RobotDoc

# FEEL & WANT node:
# Embodied Reward Learning and Development

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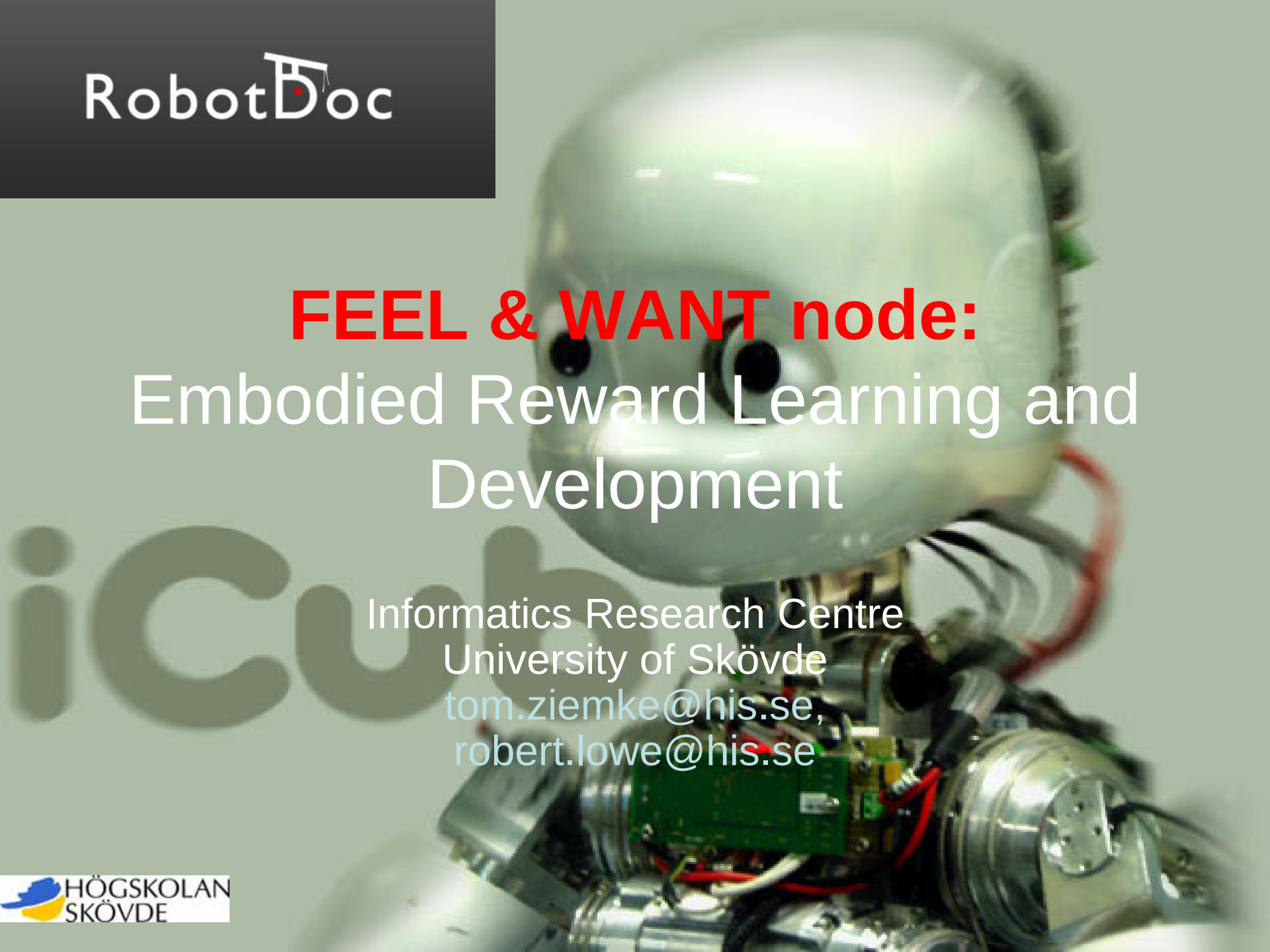
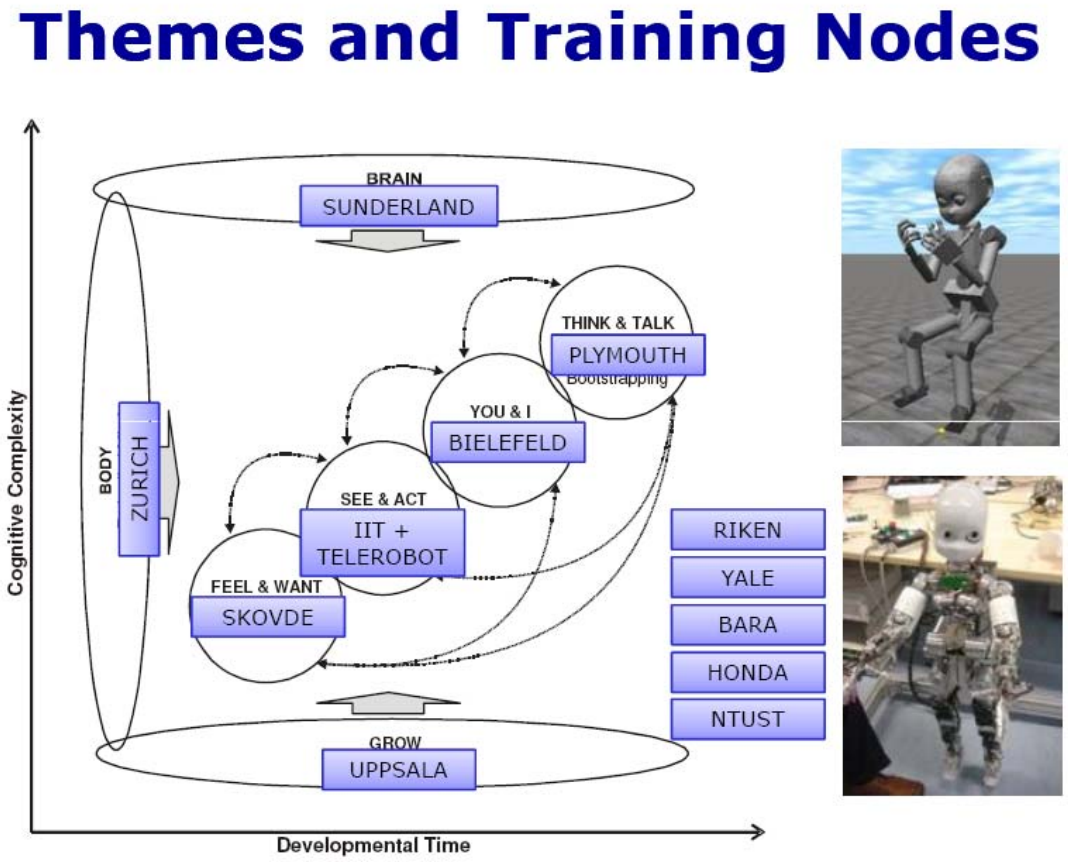


