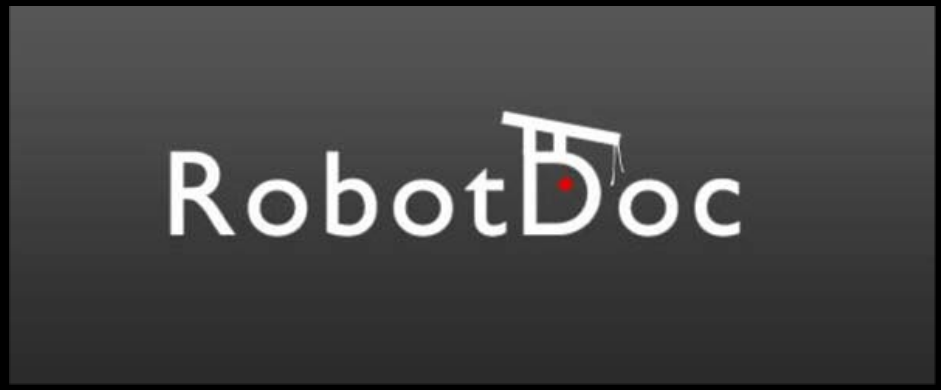
FEEL & WANT node

Cognition & Interaction Lab



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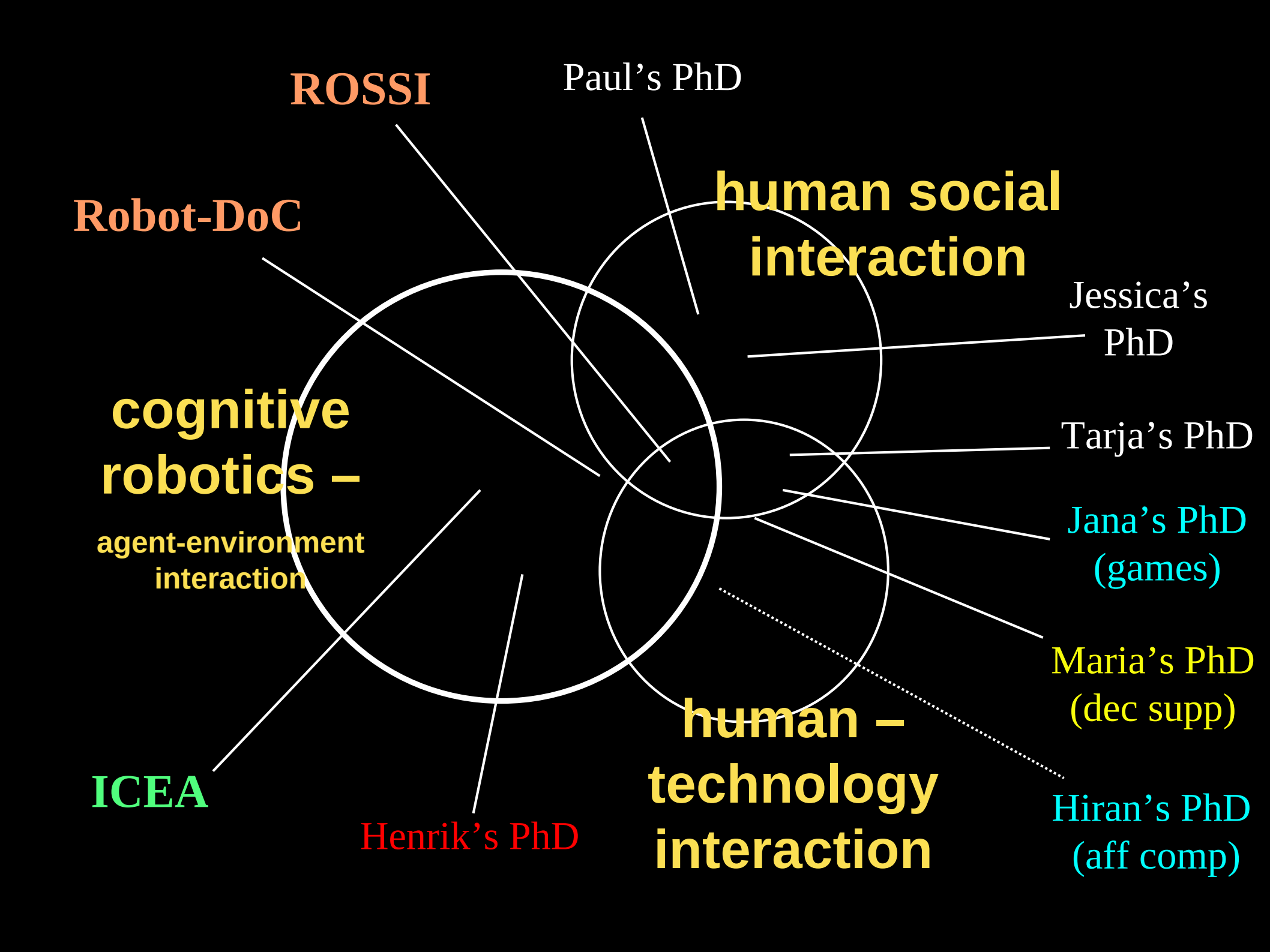
Embodied Cognition

Our perception of the world, our thoughts, and our social interactions are crucially dependent on our bodies and our embodied interaction with the world.

Situated Cognition

Cognition does not (only) take place ”in the head”, based on internal models of the world, but crucially depends on active situated interaction with the world.


ROSSI
Paul's PhD
Robot-DoC
human social interaction
Jessica's PhD
cognitive robotics –
agent-environment interaction
Tarja's PhD
Jana's PhD (games)
Maria's PhD (dec supp)
human – technology interaction
ICEA
Henrik's PhD
Hiran's PhD (aff comp)

Cognition & Interaction Lab

Professor(s)

