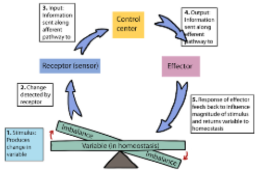
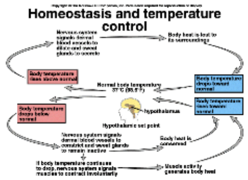
From Homeostasis to Allostasis





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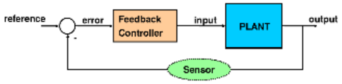
Definition (Bruce S. McEwen, Neurobiology of Aging, 2002):
Allostasis is the process that keeps the organism alive and functioning, i.e. maintaining homeostasis or "maintaining stability through change" and promoting adaptation and coping, at least in the short run.

(Peter Sterling and Joseph Eyer, 1988)
"Homeostasis emphasized that the body's internal environment is held constant by the self-correcting (negative feedback) actions of its constituent organs. Allostasis emphasizes that the internal milieu varies to meet perceived and anticipated demand. This variation is achieved by multiple, mutually reinforcing neural and neuroendocrine mechanisms that override the homeostatic mechanisms."

(The sims)

Feedback control



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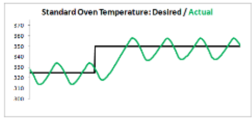
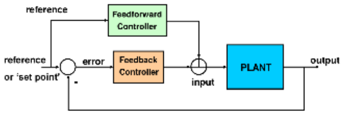
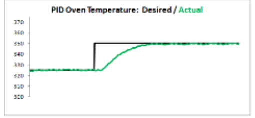
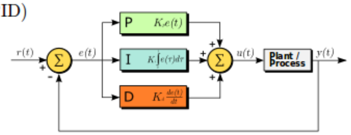


Coupling Reactive Feedback
with
Adaptive Feed-Forward Control





Proportional-Integral-Derivative controller (PID)



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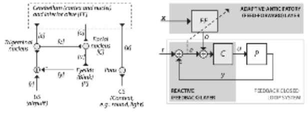
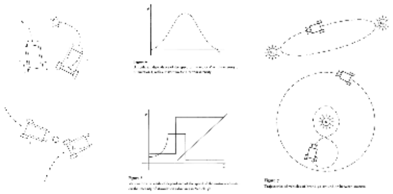
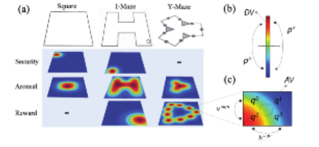


Figure 2: Neuroanatomy of eye-blink conditioning and the CFPC architecture. *Left*: Mapping of signals to anatomical structures in eye-blink conditioning [De Zeeuw and Yeo, 2005, Medina et al., 2002], regular arrows indicate inputs and outputs that interact in the world, arrows with inverted heads indicated neural pathways. *Right*: CFPC architecture. Abbreviations: *P*, plant; *C*, feedback controller; *FF*, feed-forward module; *r*, reference signal; *y*, plant's output; *e*, output error; **x**, basis signals; *o*, feed-forward signal; and *u*, motor command.

Homeostasis in Braitenberg Vehicles



Allostatic Control in a Synthetic Forager (Sanchez-Fibla et al., 2010)



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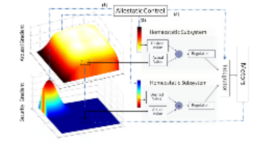
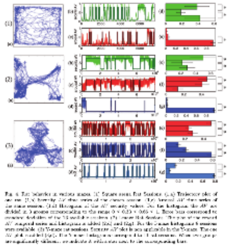
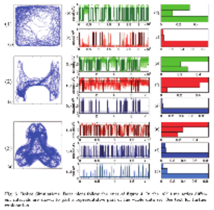
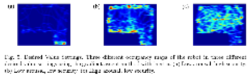


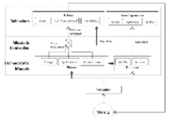
Fig. 1. Minimal allostatic control integrating two homeostatic subsystems. These subsystems can be related to a security subsystem (on bottom) with a preferred location on the top right corner and an arousal subsystem with its maximum in the center and dropping to zero close to the walls. See text for further explanation.



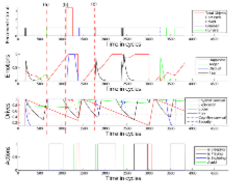


Allostatic Control and Personality





(Lallee et al., 2015)

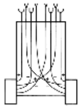


(Vouloutsi et al., 2013)

EFAA project (2011-2014)

WYSIWYD project (2014-2016)

Back to Braitenberg



Homeostasis

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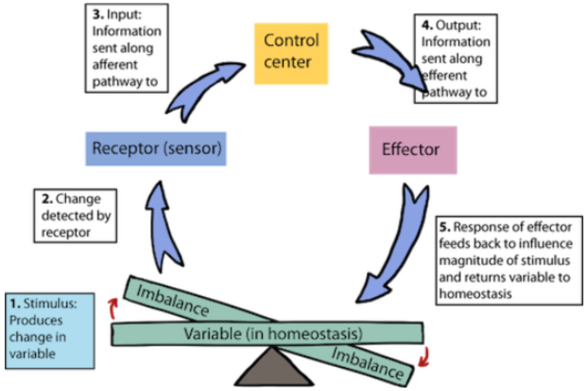

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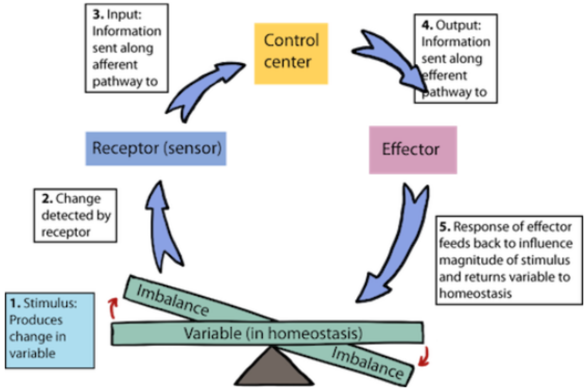