HÖGSKOLAN SKÖVDE

# Background

- ICEA project (2006-2009):
  - Collaborations with LOCEN - CNR (Rome):
    - Reward learning algorithms using reservoir systems,
    - See Lowe et al. (2009); Lowe et al. (2010, in preparation).
  - Iowa gambling task (development and reinforcement learning)
    - Dynamic field modelling,
    - See Lowe, Duran & Ziemke (2010); Lowe & Ziemke (2010).
- ROSSI (2008-2011):
  - Dynamic field and mirror neuron system modelling,
- NeuralDynamics (2011-2015):
  - Sequence learning/generation and reinforcement learning
  - HIS role to develop motivation (neural dynamic) architectures that can handle aspects of timing and goal-directed sequence learning

# Skovde (HIS) Role



# Hypotheses

1. Cognition:

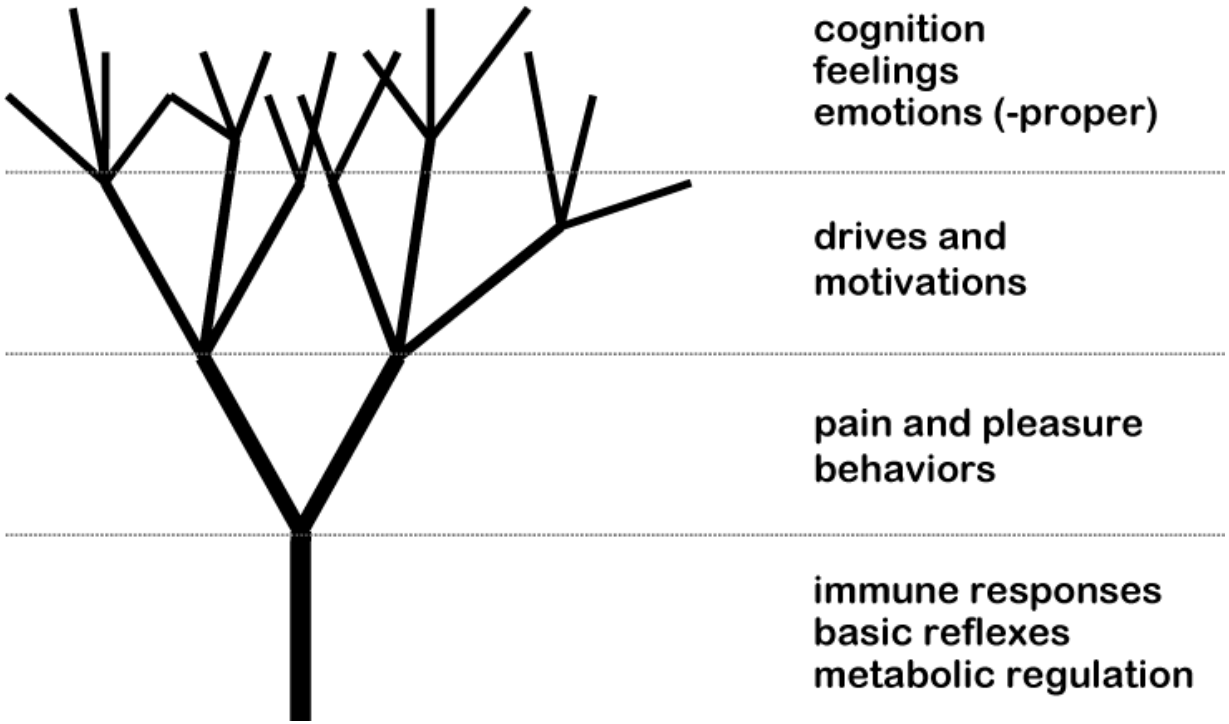
   a function of internal needs and external demands (cf. ”Internal Robotics”, Parisi 2004).

2. Emotion:

   *constituted by, and participates in, sensorimotor and internal bodily feedback* (cf. Lewis 2005, Ziemke 2008, Gros 2010, Ziemke & Lowe 2009).