Tom Ziemke

Assistant professors

Paul Hemeren – ROSSI

Jessica Lindblom

Tarja Susi – IF, comp games

Postdocs

Rob Lowe – ICEA, RobotDoC

Serge Thill – ROSSI

Boris Duran – ROSSI

Research engineers

Pierre Philippe – ICEA

Filippo Saglimbeni – ICEA

PhD students

Henrik Svensson – ICEA

Jana Rambusch – comp games

Maria Nilsson – IF

Alberto Montebelli – ICEA

Malin Aktius – ROSSI

Hiran Ekanayake – aff comp

new X – RoboDOC

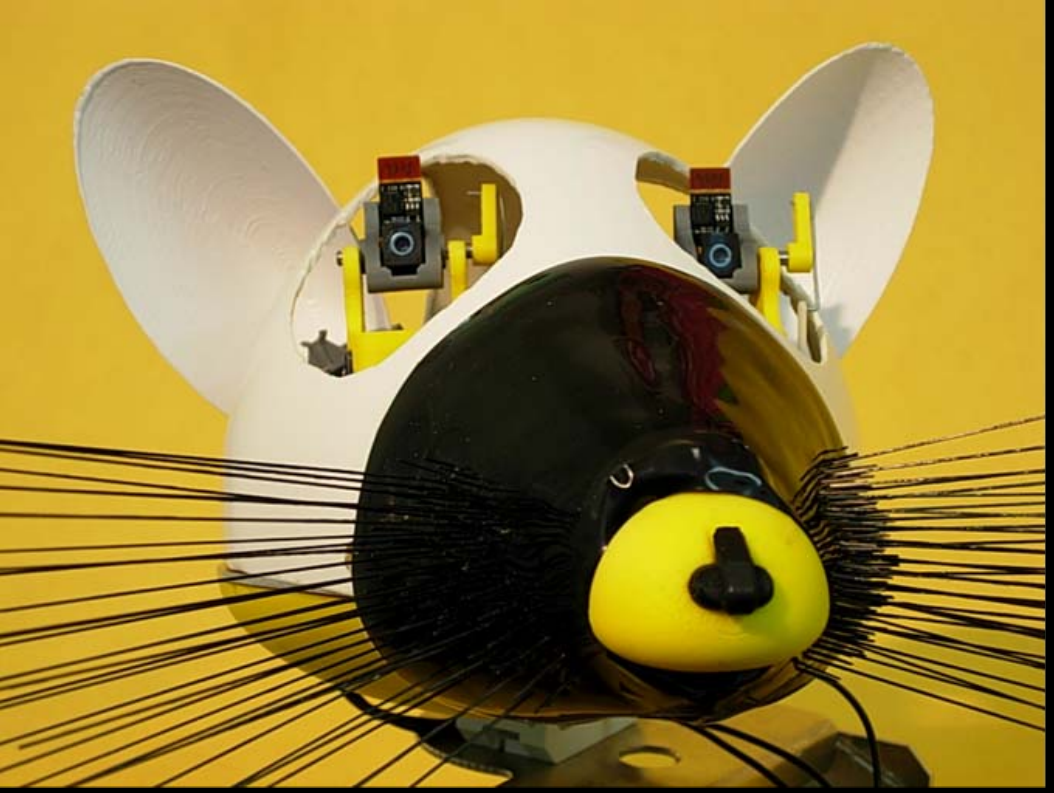
new Y – RoboDOC

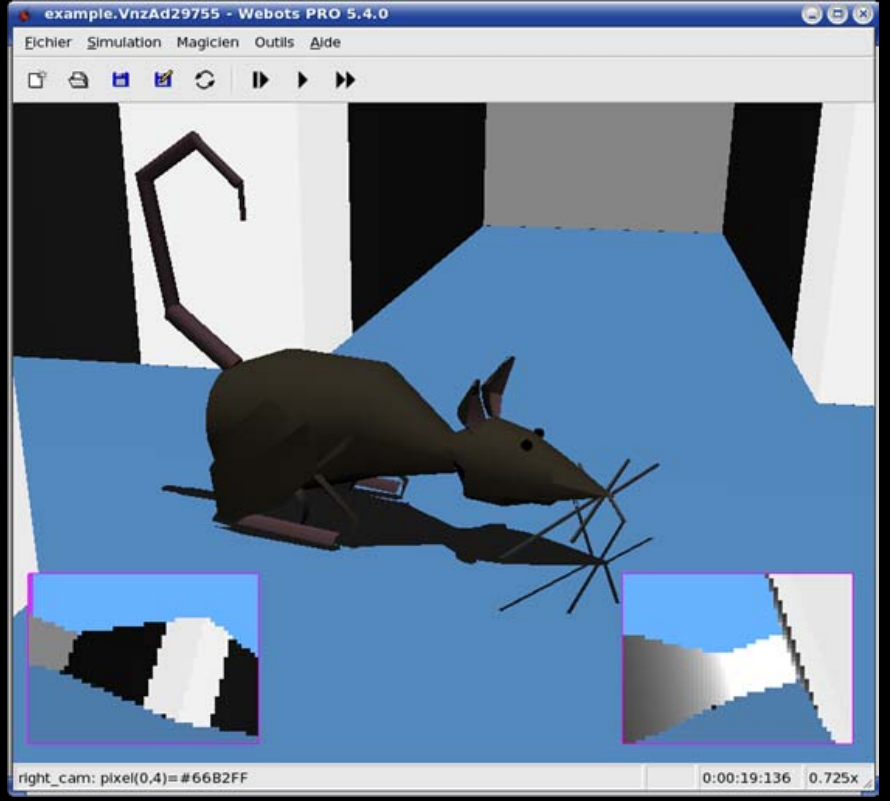
ICEA

European FP6 project
2006 – 2009, 8.1 M€
10 labs, 7 countries,
40+ people

- neurophysiologists
- brain modellers
- cognitive modellers
- roboticists
- control engineers

www.iceaproject.eu

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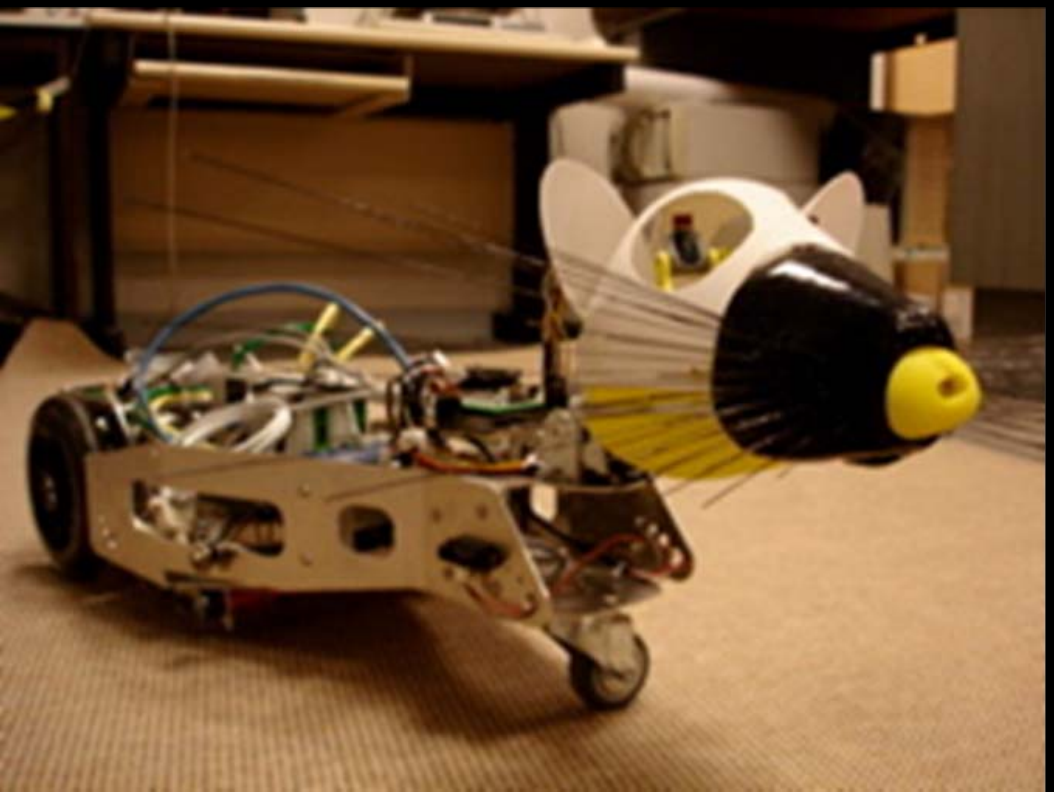
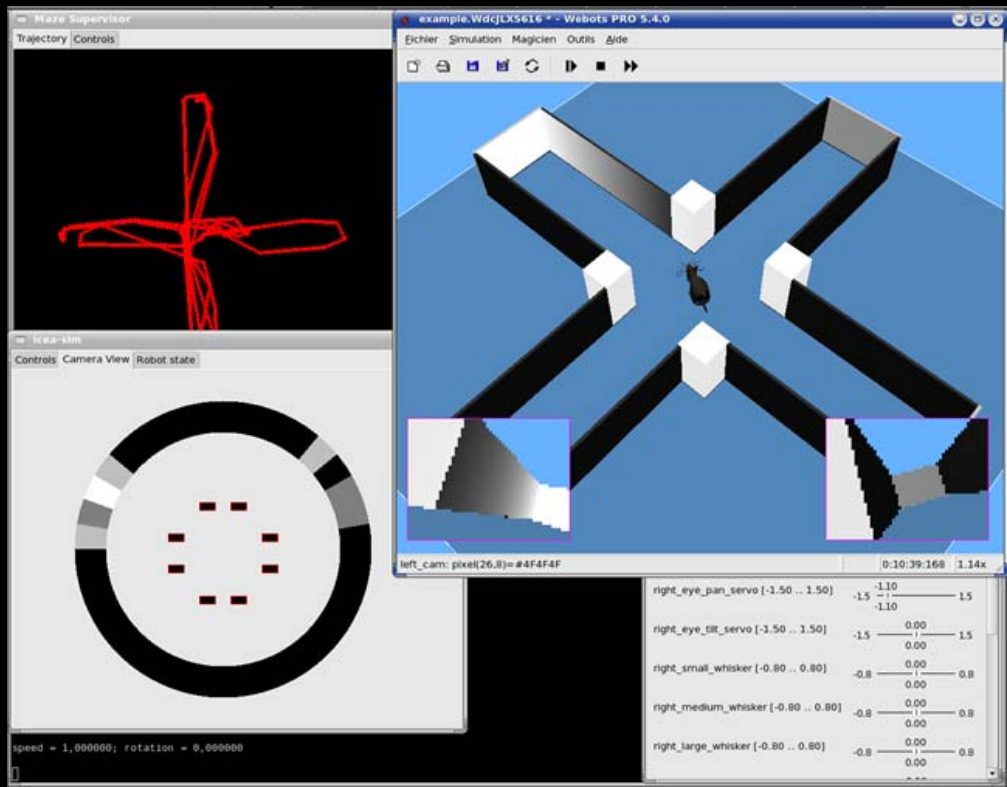
0.725x




Maze Supervisor
Trajectory Controls
Icea-sim
Controls Camera View Robot state
speed = 1,000000; rotation = 0,000000
example.WdcJLX5616 * - Webots PRO 5.4.0
Fichier Simulation Magicien Outils Aide
left_cam: pixel(26,8)=#4F4F4F
0:10:39:168
1.14x
right_eye_pan_servo [-1.50 .. 1.50]
right_eye_tilt_servo [-1.50 .. 1.50]
right_small_whisker [-0.80 .. 0.80]
right_medium_whisker [-0.80 .. 0.80]
right_large_whisker [-0.80 .. 0.80]

