Human Brain Project

The University Of Sheffield.

Brain-based robots:

Understanding how the brain, body and environment interact to generate intelligent behavior

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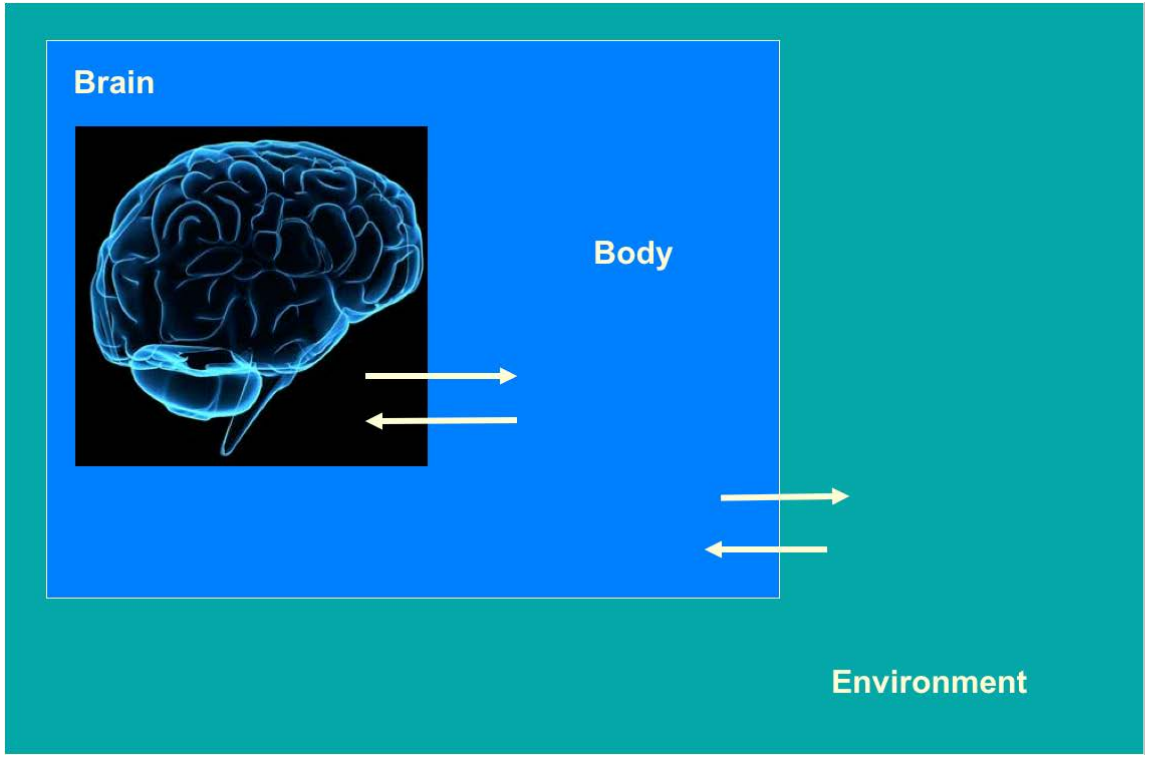
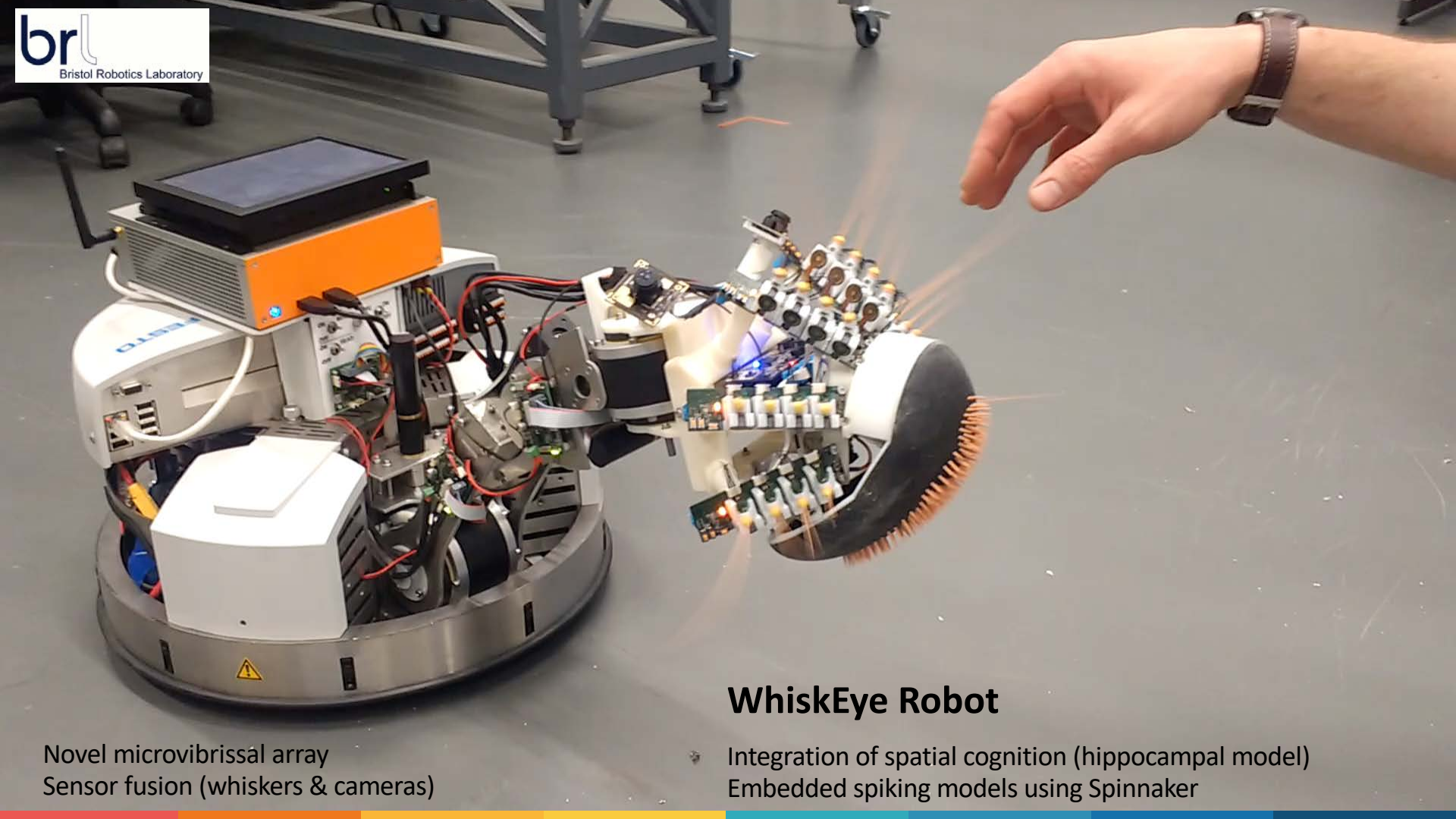