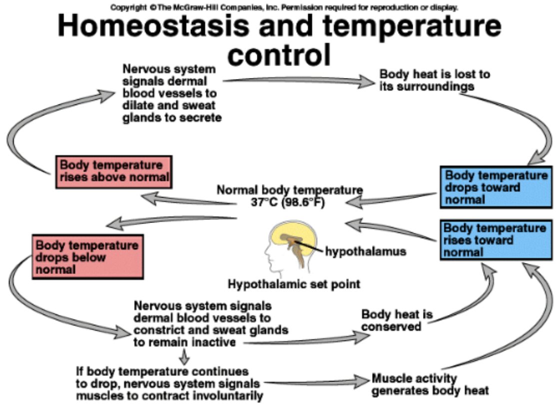

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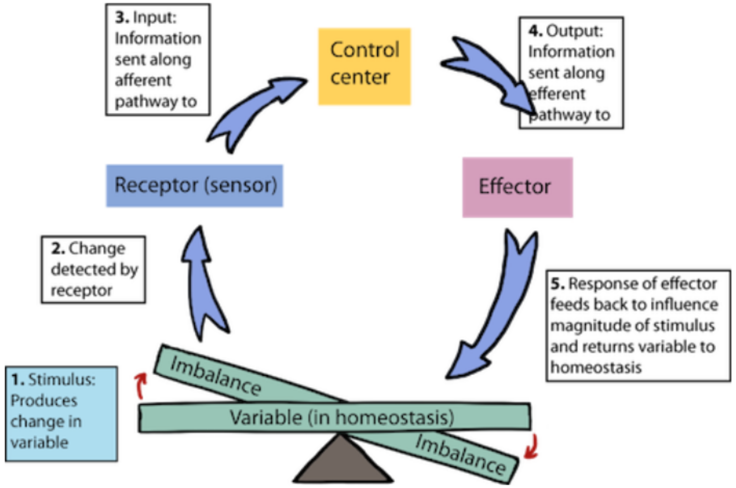

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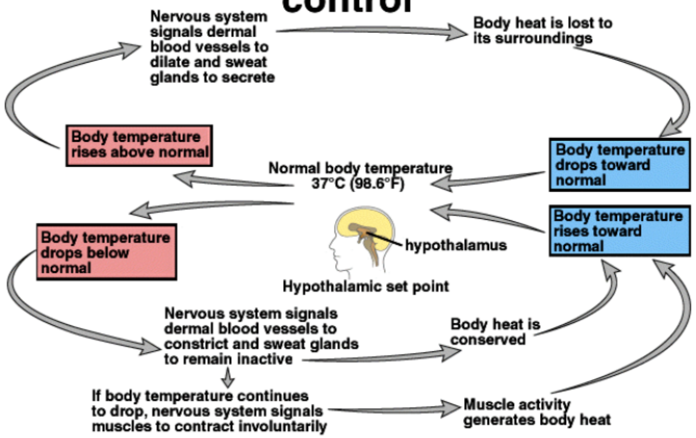
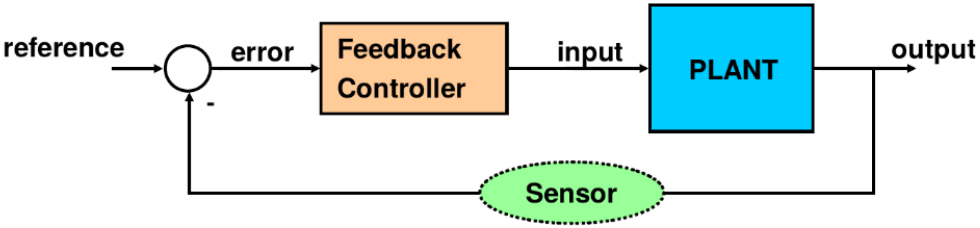
Homeostasis and temperature control



Feedback control



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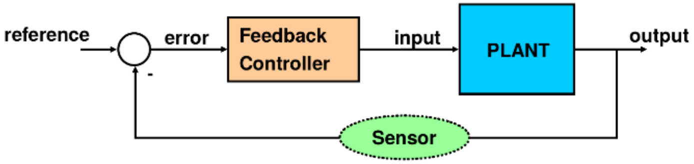

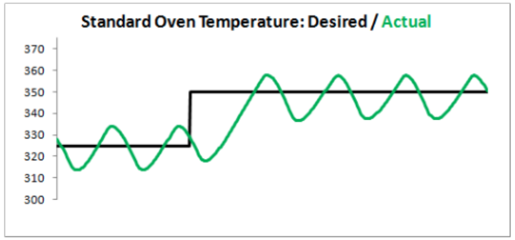

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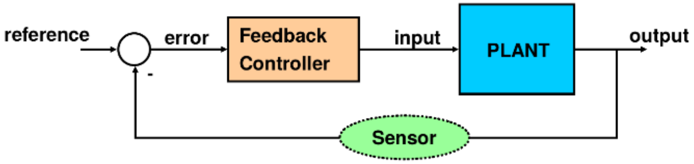

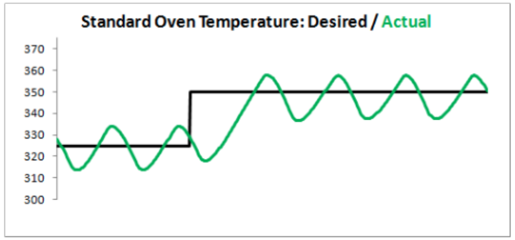

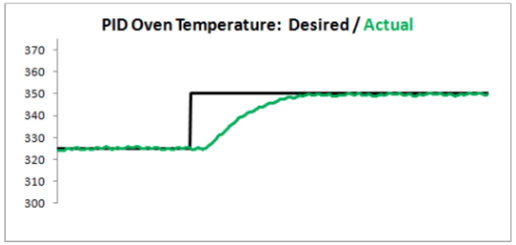

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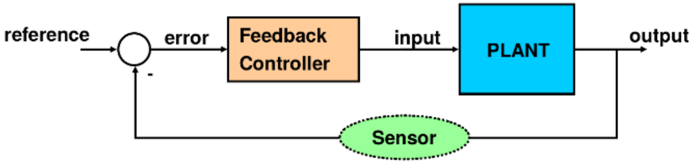

