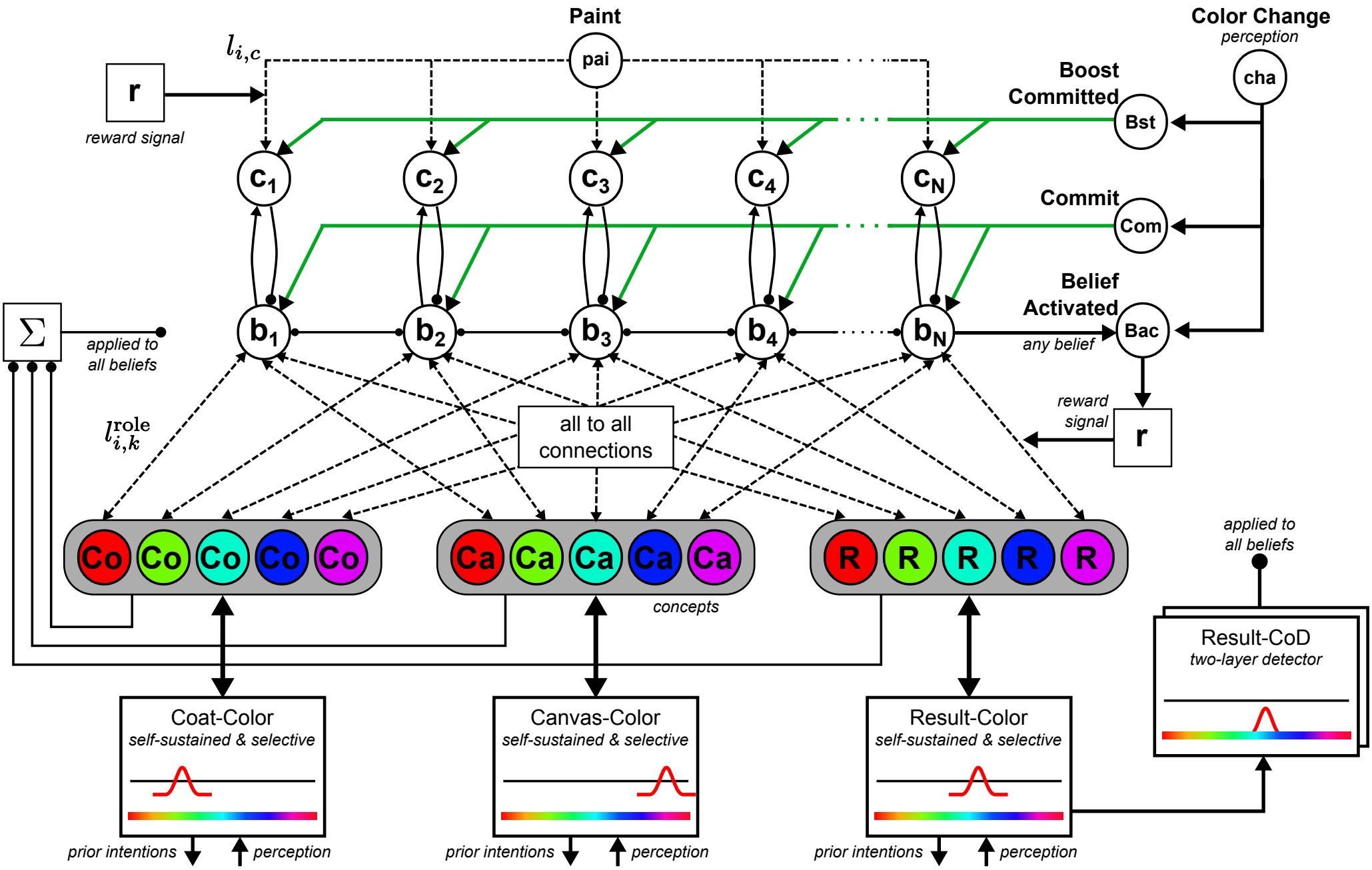


Expected Height



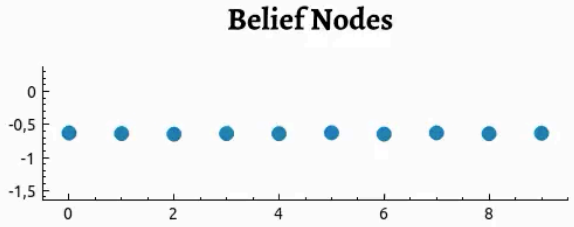

Belief
Desire
Prior Intention
B1
B2
B3
B4
B5
r
color concepts
Co Co Co Co Co
Ca Ca Ca Ca Ca
R R R R R
Coat - Color
single-peak
Canvas - Color
single-peak
Result - Color
single-peak
Paint
single-peak
Space/Height Mem.
memory trace
horizontal world space
Collect
single-peak
Apply
single-peak
Locate
single-peak
height
Locate
single-peak
Space/Height Perc.
selective single-peak
Arm-Proprioception
single-peak
Full
Empty
Drive
Vis. Search
Vis. Sea

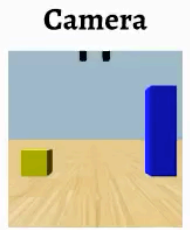
Learning a new belief

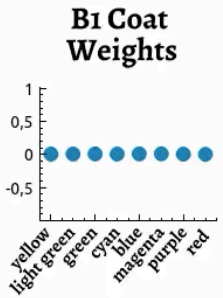


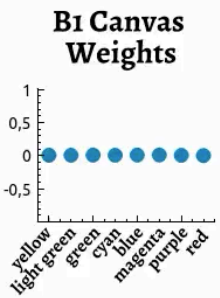
Learn a new belief

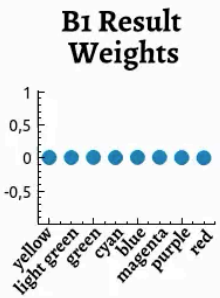
[while exploring: applying blue paint to yellow cube]

