

Neural dynamic concepts for intentional systems

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How does the mind emerge from neural processes?

- What do I mean by the “mind”?
- *Intentionality* = the capacity of 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*

Six *psychological modes* of intentional states (Searle)

■ *mind-to-world*

■ *world-to-mind*

■ *perception*

■ *intention-in-action*

■ *memory*

■ *prior intention*

■ *belief*

■ *desire*

■ => reflect the
sensory-motor
basis of
cognition

■ attention/gaze

■ active perception/working memory

■ background knowledge

■ motor control

■ action plans/decisions/ sequences

■ goals



Scenario: intentional agent in simple world

world

colored objects (small)

paint buckets (tall)

vehicle with arm

perception

see color/feature

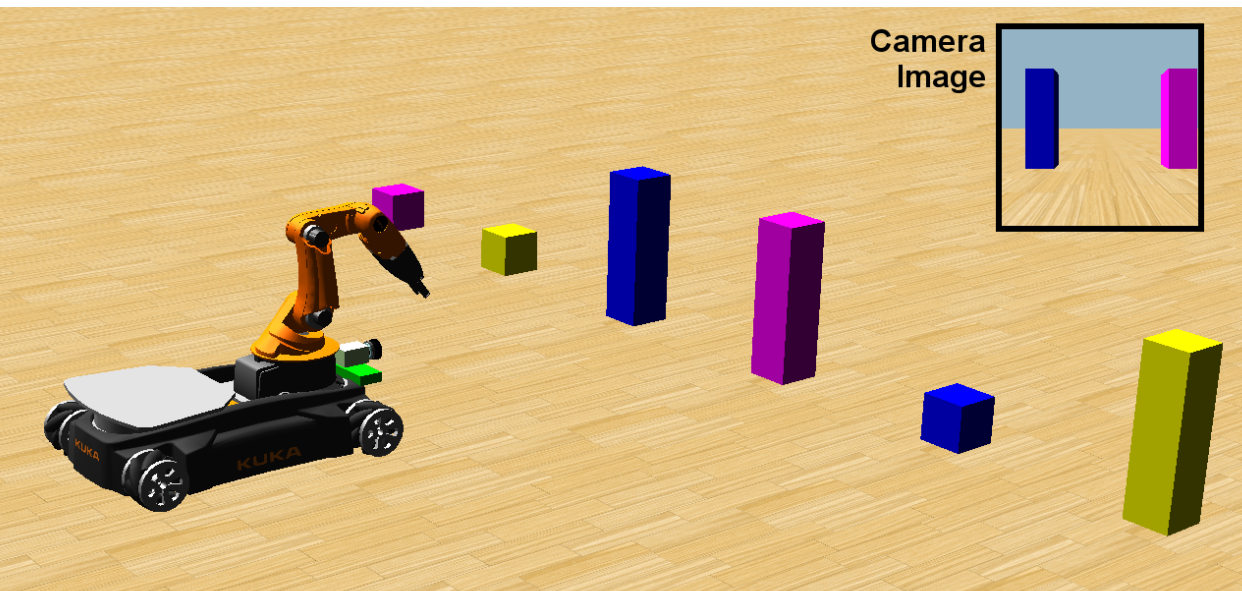
sense position, arm, paint in gripper

intention in action

move in ID

reach to take up paint

reach to apply a coat of paint



Scenario: intentional agent in simple world

■ memory

■ of visual scene

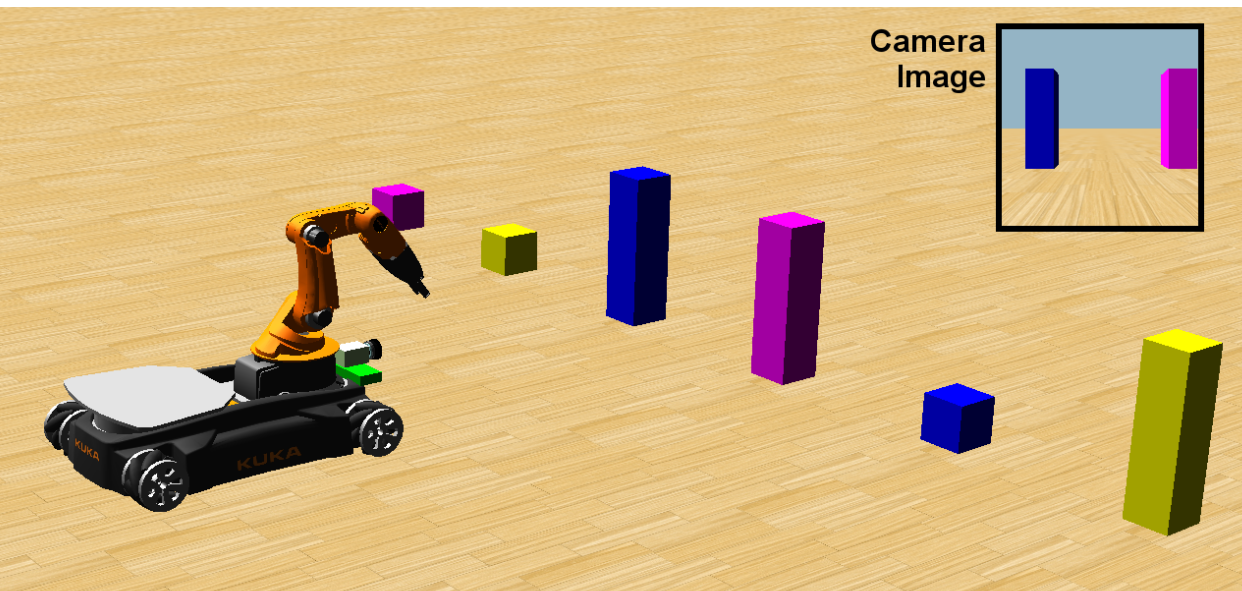
■ prior intentions

■ search to paint

■ search to load paint

■ reach to apply paint

■ move to a recalled location ...