# Cognition and Emotion

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

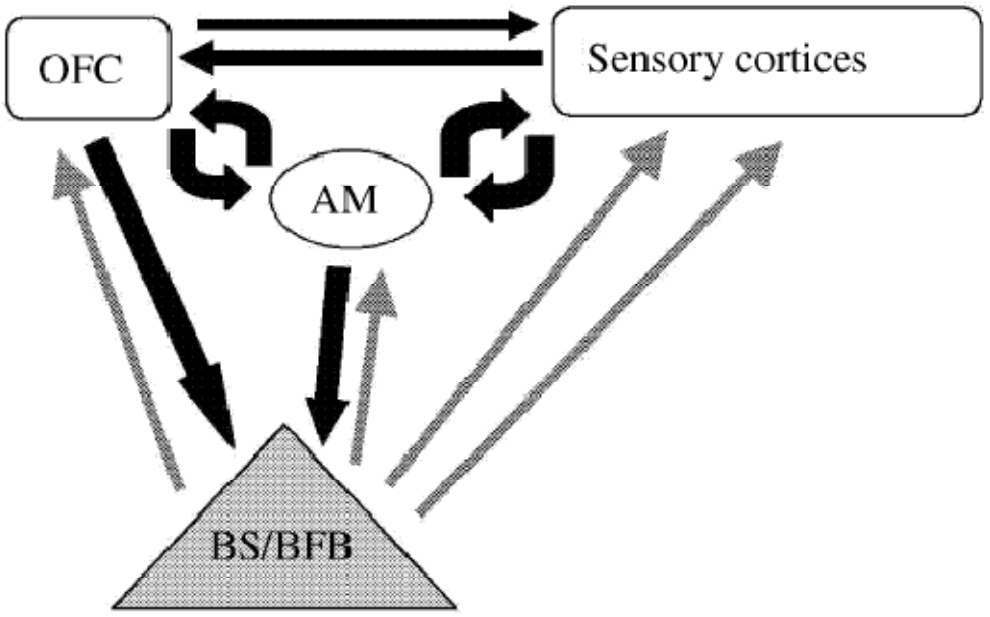


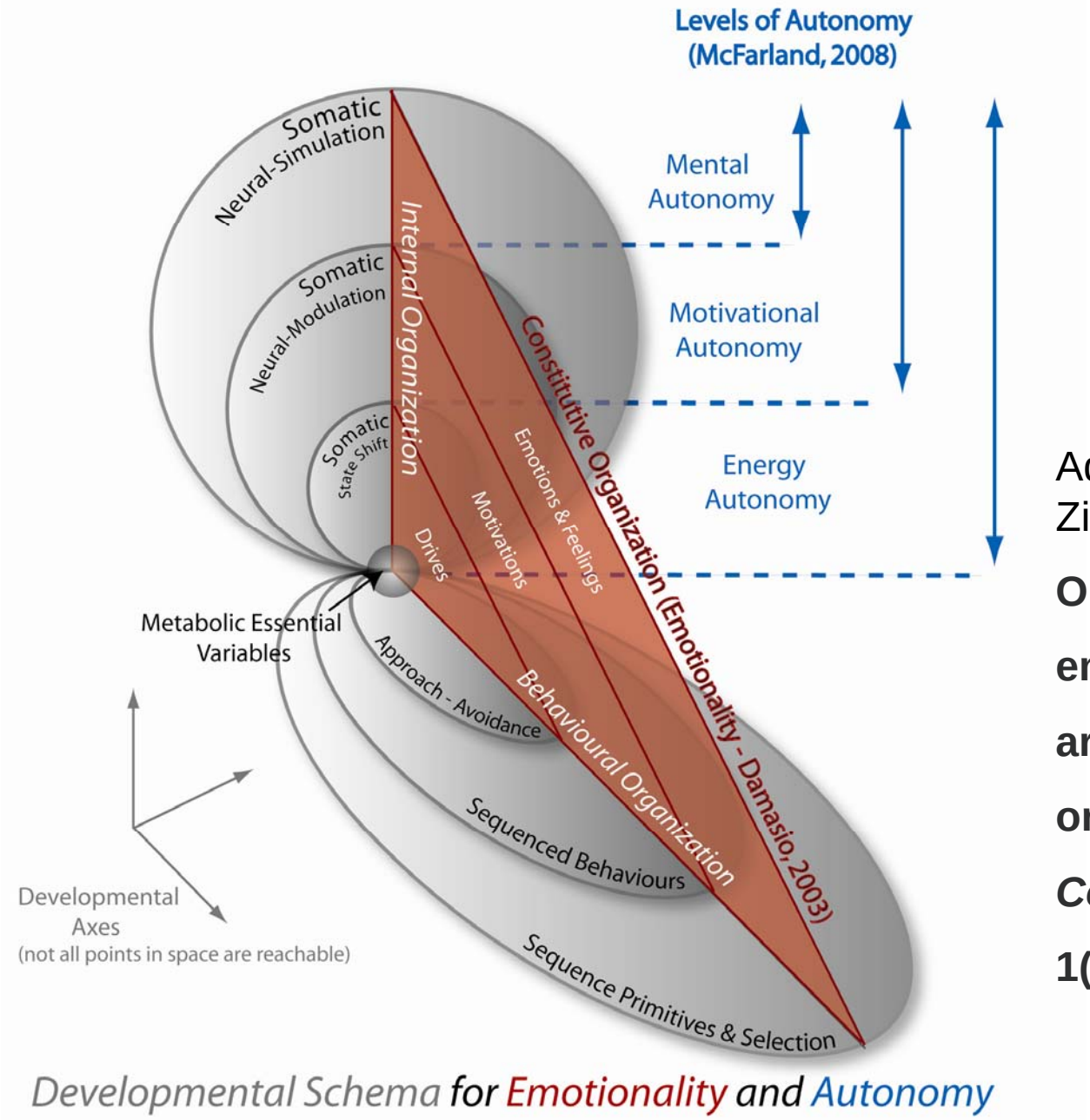

E.g. Damasio: nature has “built the apparatus of rationality not just on top of the apparatus of biological regulation, but also from it and with it"

# Cognition and Emotion

Dynamic systems perspective (complementary to Damasio):

- Lewis (2005),
- Gros (2010),
- Freeman (2000).

