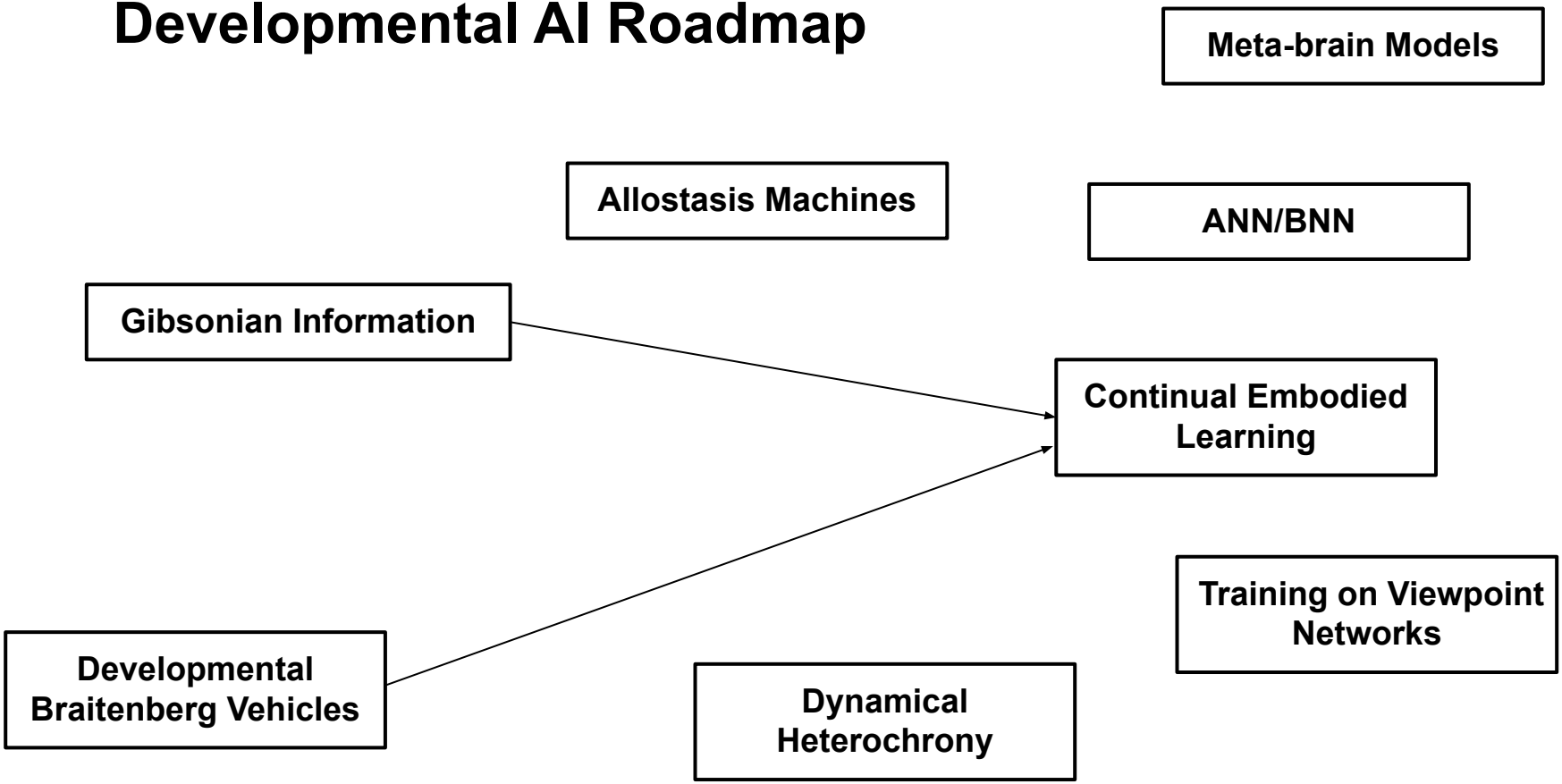