Integrating Cognition, Emotion & Autonomy

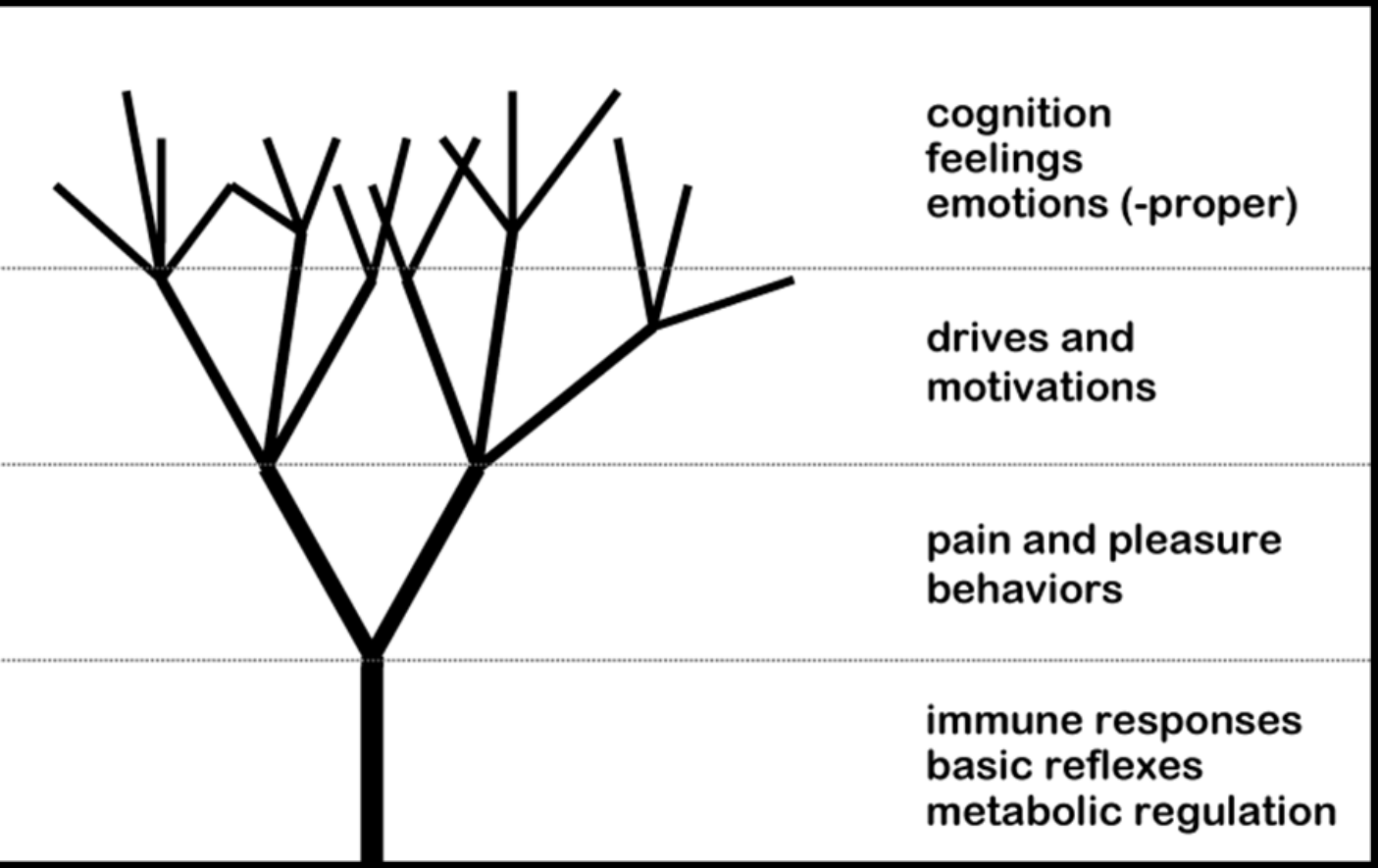
"A key hypothesis … is that emotional and homeostatic/autonomic mechanisms play a critical role in structuring the high-level thought processes of living cognitive systems, and

models of these mechanisms can be usefully integrated in **artificial cognitive systems architectures**, which will constitute a significant step towards **truly autonomous cognitive systems** that reason and behave, externally and internally, in accordance with energy and other self-preservation requirements, and thus sustain themselves over extended periods of time."

[from the proposal]

Cognition & Emotion …

… according to somatic theories of emotion – emerge from multiple levels of homeostatic bodily self-regulation



E.g. Damasio: nature has “built the apparatus of rationality not just on top of the apparatus of biological regulation, but also from it and with it"

Why Emotion in Robots?

”Emotions are necessary for the survival of the individual and the species. Therefore, a simple answer to the title of this book [“*Who needs emotions?*”] is that all organisms on earth need emotional systems, in their broadest biological definition.

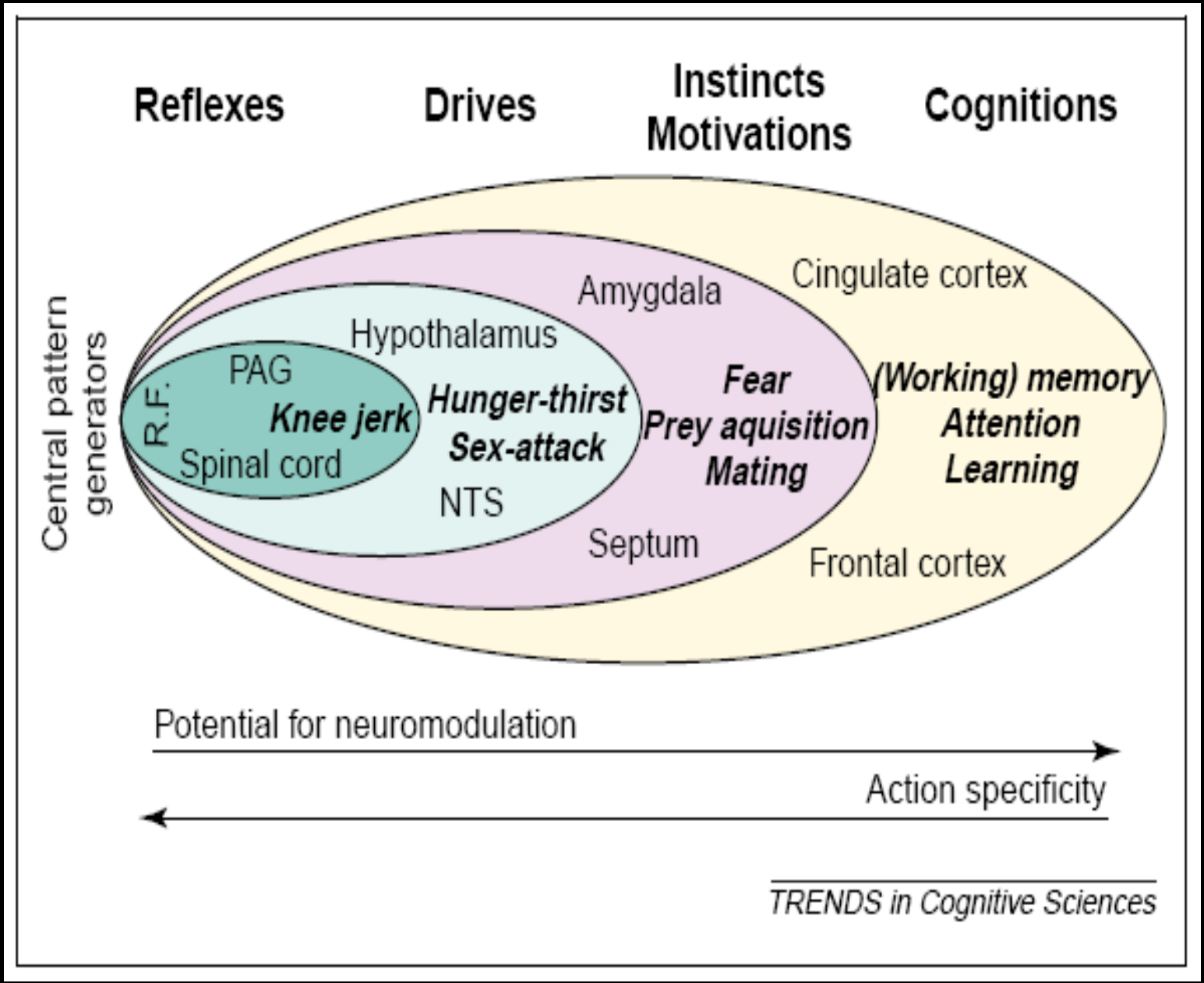
Emotional systems enable animals to more effectively explore and interact with their environment, eat, drink, mate, engage in self-protective and defensive behaviors, and communicate.

