Motivation and Affect in MicroPsi

MAS S66

New Destinations in Artificial Intelligence

Goals and Directions for Future Research

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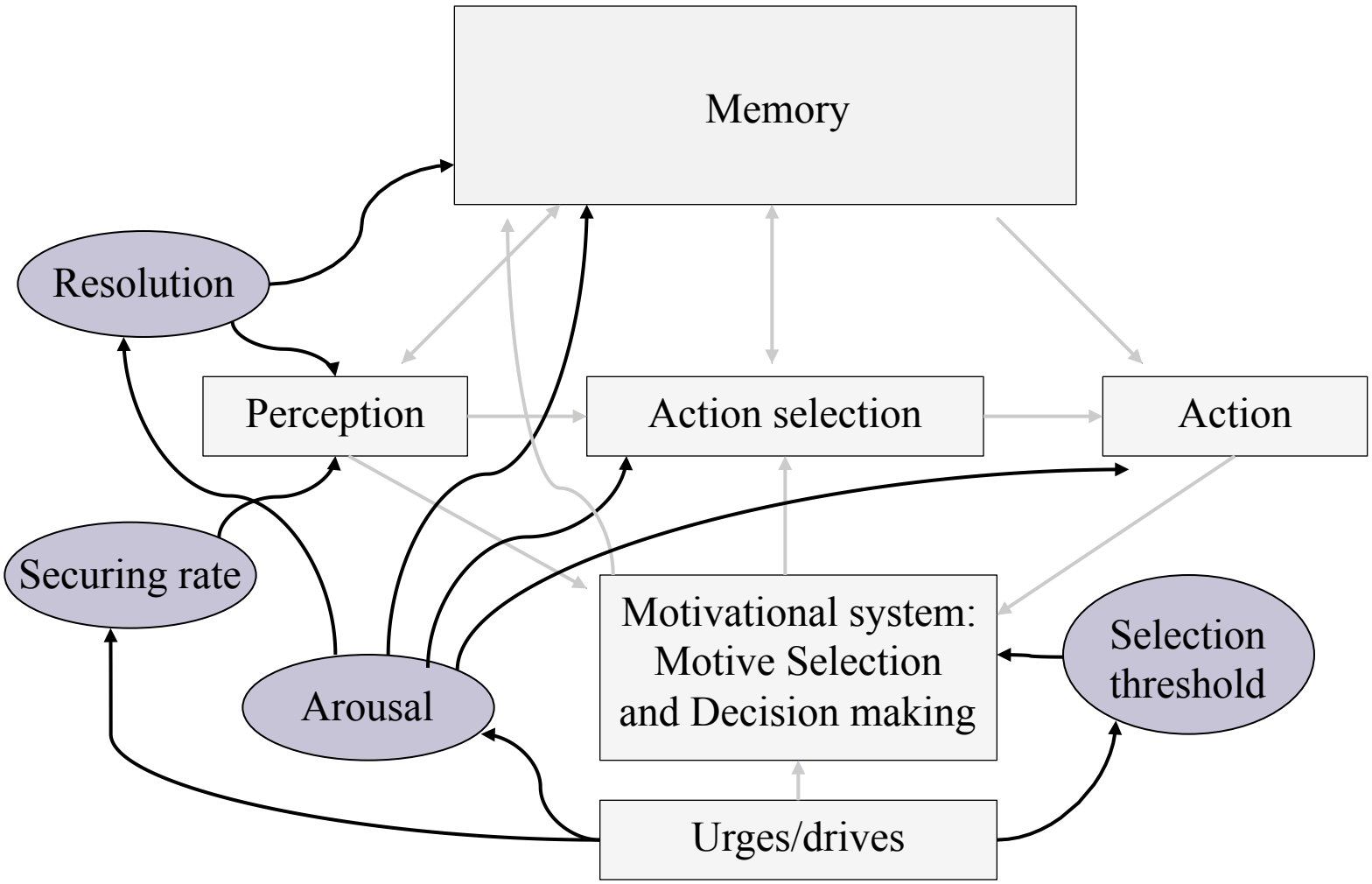
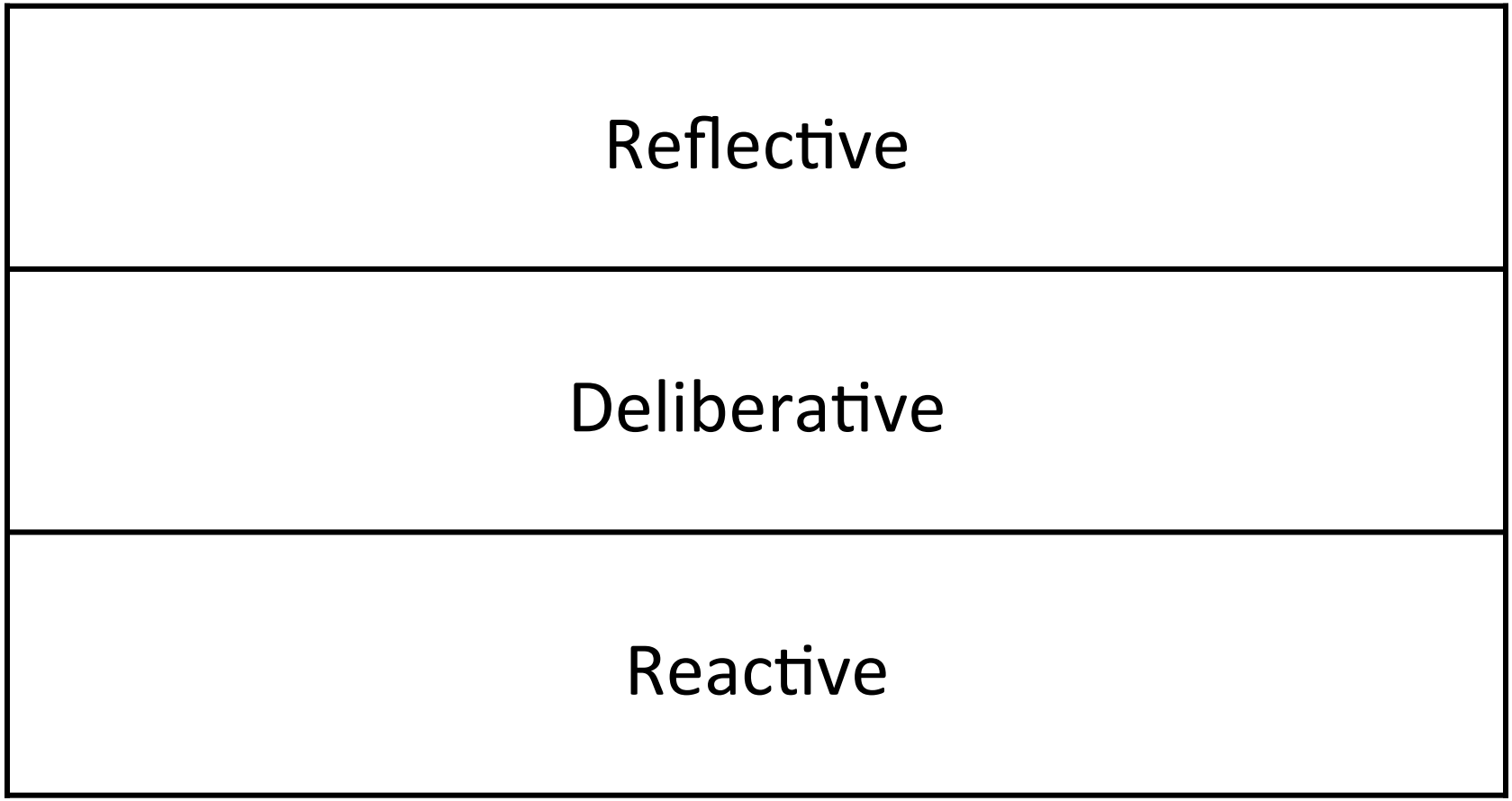
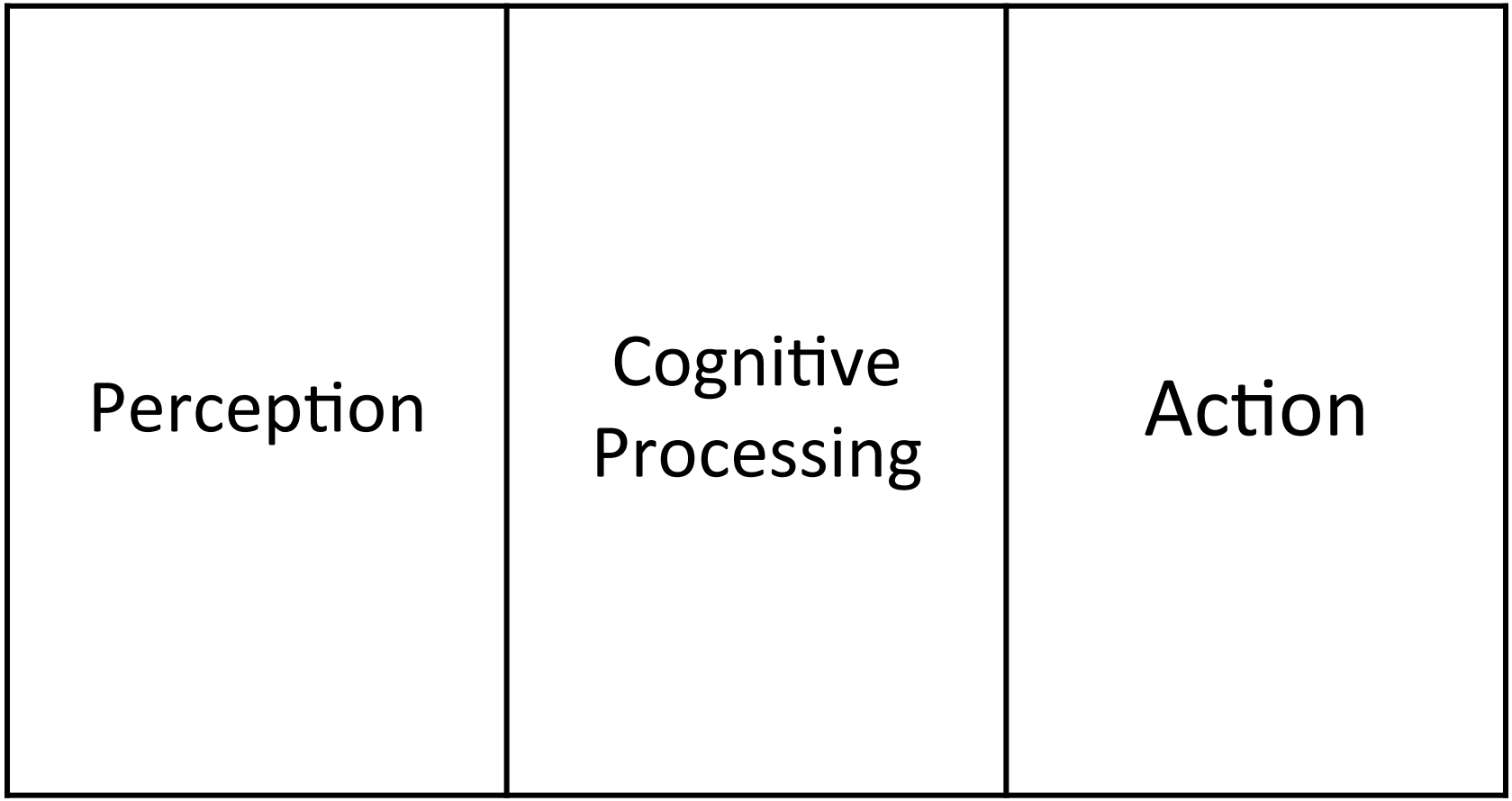
Components for Cognitive AI