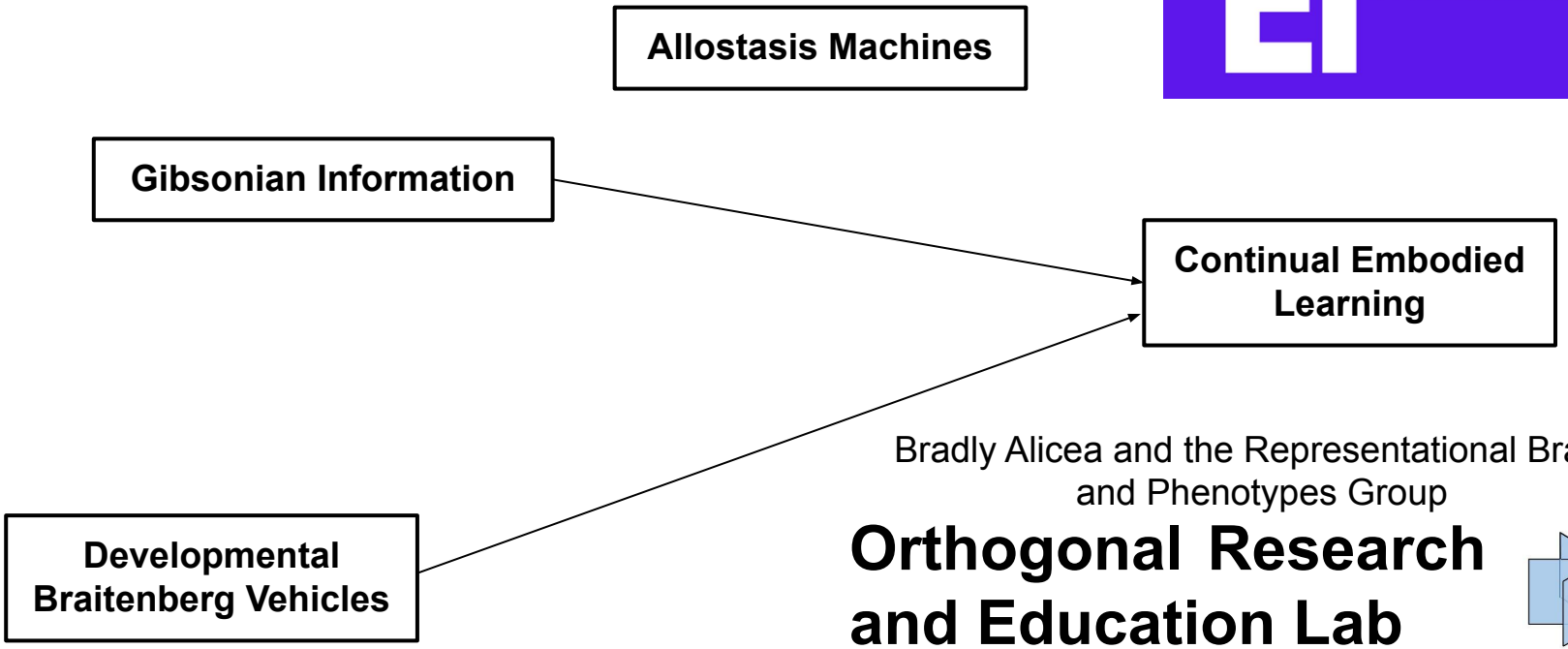
Developmental AI Roadmap

