



Emotion Simulation for a Virtual Human: Implementing the "As-If" Body-Loop in a Cognitive Architecture

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Overview of the talk



I. Introduction

The Virtual Human “Max” ..

- a) .. as a guide in a computer museum.
- b) .. as an opponent in a cards game.

II. Psychological background of emotion simulation

- a) Structural theories
- b) Dimensional theories
- c) Neurobiological background

III. Implementation

- a) Emotion Dynamics Simulation
- b) Non-Conscious & Conscious Appraisal

IV. Summary



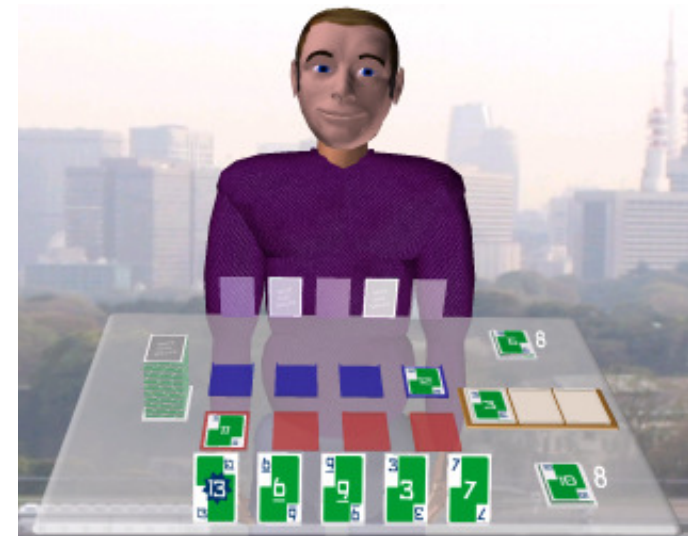
I. Introduction

The Virtual Human “Max” ..



.. as a guide in a computer museum (Germany, 2004).
→ A cooperative scenario!

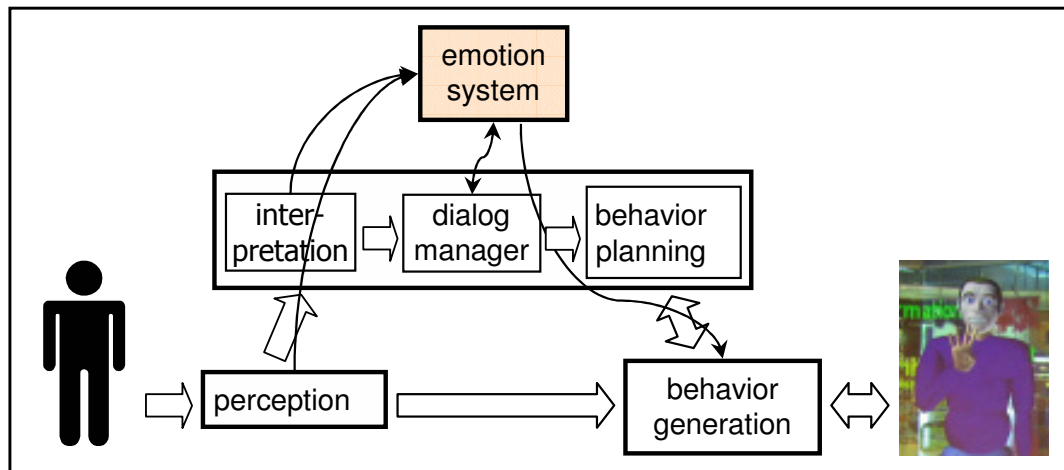
.. as an opponent in a cards game (Tokyo, 2005).
→ A competitive scenario!