Layers of Cognition



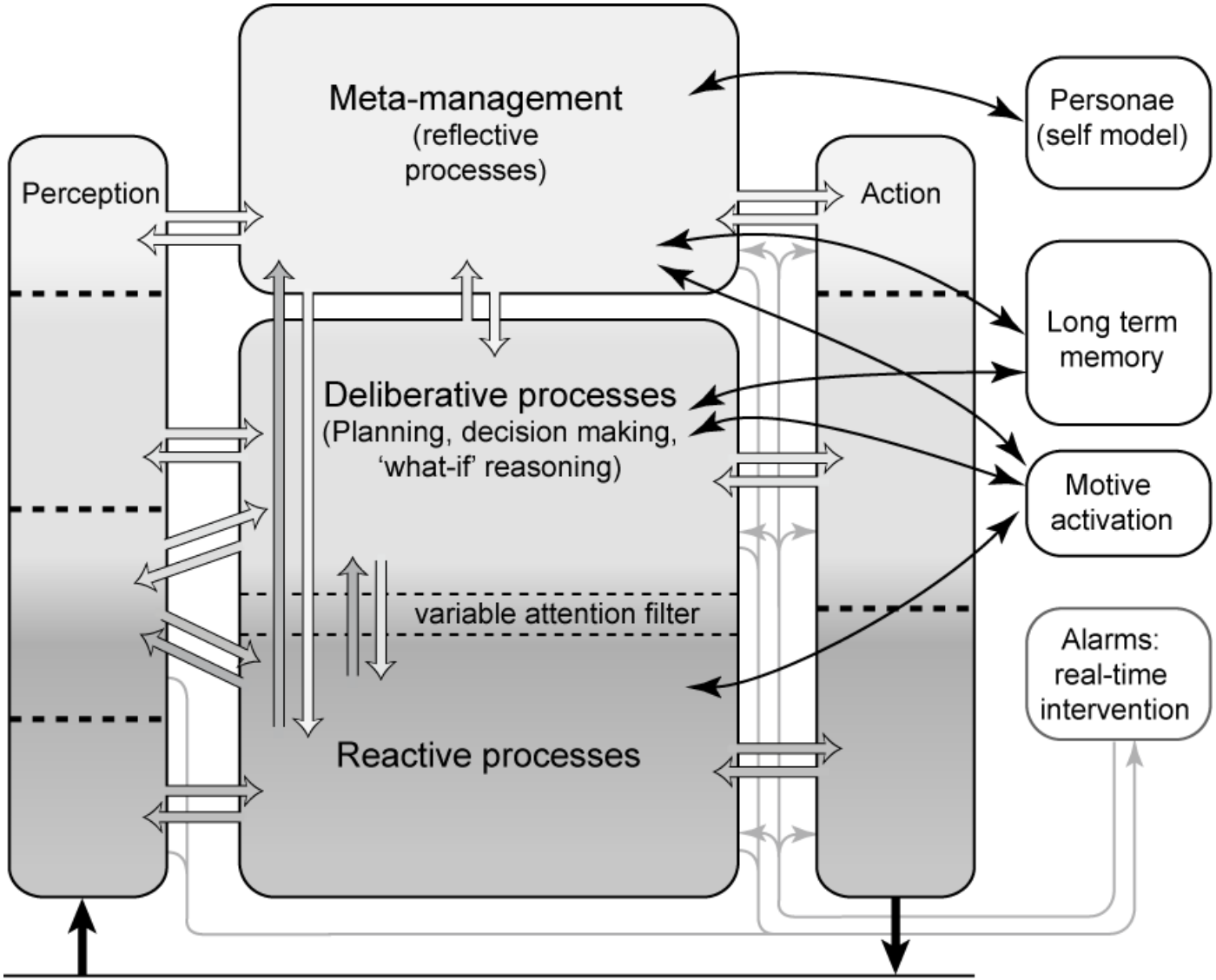
Columns of Cognition



Cognitive Grid

Reflexive Perception	Meta-Management	Management Action
Deliberative Perception	Planning, Reasoning	Deliberative Action
Reactive Perception	Reflexes	Reflexive Action

Conceptual Analysis: HCogAff (Sloman 2001)



Cognitive Artificial Intelligence

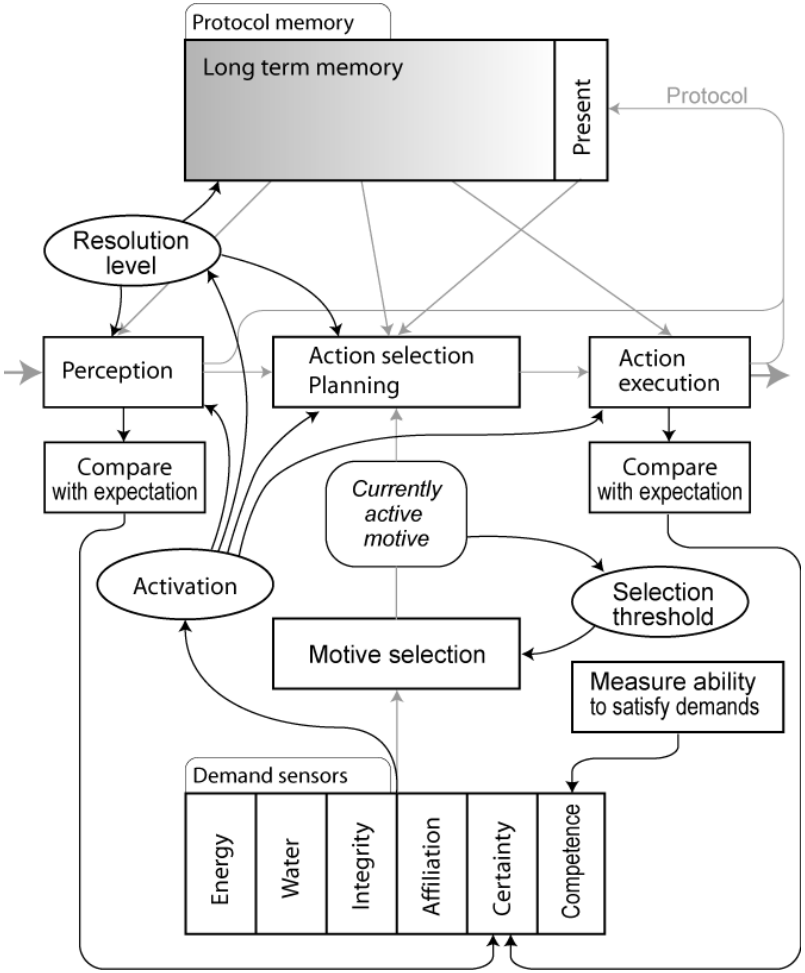
Methods should focus on components and performances necessary for intelligence:

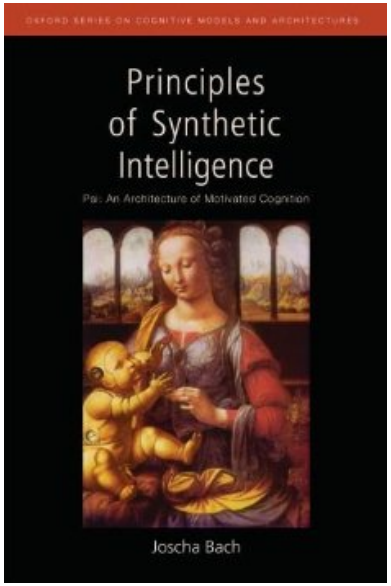
- **Universal Representations:**
  Grounded neuro-symbolic representations (integrate both symbolic and distributed aspects)
- **(Semi-) Universal Problem Solving:**
  Learning, Planning, Reasoning, Analogies, Action Control, Reflection ...
- **Universal Motivation:**
  Polythematic, adaptive goal identification
- **Emotion and affect**
- **Whole, testable architectures**

Modeling Motivation in a Cognitive Architecture

- *General intelligence needs General Motivation*
- Motivational system structures cognition
- Motivational dynamics: physiological, social and cognitive drives
- Intention selection and action control
- Motivation vs. affect

MicroPsi architecture





PSI theory

Principles of Synthetic Intelligence

(Dörner 1999; Bach 2003, 2009)

Acknowledgements

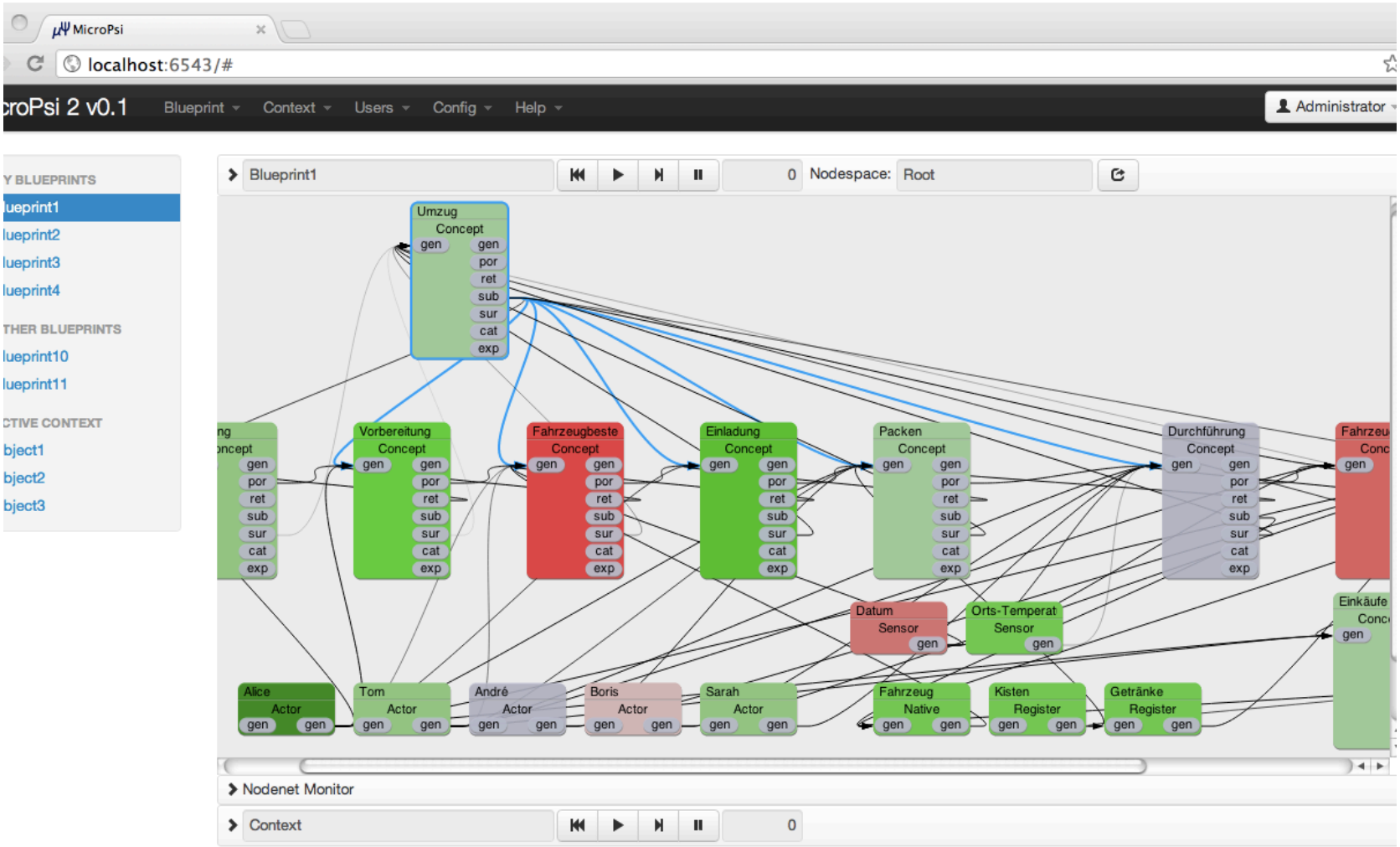
Work on MicroPsi2 is collaborative effort:

- **Ronnie Vuine, Dominik Welland, Priska Herger, Jonas Kemper** are contributors to the current version
- Architecture/concepts have been inspired by Dietrich Dörner, Aaron Sloman, Marvin Minsky, Stan Franklin and many others
- Support from Humboldt University of Berlin, University of Osnabrück (Institute for Cognitive Science), Berlin School of Mind and Brain, Harvard Program of Evolutionary Dynamics, MIT Media Lab

MicroPsi Principles

- Neuro-Symbolic architecture
- Agents implemented as spreading activation networks
- Unified representations, different sets of operations
- All representations are grounded
- Meaning is attached to representations by motivation

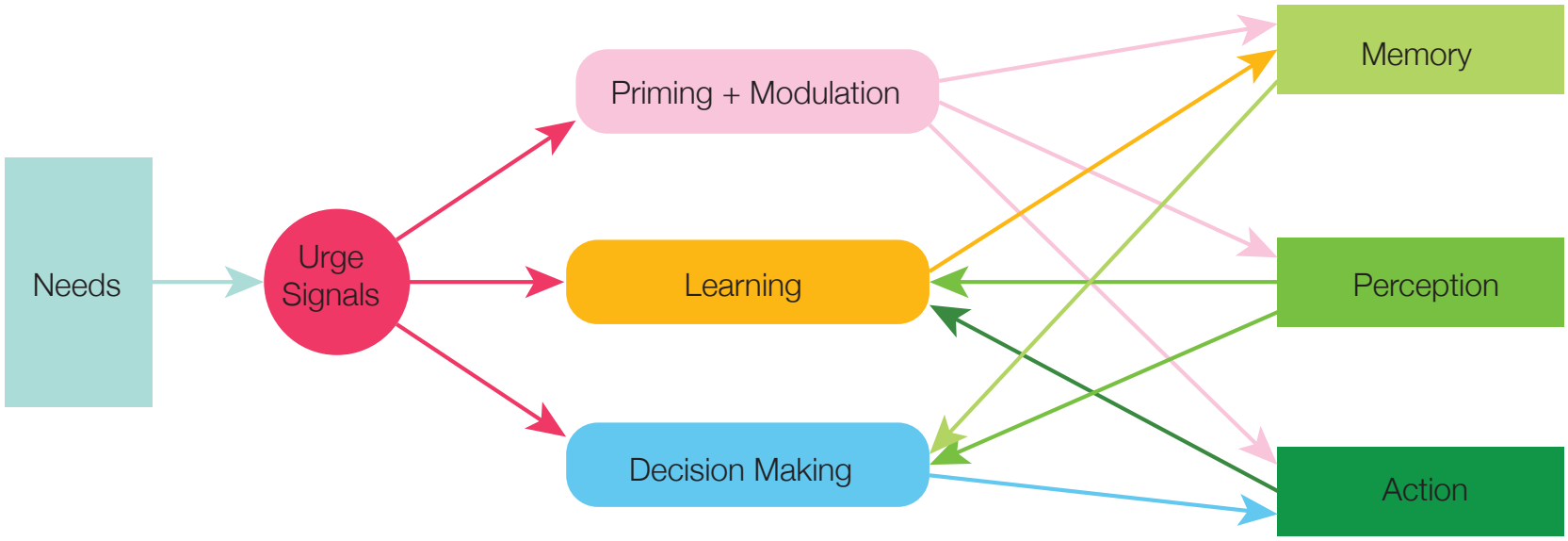
Implementation: MicroPsi 2 (Bach, Welland, Vuine, Herger 12, 14)



Goals in MicroPsi

- Goal: situation or action that afforts to satisfy a need
- Aversive goal: situation or action that frustrate a need
- All behavior is directed on satisfying an appetitive goal or avoiding an aversive goal
- Needs are predefined, goals are learned

From Needs to Behavior



Motivation in MicroPsi

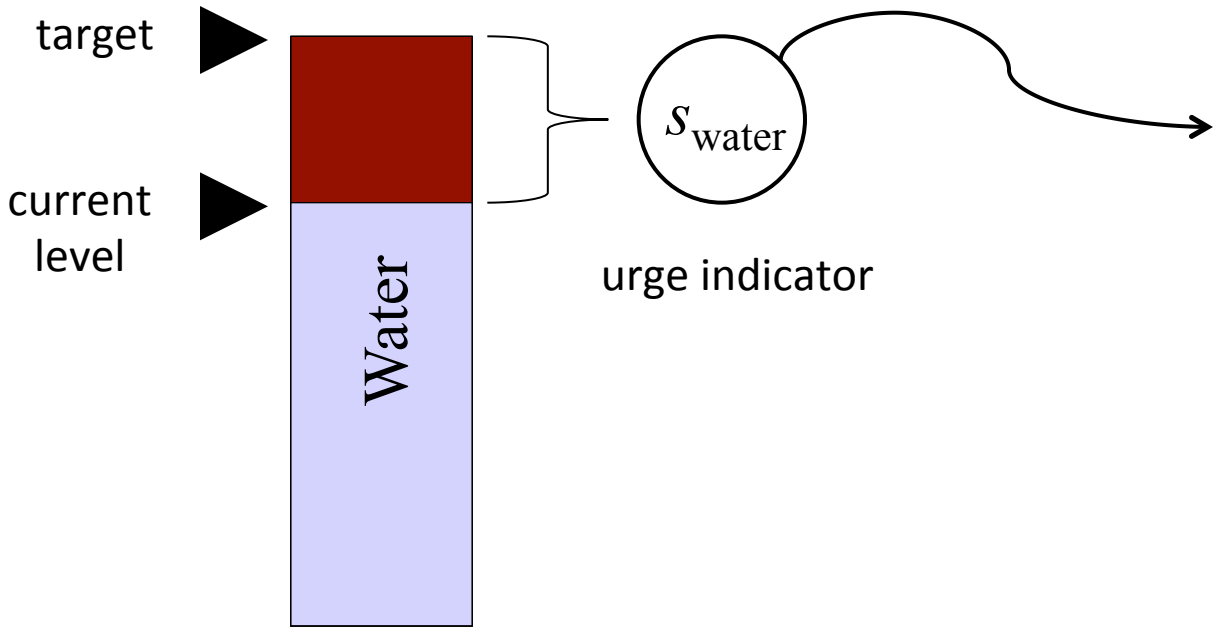
Pleasure and distress:

- *Change* of a demand is reflected in *pleasure* or *distress signal*
- Strength is *proportional* to amount of change

- Pleasure and distress signals deliver ***reinforcement*** values for behavioral procedures and episodic sequences and define ***appetitive*** and ***aversive*** goals.