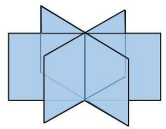


Approaches to Developmental Embodied Neurosimulation



Bradly Alicea and the Representational Brains and Phenotypes Group

Orthogonal Research and Education Lab



https://orthogonal-research.weebly.com/

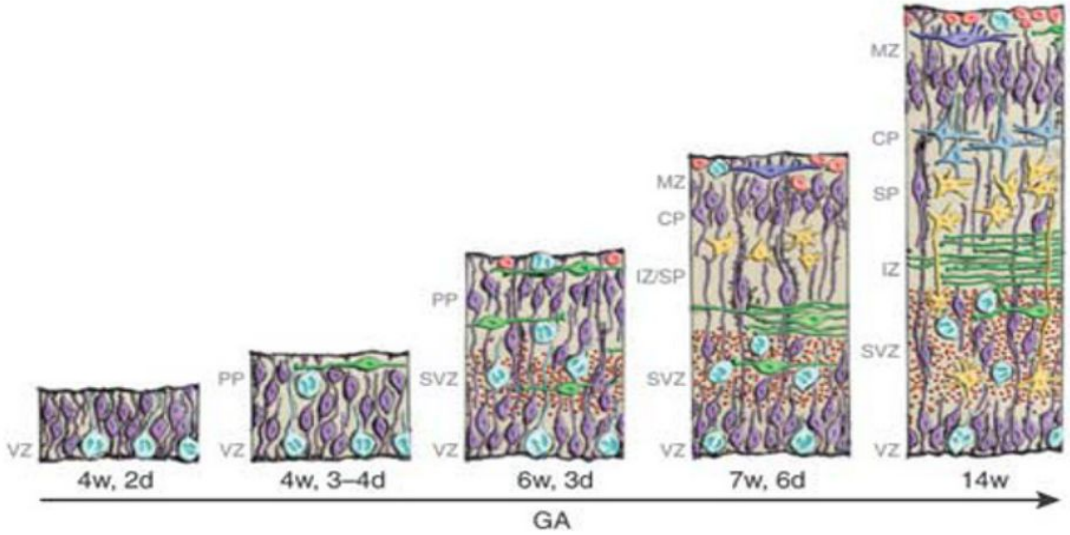


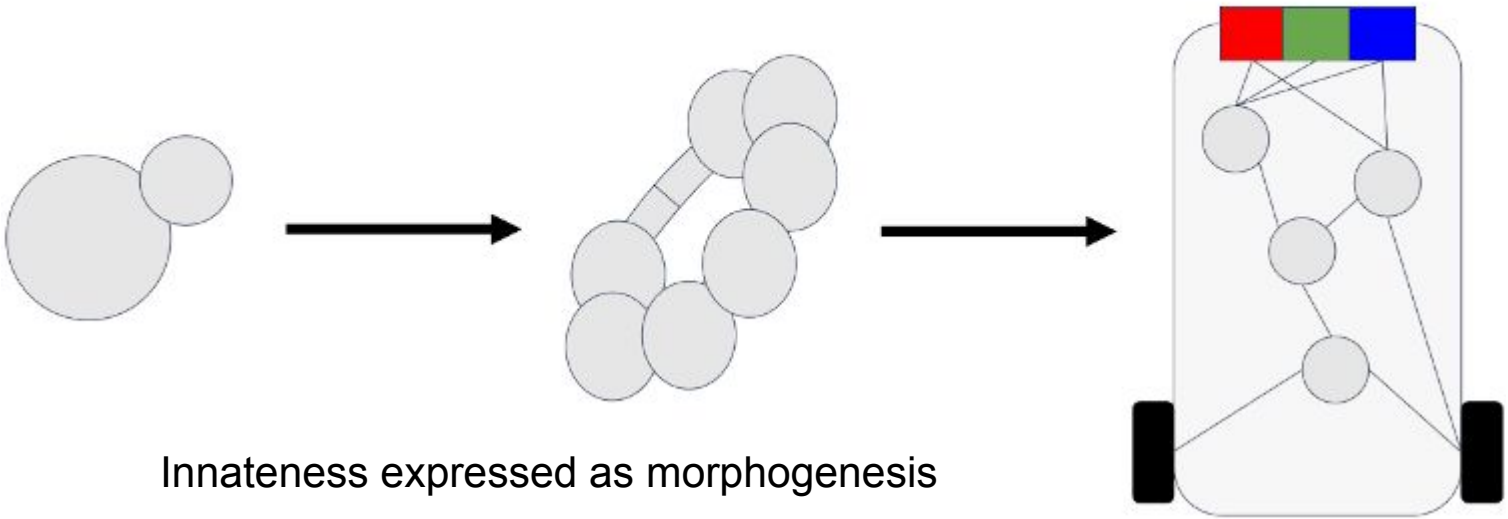
Figure 2. Tau and Peterson, Normal Development of Brain Circuits. *Neuropsychopharmacology*, 35, 147-168 (2010).

"*During development, these circuits emerge from dynamic interactions between cell-intrinsic, genetically determined programs and input/activity-dependent signals, which together shape these circuits into adulthood*"

Jabaudon, Fate and freedom in developing neocortical circuits. *Nature Communication*, 8, 16042 (2020).

Experience-dependence during developmental freedom (learning)

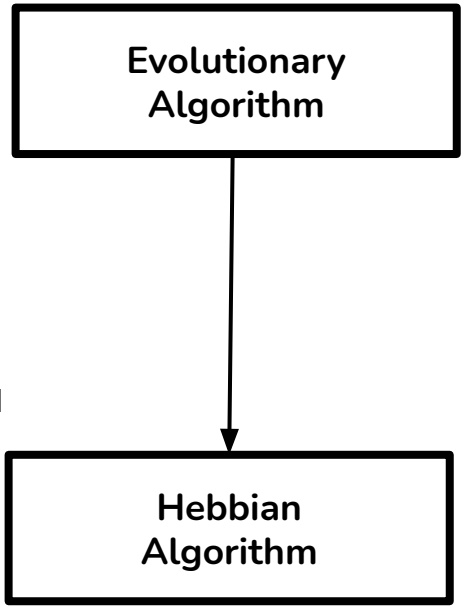
Extending Stefan Dvoretskii's work on Developmental Braitenberg Vehicles