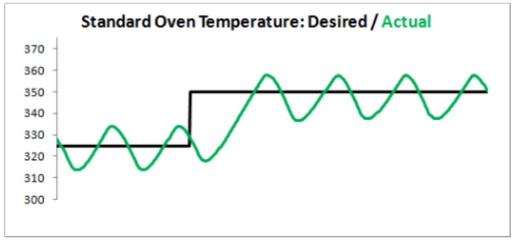

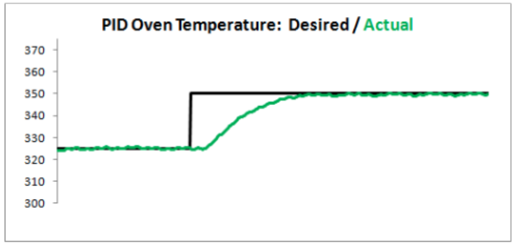

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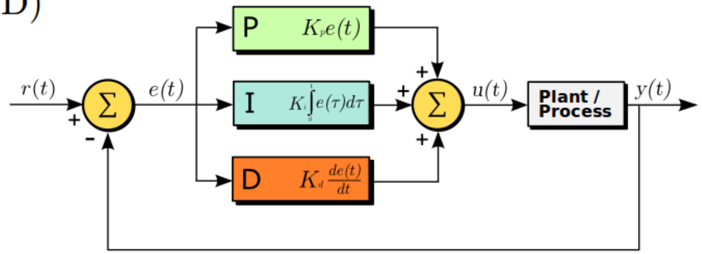

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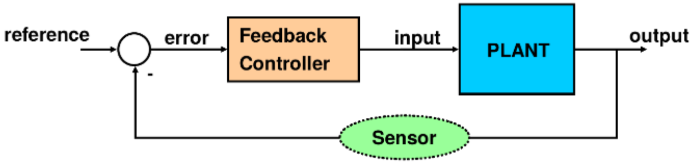

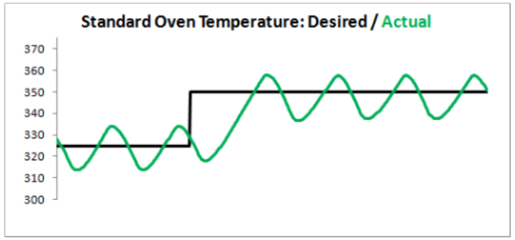

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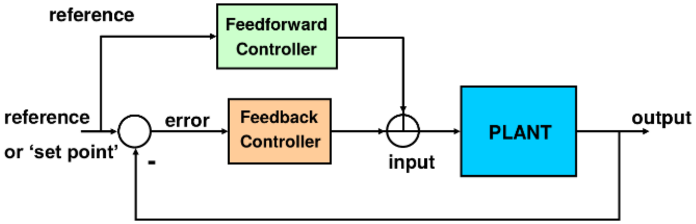

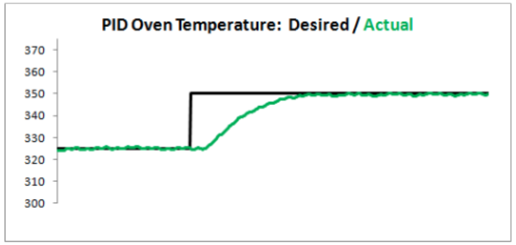

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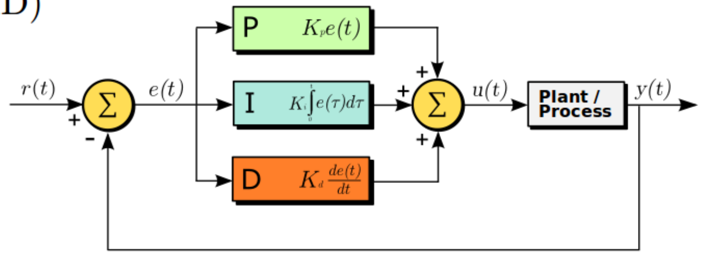

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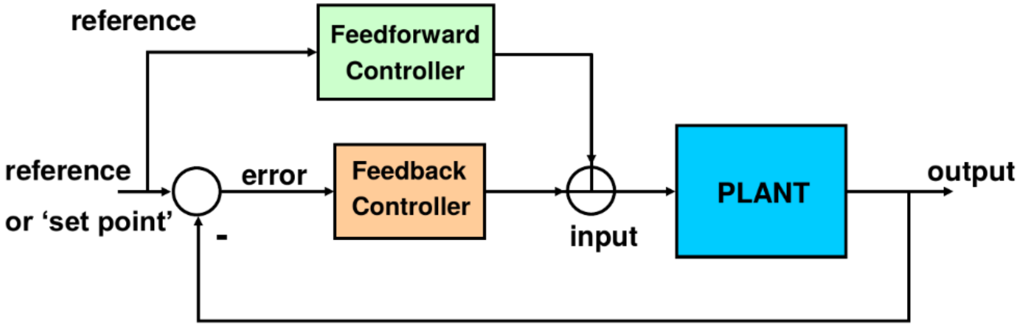

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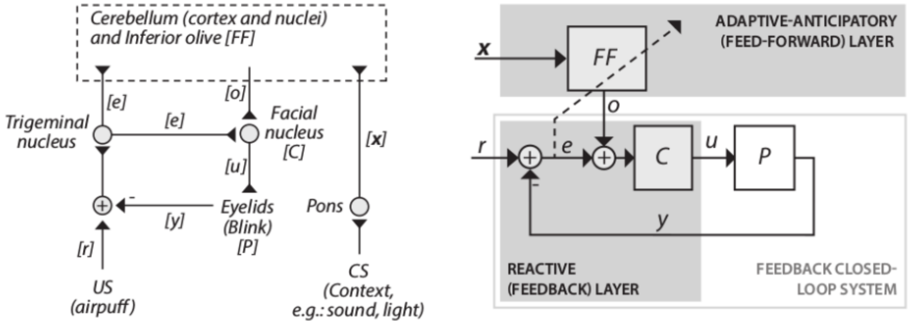