The interactions of the nervous system, body, and environment together give rise to observable behaviour

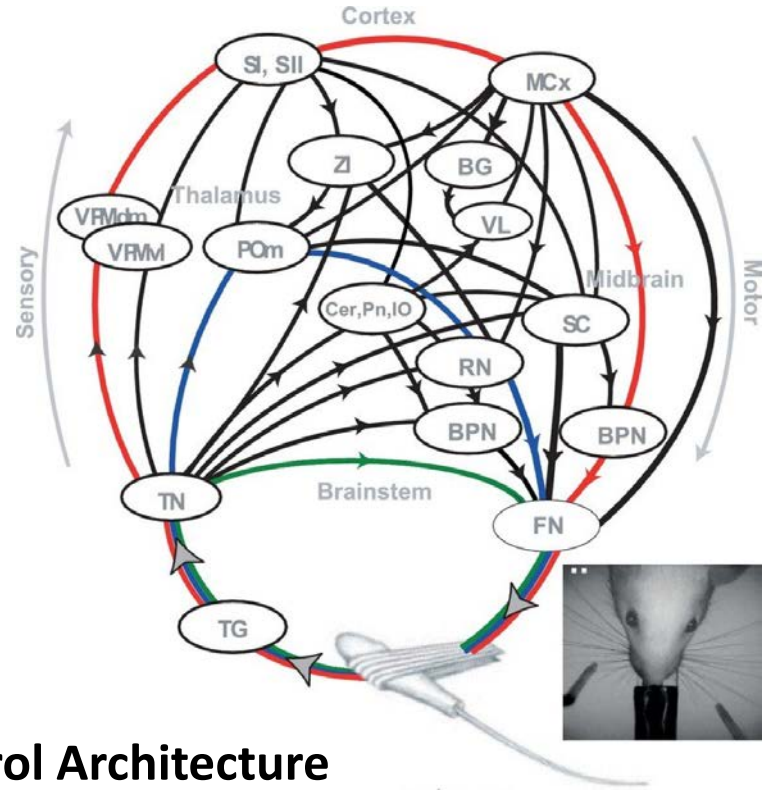


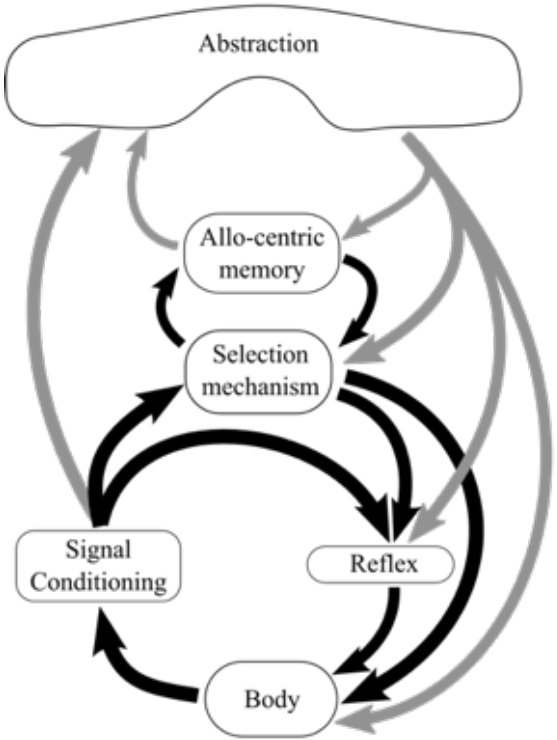
Bristol Robotics Laboratory

WhiskEye Robot

Novel microvibrissal array
Sensor fusion (whiskers & cameras)

- Integration of spatial cognition (hippocampal model)
- Embedded spiking models using Spinnaker





Control Architecture

Left. Neural systems involved in active vibrissal sensing in rodents (from Ahissar and Kleinfeld, 2003, Cereb. Cortex). Right. An abstraction of the neural architecture as a series of nest-control loops (coloured arcs), with centralised control and decision-making systems (cerebellum, basal ganglia).

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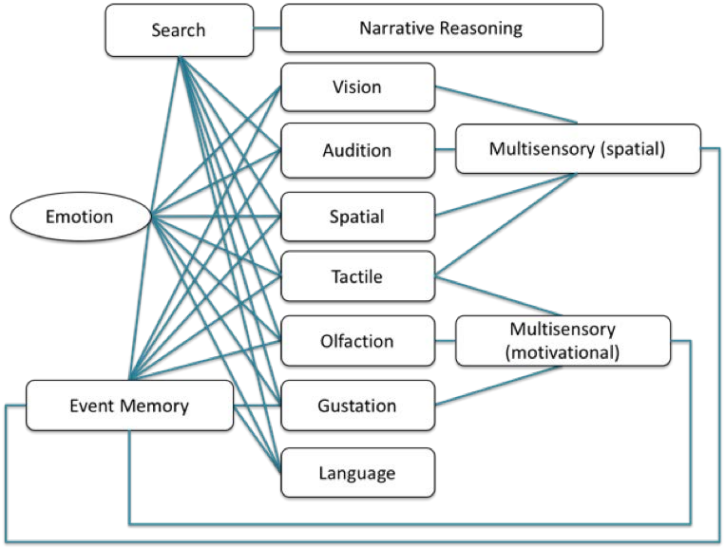
A