Innateness expressed as morphogenesis

Developmental Time

Morphogenesis



Developmental Learning

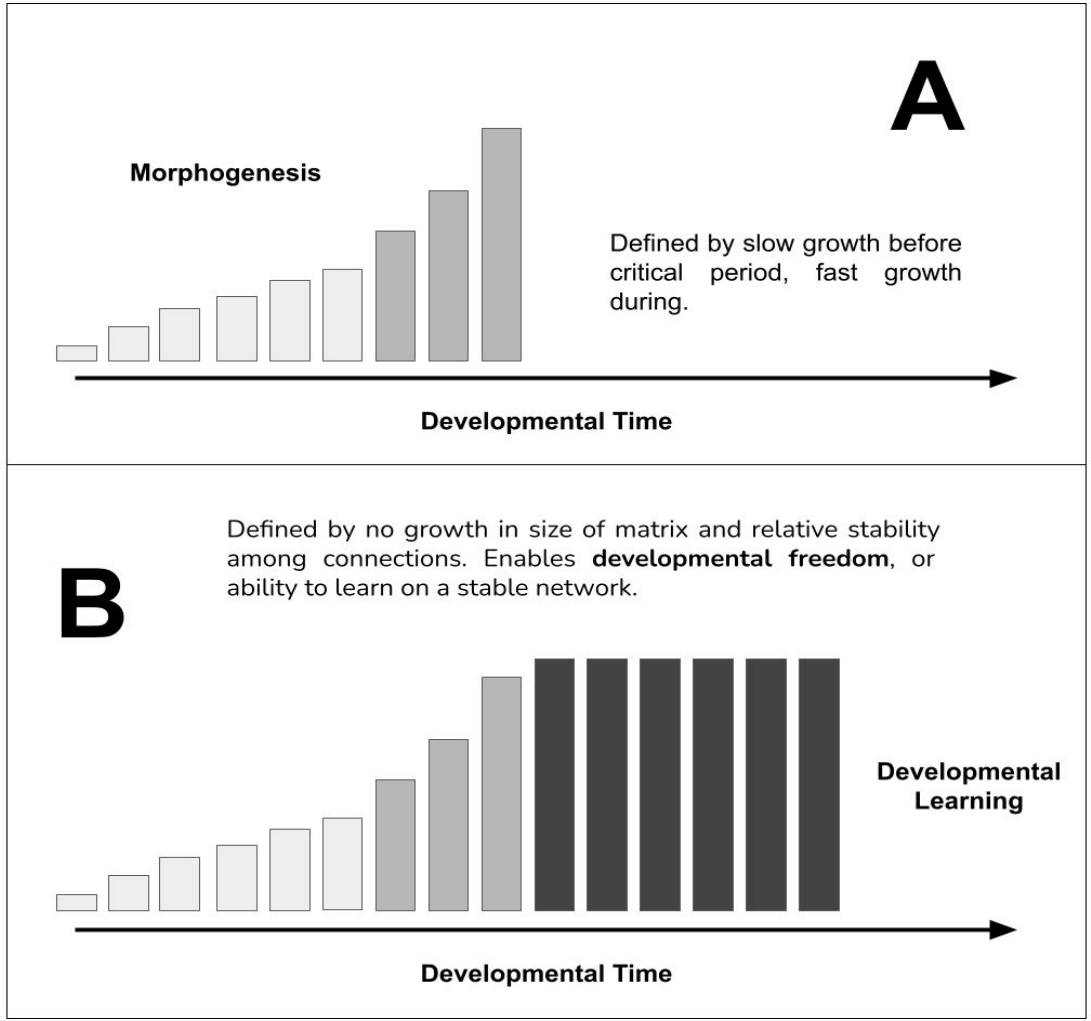
Developmental Time

Morphogenesis

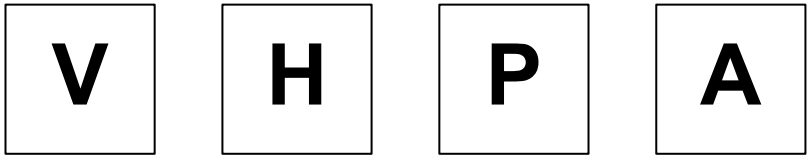
Evolutionary Algorithm

Developmental Learning

Hebbian Algorithm



Four-channel embodiment



Each channel captures information from an action sequence in a specific modality.

V (vision), H (haptic), P (proprioceptive), A (auditory)

Congruence vs. incongruence?

- each channel contains information, is it convergent or divergent across channels over time.
- convergent -- multisensory multiplicative.
- divergent -- multisensory suppressive.

Four-channel embodiment

Direct Perception

Inferred Perception (from directly observed cues)