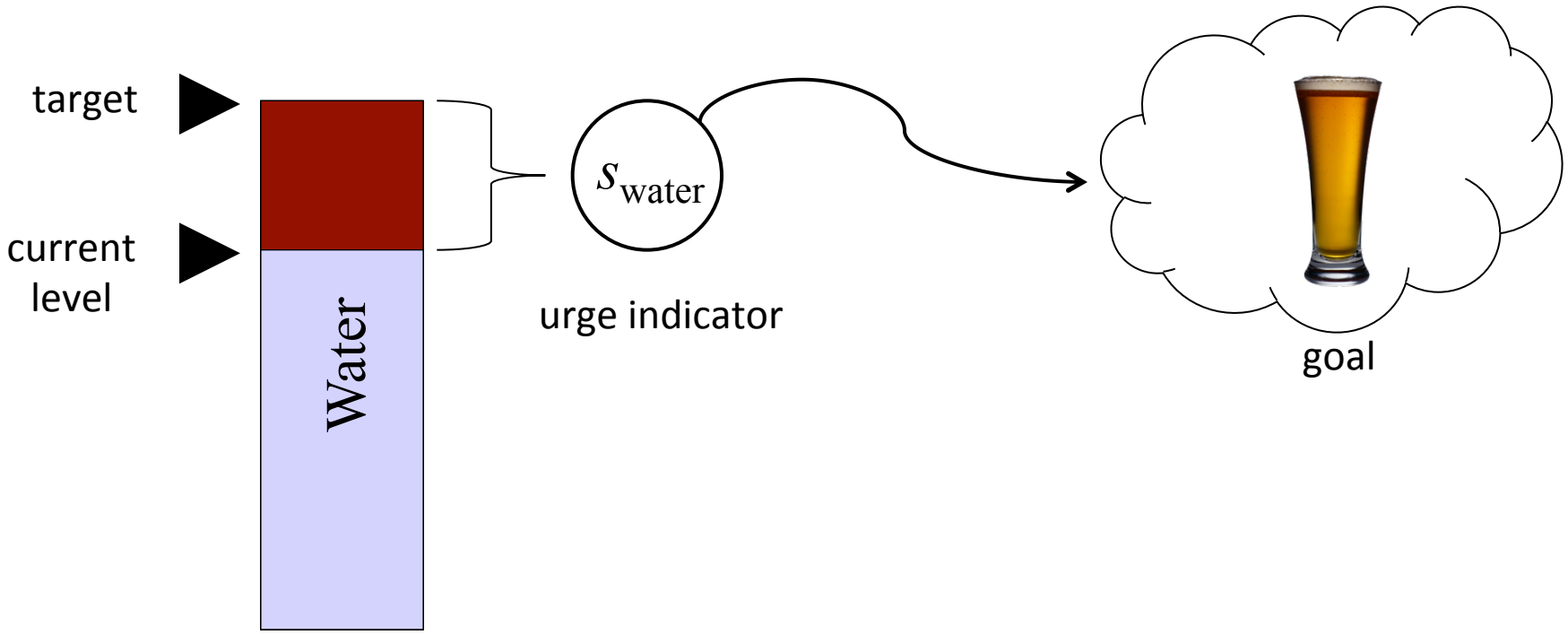
Motivational System

- drive = demand + urge indicator



Motivational Learning

- motive = urge + goal situation



Motivational Learning

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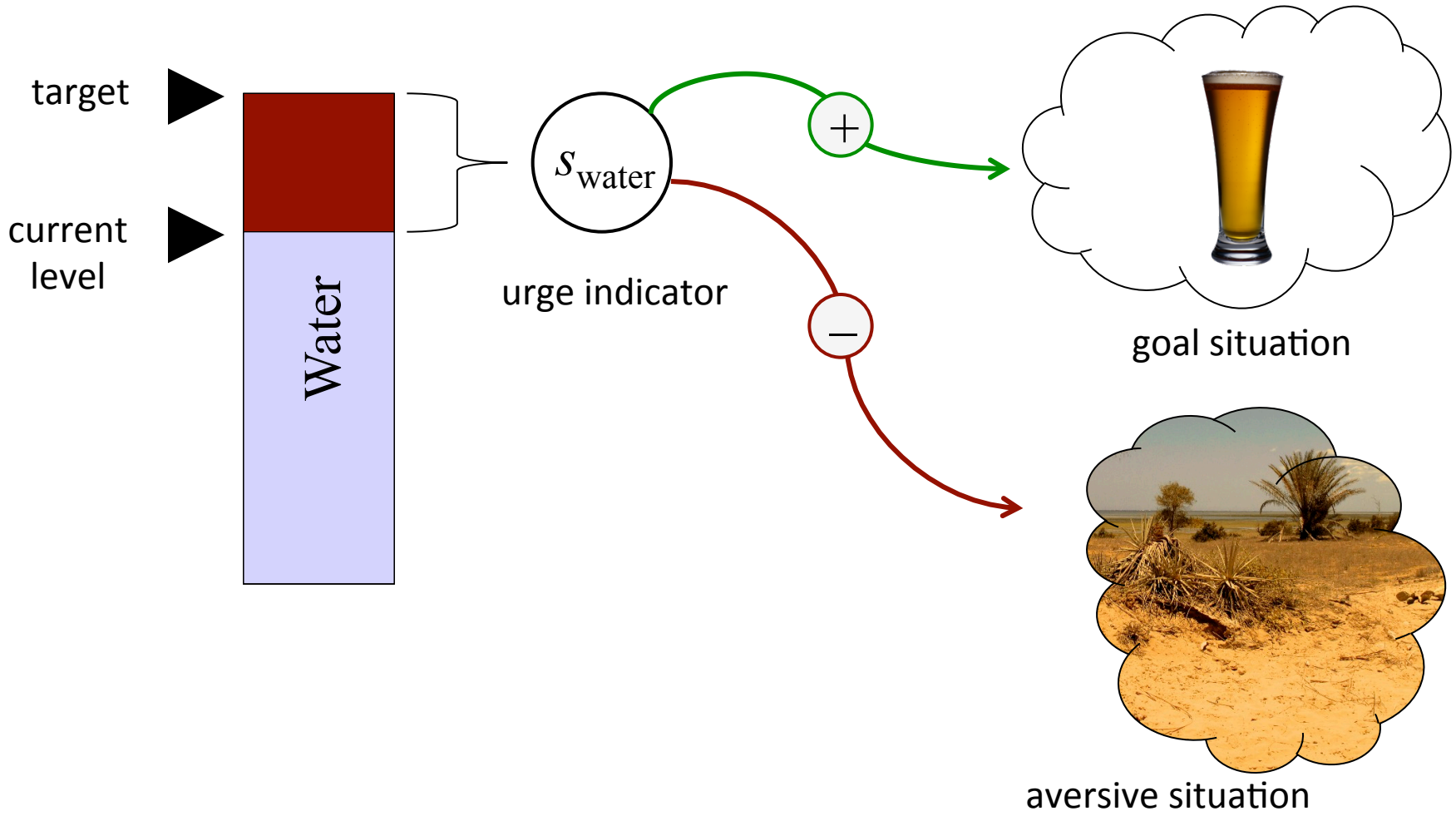


Physiological needs

- Thirst
- Hunger
- Rest
- Warmth
- Libido
- …

→ Survival as emergent property

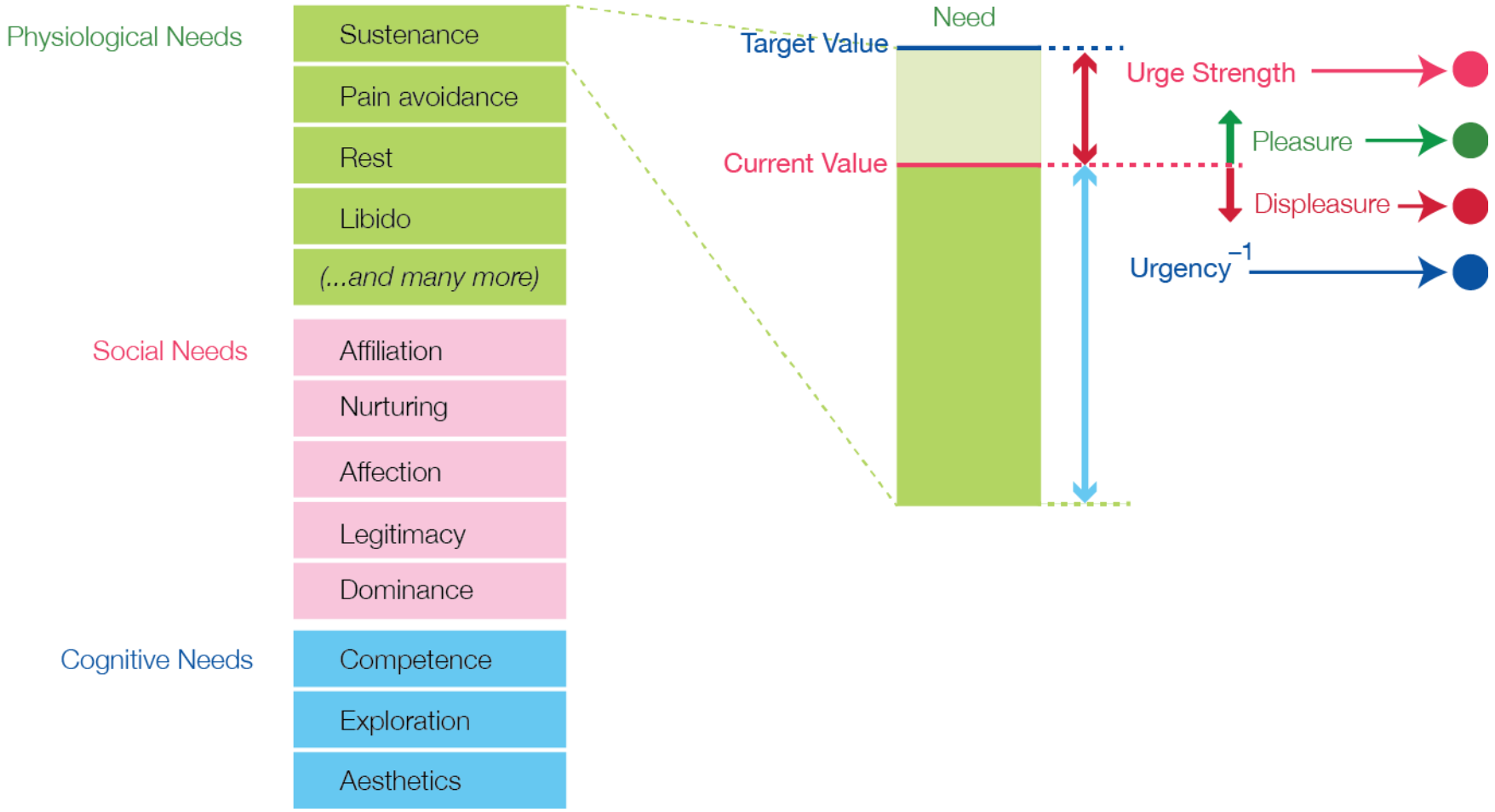
Social needs

- Affiliation (Attention from others, external legitimacy)
- Internal legitimacy
- Nurturing (caring for others)
- Affection
- Dominance

Cognitive needs

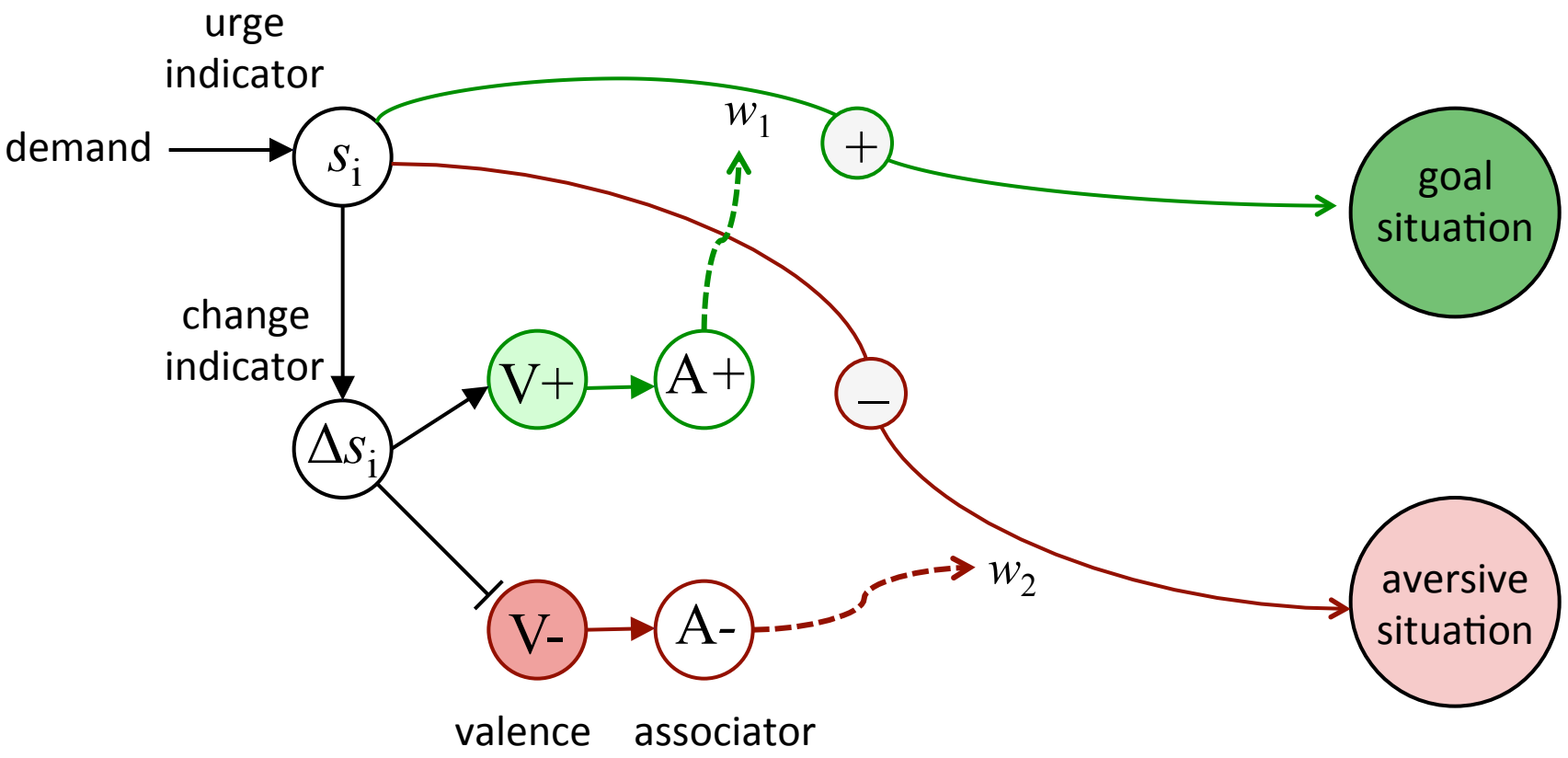
- Competence:
  - Skill acquisition (epistemic competence)
  - Coping/control ability (general competence)
  - Effect generation
- Uncertainty reduction:
  - Exploration
- Aesthetics:
  - Stimulus oriented
  - Structure oriented (abstract aesthetics)