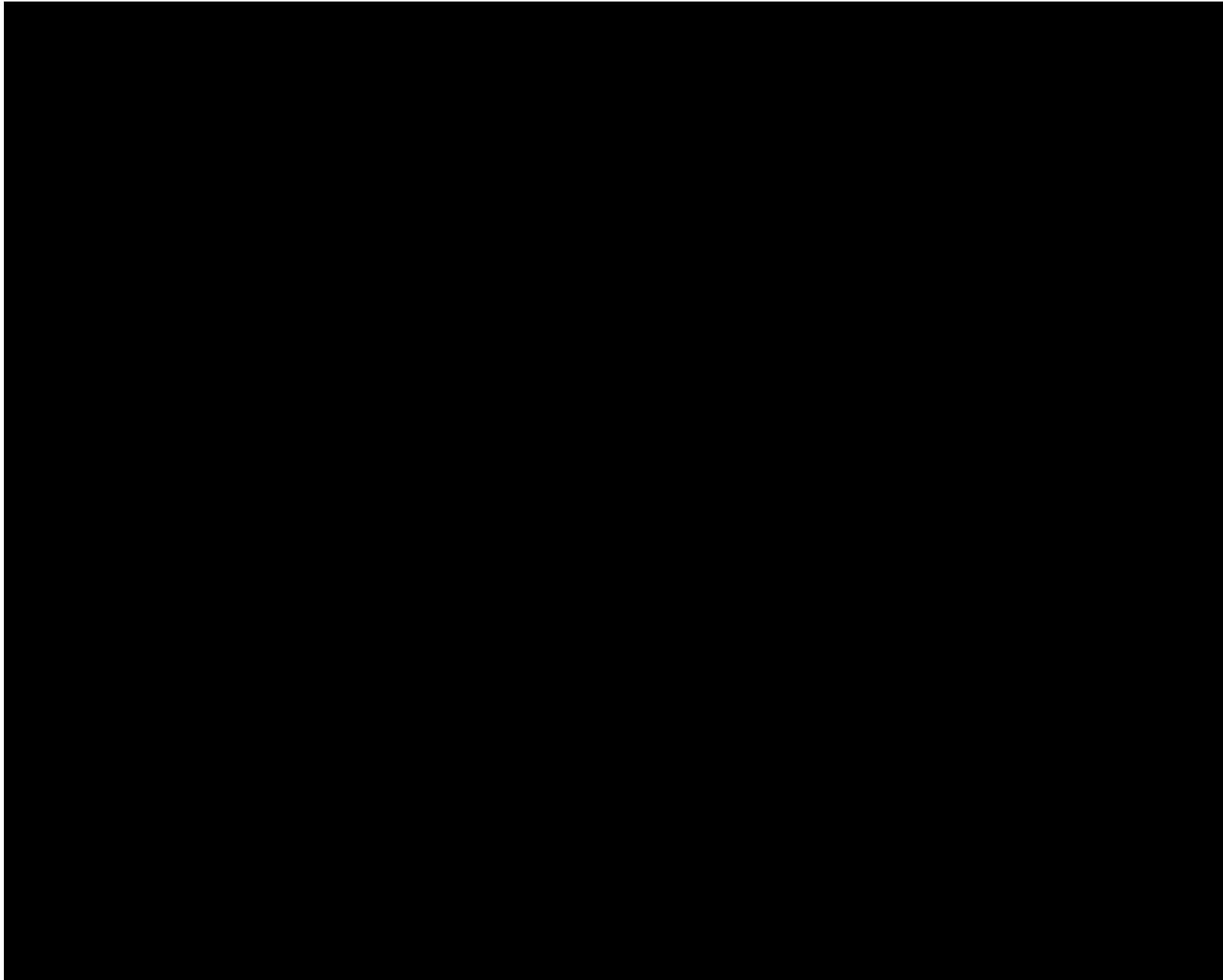
I. a) Smalltalk with Max

Virtual guide scenario since 01/2004:

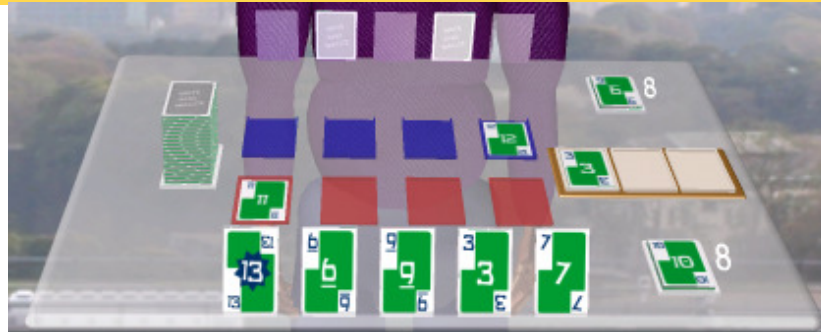
- Emotion dynamics system driven by:
 - perception (video camera)
 - interpretation (keyboard input)
 - dialog manager (BDI-based reasoning)
- Feeds back to:
 - dialog manager (cognitive)
 - behavior generation (non-cognitive)