Forward Motion

Forward Momentum

Shift Left

V

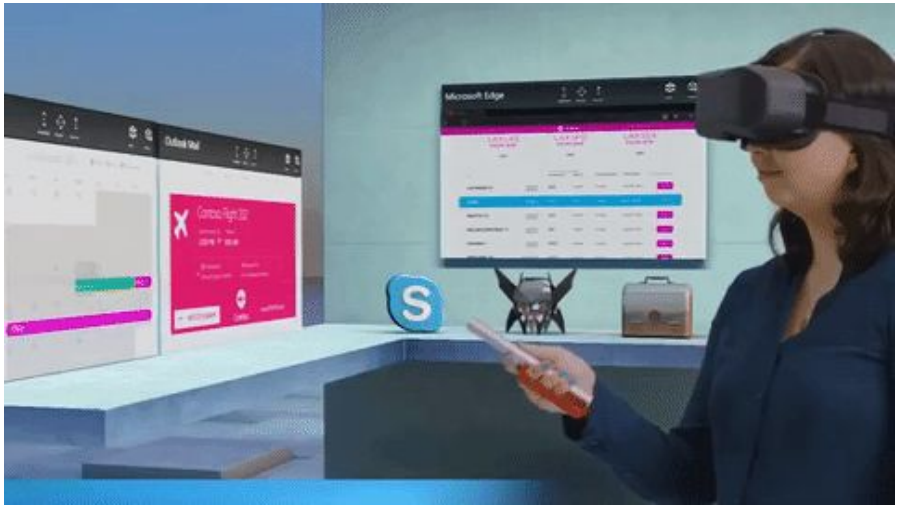
H

P

A

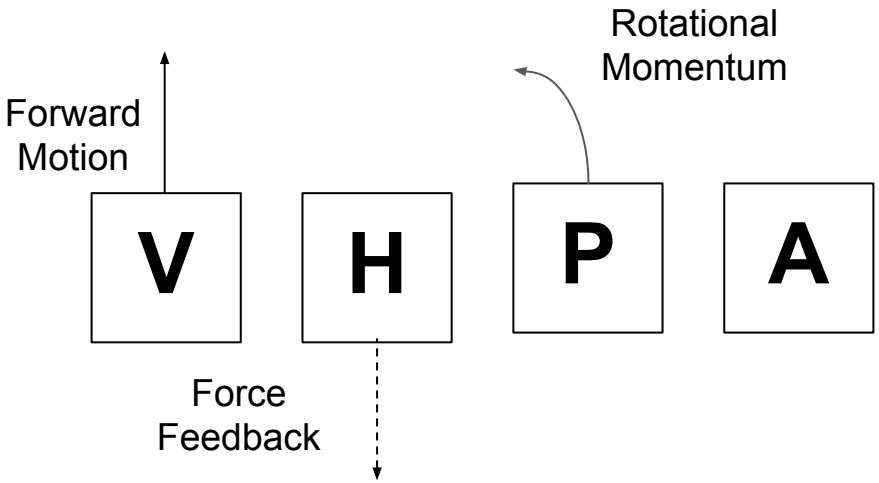
Birds Chirping

Four-channel embodiment

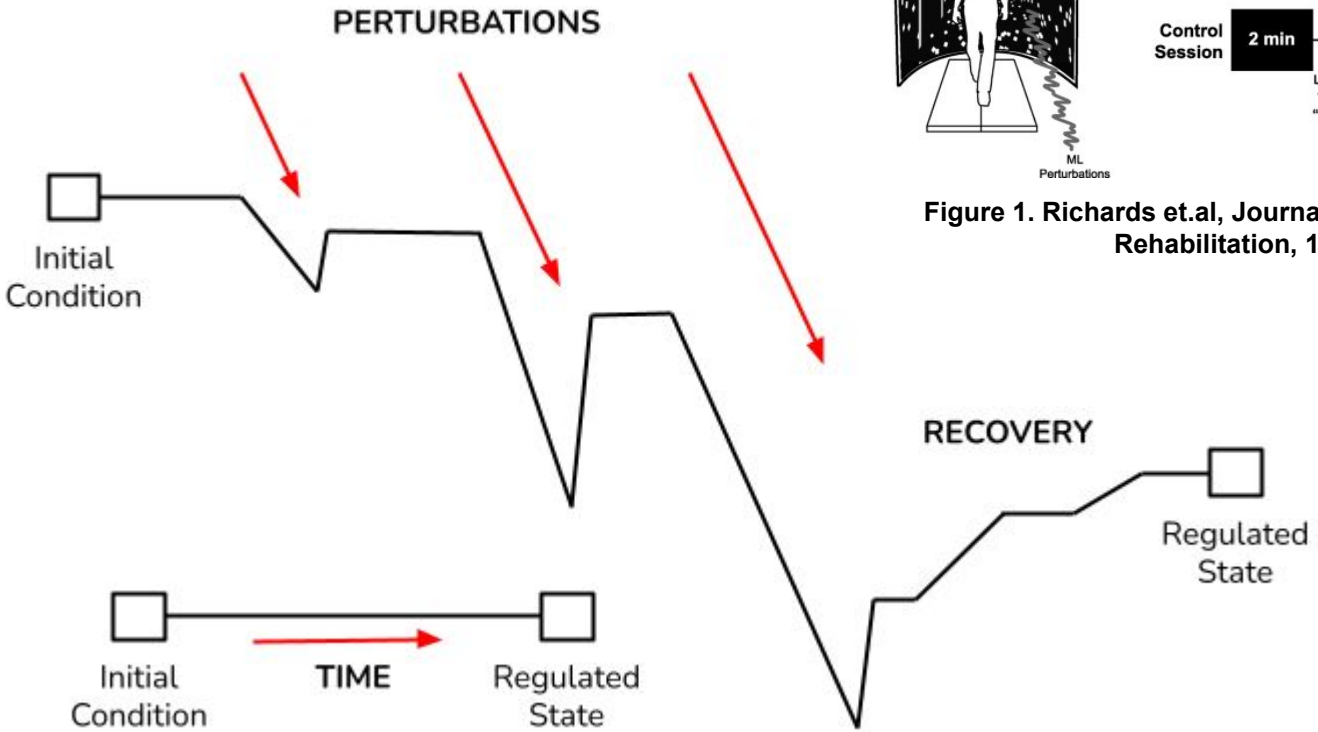


Direct Perception

Inferred Perception (from directly observed cues)