Thus, a robot designed to survive in the world as successfully as its living counterparts undoubtedly would require an equivalent system, one that instills urgency to its actions and decisions – in short, one that motivates and directs.”

Kelley (2005, p. 30)

Emotion & Neuromodulation

Arbib & Fellous (2004). *Trends in Cognitive Sciences*.

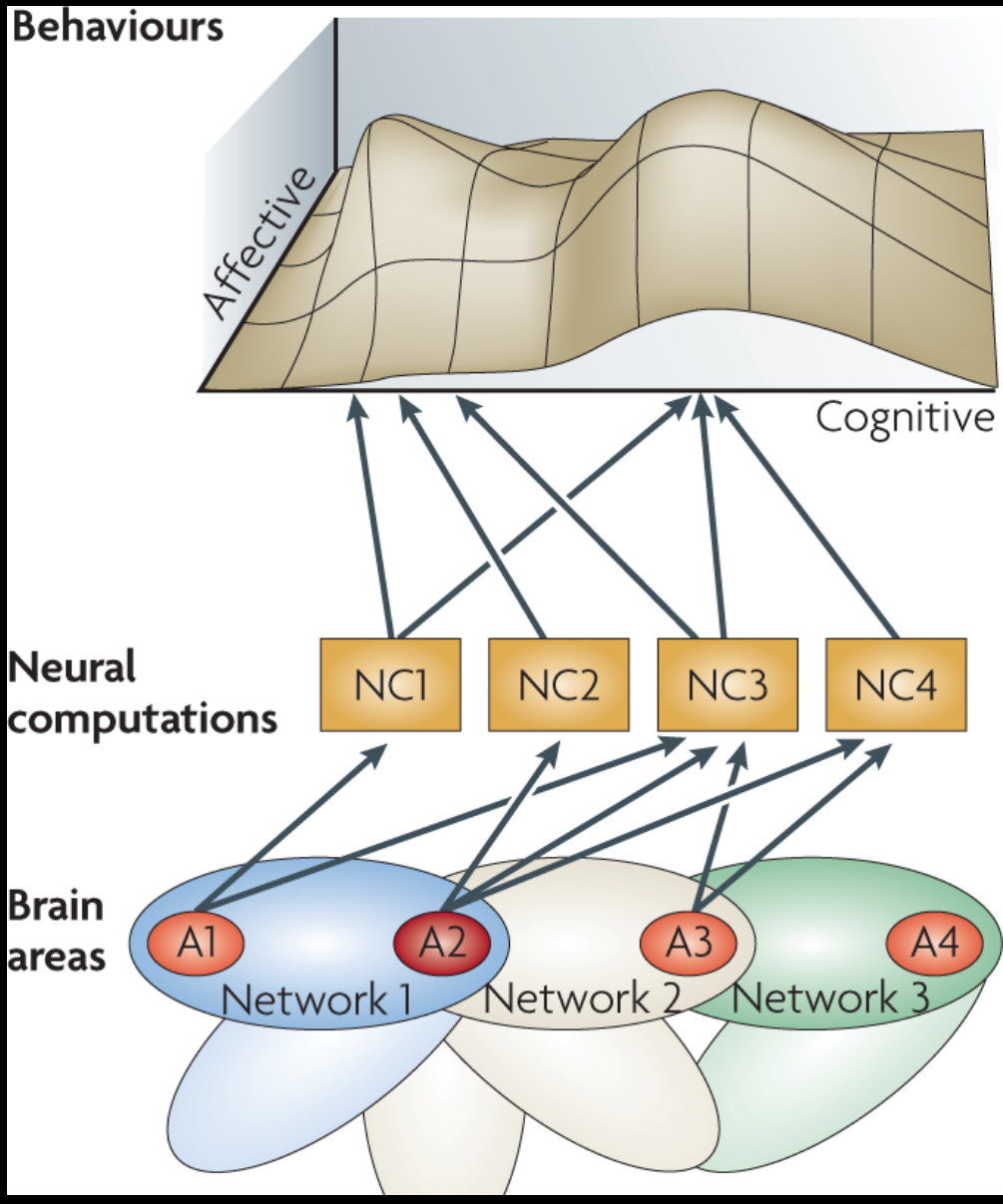


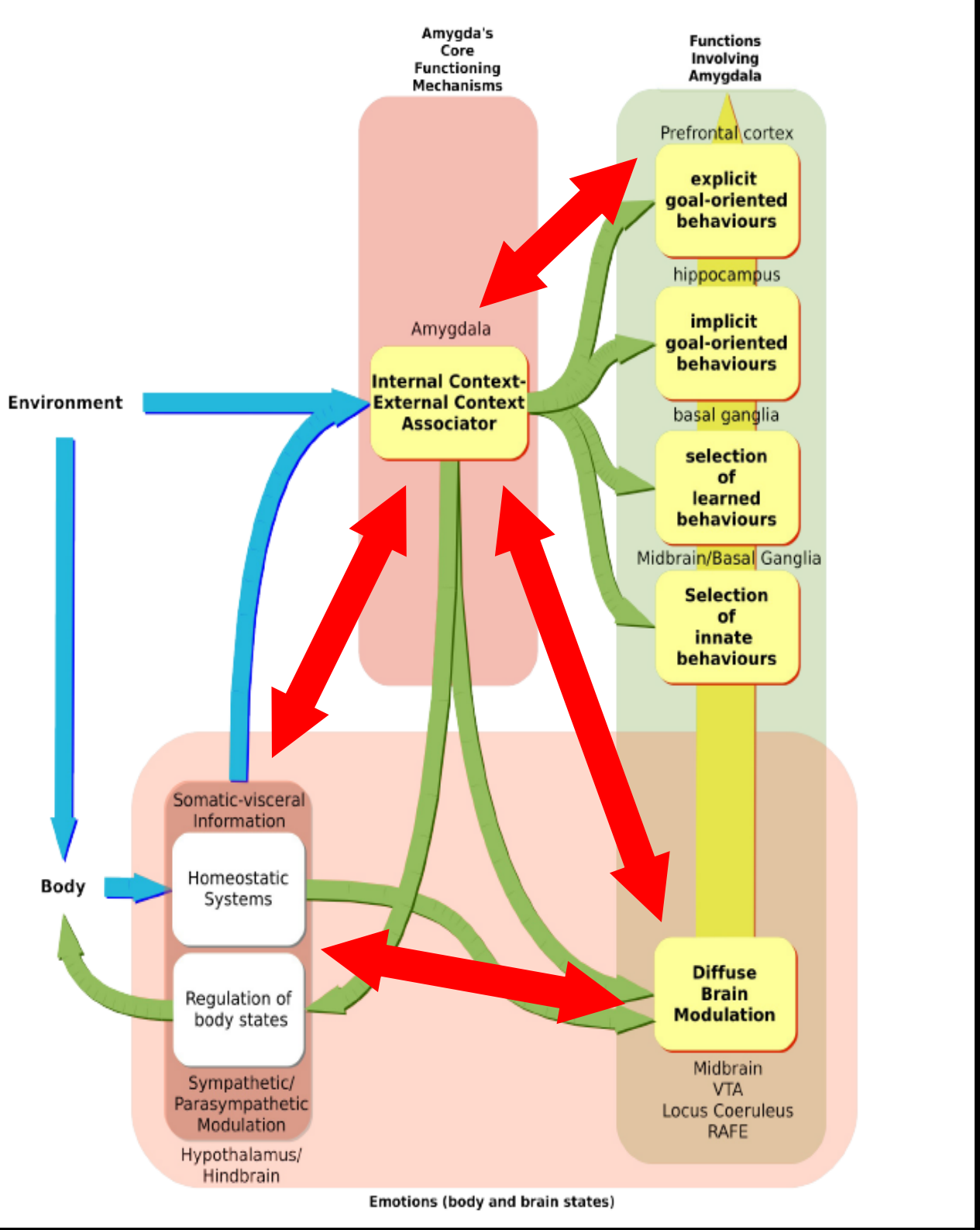
Emotion & Cognition

Pessoa (2008). *Nature Rev Neurosci,* 9(2):148-157.

”… complex cognitive-emotional behaviors have their basis in dynamic coalitions of networks of brain areas, none of which should be conceptualized as either ’affective’ or ’cognitive’.