I. a) Smalltalk with Max - Video

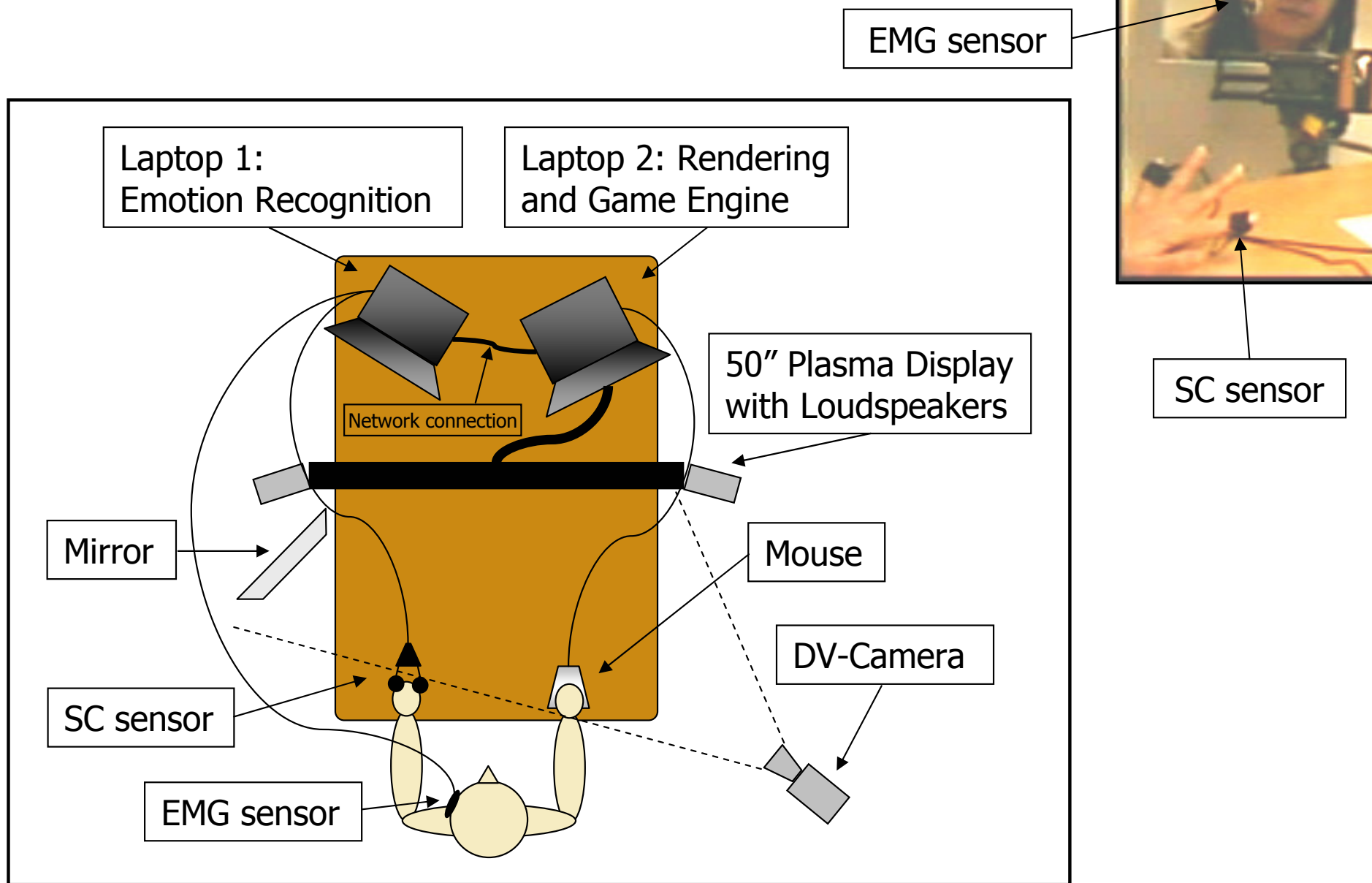


I. b) Competing with Max



- Playing the cards game “Skip-Bo” against Max:
 - Competitive game with contrary goals for two players
- Emotion recognition using biometrical sensors (Skin Conductivity & EMG, data recorded)
- Empirical study conducted at NII, Japan, 2005
 - 32 subjects, average age 30, one non-Japanese
 - Interactions recorded on digital video
- In cooperation with Prof. Helmut Prendinger during a three month stay as a pre-doctoral JSPS-fellow