Allostasis Machines



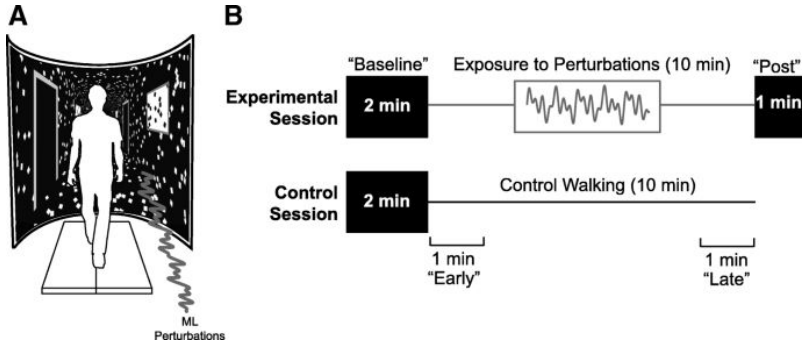


Figure 1. Richards et.al, Journal of NeuroEngineering and Rehabilitation, 16, 81 (2019)

Allostasis Machines

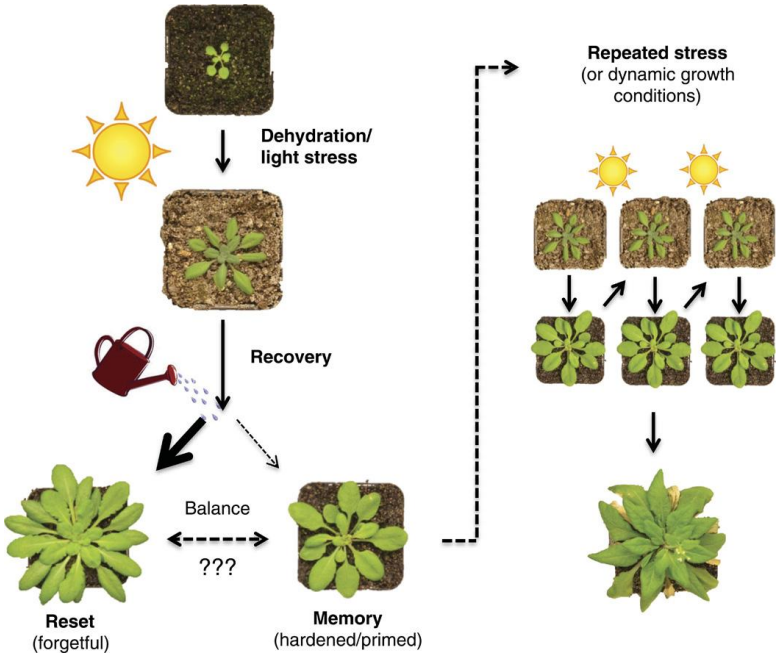