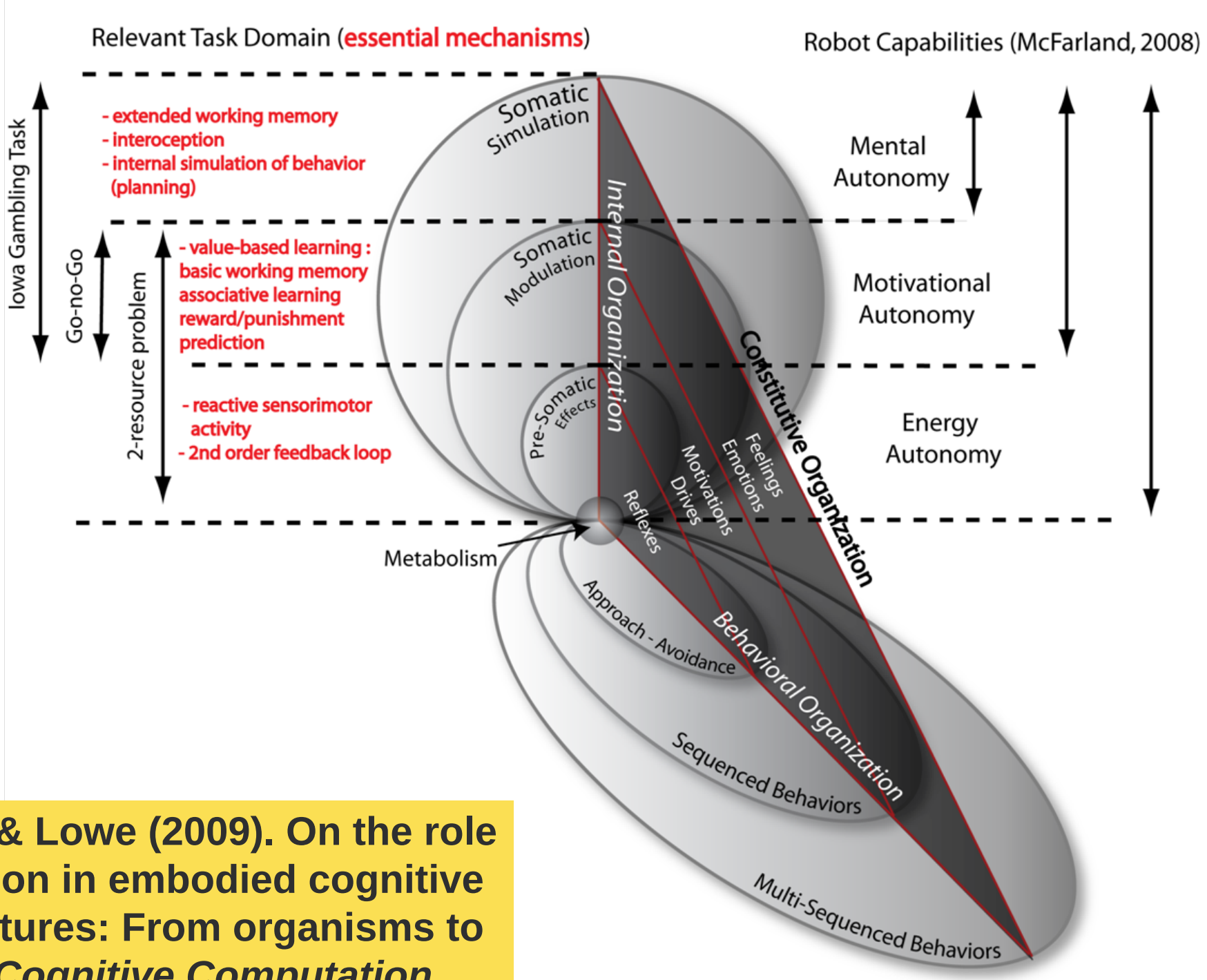
Central to cognitive emotional interactions are brain areas with a high degree of connectivity, called ***hubs***, which are critical for regulating the flow and integration between regions.”





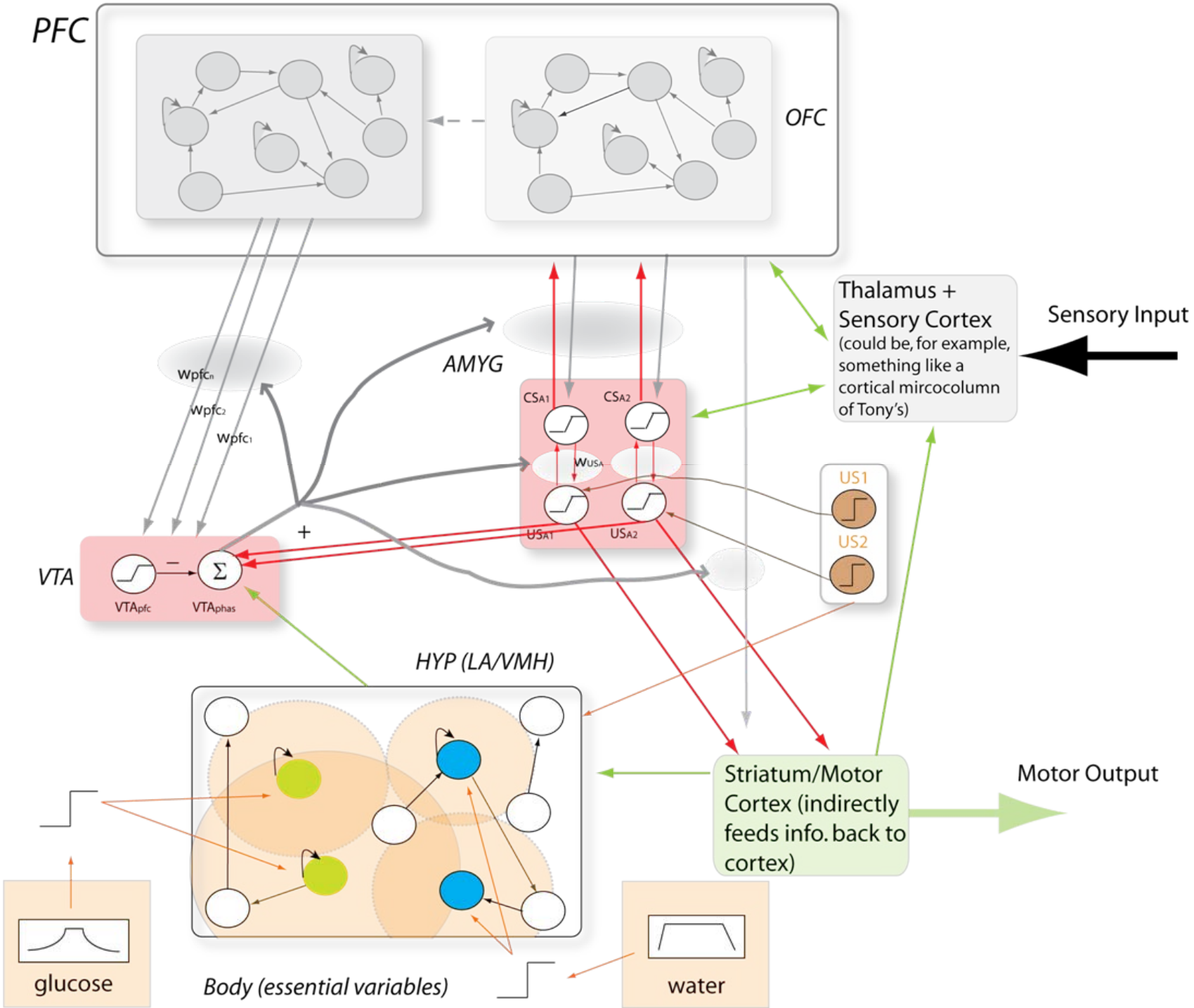
ICEA focus in Skövde:

Modeling the interaction of mechanisms at different levels in a neuro-computational cognitive-affective architecture



Ziemke & Lowe (2009). On the role of emotion in embodied cognitive architectures: From organisms to robots. *Cognitive Computation*, 1(1), 104-117.