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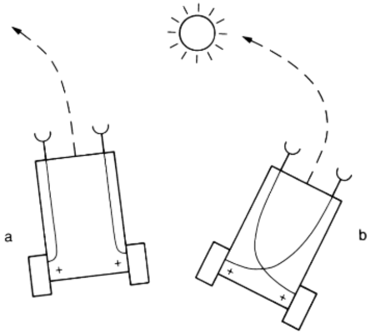
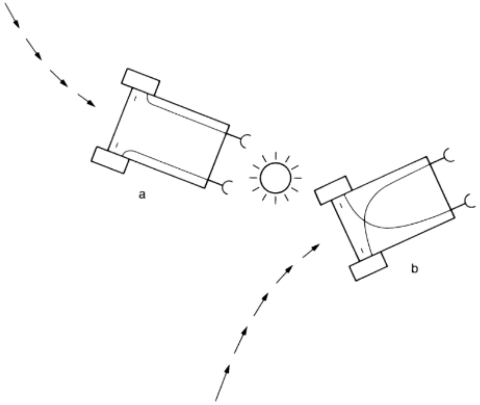
Homeostasis in Braitenberg Vehicles





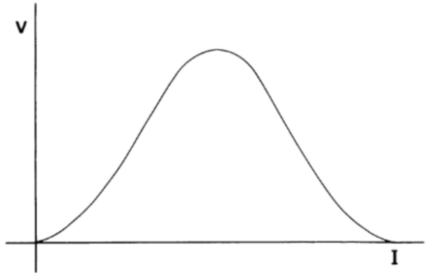


Figure 6
A nonlinear dependence of the speed of the motor V on the intensity of stimulation I, with a maximum for a certain intensity.

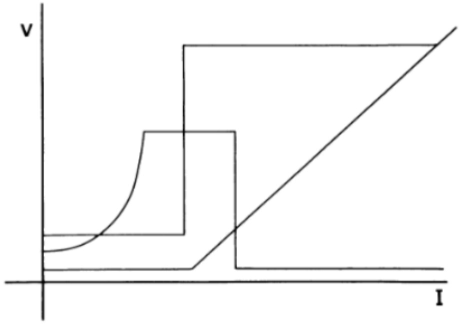


Figure 8
Various bizarre kinds of dependence of the speed of the motor (ordinate) on the intensity of stimulation (abscissa) in Vehicle 4b.

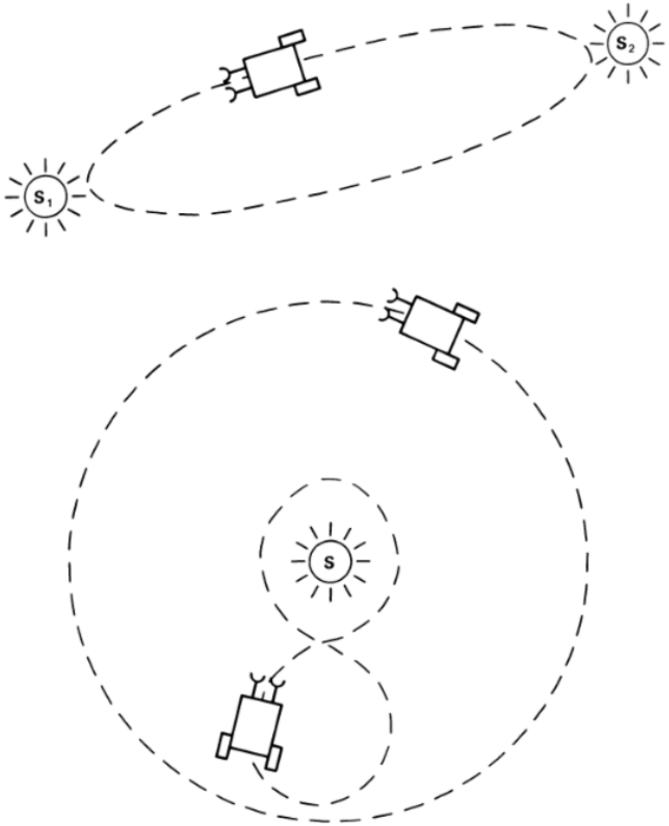


Figure 7
Trajectories of vehicles of brand 4a around or between sources.

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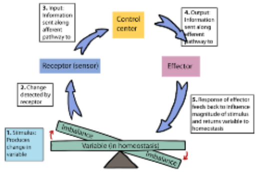

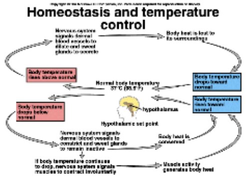

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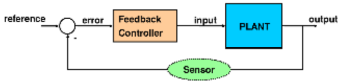

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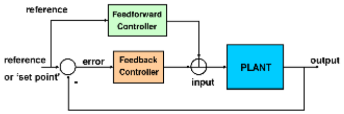

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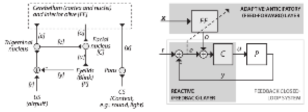

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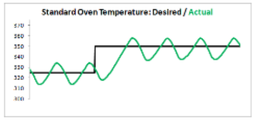

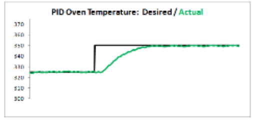

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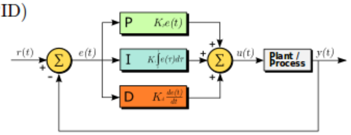

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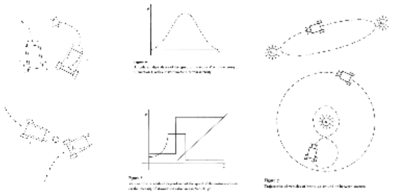

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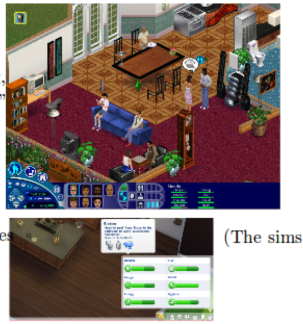
(The sims)

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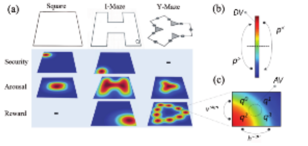

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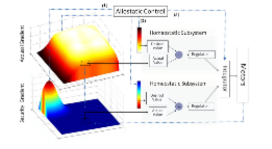
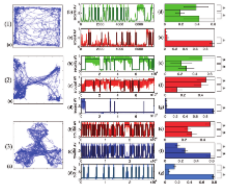
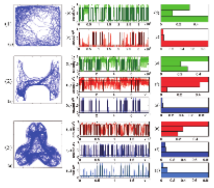
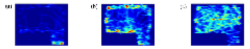


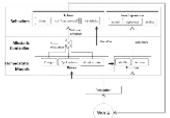
Fig. 1. Minimal allostatic control integrating two homeostatic subsystems.