I. b) "Skip-Bo" Setup

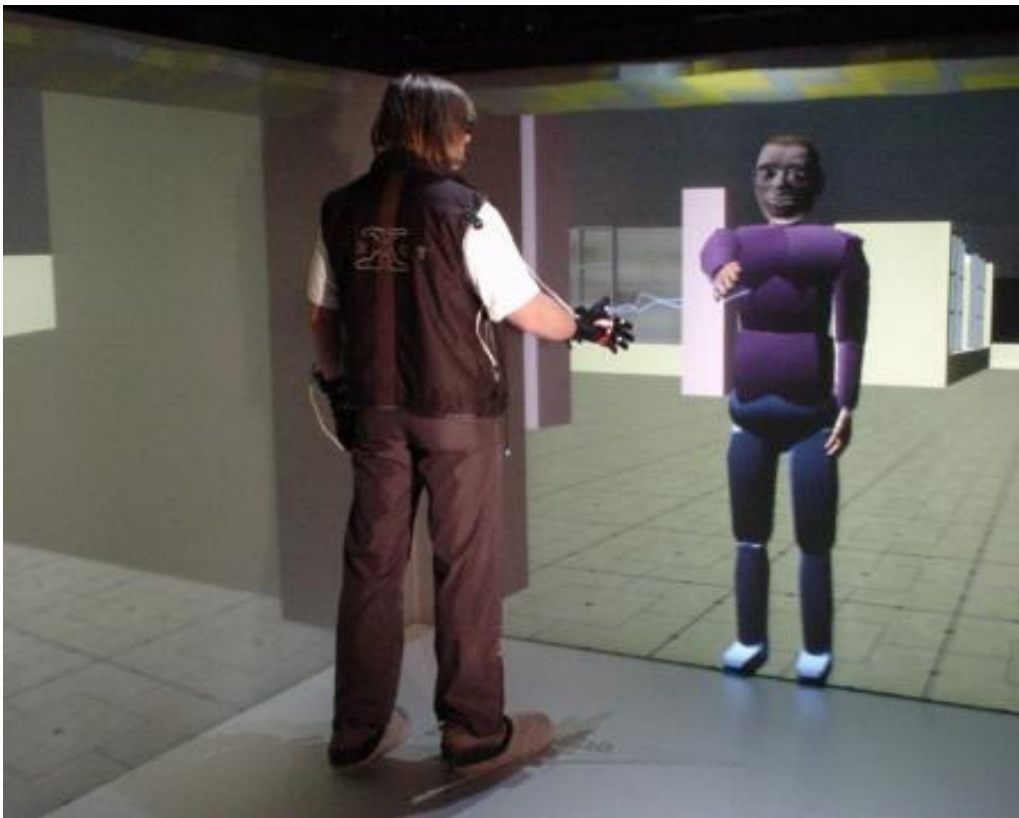


I. b) Max plays SkipBo - Video

Playing SkipBo
against an
Empathic Max

The Virtual Human Max..

.. is a testbed for studying human-like behavior in natural face-to-face interactions.



Multimodal interaction in our three-sided cave-like installation using:

- data-gloves
- infrared cameras
- 3D-vision interface

Part II

Emotion Simulation for Max

or

How do we improve our agent's acceptance as a social partner?