Fully Integrated Architecture: Reward Based Model of 'Wanting' -
abstractly related to a corticostriatal-hypothalamic-brainstem network (see Kelley & Berridge, 2002)



ROSSI

emergence of communication in RObots through Sensorimotor and Social Interaction

3-year FP7 EU project, March 2008 to February 2011, involving six labs:

- cognitive neuroscience
  - Parma, Lübeck
- experimental psychology
  - Bologna (coord.)
- neurocomputational modeling
  - Skövde
- robotics
  - Ankara, Aberystwyth

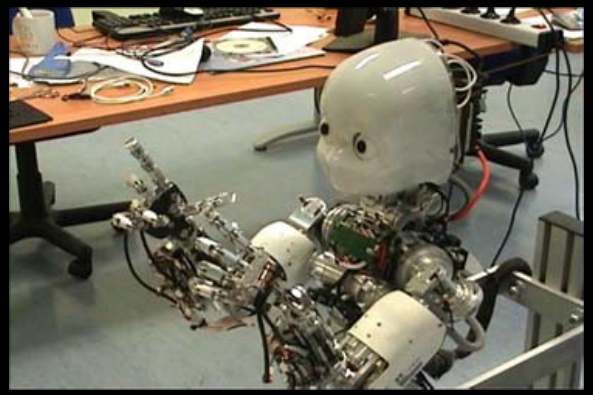
ROSSI - Aims

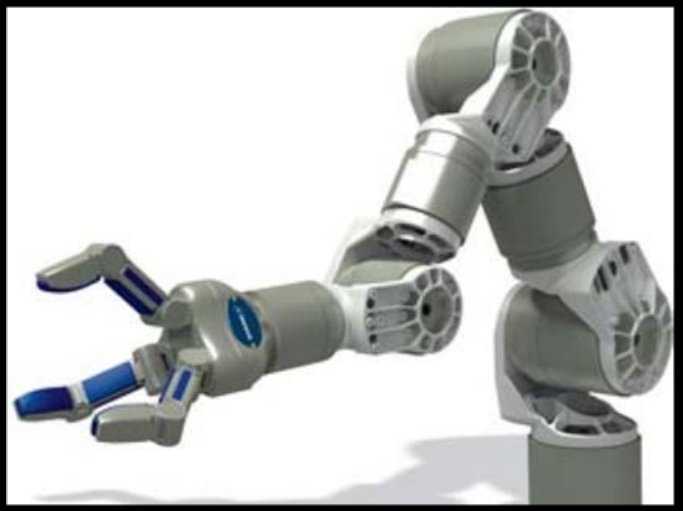
The main aims of the project are:

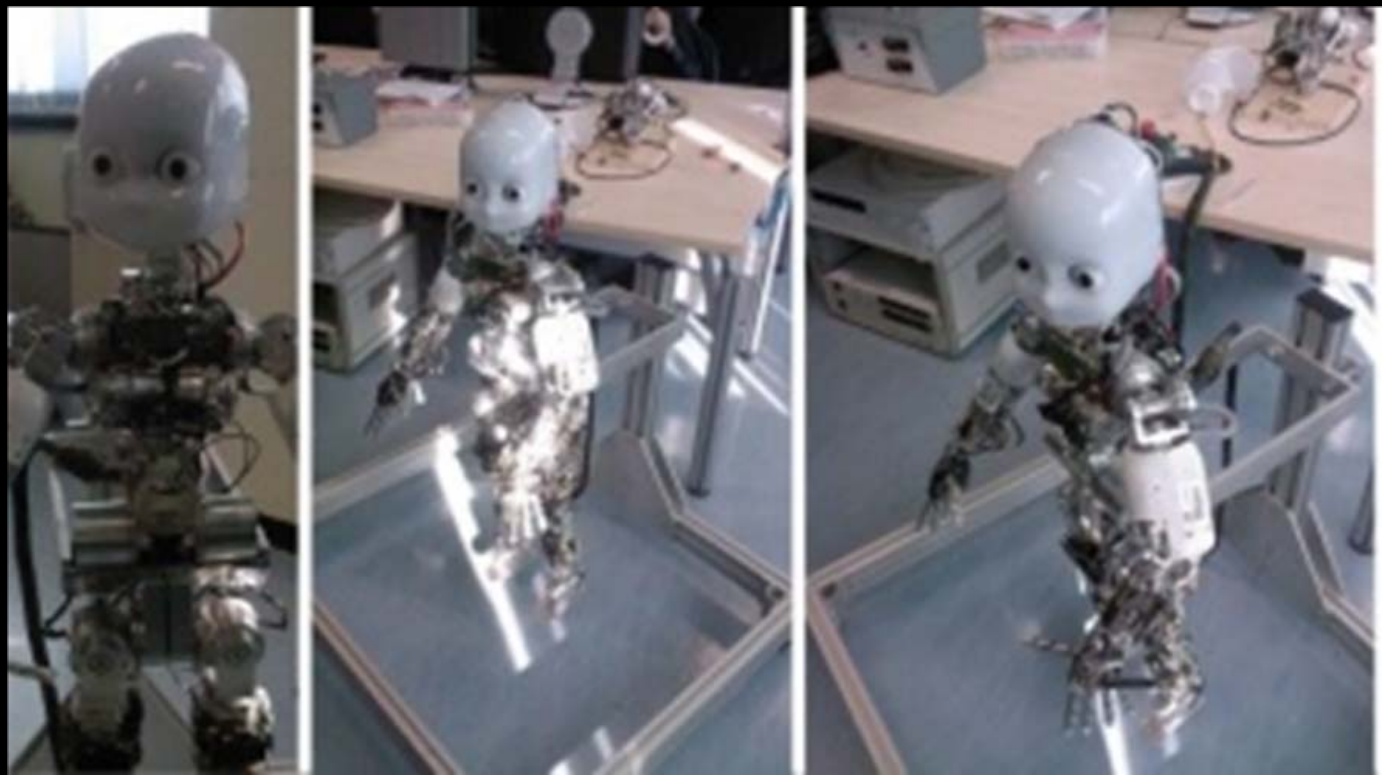
- to provide new neuroscientific & psychological insights into the **sensorimotor grounding of human conceptualization and language use**, in particular the role of canonical and mirror neurons as underlying the use of nouns and verbs,

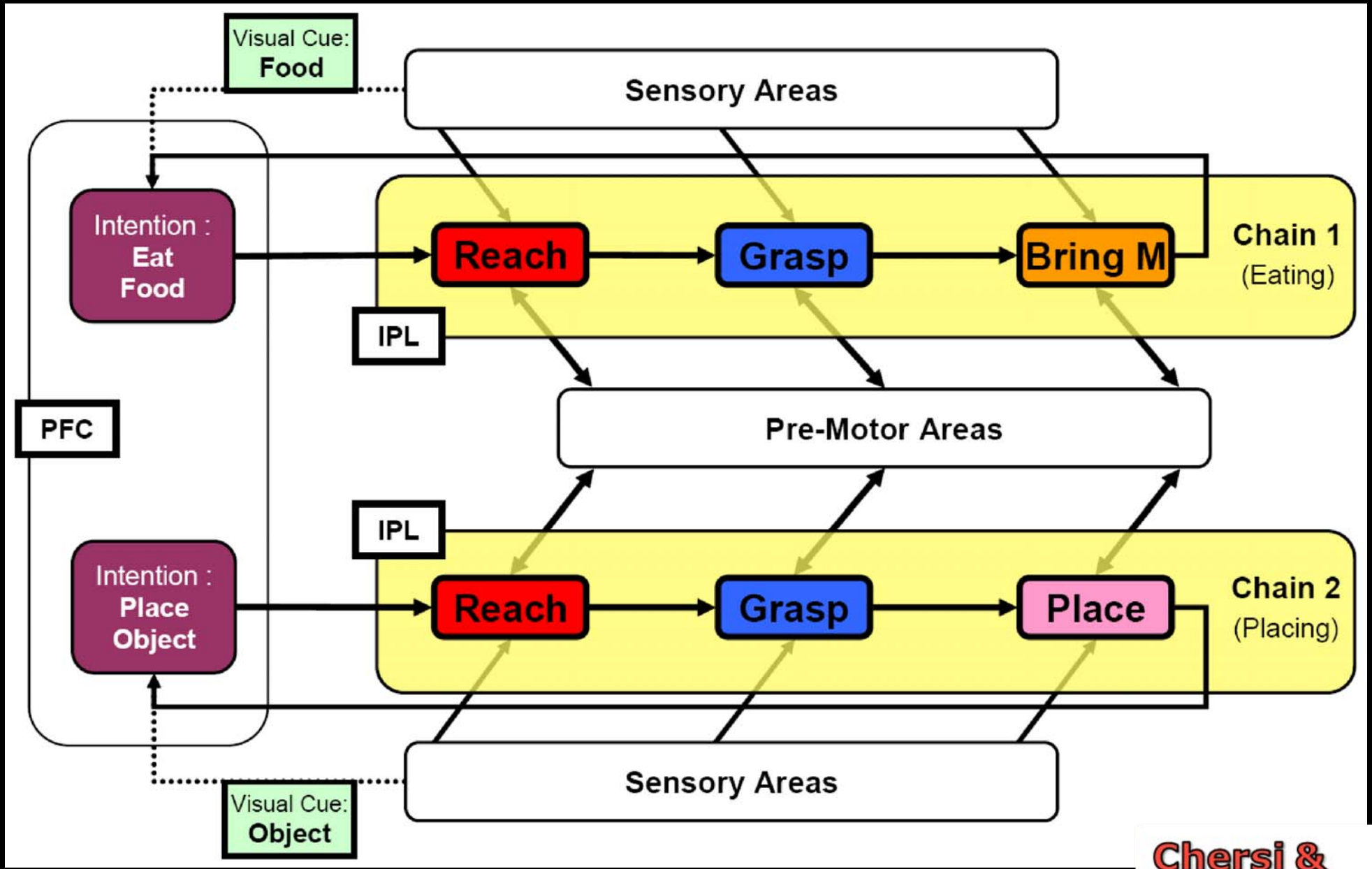
- to develop novel approaches to **sensorimotor grounding of robotic conceptualization and language use** (more precisely, verbal labeling of objects and actions), based on the insights gained under (a) and richer computational & robotic models of the underlying neural mechanisms.