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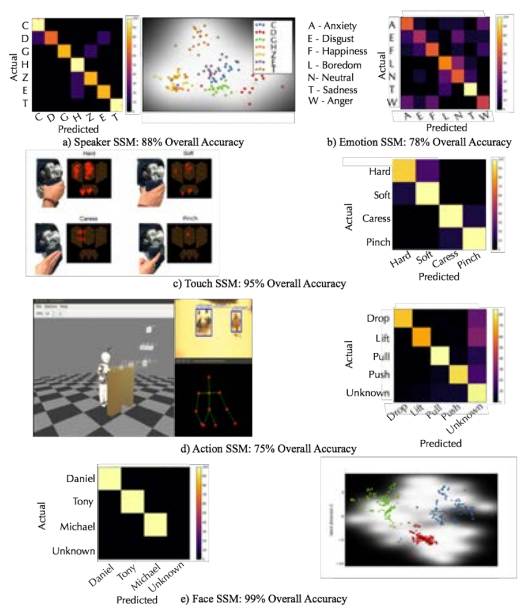
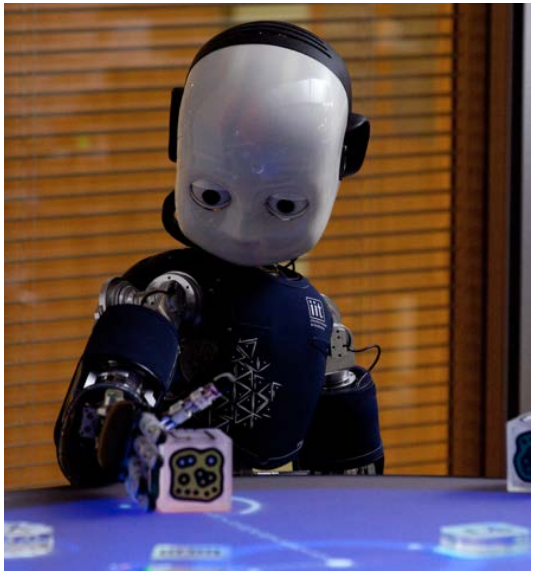


C



Prescott, Camilleri, Martinez, Damianou, and Lawrence (2019). *Phil Trans Roy Soc B*.

Modelling Perceptual Learning for Episodic Memory

A. Framework for understanding the human cognitive architecture for autobiographical memory based on data from neuropsychology and brain imaging (based on Ruben 2006, Persp. on Psych. Sci.). B. Using generative machine learning models to create component memory systems for the iCub humanoid robot (C).