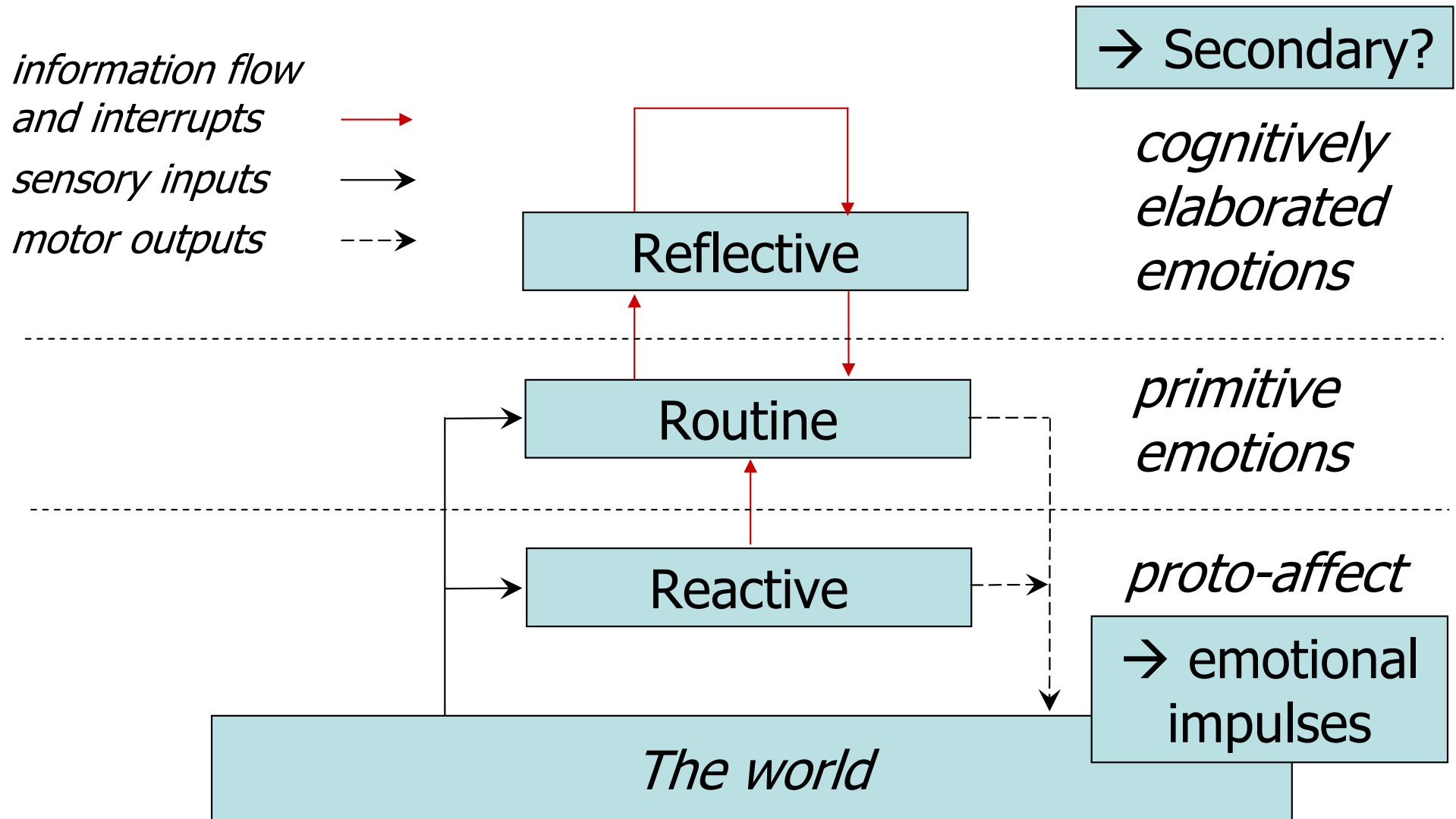
II. Psychological background

- a) Cognitive emotion theories
 - Affect & Proto-Affect (Ortony et al., 2005)
 - Component Process Model (Scherer, 2006)
- b) Dimensional emotion theories
 - "Gefühlsverlauf" (Wundt, 1922)
 - Conscious vs. non-conscious appraisal (Scherer, 2006)
- c) Neurobiological background
 - Primary and Secondary Emotions (Damasio, 1994)
 - The "as-if" body loop of emotions