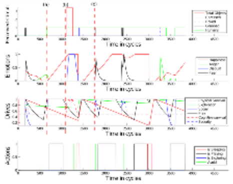


Allostatic Control and Personality





(Lallee et al., 2015)



(Vouloutsi et al., 2013)

EFAA project (2011-2014)

WYSIWYD project (2014-2016)

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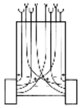

Allostasis

Definition (Bruce S. McEwen, Neurobiology of Aging, 2002):
Allostasis is the process that keeps the organism alive and functioning, i.e. maintaining homeostasis or ”maintaining stability through change” and promoting adaptation and coping, at least in the short run.

(Peter Sterling and Joseph Eyer, 1988)
”Homeostasis emphasized that the body’s internal environment is held constant by the self-correcting (negative feedback) actions of its constituent organs. Allostasis emphasizes that the internal milieu varies to meet perceived and anticipated demand. This variation is achieved by multiple, mutually reinforcing neural and neuroendocrine mechanisms that override the homeostatic mechanisms.”

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Bladder
Need to pee? Send Bruce to the bathroom to avoid catastrophic humiliation!
Click to Auto-Solve

(The sims)

Allostatic Control in a Synthetic Forager (Sanchez-Fibla et al., 2010)

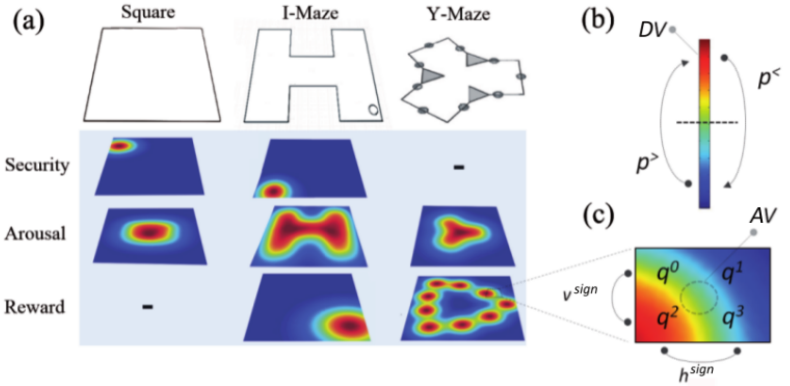
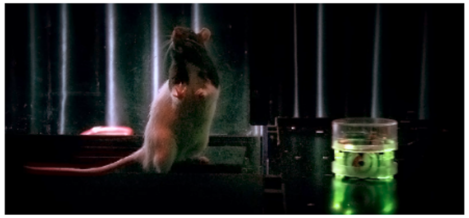


Fig. 2. Behavioral gradients used to drive the allostatic control system. (a) Table of the used gradients: rows correspond to security, arousal and reward respectively and columns to the different setups. The cue gradient as it is dynamic and is only used in the Y-Maze it is not shown. The presence of a reward port is indicated with a circle in the arena schema (top row). (b) Color scale of the gradients. The switching mechanism of desired values DV is illustrated. $p^>$ is the probability of switching to a higher DV, and $p^<$ to a lower one. (c) A zoom in one of the gradients indicates the four quadrants into which the local detection of the agent is divided to make the gradient ascent/descent computation.



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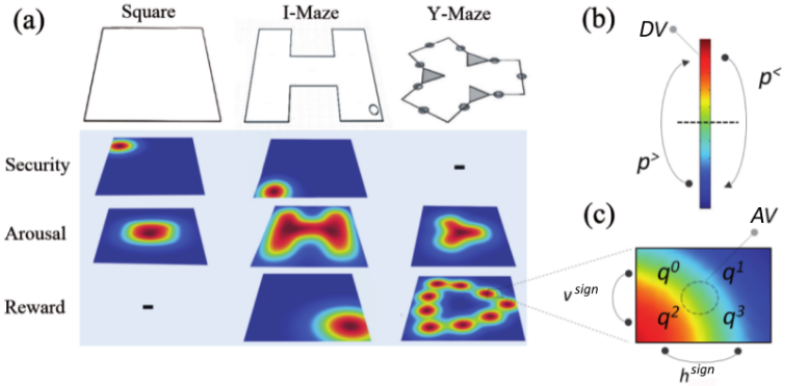

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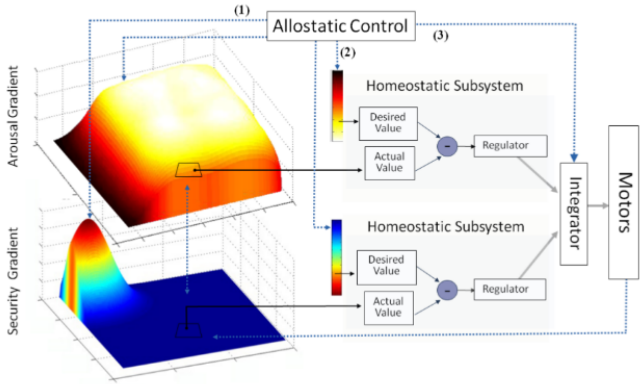
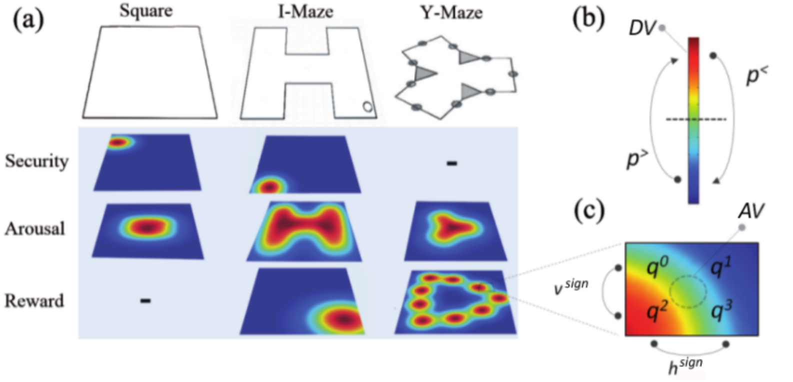