Scenario: intentional agent in simple world

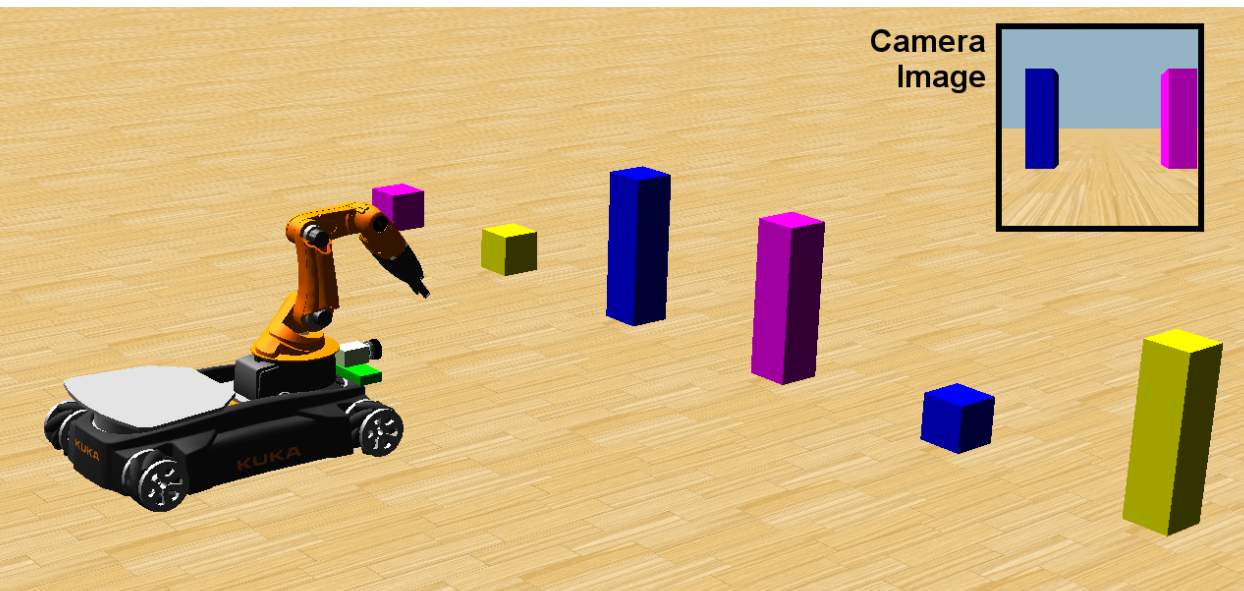
■ beliefs

■ (propositional)

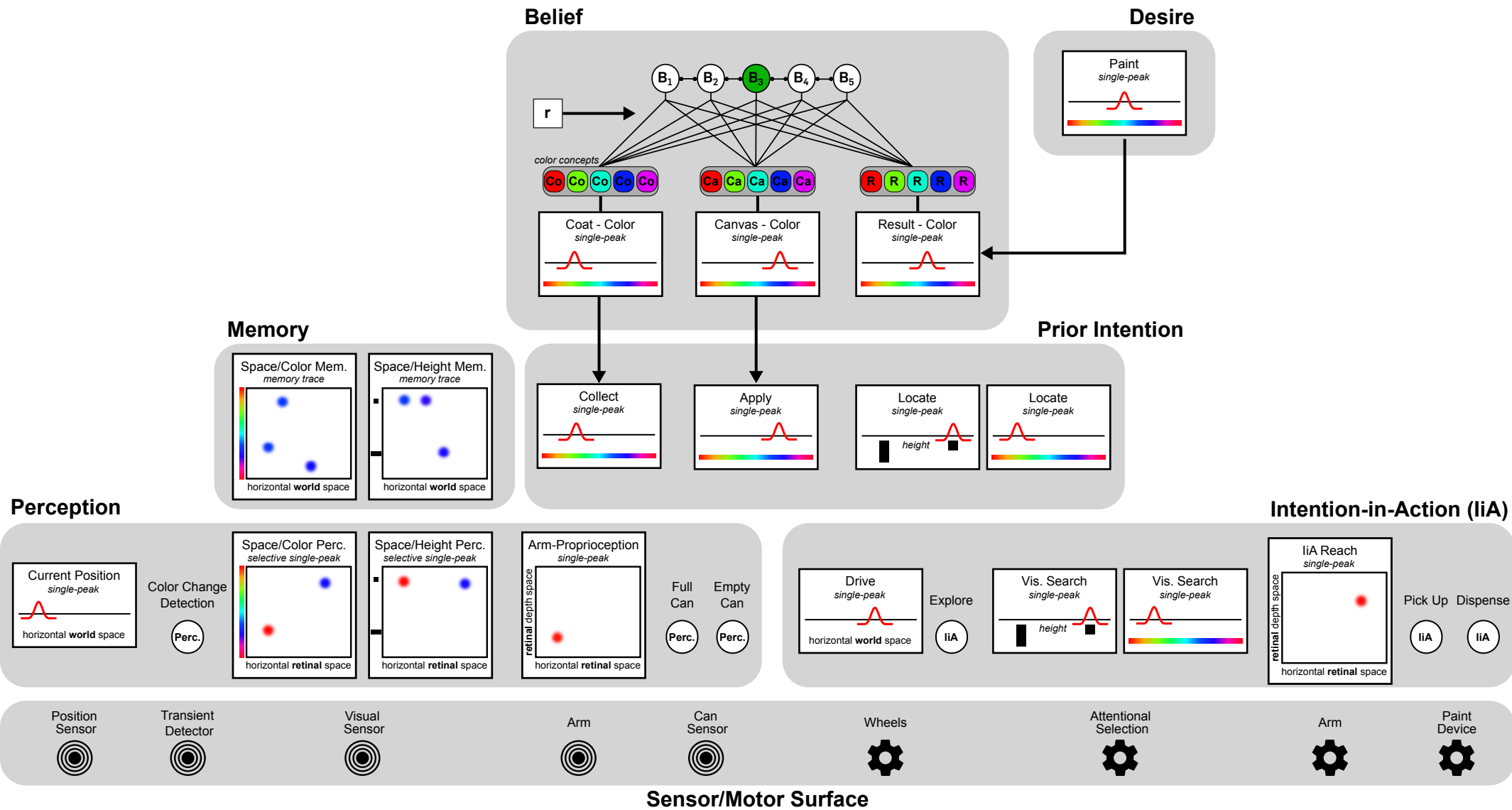
■ rules linking color concepts: which paint on which canvas generates which new color

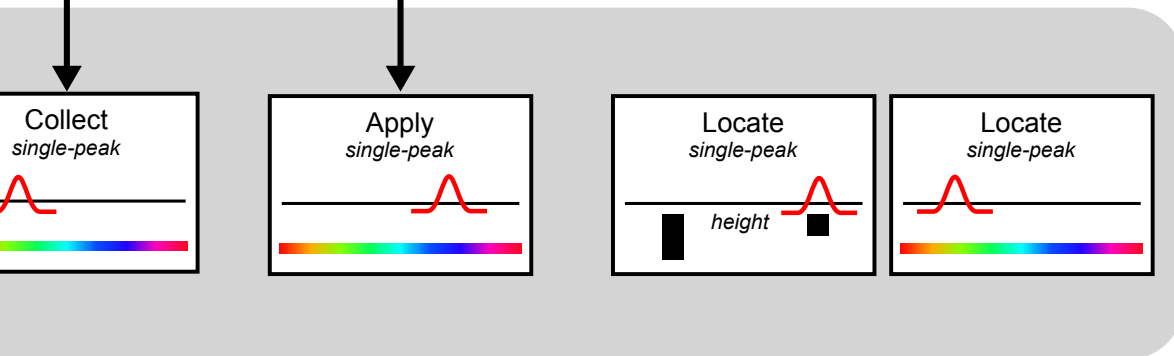
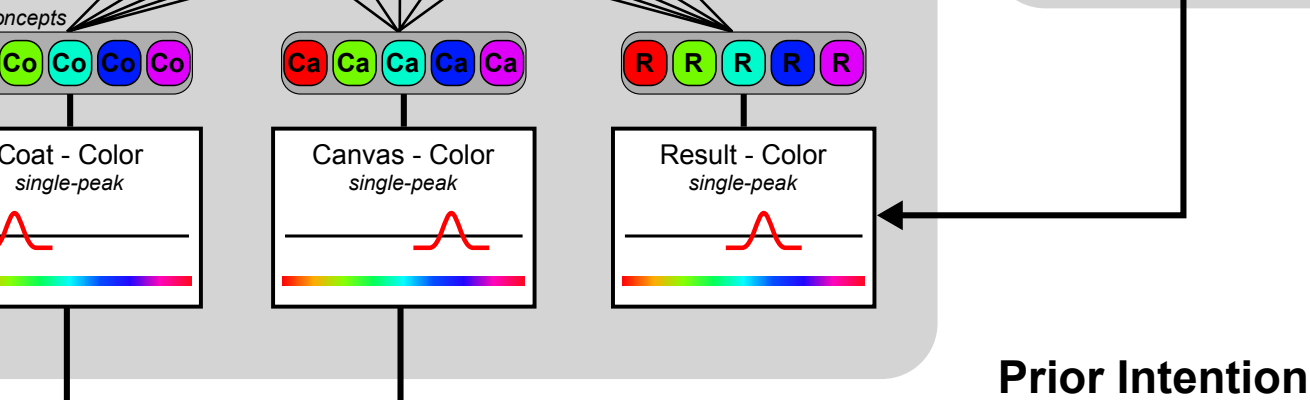
■ desires