Needs and urges



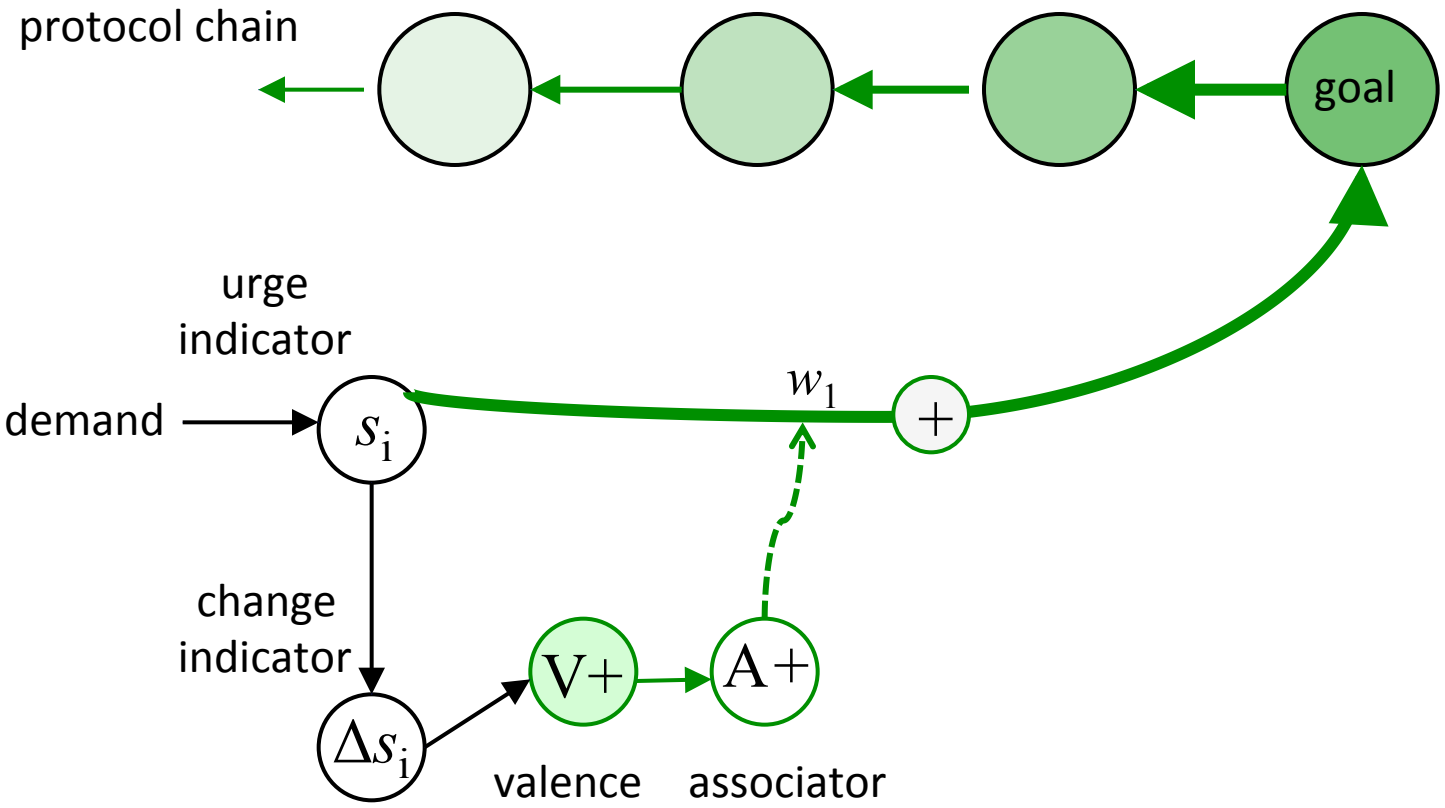
Motivational Learning

- association by learning:



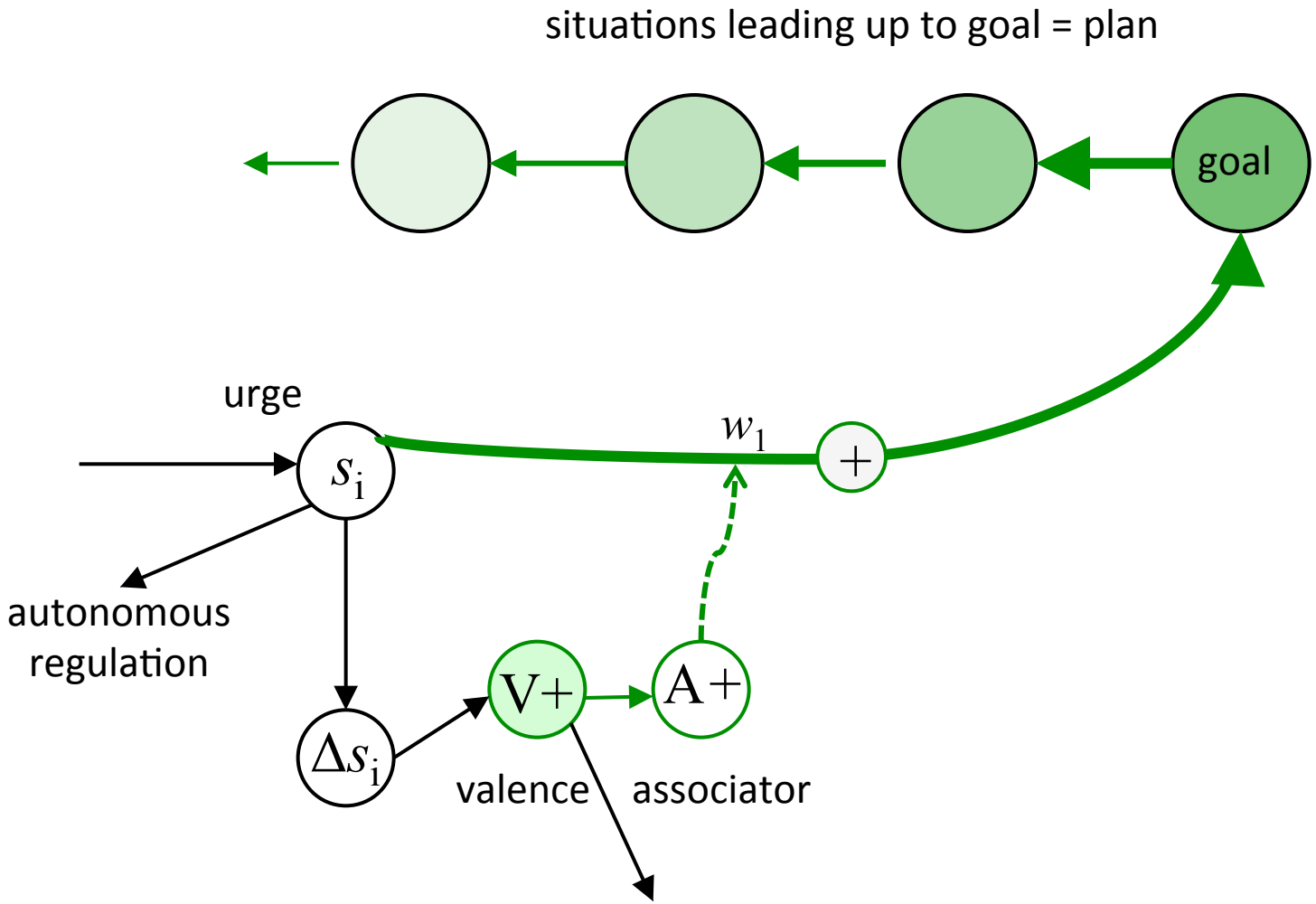
Motivational Learning

- retrogradient reinforcement



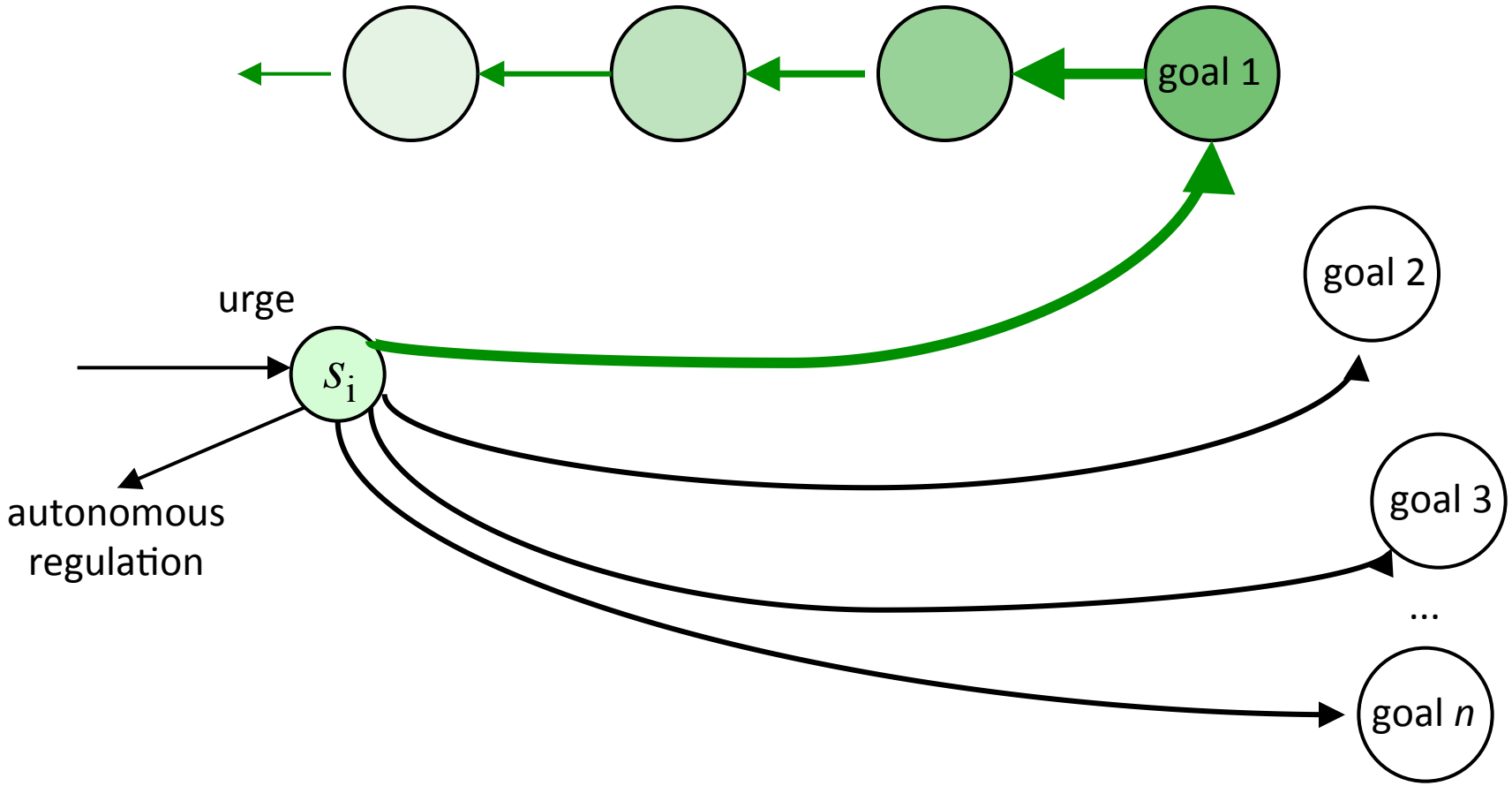
Motivational Learning

Motivator:

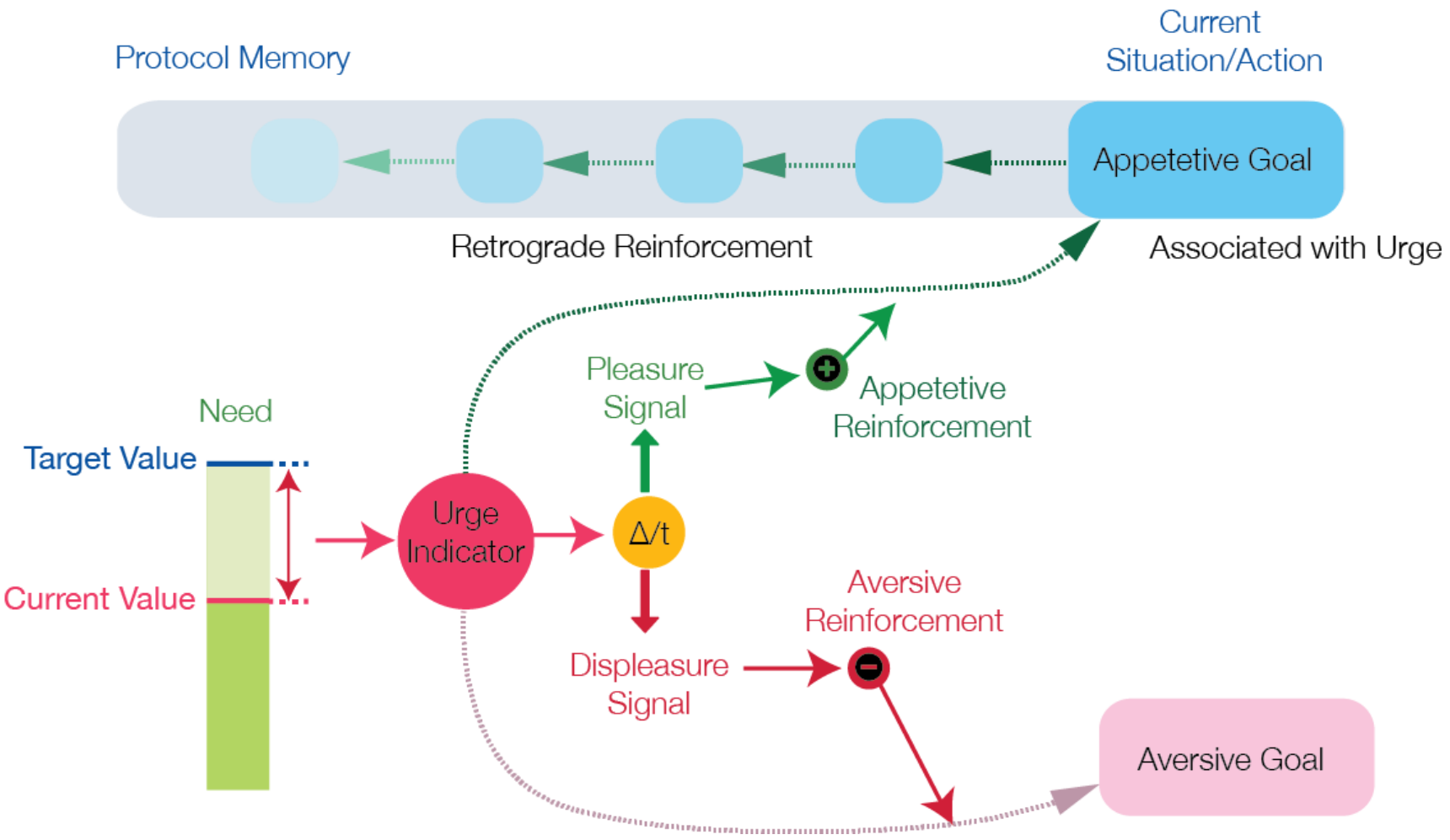


Motivational Learning

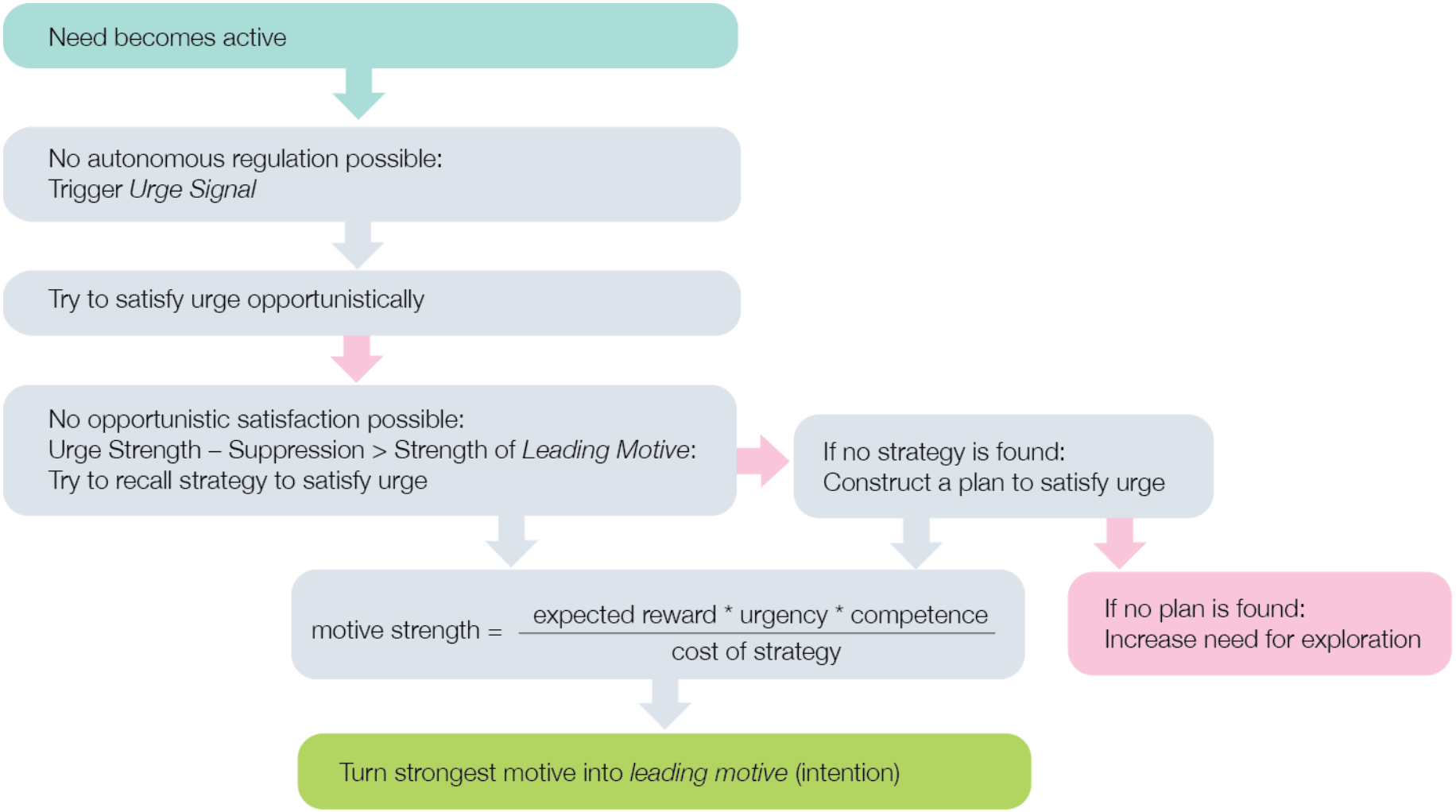
Intention:



Motivational learning



Motive selection

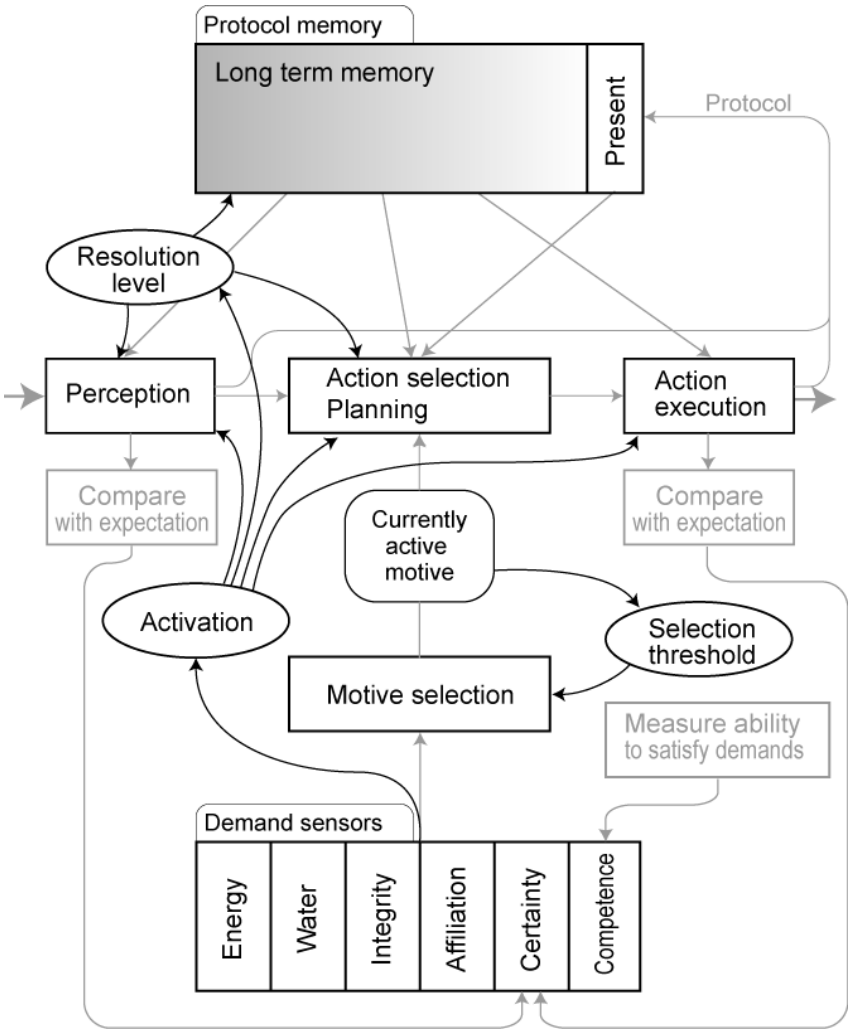


Need parameters

- Strength: relative importance
- Decay: rate of replenishment
- Gain: effect of satisfaction
- Loss: effect of frustration

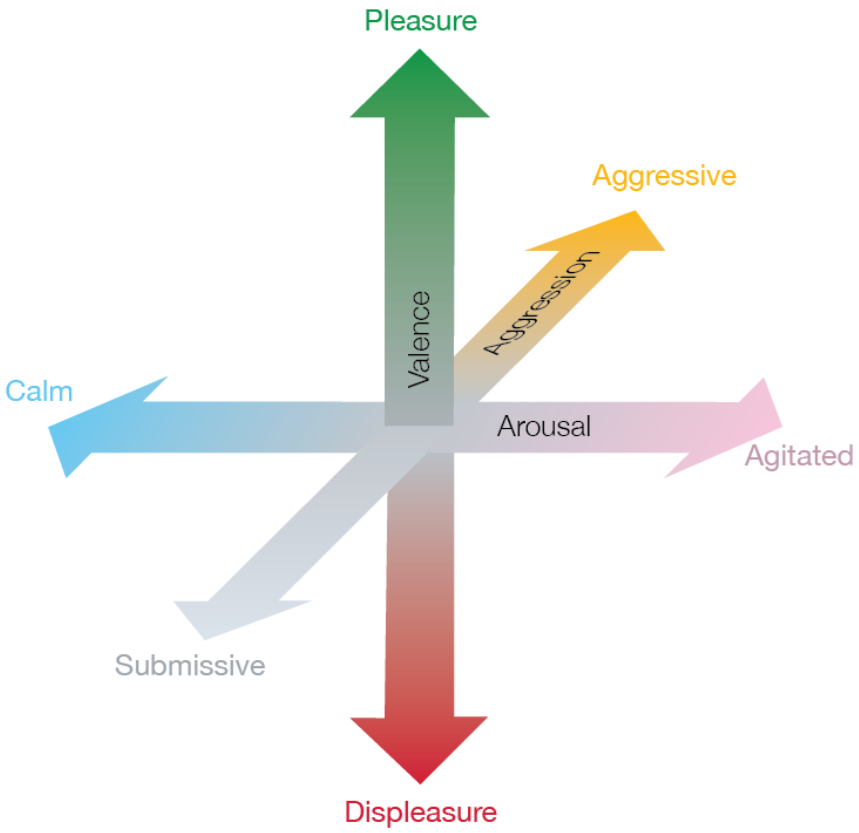
- different configuration of need parameters = different personality traits