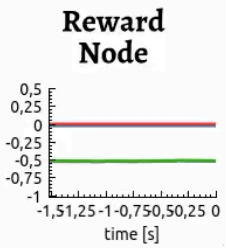


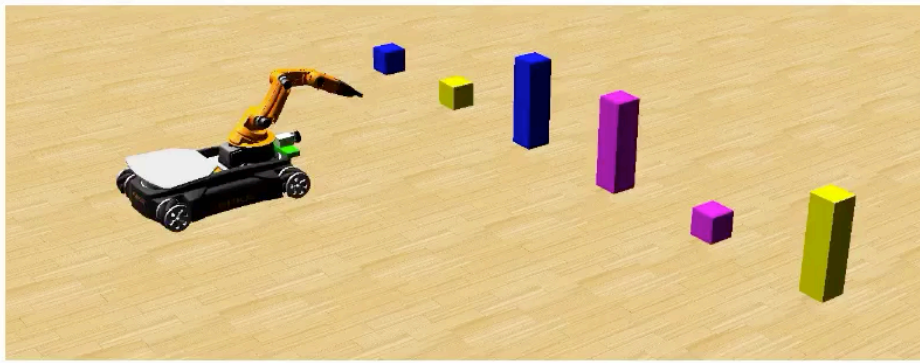


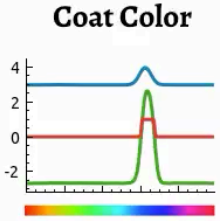


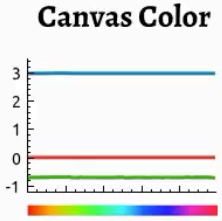


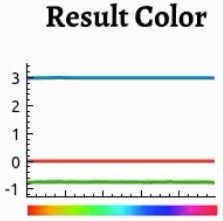


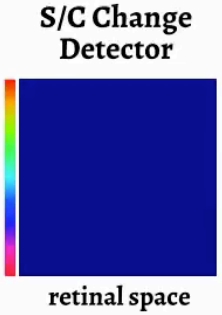






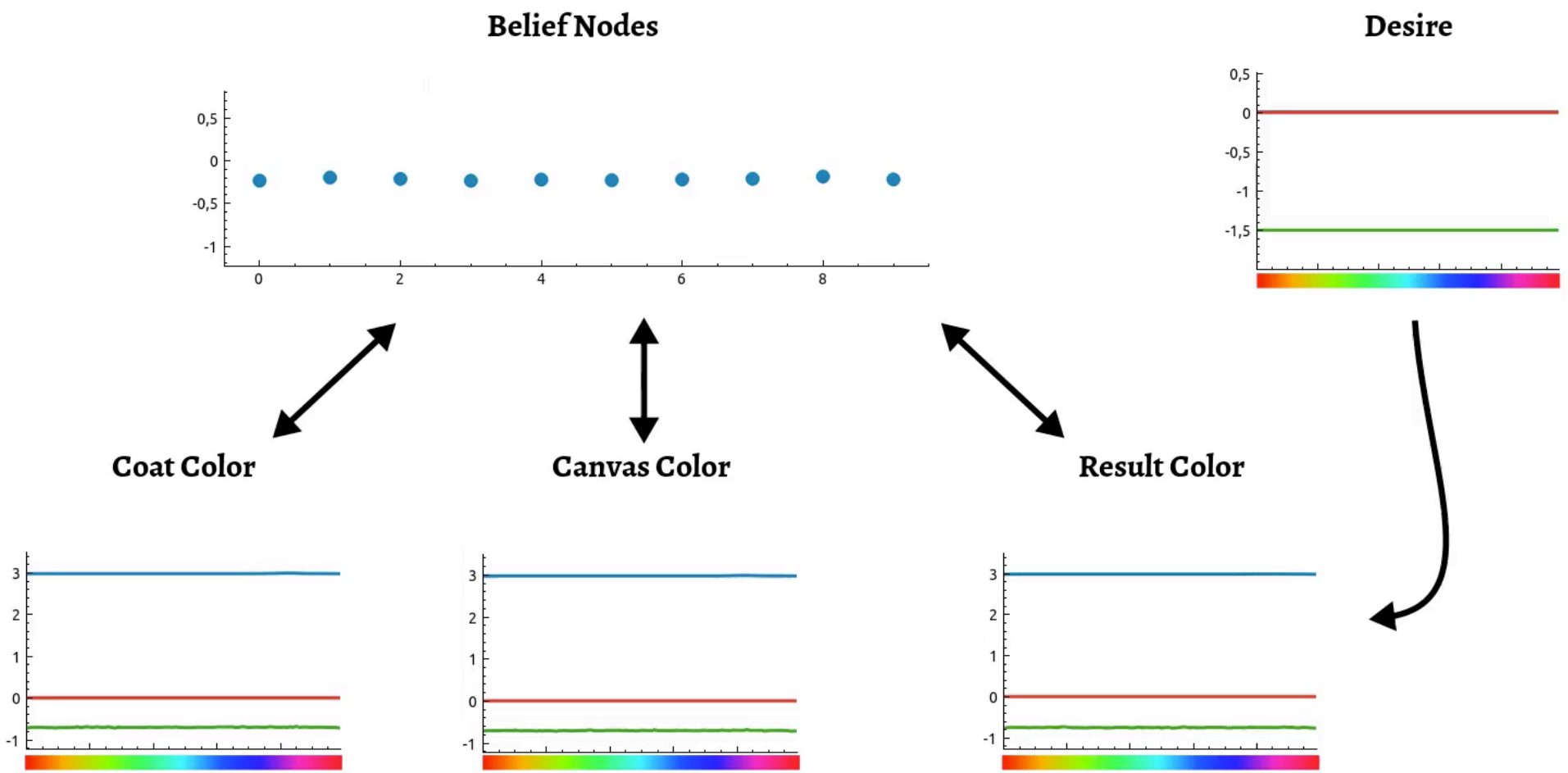