Fig. 1. Minimal allostatic control integrating two homeostatic subsystems. These subsystems can be related to a security subsystem (on bottom) with a preferred location on the top right corner and an arousal subsystem with its maximum in the center and dropping to zero close to the walls. See text for further explanation.

Allostatic Control in a Synthetic Forager (Sanchez-Fibla et al., 2010)



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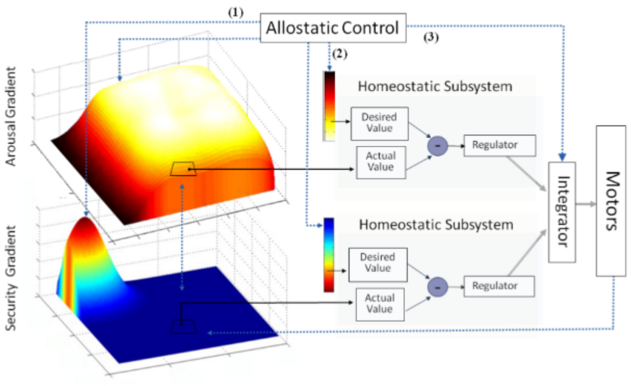

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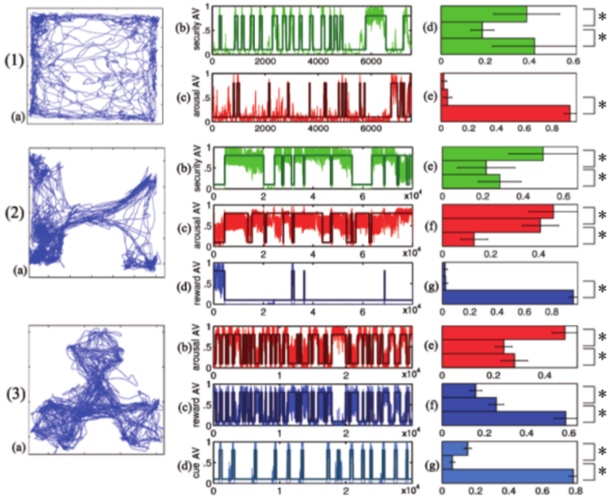

Fig. 4. Rat behavior in various mazes. (1) Square arena Rat Sessions. (1,a) Trajectory plot of one rat. (1,b) Security *AV* time series of the chosen session. (1,c) Arousal *AV* time series of the same session. (1,d) Histogram of the *AV* security values. For the histogram the *AV* are divided in 3 groups corresponding to the range $0 \leq 0.33 \leq 0.66 \leq 1$. Error bars correspond to standard deviation of the 13 available sessions. (2) I-maze Rat Sessions. The plot of the reward *AV* temporal series and histogram is added (2,d) and (2,g). For the I-maze histograms 8 sessions were available. (3) Y-maze rat sessions. Security *AV* plot is non applicable in the Y-maze. The cue *AV* plot is added (3,d). The Y-maze histograms correspond to 11 rat sessions. When two groups are significantly different, we indicate it with a star next to the corresponding bars.

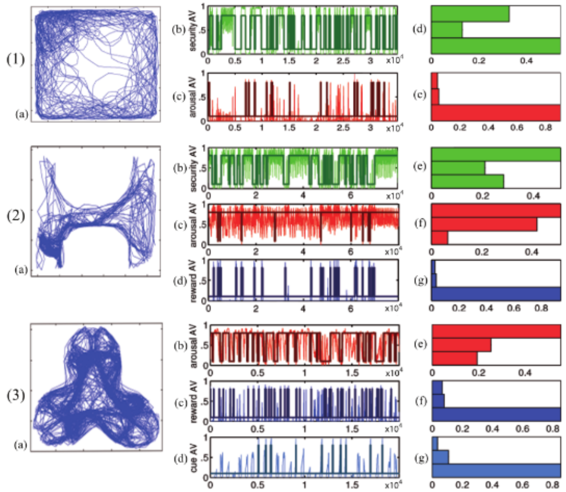

Fig. 6. Robot Simulations. Data plots follow the ones of figure 4. In the *AV* time series different intervals are shown to plot a representative part of the whole data set. See text for further explanation.

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(a) (b) (c)