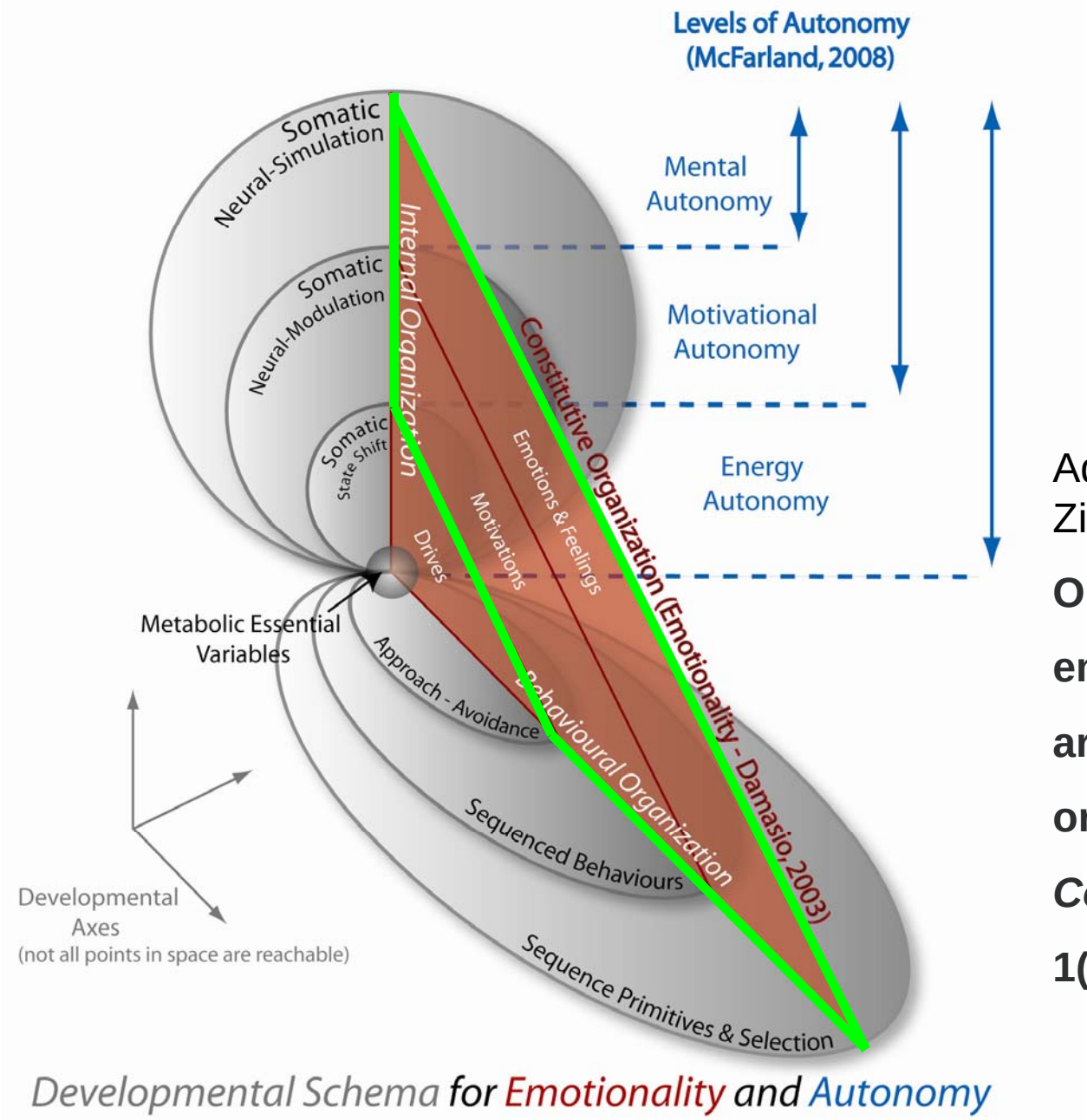





Adapted from
Ziemke & Lowe (2009).

**On the role of emotion in embodied cognitive architectures: From organisms to robots.**

***Cognitive Computation*, 1(1), 104-117.**

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# Embodied Reward Learning and Development