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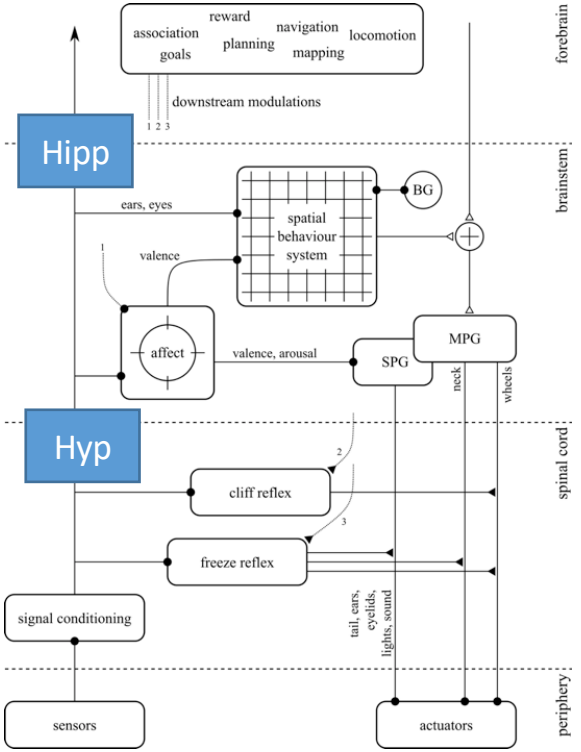
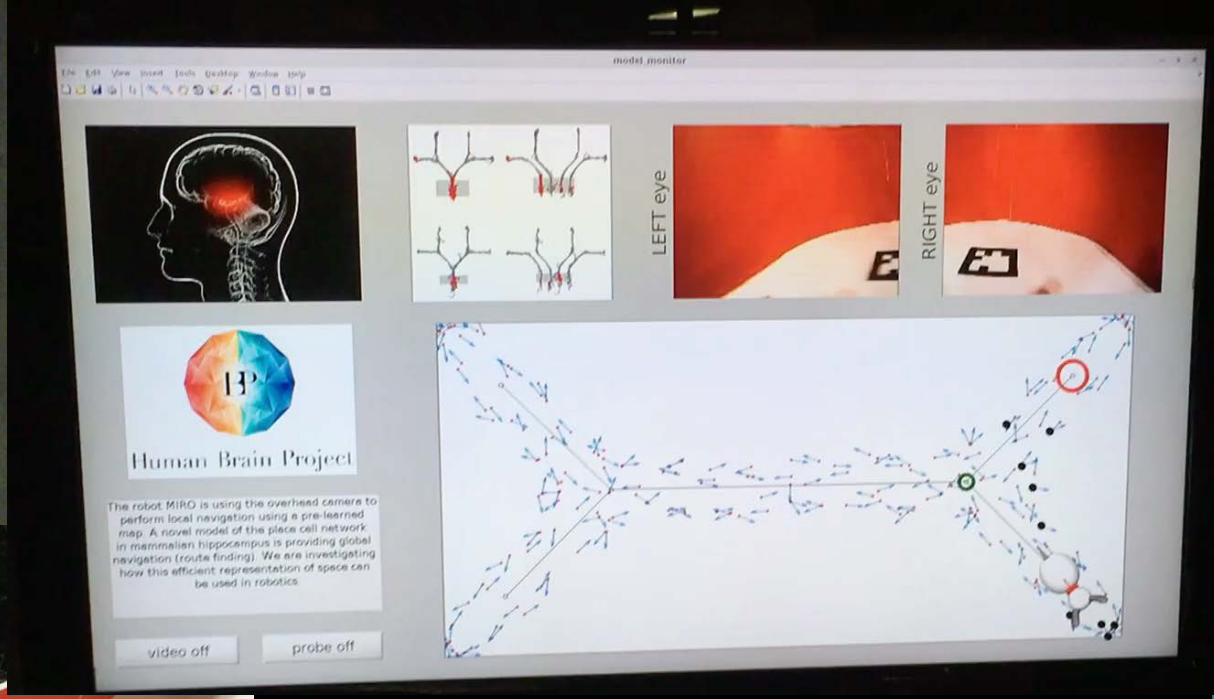


A Brain-based robot for research, education and therapy

To advance brain-based robotics towards application we have developed the pet-like robot, MiRo, with the simplified layered architecture shown above. The forebrain components illustrated in D will be developed in the current project alongside richer models of brainstem sub-systems and circuits.