■ for cubes of a particular color

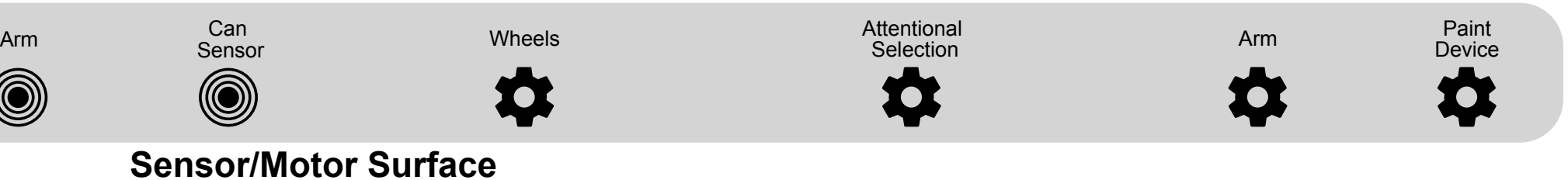
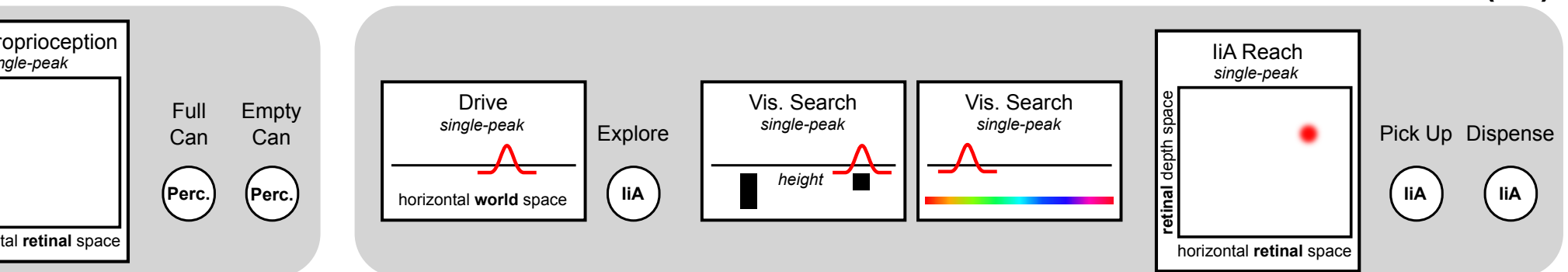