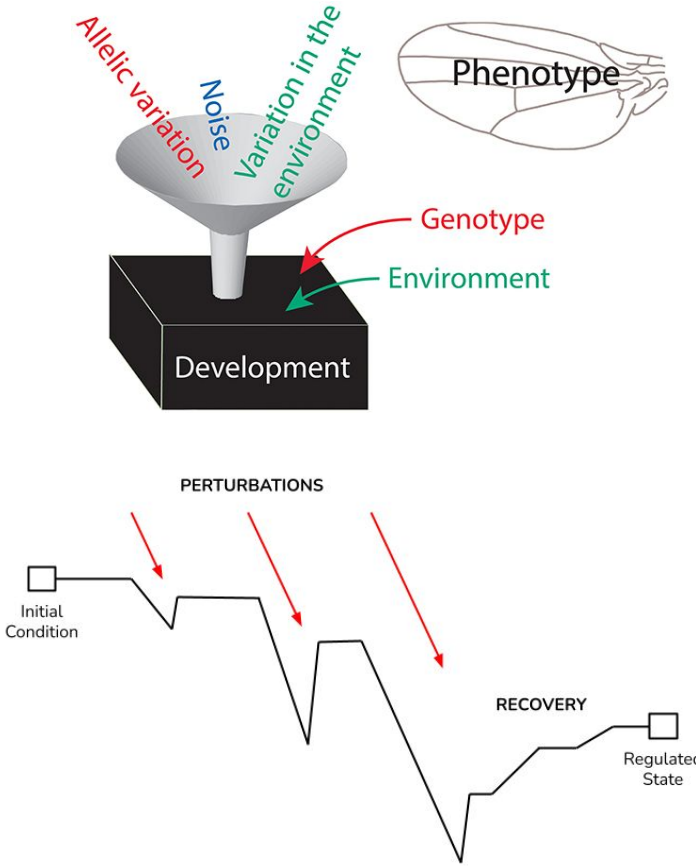
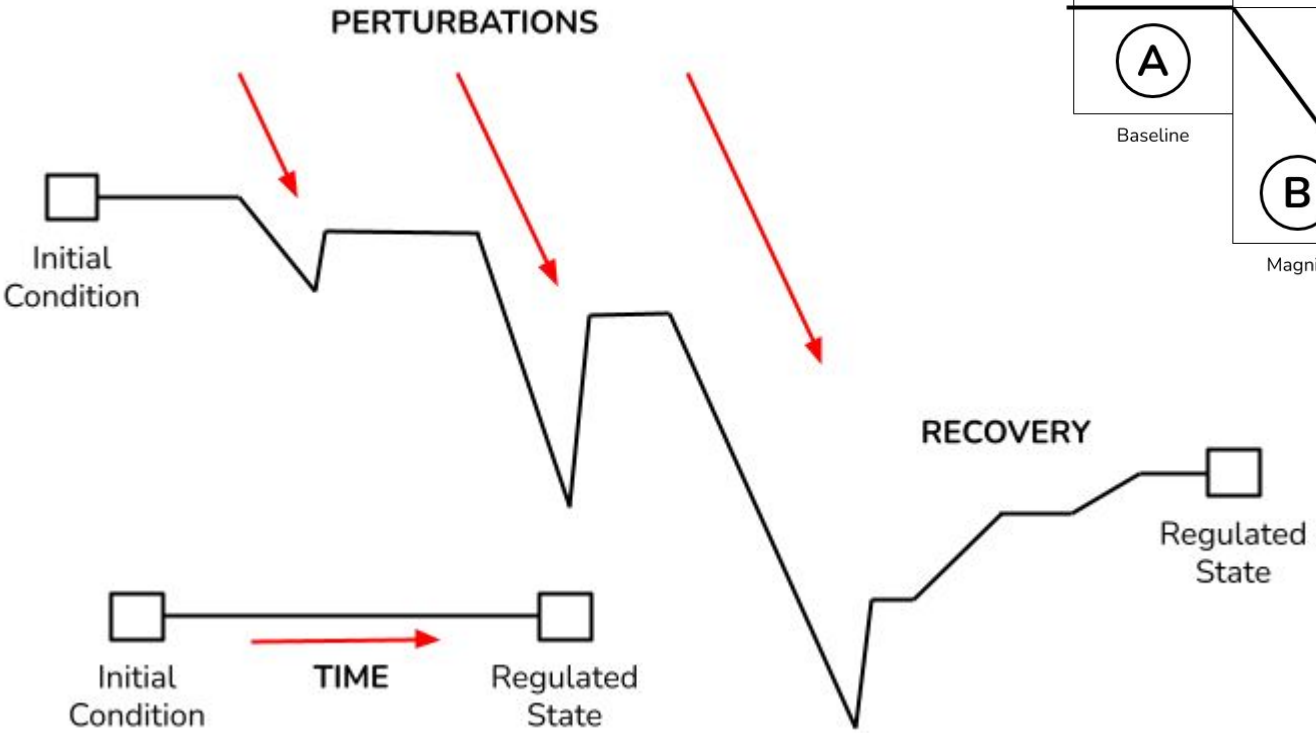


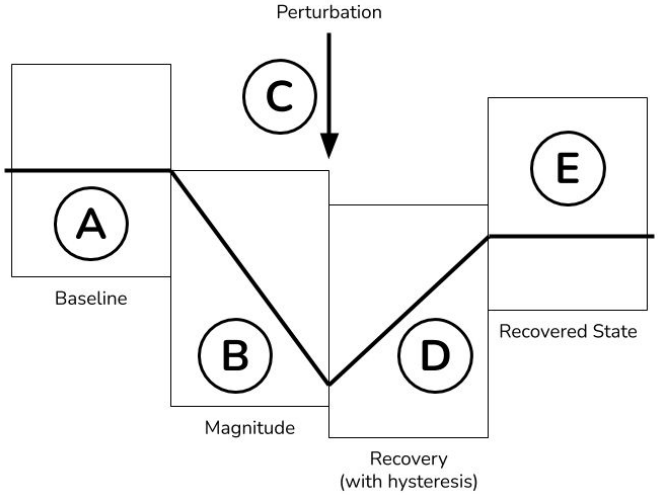
Figure 1. Crisp et.al, *Science Advances*, 2(2), e1501340 (2016).