Allostatic Control and Personality

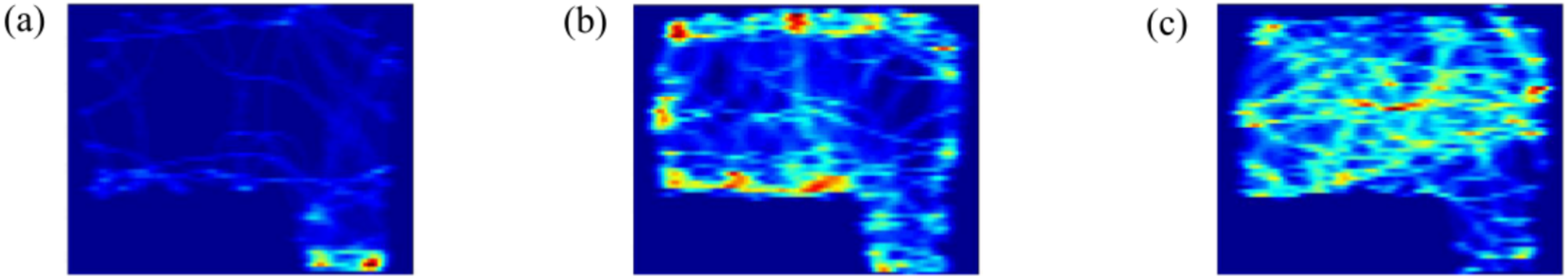
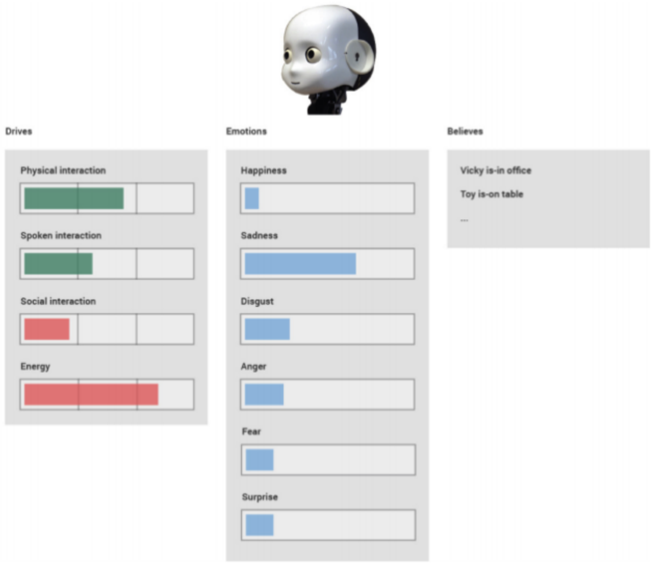


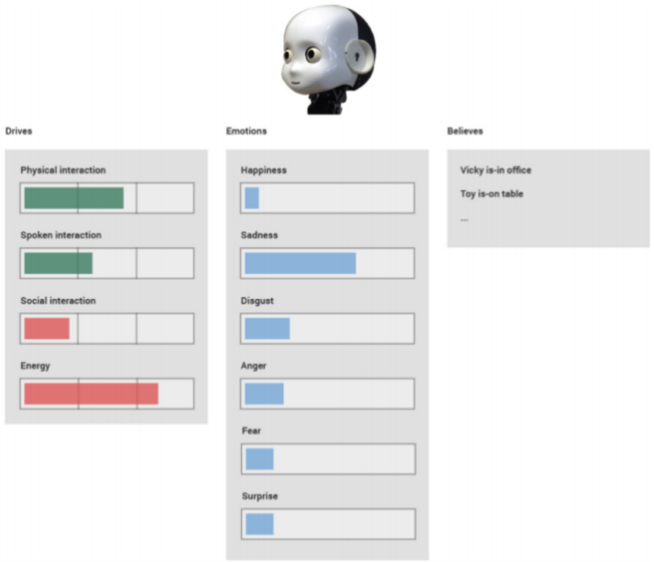
Fig. 5. Desired Value Settings. Three different occupancy maps of the robot in three different desired value settings using the gradient ascent method with inertia. (a) Low arousal, high security. (b) Low arousal, low security. (c) High arousal, low security.

Allostatic Control and Personality

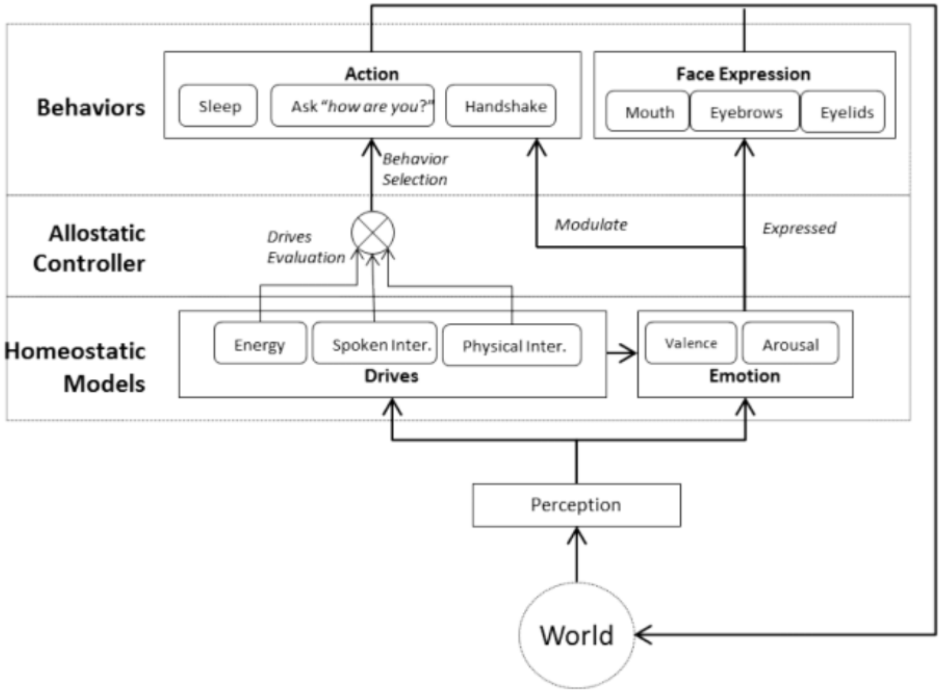


(Lallee et al., 2015)

Allostatic Control and Personality



Vicky is-in office
Toy is-on table
...