Neural dynamic architecture

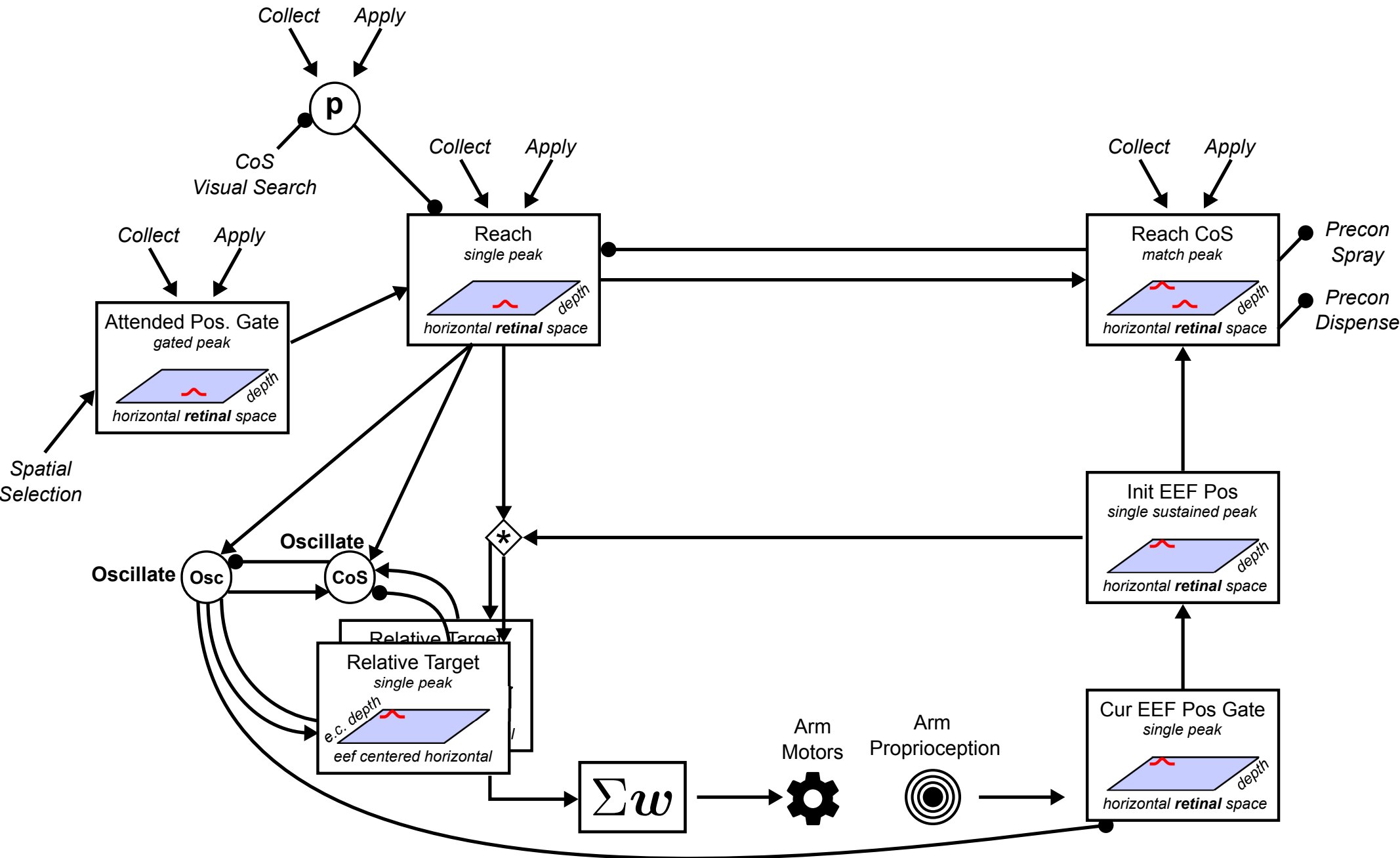


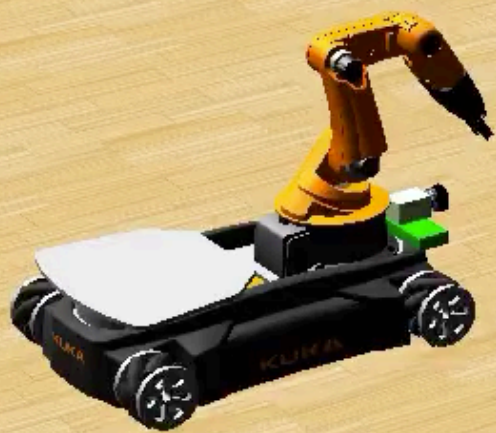


Intention-in-Action (liA)

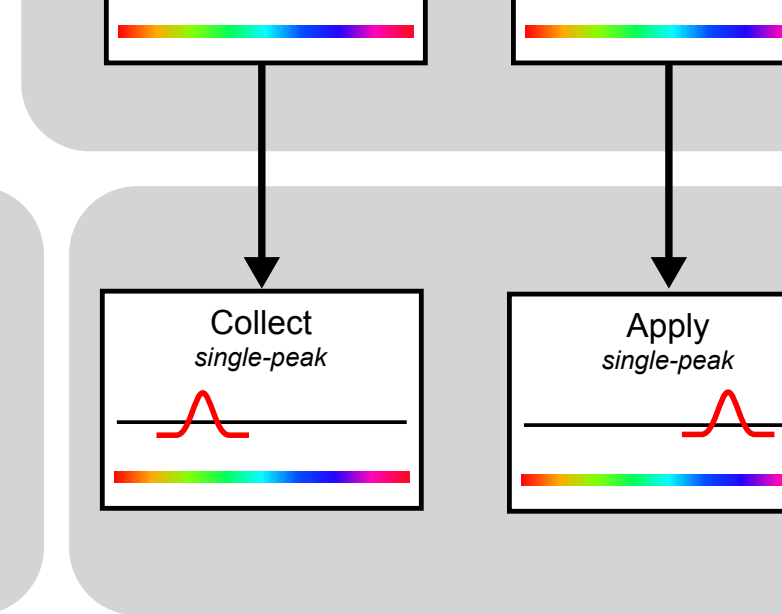
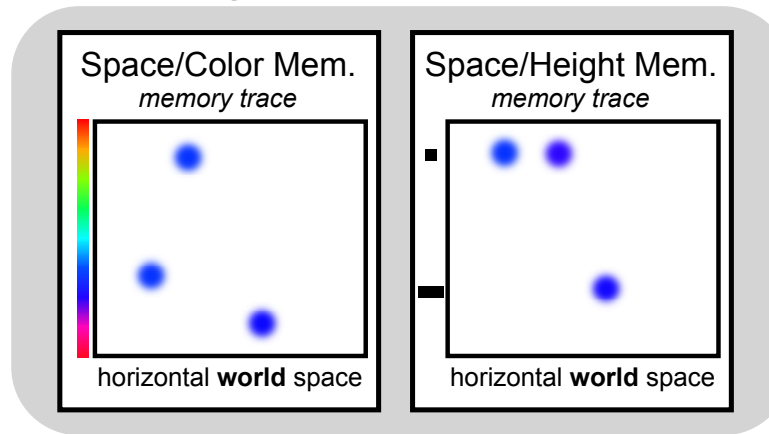


Intention in action: reach

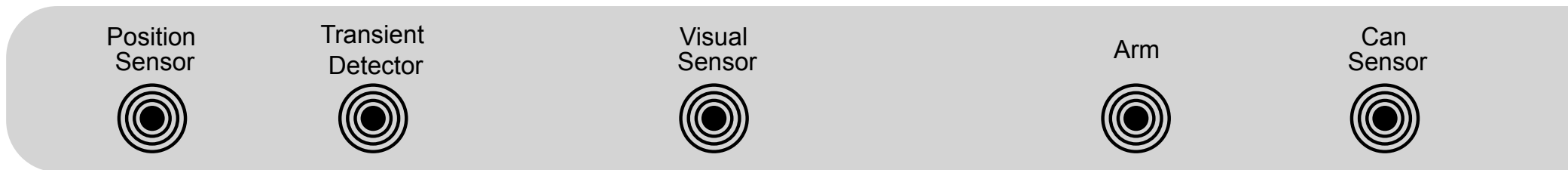
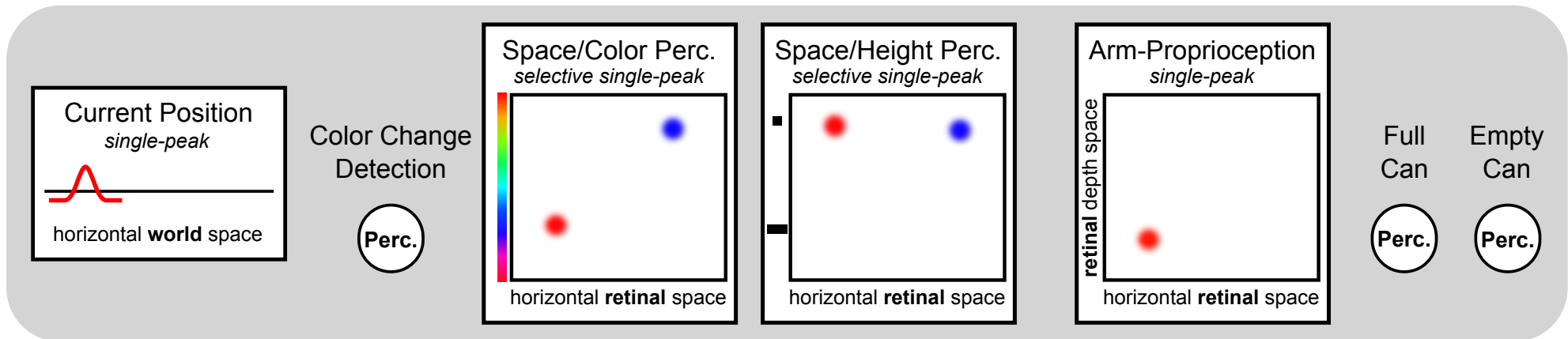