Figure 1. Klingenberg et.al, *Frontiers in Ecology and Evolution*, 7(56), doi:10.3389/fevo.2019.00056 (2019).



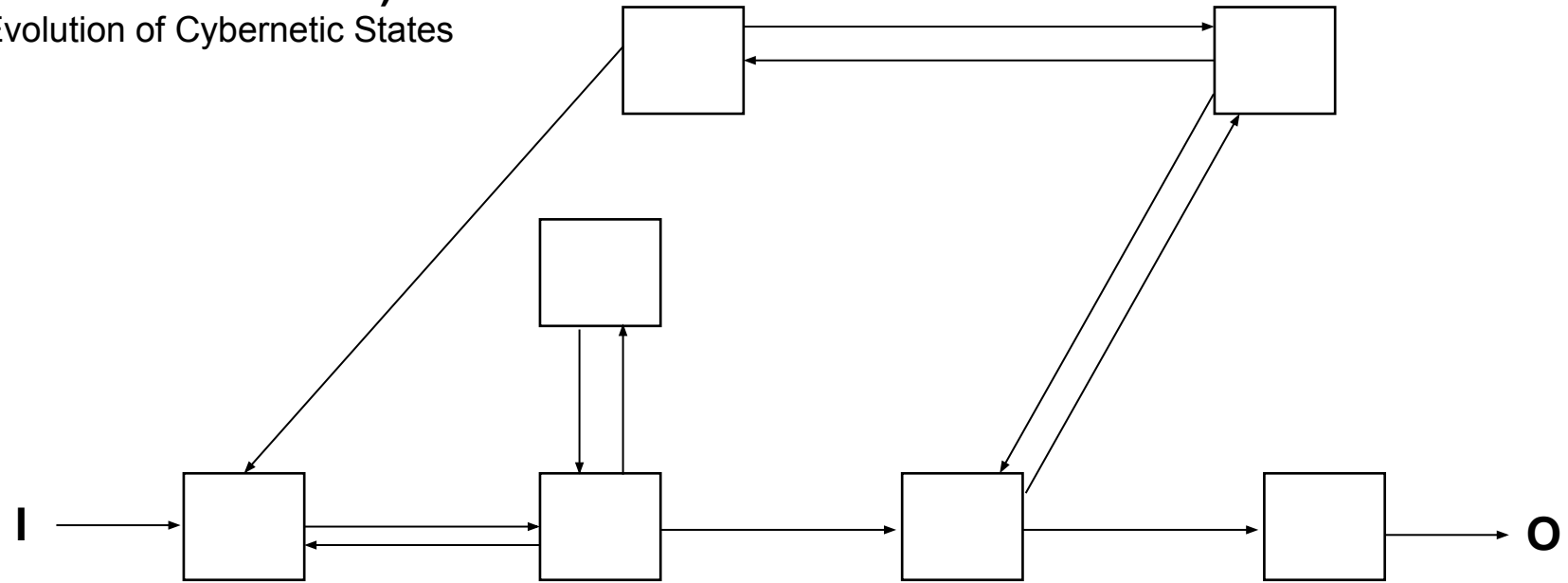
Allostasis Machines





Regulatory model (innate feature) that produces allostasis function):

Evolution of Cybernetic States

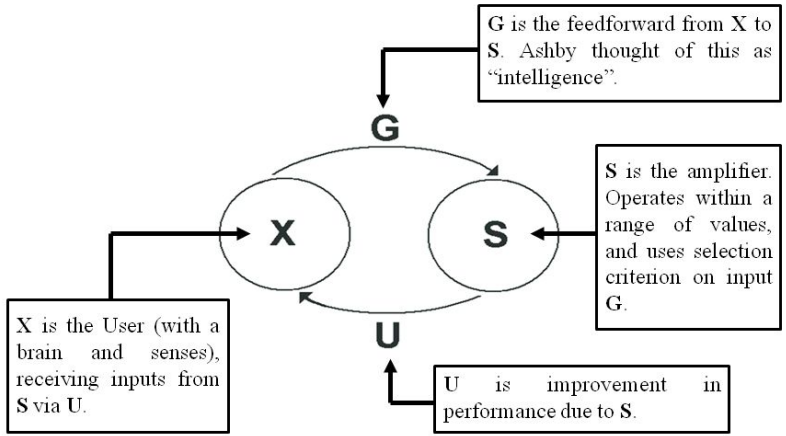


Model of internal regulatory mechanisms: neutral, stable, and fragile states.

Thanks for your Attention!

Humani Victus Instrumenta, 1570s

Design for an Intelligence Amplifier, Ashby, 1958



BEFORE

AFTER