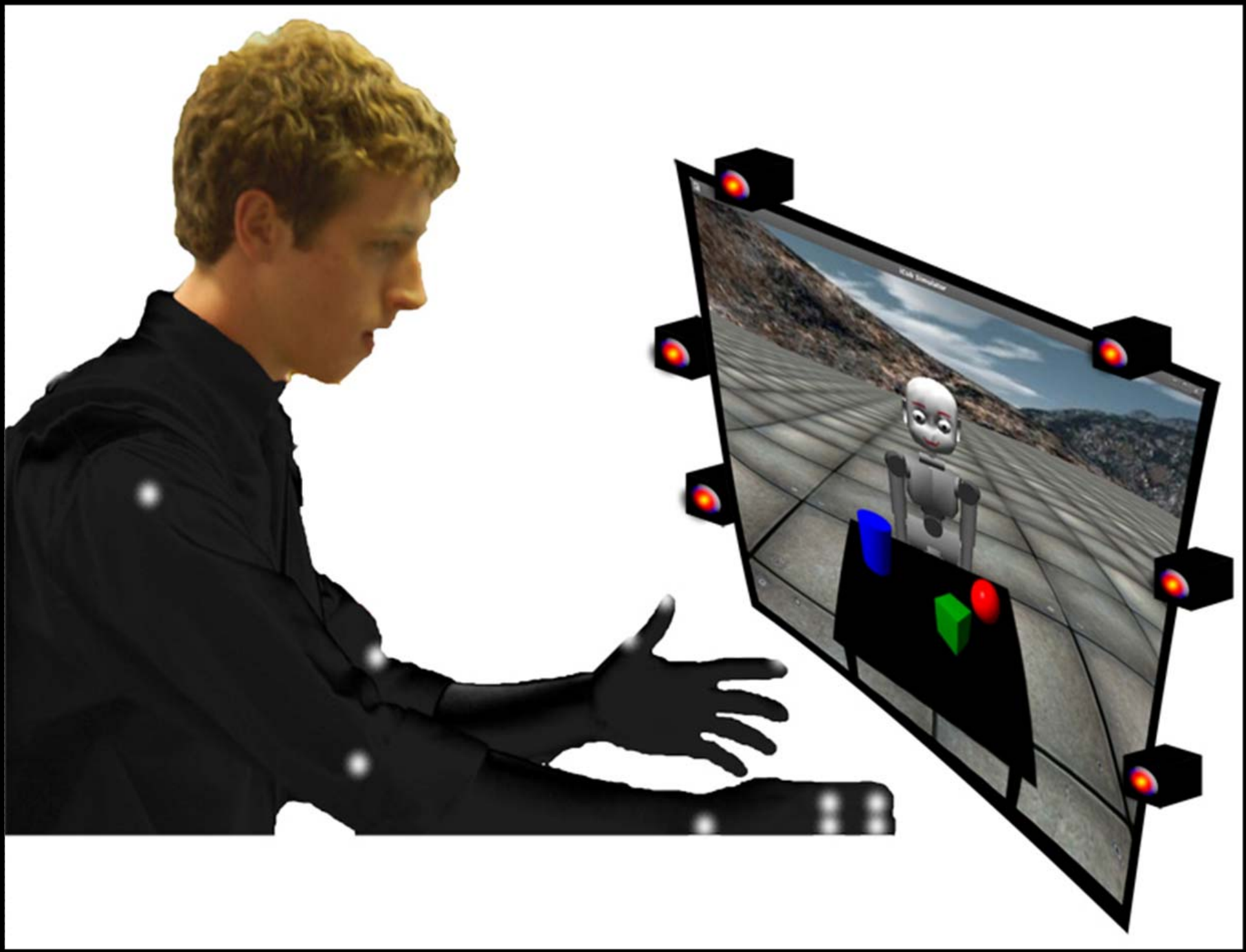
Robot platforms in ROSSI

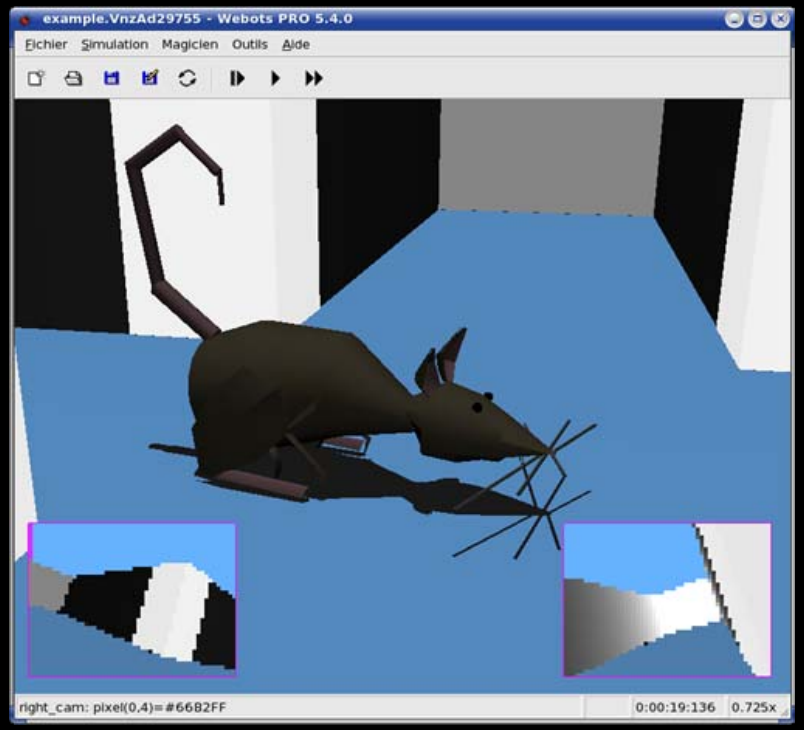







Visual Cue:
Food
Sensory Areas
Intention :
Eat
Food
Reach
Grasp
Bring M
Chain 1
(Eating)
IPL
PFC
Pre-Motor Areas
IPL
Intention :
Place
Object
Reach
Grasp
Place
Chain 2
(Placing)
Sensory Areas
Visual Cue:
Object
Chersi &
colleagues

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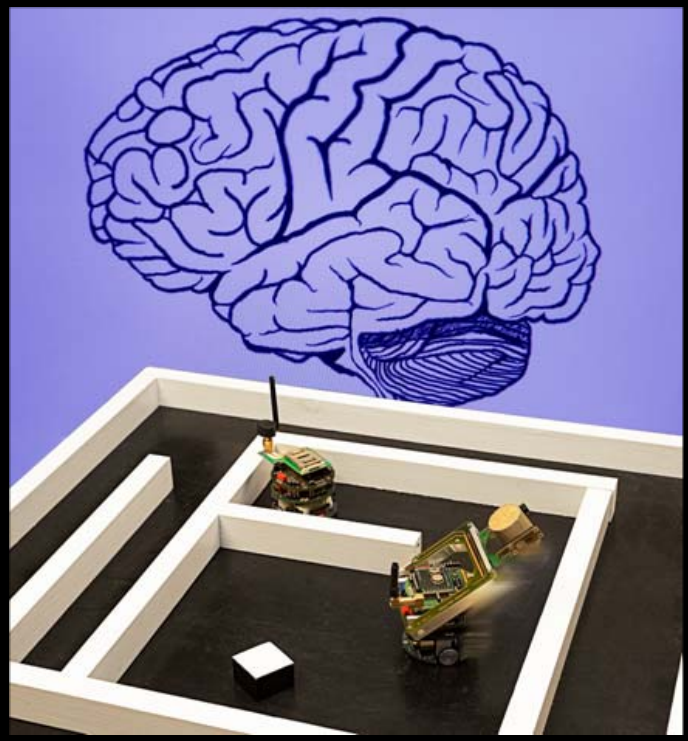