Memory

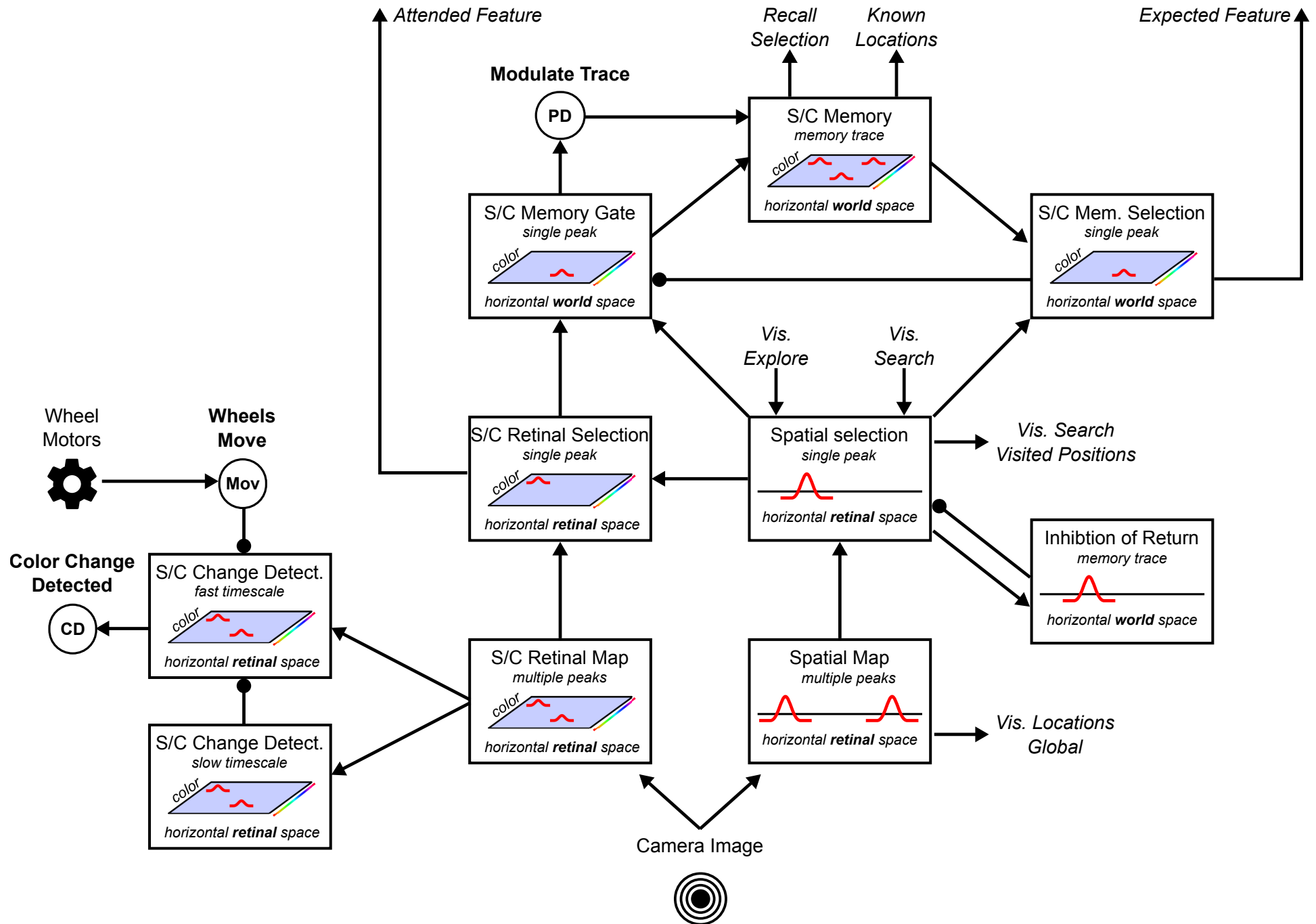


Perception



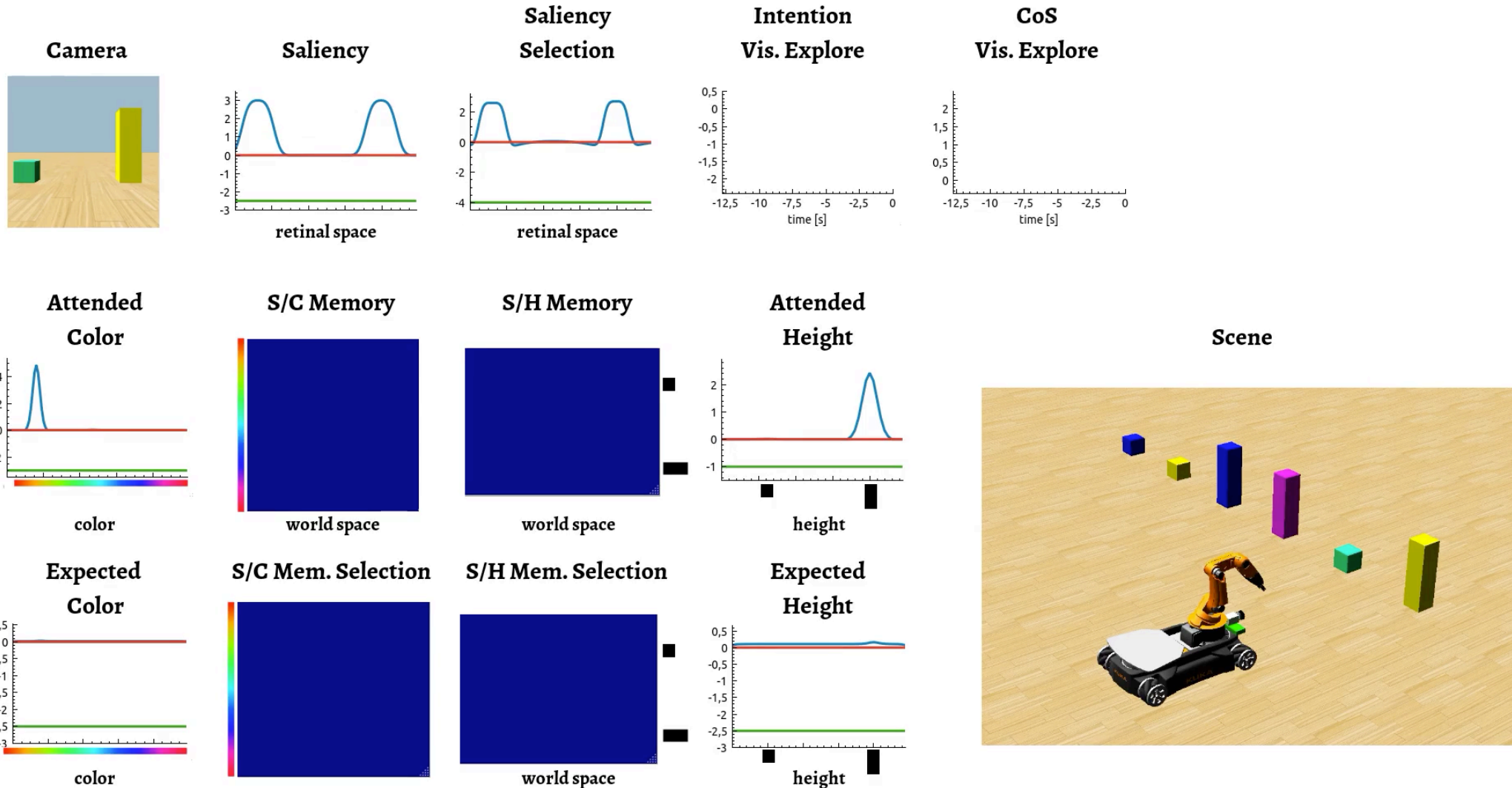
Sensor/Motor S

Perception and memory

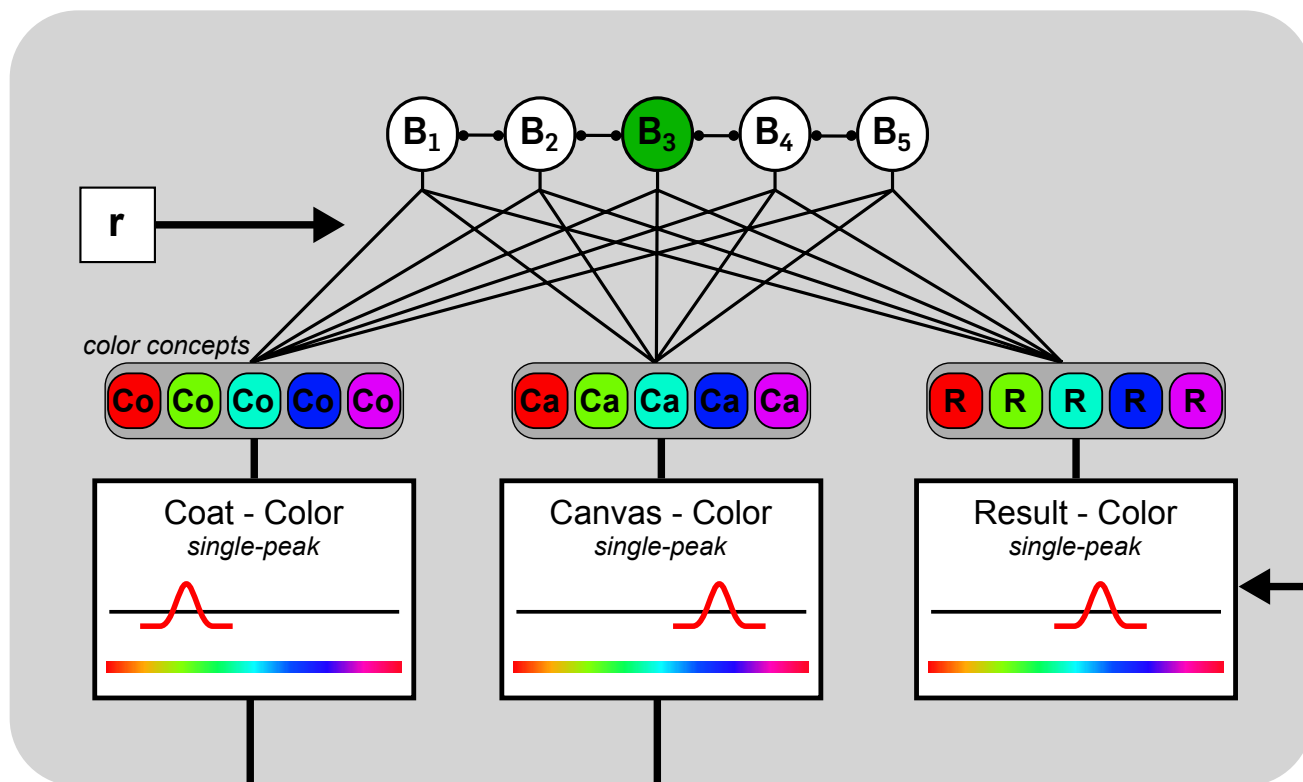


From perception to scene memory

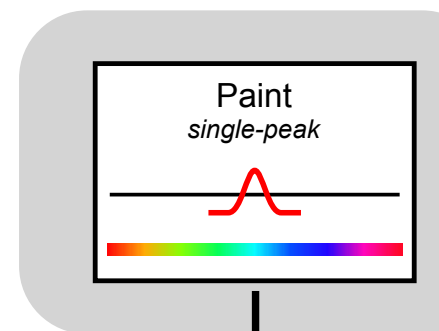