Designed for research



Vicarious Trial and Error in a Model of Mammalian Hippocampus

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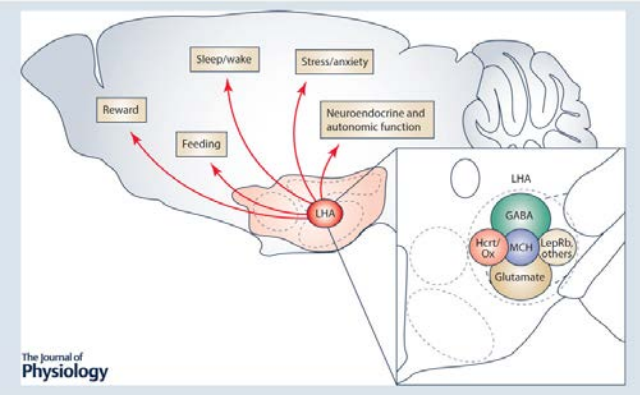
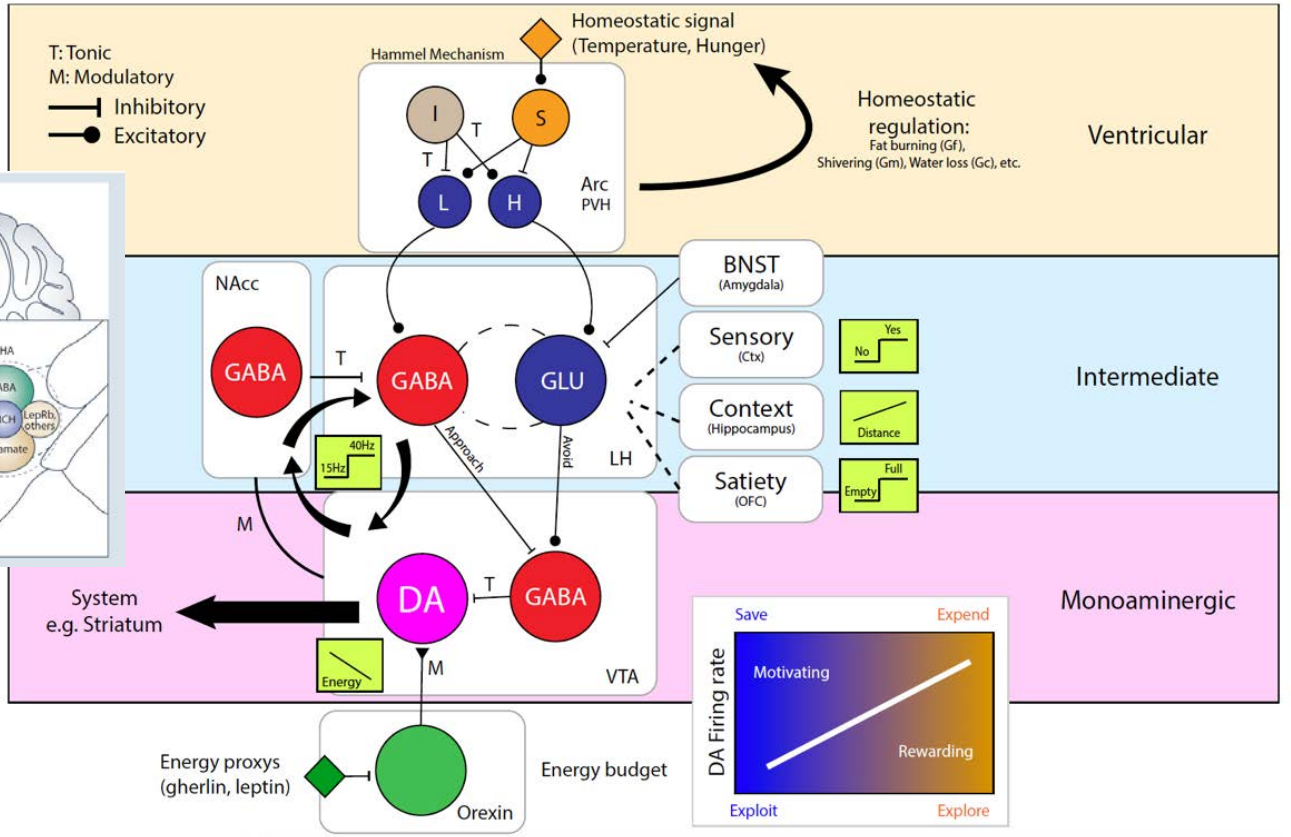
Hypothalamus is critical brain-stem system for motivation/homeostasis