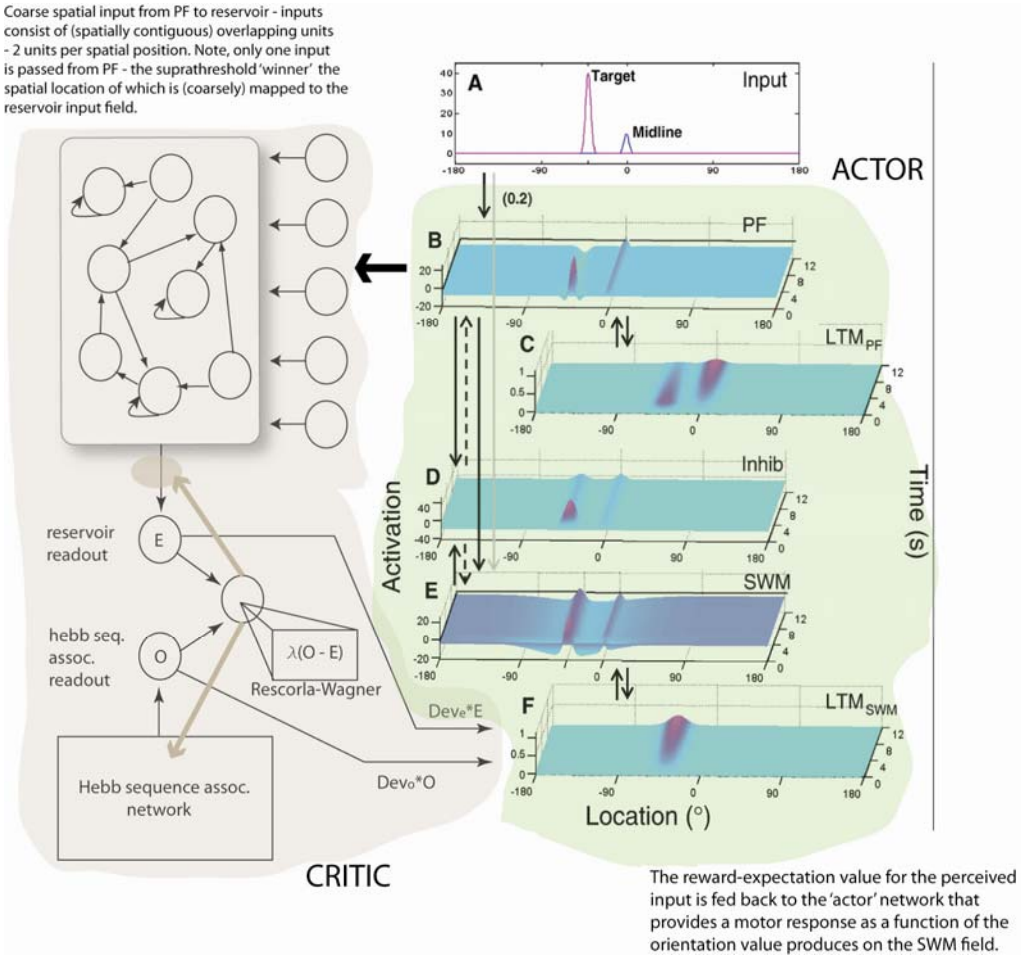
Dynamic systems and development:

Thelen & Smith (1994): A not B task in infants and the motor memory hypothesis (implicit reward, cf. Lowe & Ziemke 2010)

Thelen et al. (2001): Dynamic field theory modelling of A not B task – provides neural dynamic explanation of motor memory hypothesis.

Lowe et al. 2010; Lowe & Ziemke (2010): Dynamic field theory modelling and reward learning explanation of Iowa gambling task and development.

# Embodied Reward Learning and Development



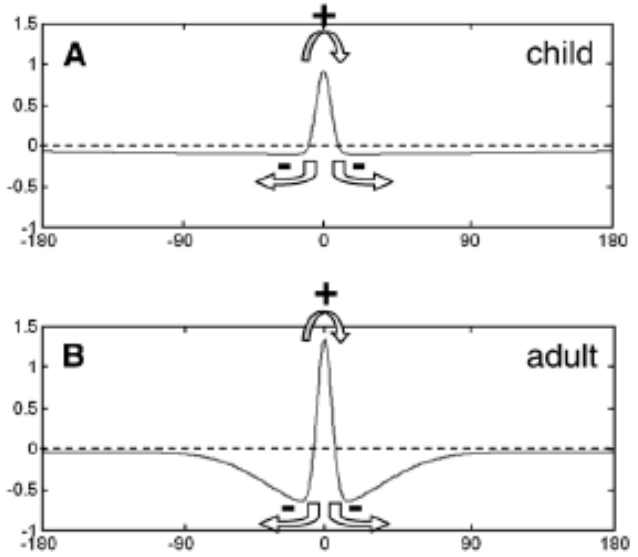
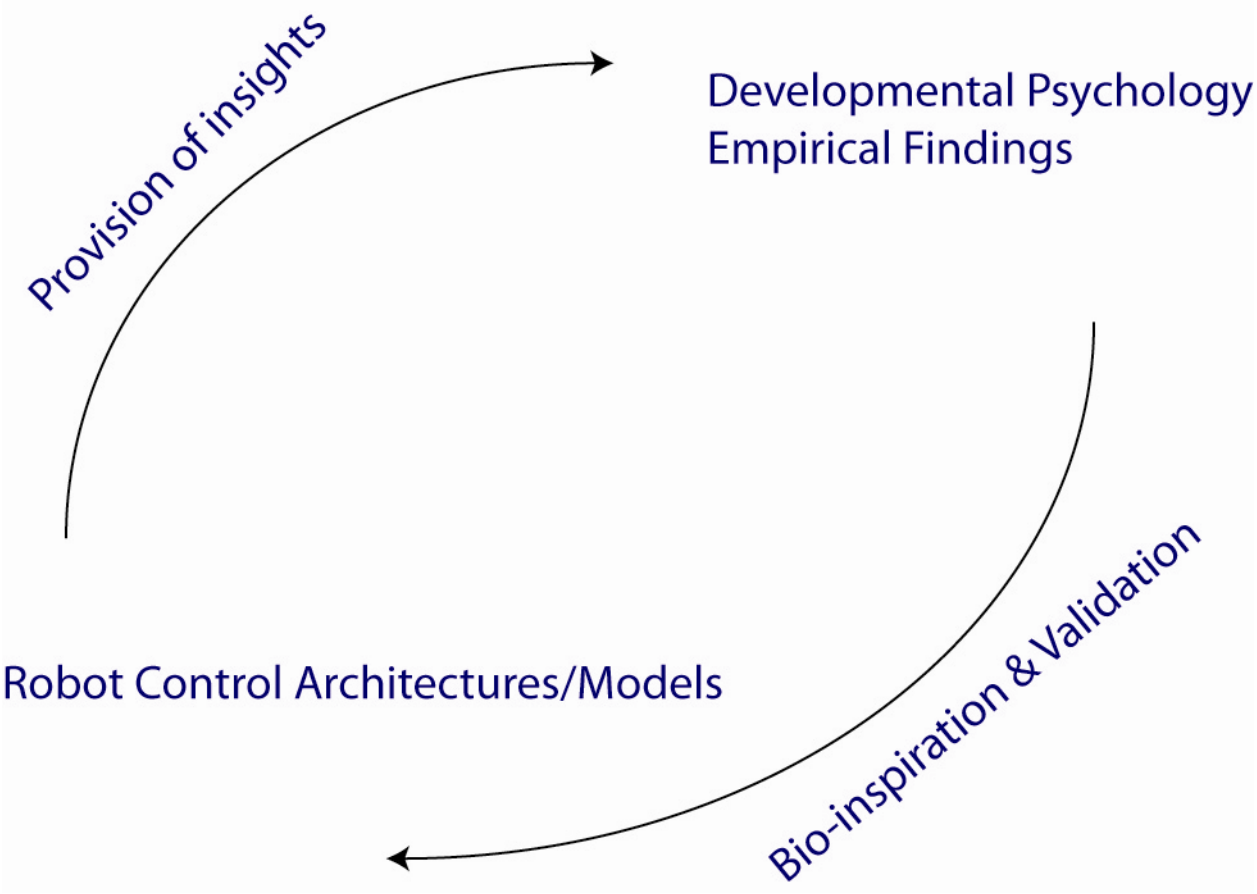