[memory initially empty, then sequentially built]



Belief

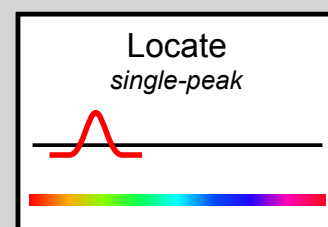
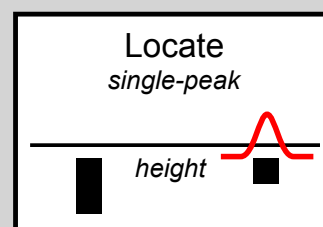
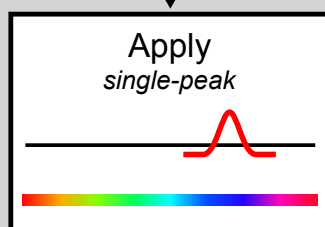
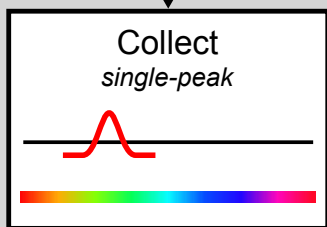
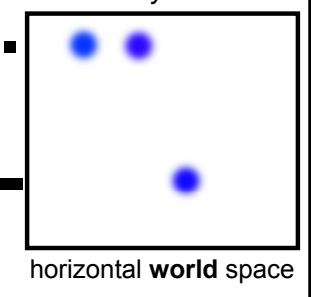