Hypothalamus: Motivation & Drives



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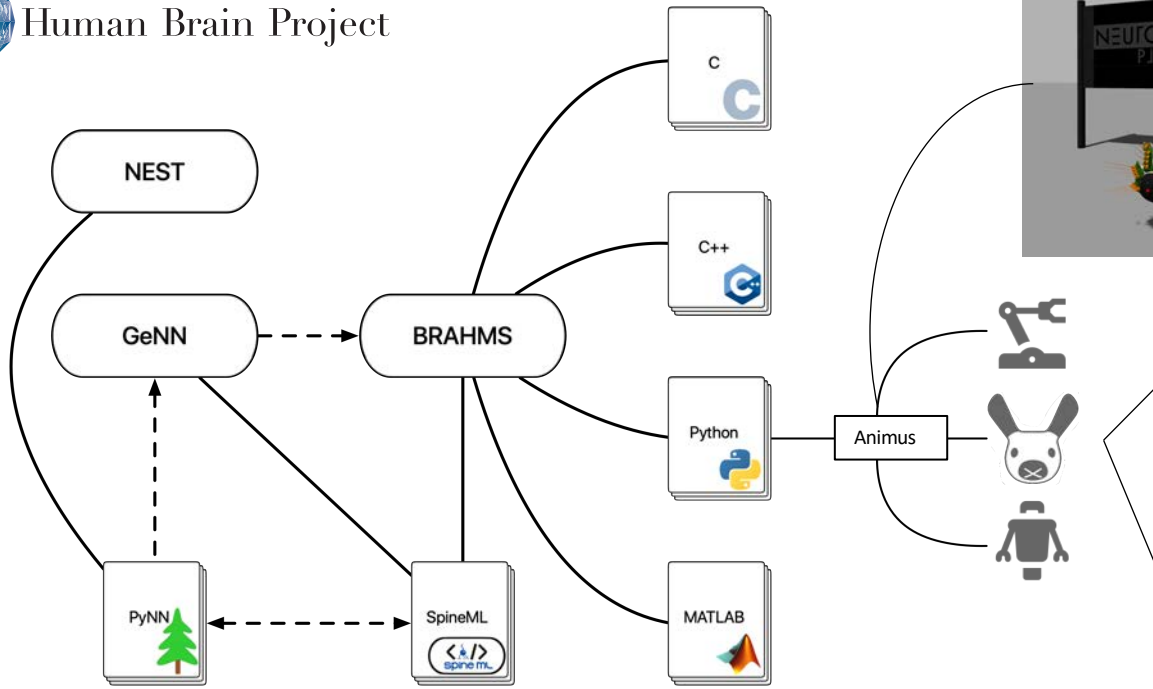

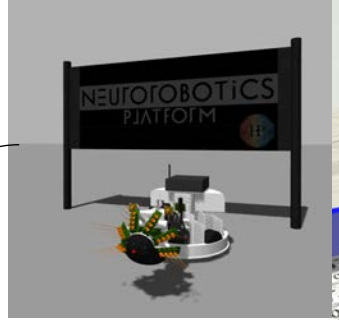

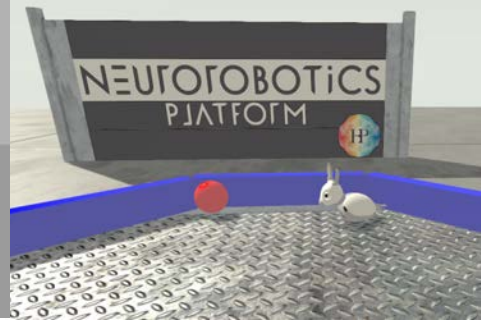

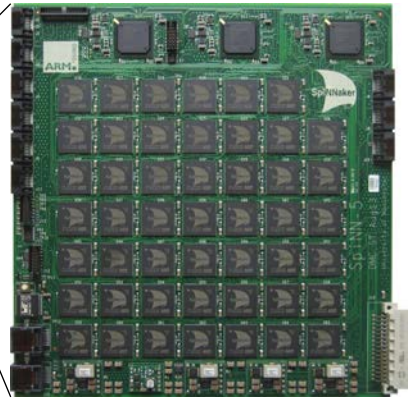

Spinnaker

Technical Integration with EBrains

The “mammalbot” open source framework is intended to maximise inter-operability between different kinds of models and to minimise the difficulty of deployment brain-based control systems on robot hardware. **BRAHMS** supports the execution of models with components written in a variety of languages, **Animus** enables easier deployment across a variety of robotics platforms via a unified Python interface. The framework supports incorporation of algorithmic models (via BRAHMS) of more detailed spiking/rat-coded neural models (implemented in **NEST** or **PyNN)** and neuromorphic processor such as the University of Manchester’s Spinnaker.

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Towards Applications for Brain-Based Robots

Brain-based robots, such as MiRo are showing promise as platforms for teaching children about coding (AI, robotics, and neuroscience. Extending the social cognition of this robot will support new applications in therapy and healthcare.

THANK YOU!

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