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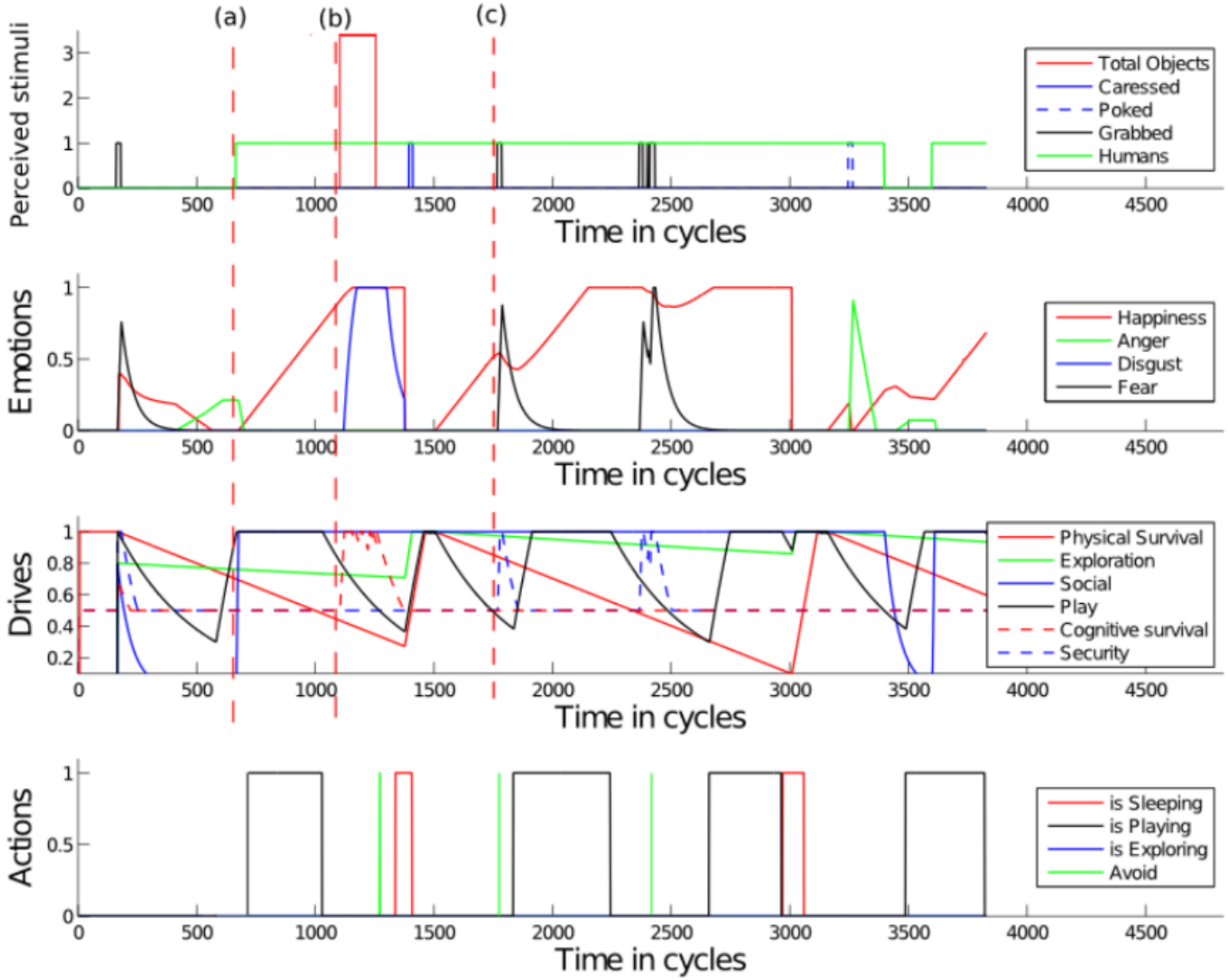

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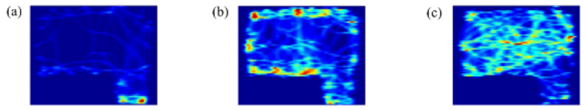
Allostatic Control and Personality



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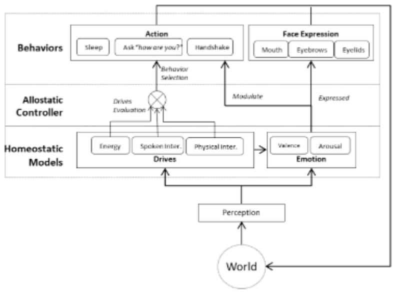

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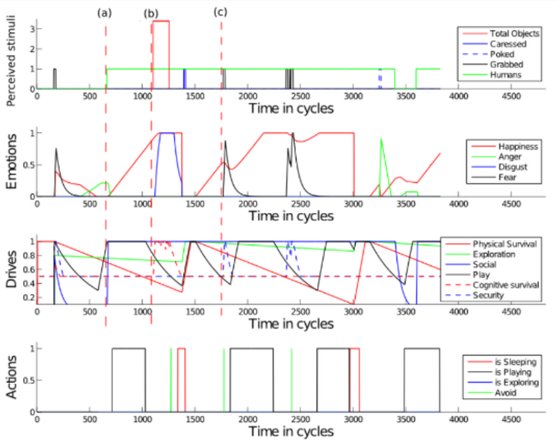

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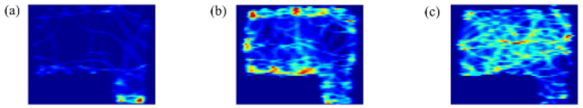
WYSIWYD project (2014-2016)

Allostatic Control and Personality



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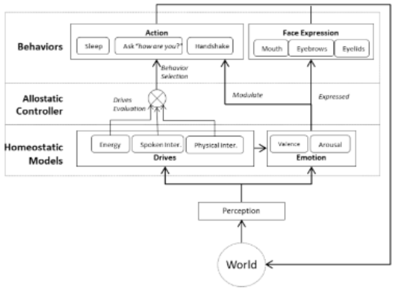

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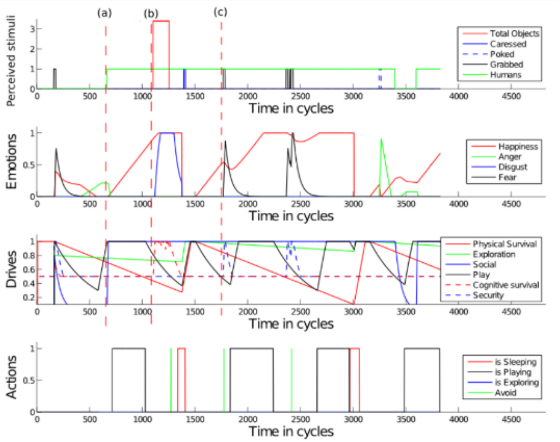

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