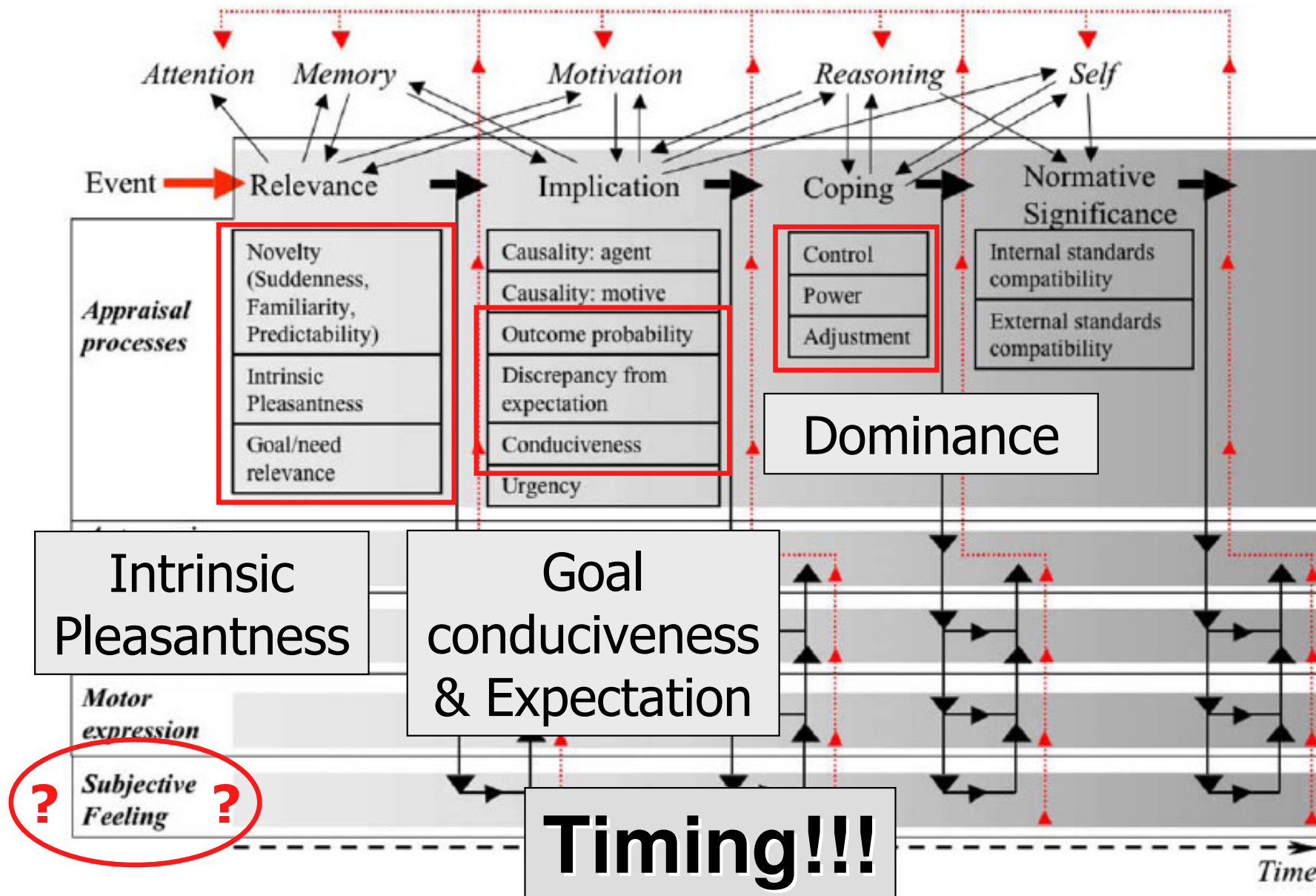
II. a) Affect & Proto-Affect (Ortony et al., '05)

- Three levels of information processing:
 1. Reactive:
 - limited to processing simple stimuli and initiating approach and avoidance behaviors.
→ proto-affect
 2. Routine:
 - locus of unconscious, uninterpreted expectations and automatized activity.
→ primitive and unconscious emotions
 3. Reflective:
 - home of higher-order cognitive functions, including metacognition, consciousness, and self-reflection
→ full-fledged, cognitively elaborated emotions