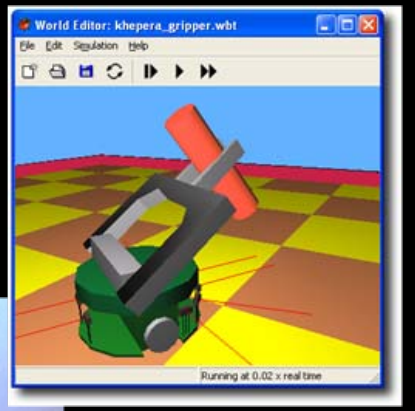
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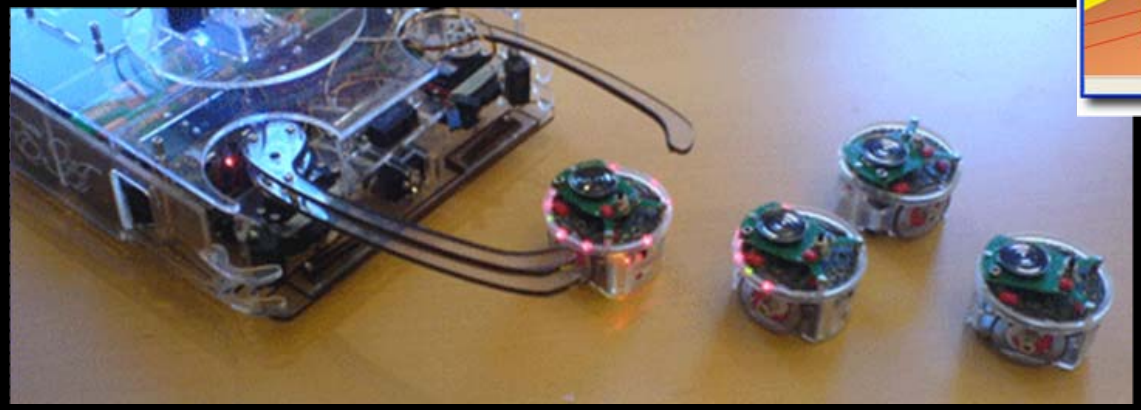
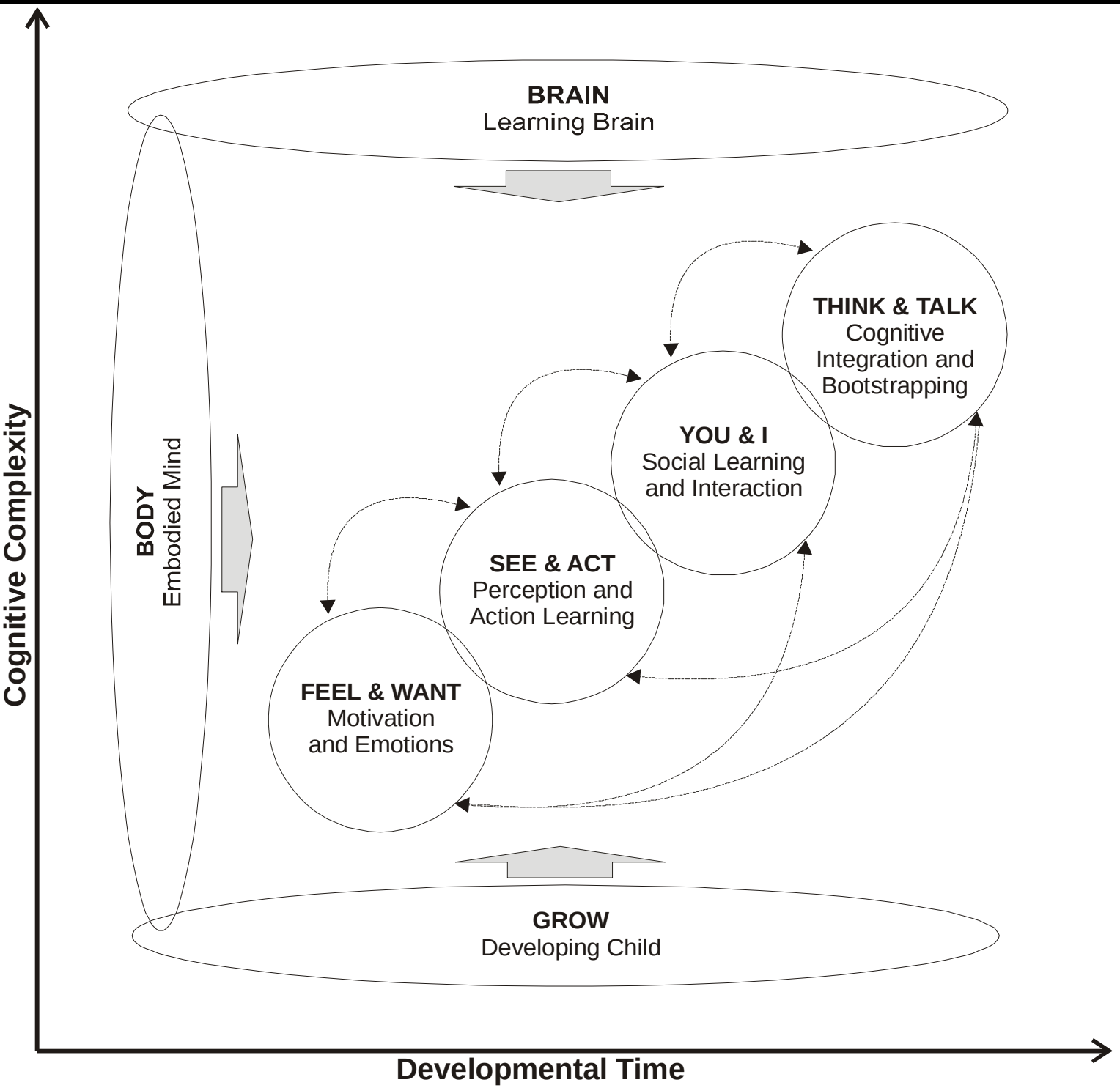
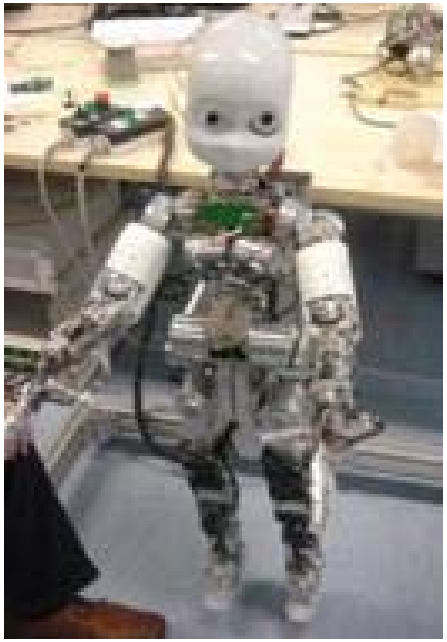



BRAIN
Learning Brain
BODY
Embodied Mind
THINK & TALK
Cognitive
Integration and
Bootstrapping
YOU & I
Social Learning
and Interaction
SEE & ACT
Perception and
Action Learning
FEEL & WANT
Motivation
and Emotions
GROW
Developing Child
Cognitive Complexity
Developmental Time



Motivation and Emotions

- *leader node: FEEL&WANT; collaborating nodes: BRAIN, BODY, THINK&TALK*
- Emotion plays a crucial role in rational decision-making and they play a crucial role in coordinating the interactions of different brain systems and different levels of cognitive processing.
- The Collegium will further our understanding of the role of affective mechanisms in cognition through novel developmental robotics investigations.
- The Fellows' research projects in this area will be:
  - Affective 'representation' and anticipation. (ESR7 Task 4.1)
  - Affective modulation of embodied cognition. (ESR8 Task 4.2)

Task 4.1 - Affective 'representation' and anticipation

- *Fellow ESR7; leader SKOVDE*
- *collaborators PLYMOUTH*
- *Inspired by Damasio's notion of "feelings" as "brain representations" of emotional bodily states and Grush's emulation theory of representation, the following questions will be investigated, a.o.:*
- *How can an embodied agent make use of its perception/interoception of own body-internal/ homeostatic states (in addition to perception of the external environment) in structuring its cognition and behaviour? In particular, how can embodied simulation/ anticipation of both sensorimotor and affective consequences of actions interact in the preparation and planning of action (possibly at different levels of abstraction)?*

Task 4.2 Affective modulation of embodied cognition

- *Fellow ESR8; leader SKOVDE*
- *collaborators SUNDERLAND, PLYMOUTH*
- *This research will expand on the ICEA project's cognitive-affective architecture involving different levels of homeostatic regulation in embodied cognitive agents, based on neurocomputational models of the interaction of different mammalian brain structures. While the work in ICEA has been based mainly on models of rat behaviour, the new research will be adapted to the more complex iCub humanoid platform as well as more human-like cognition and behaviour. Questions include:*
- *How can (higher levels of) cognition be grounded in and informed by affective mechanisms? In particular, how can decisionmaking/action selection be based on so-called somatic-markers. How do the time scales of processes at different levels interact?*