Desire

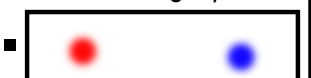


Prior Intention

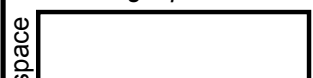
Space/Height Mem.
memory trace



Space/Height Perc.
selective single-peak



Arm-Proprioception
single-peak



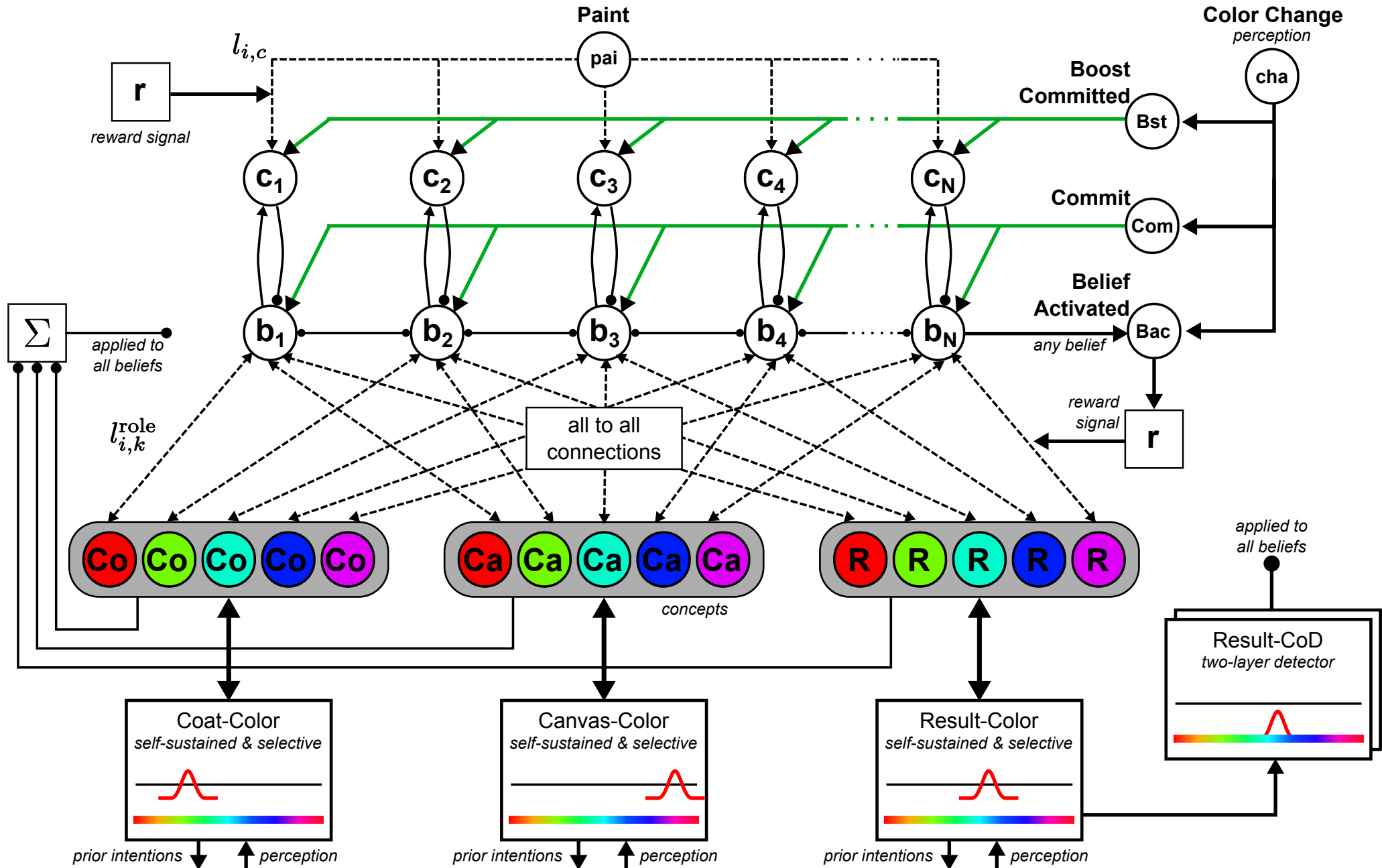
Full Empty

Drive

Vis. Search

Vis. Search

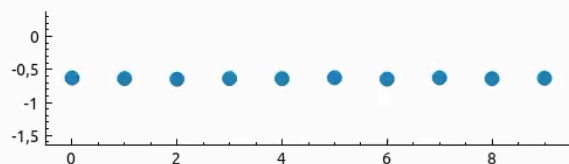
Learning a new belief



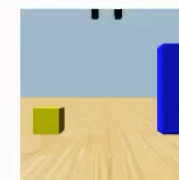
Learn a new belief

[while exploring: applying blue paint to yellow cube]