**Fig. 2 – The local excitation (+)/lateral inhibition (–) function used for child (A) and adult (B) simulations. Dashed line indicates the zero threshold.**

Actor component adapted from Simmering, Schutte & Spencer 2008.

Developmental parameters – different values represent different spatial cognition tuning.

# Research Cycle



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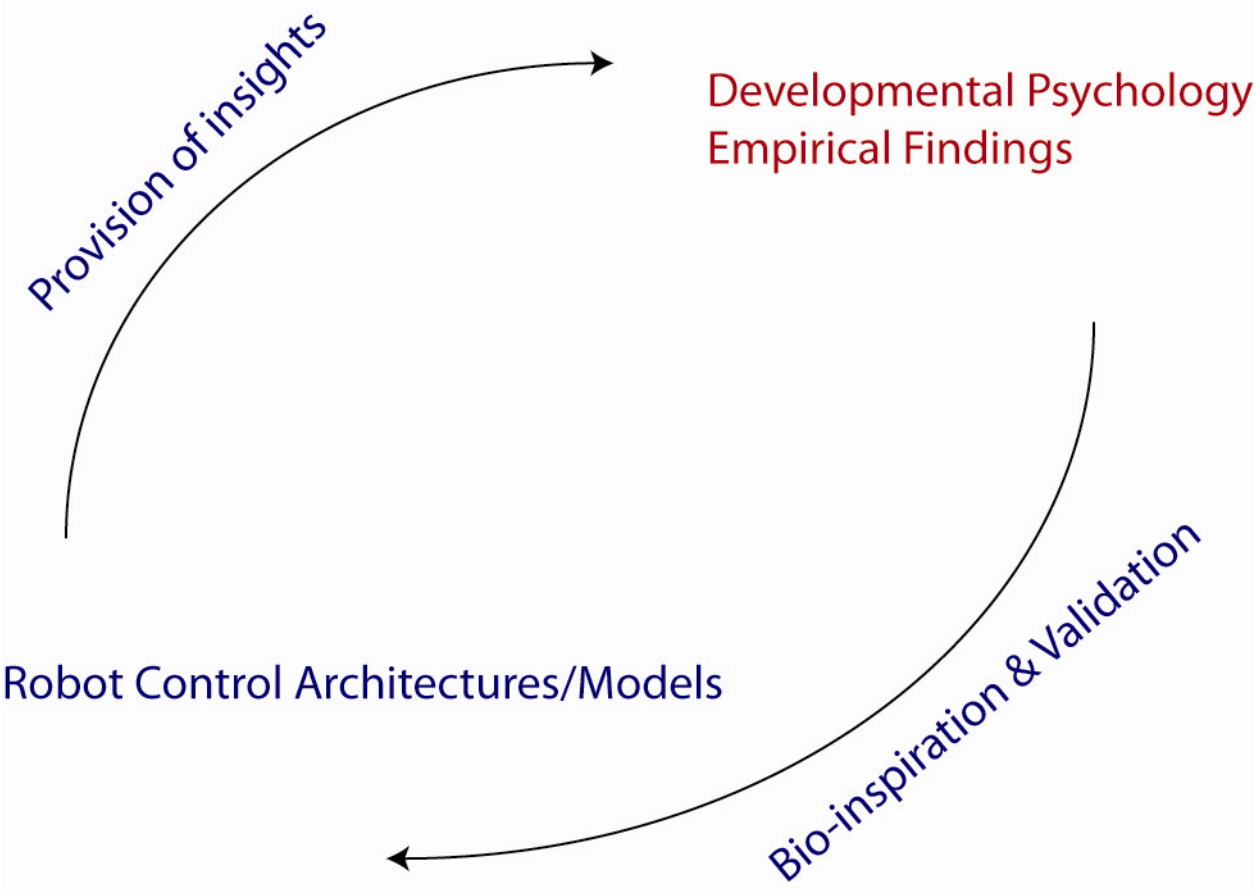