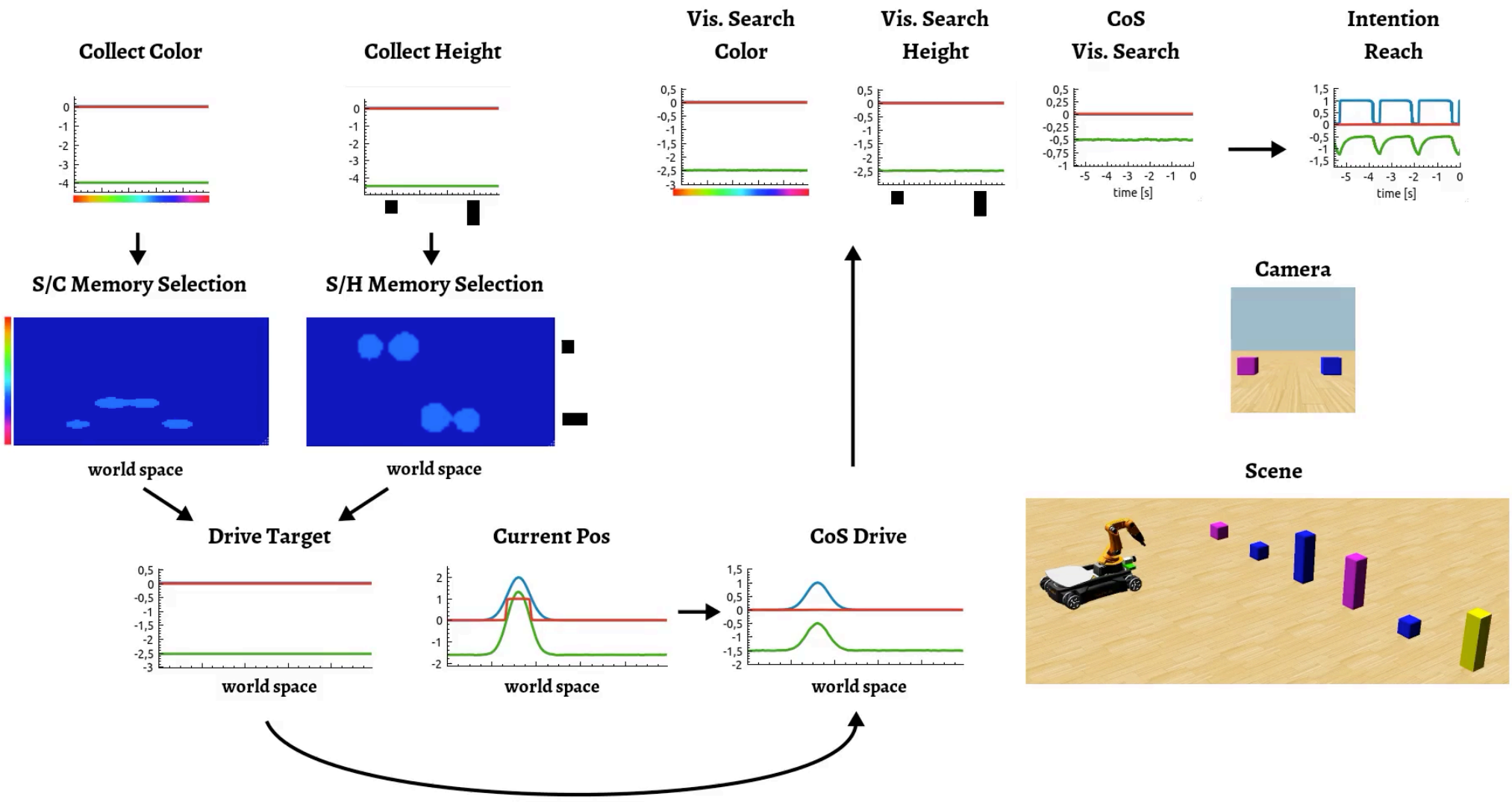
Recall a belief

[triggered by a desire and objects in scene memory]



Recall-drive-search

[based on a desire and an activated belief, looking for a tall pink object, which is in memory]



Toward intentional agents

- *Intentional states* as neural attractors
- that emerge and disappear through instabilities controlled by *conditions of satisfaction*
- neural dynamic architecture organizes *processes* of an *intentional agent* across the *two directions of fit* and *six psychological modes*
- neural dynamics scales due to the robustness of attractor states