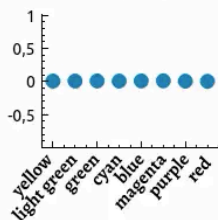
Belief Nodes



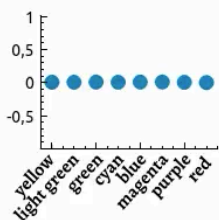
Camera



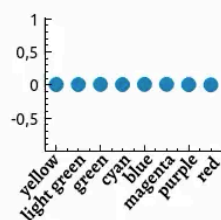
B1 Coat Weights



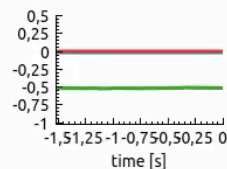
B1 Canvas Weights



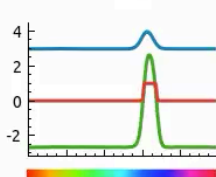
B1 Result Weights



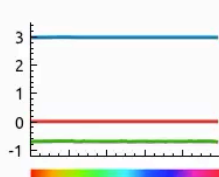
Reward Node



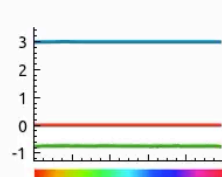
Coat Color



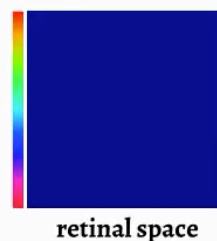
Canvas Color



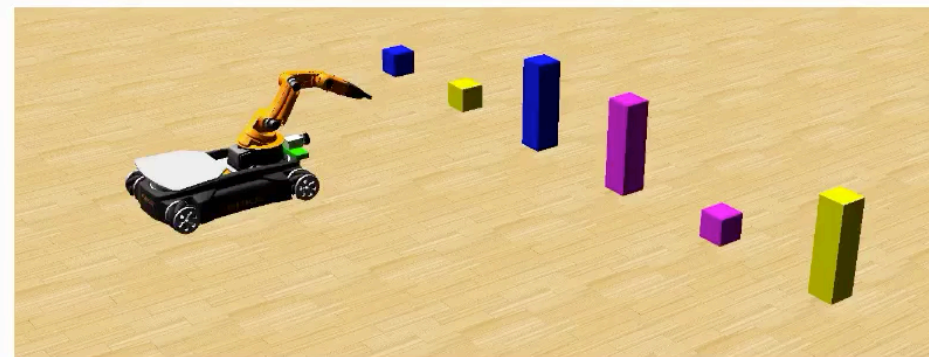
Result Color



S/C Change Detector

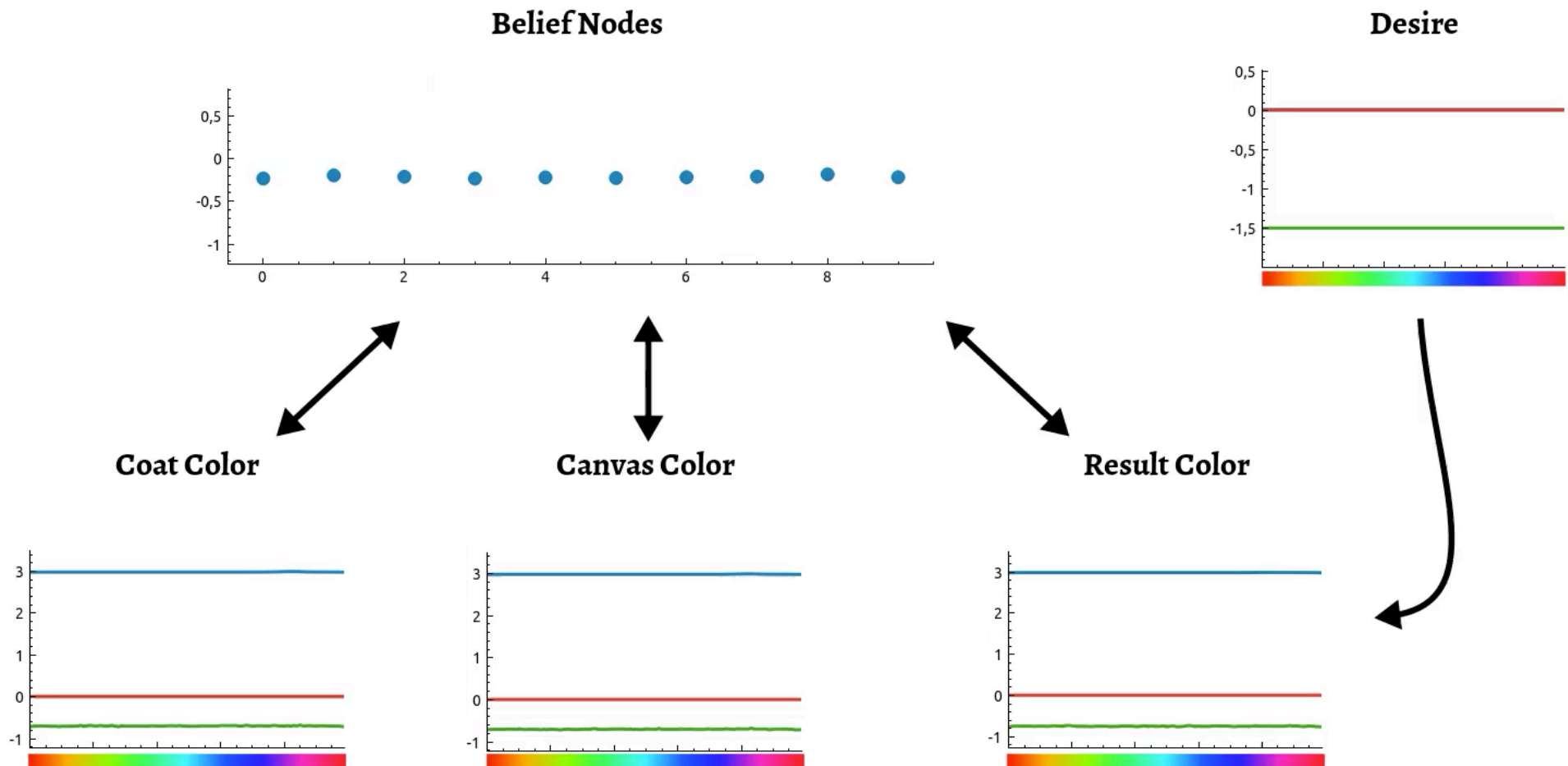


Scene



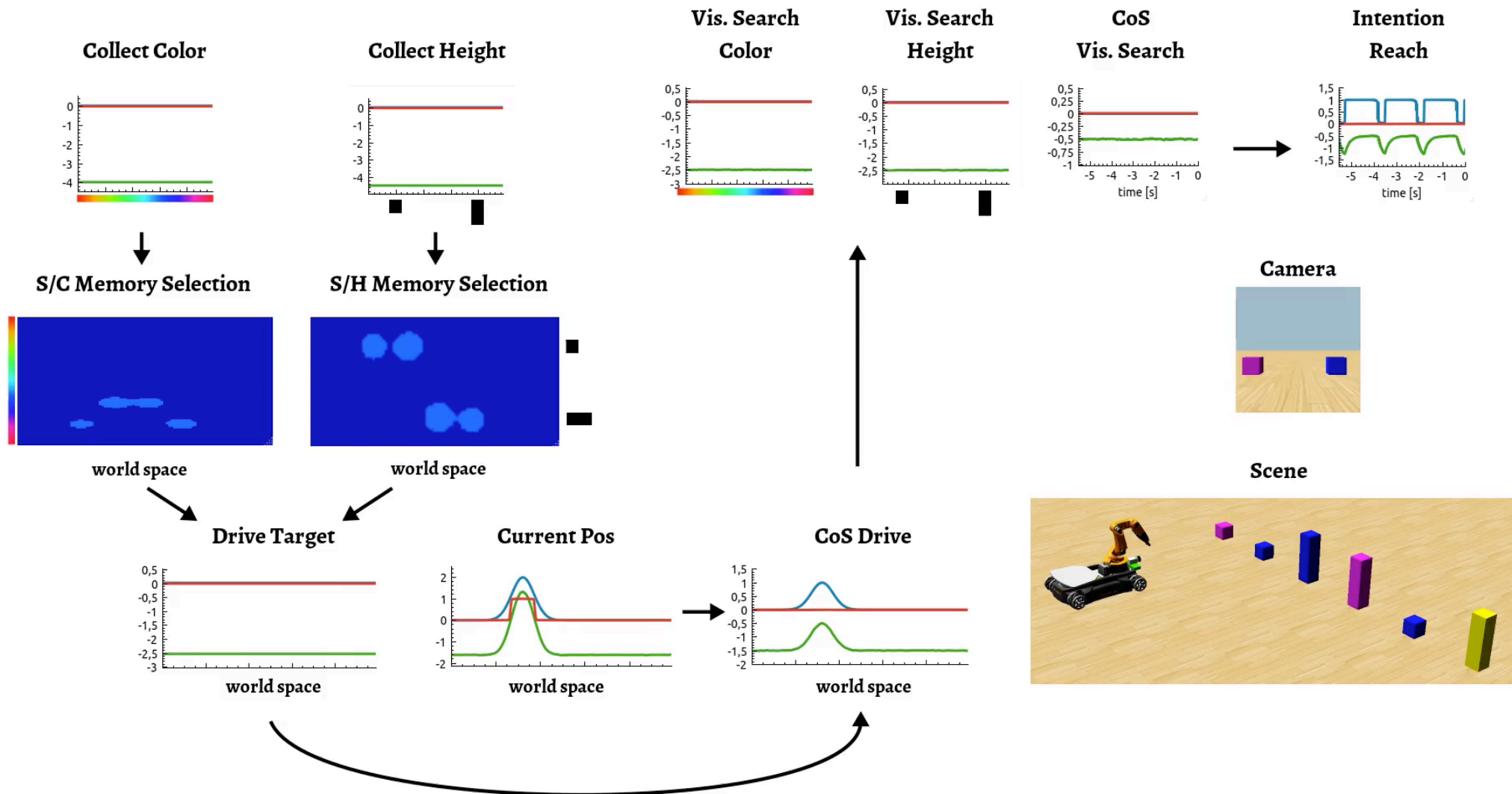
Recall a belief

[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]



Conclusion

- *Intentional states* are neural attractors
- that emerge and disappear through instabilities controlled by *conditions of satisfaction*
- neural dynamic architectures organize *intentional processes* in an *intentional agent* across the *two directions of fit* and *six psychological modes*
- neural dynamics scales due to the stability => robustness properties of neural attractors