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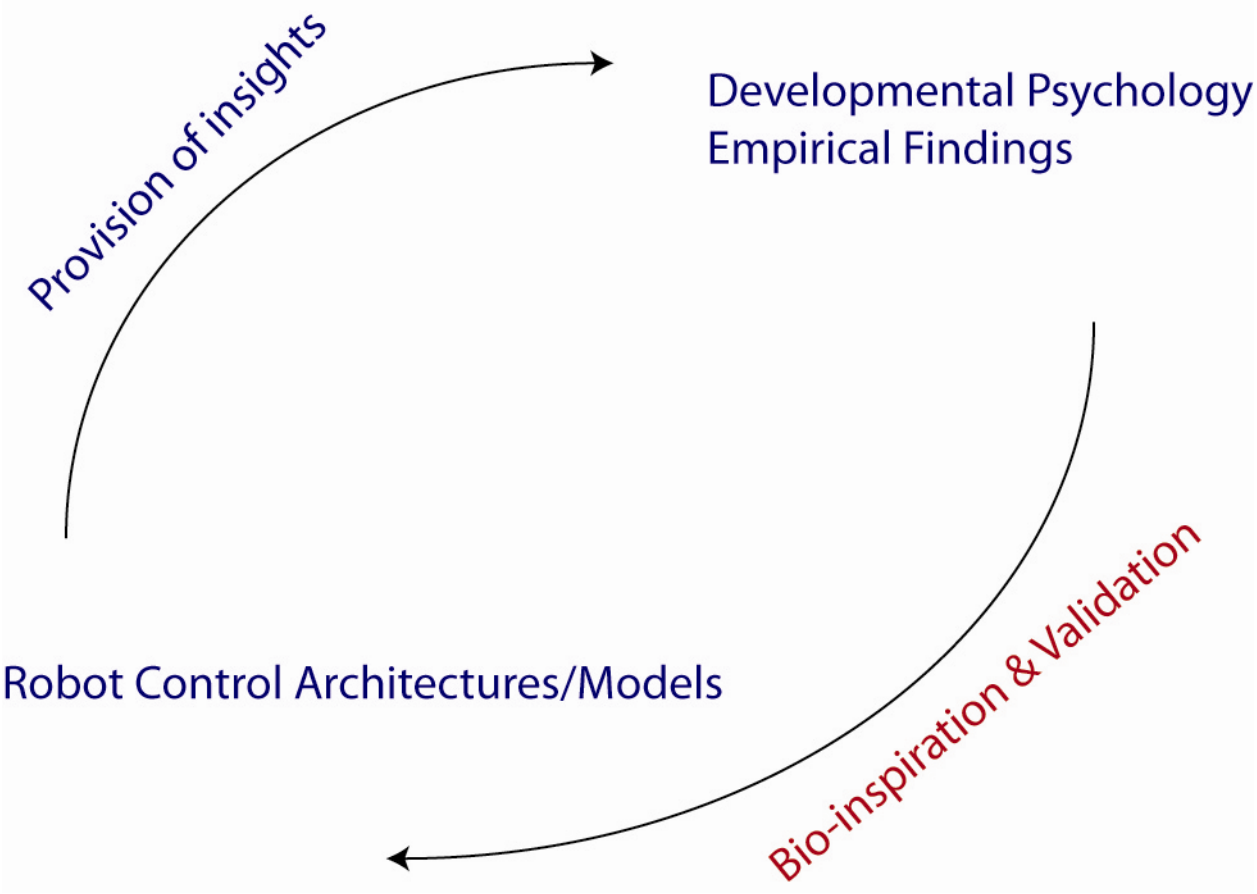

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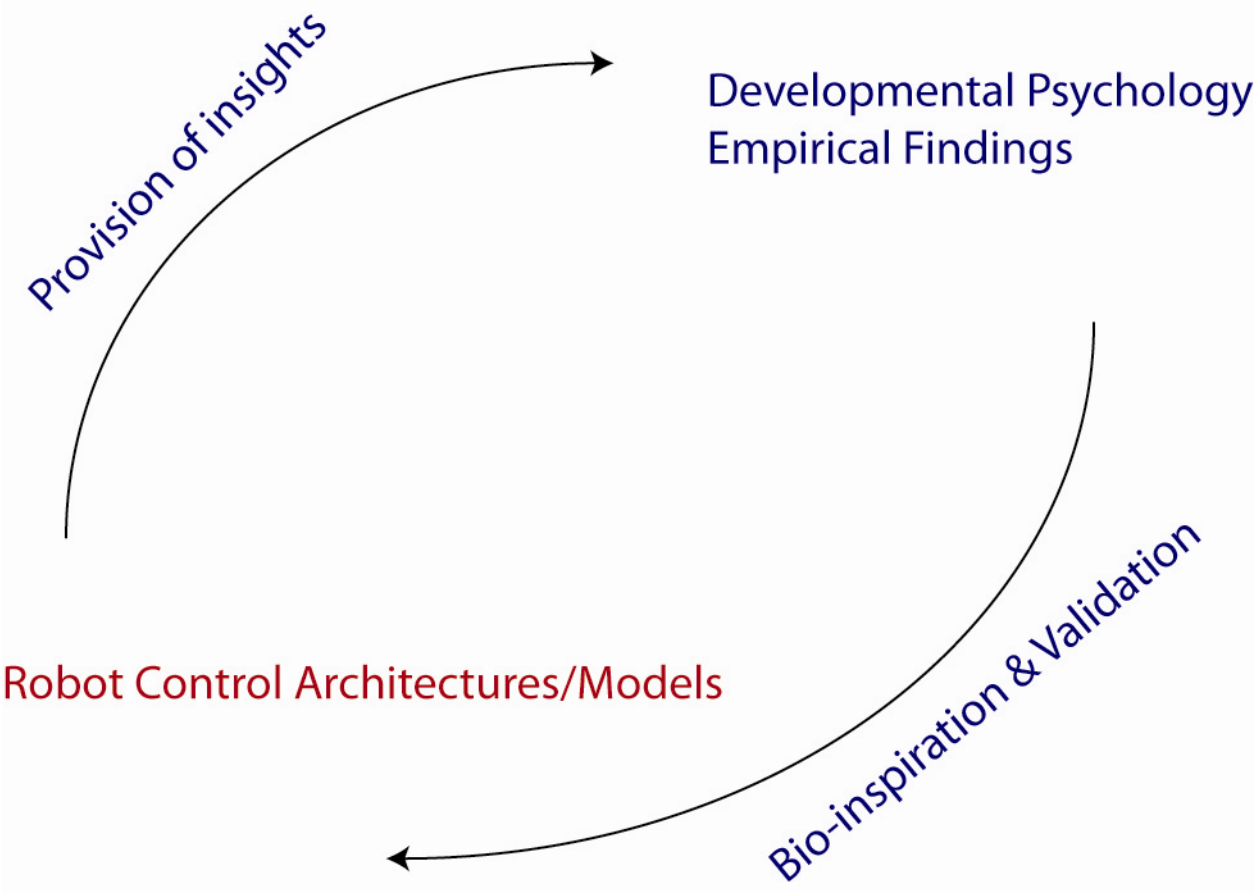