Modulation in PSI/MicroPsi

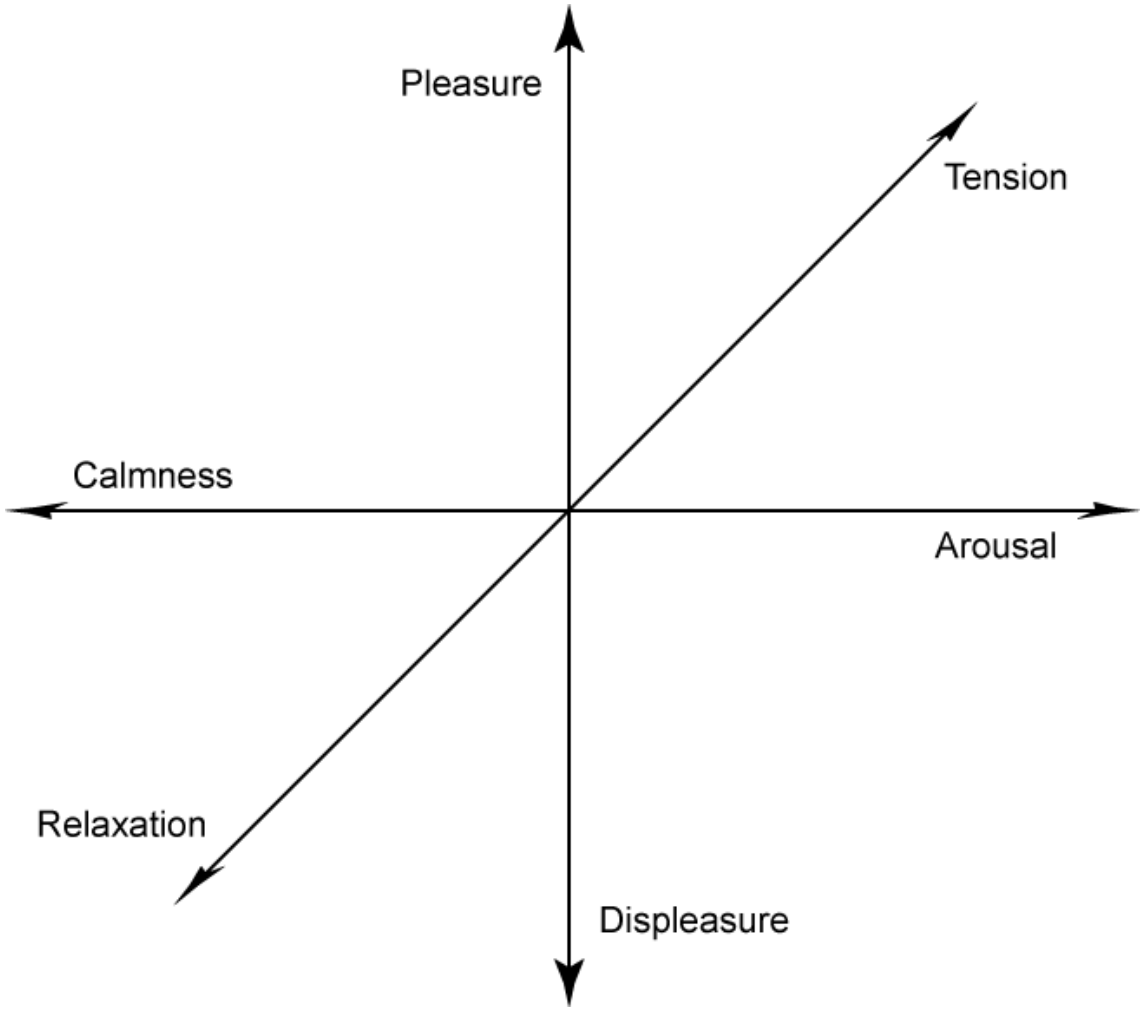


Primary modulators

Arousal	unspecific sympathicus syndrome
Valence	situation evaluation (good/bad)
Aggression	fight or flight

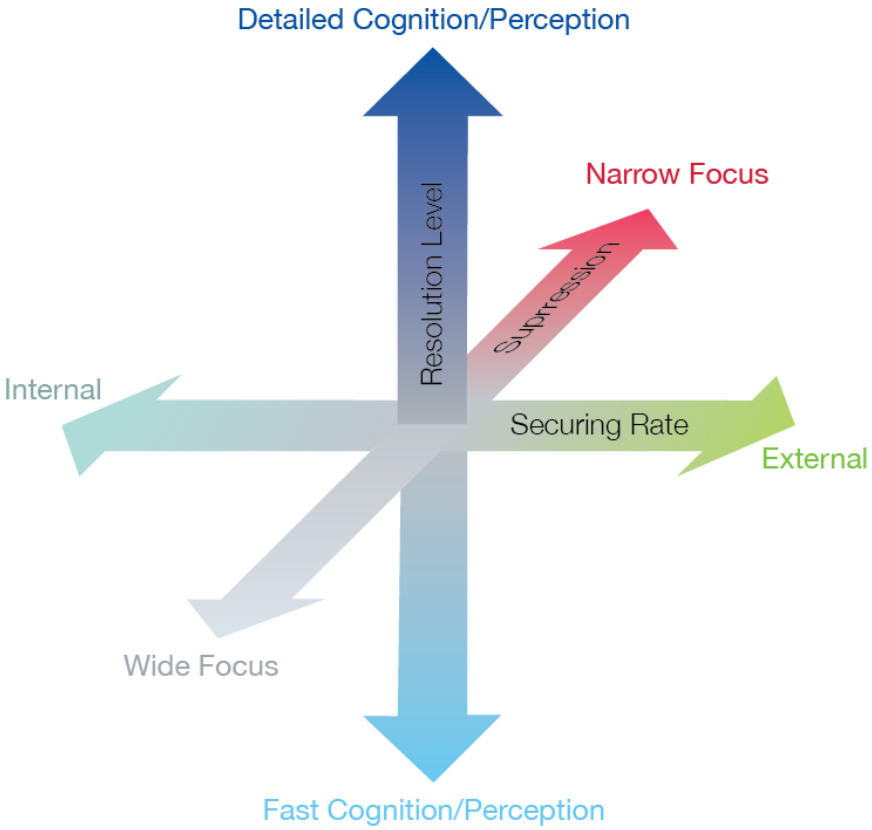


Compare: Affective dimensions (Wundt 1910)

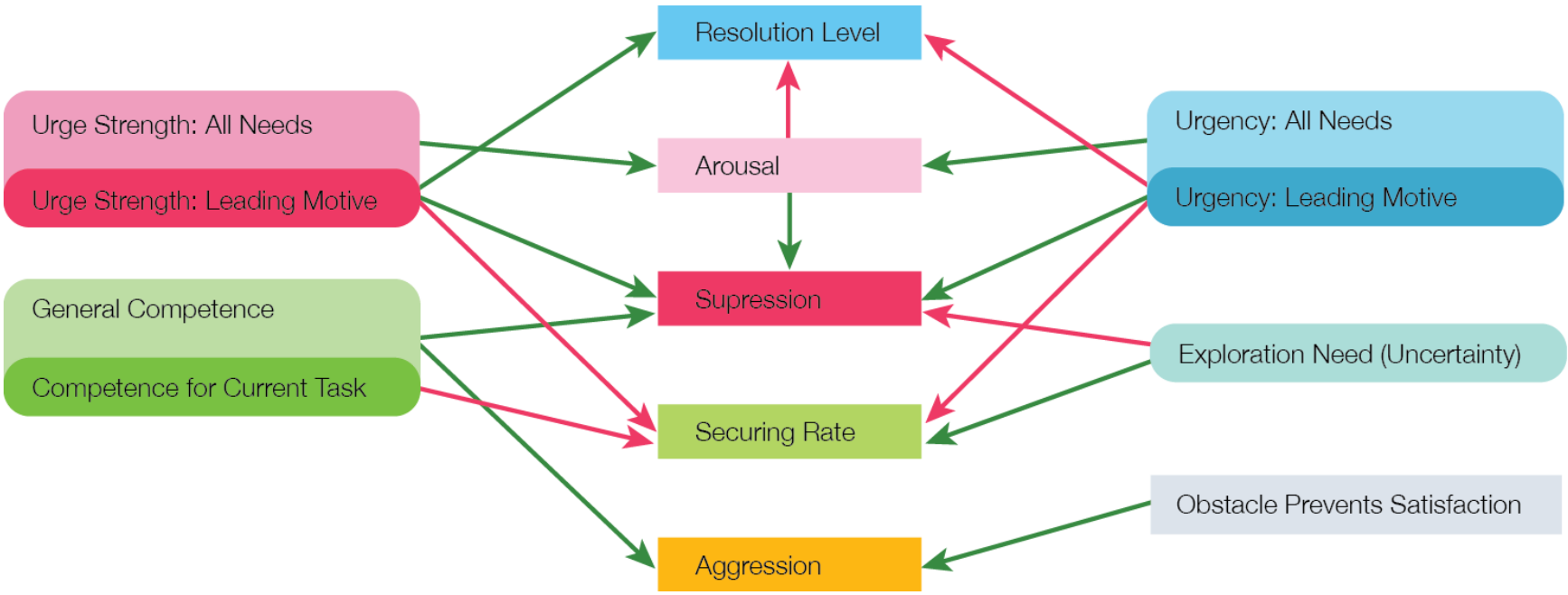


Attentional modulators

Resolution Level	width of focus
Supression	depth of focus; motive stability
Securing Rate	rate of checking the environment



Modulator dynamics



Modulator parameters

- Baseline
- Range
- Volatility
- Duration

- Different modulator parameter configurations = different temperaments

Emotions as directed affect + Modulation

Examples:

Fear: anticipation of aversive events (→ neg. valence) + arousal

Anxiety: uncertainty (→ neg. valence) + low competence + arousal, high securing behavior (frequent background checks)

Emotions as directed affect + Modulation

Examples:

Anger: Perceived obstacle (usually agent) manifestly prevented reaching of an active, motivationally relevant goal (→neg. valence), sanctioning behavior tendency (→ goal relevance is re-directed to sanctioning of obstacle), arousal, low resolution level, high action readyness, high selection threshold

Sadness: Manifest prevention from *all* conceived ways of reaching active, relevant goal, without relevant obstacle (→ neg. valence), support-seeking behavior (by increased demand for affiliation), low arousal, inhibition of active goal → decreased action readyness

Emotions as directed affect + Modulation

Examples:

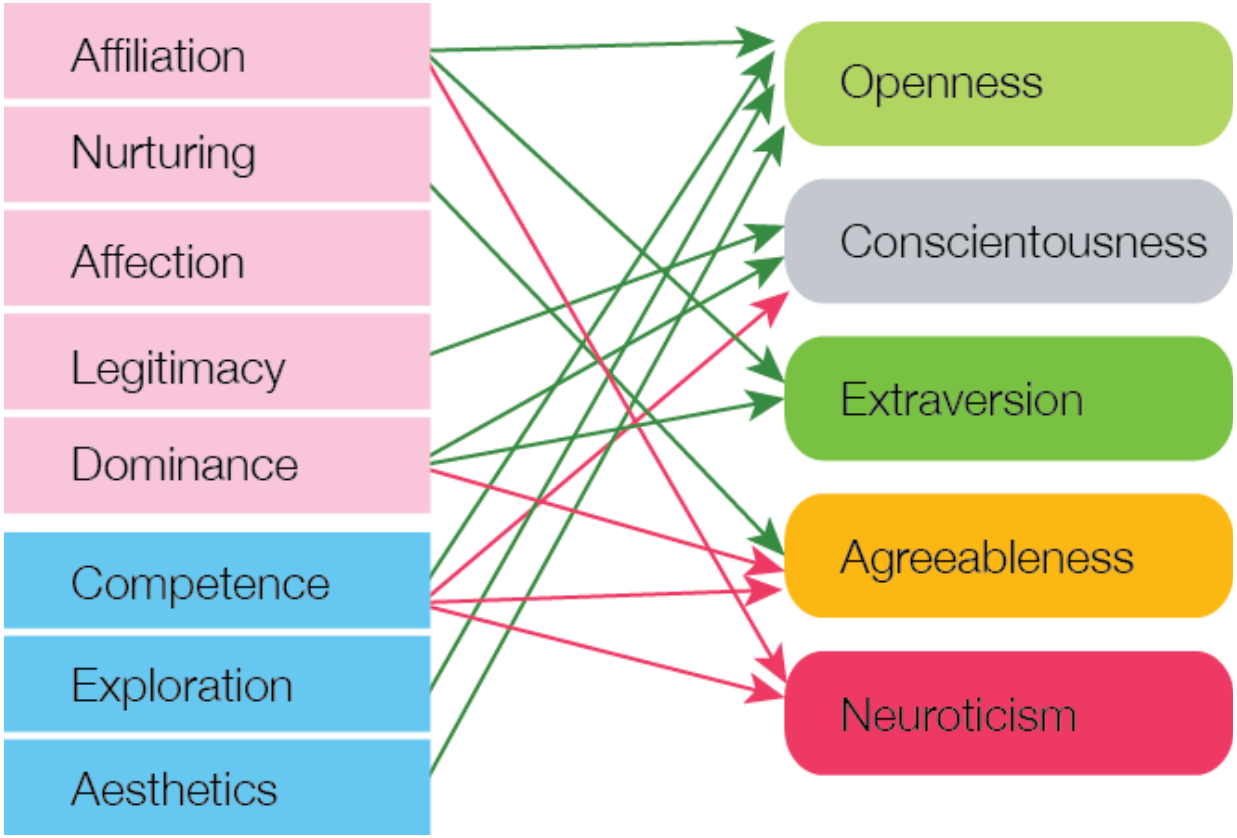
- **Pride**: high competence (→ low securing rate), high internal legitimacy, likely coincidence with high external legitimacy
- **Joy**: high arousal + high perceived reward signal from satisfying a demand
- **Bliss**: low arousal + high perceived reward signal from satisfying a demand (since physiological demands often involve high arousal, mostly related to cognitive demands, such as aesthetics)

Individual Variations by Parameterizing

Possible grounding of personality properties (FFM):

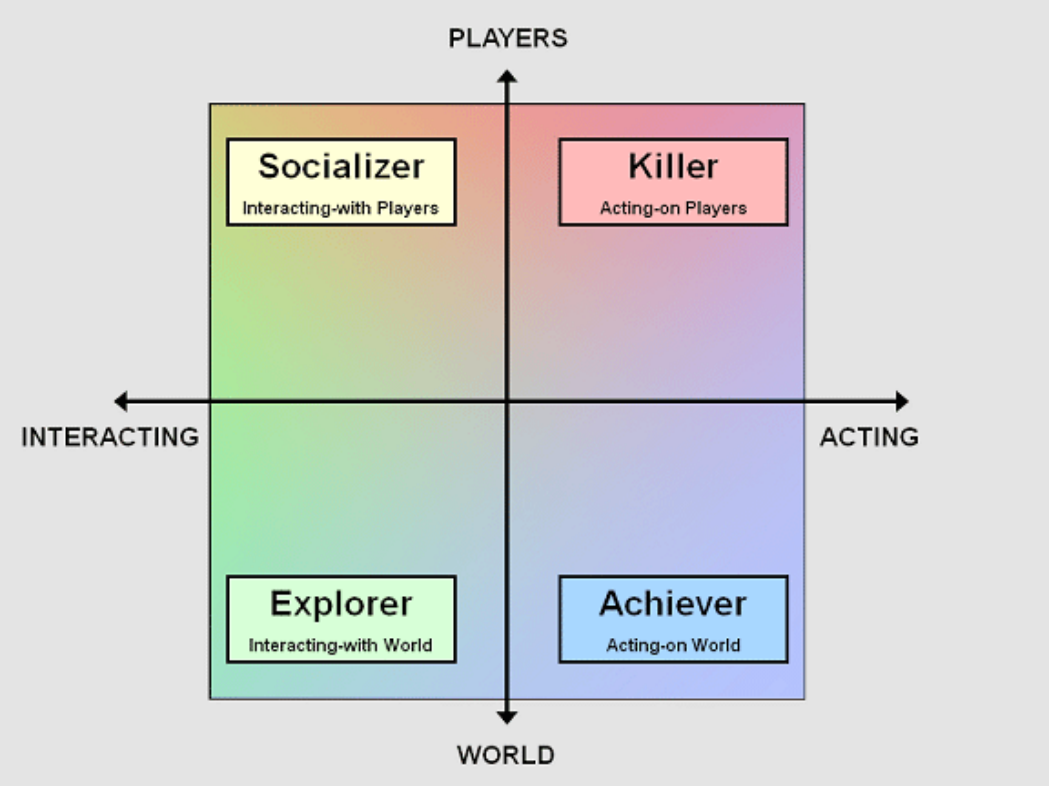
- **Openness**: appreciation of art and new ideas, curiousity
- **Conscientiousness**: rulefollowing vs. chaotic
- **Extraversion**: tendency to seek stimulation by environment and others
- **Agreeableness**: tendency for cooperativeness and compassion
- **Neuroticism**: emotional stability, effect of failure to self-confidence

Needs and Big Five



Player personality types

Richard Bartle (1996): “Hearts, Clubs, Diamonds, Spades: Players Who suit MUDs”

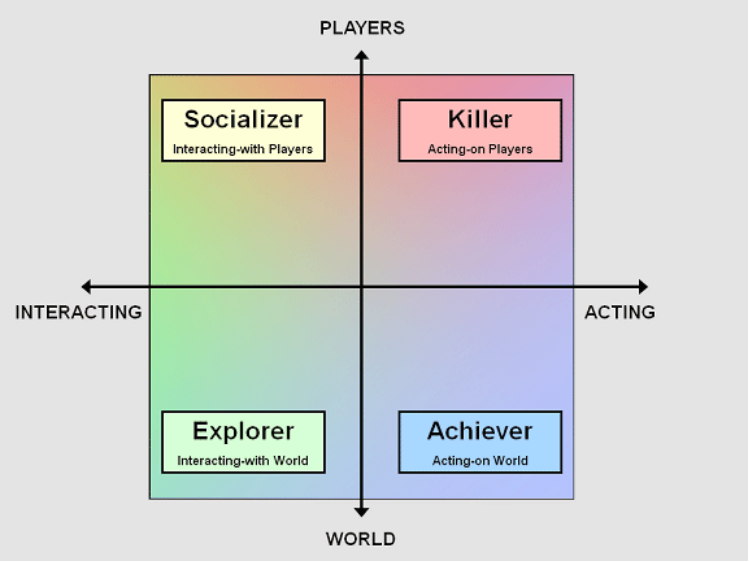


Motivation and personality

- Personality properties can be modeled as motivational variability

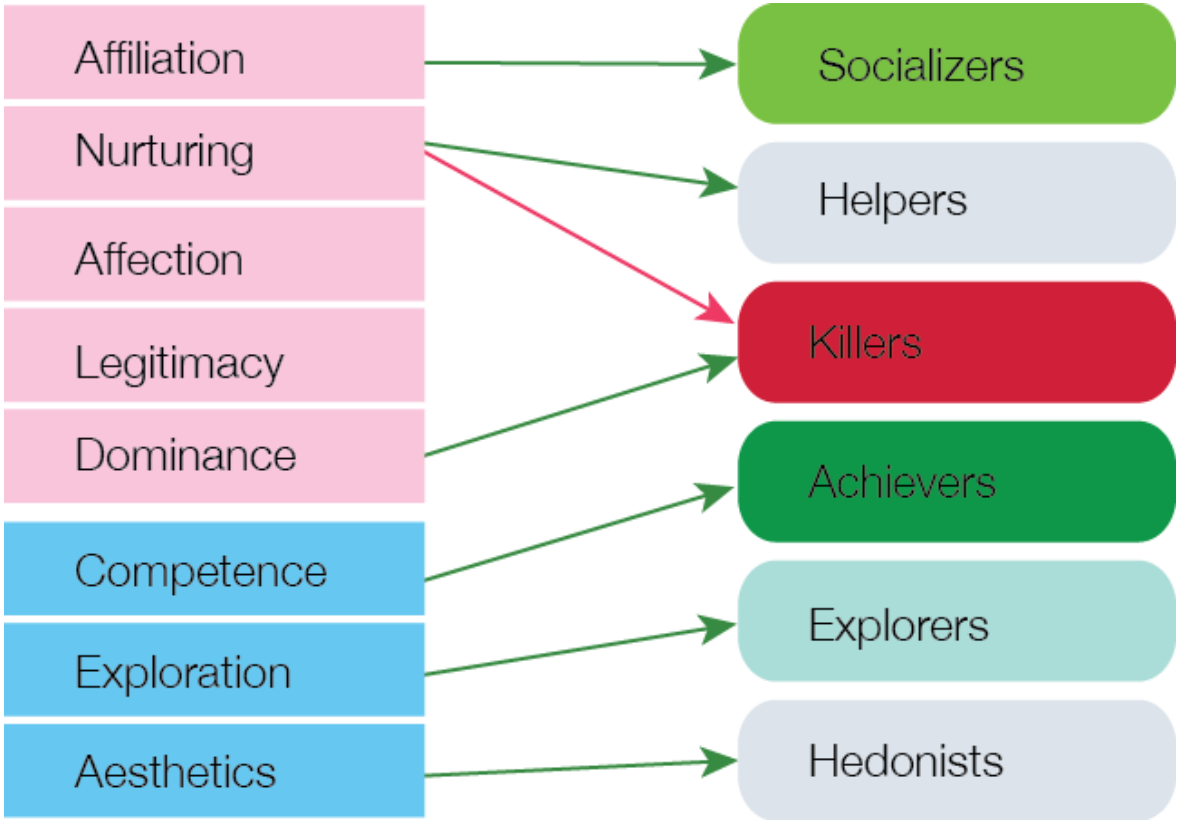
Affiliation

Uncertainty reduction



Competence

Needs and player types (with S. Tekovsky)



Motivation in MicroPsi

- All actions are directed on goals or avoidance of aversive goals
- All goals are established through learning how to satisfy needs
- All decisions are based on strengths of urges and chances to satisfy corresponding needs
- Personality differences are the result of parametrization of the motivational system

Emotion in MicroPsi

- Affective states are configurations of cognition, by modulators
- Primary modulators: arousal, valence, agression
- Attentional modulators: focus, securing rate, resolution level
- High-level emotions are determined by an affective state that is directed on motivational content