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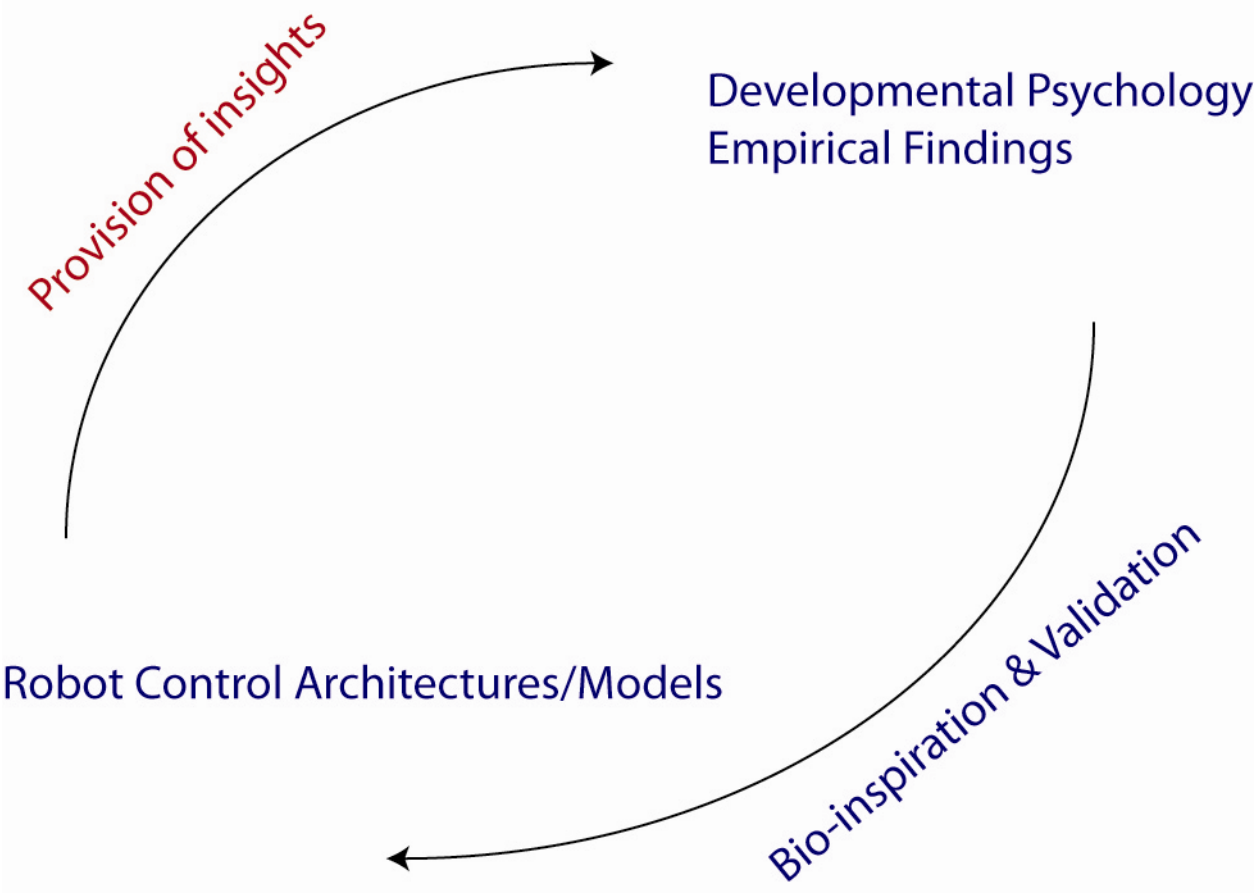

# Methodologies & Practical Considerations

We seek to ground motivated decision making according to sensorimotor activity.

- Dynamic systems theory (bipedal locomotion),
- Dynamic field theory (representation of locomotion patterns).

Focus on understanding neural dynamic basis of development of cognitive capacities (in conjunction with sensorimotor development):

- Spatial cognition (e.g. cue learning in space),
- Social Interaction (e.g. passive vs active interactions).