II. a) Affect & Proto-Affect (Ortony et al., '05)

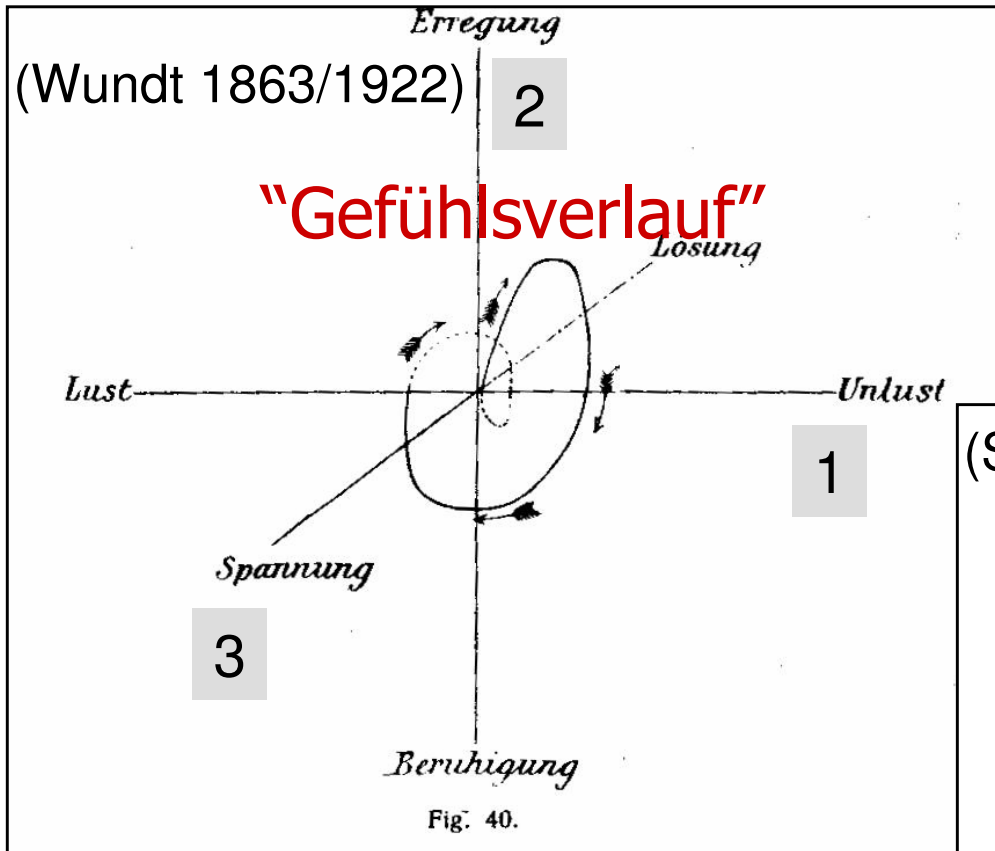


II. a) Component Process Model (Scherer '06)



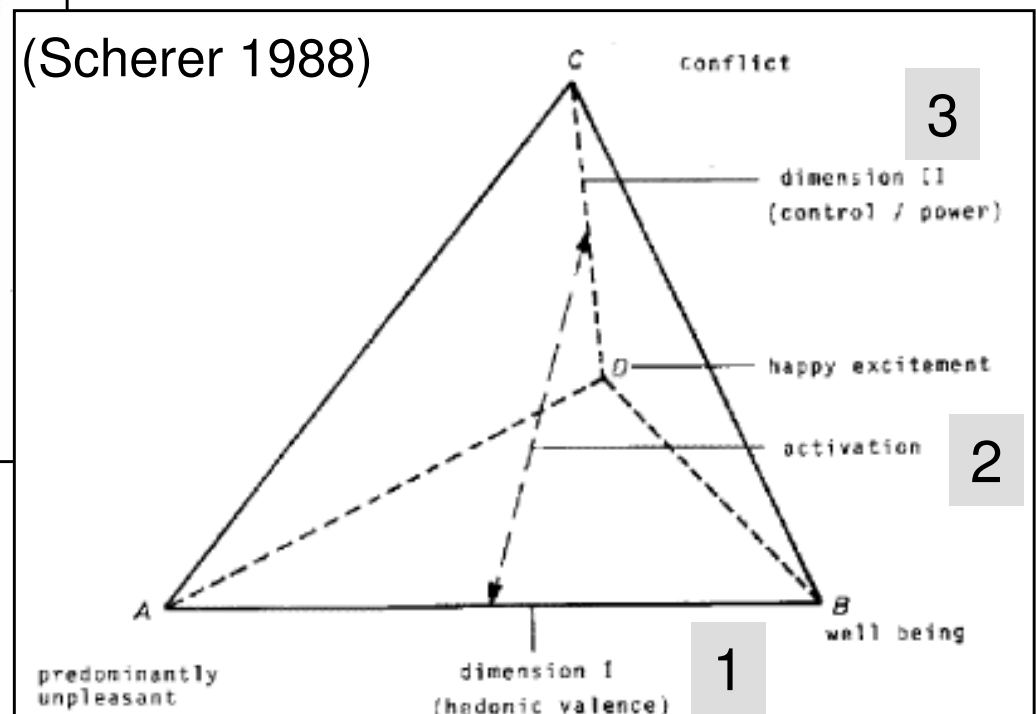
II. b) Dimensional theories of emotion

Describing the “diffuse feeling state”?



Mostly three dimensions:

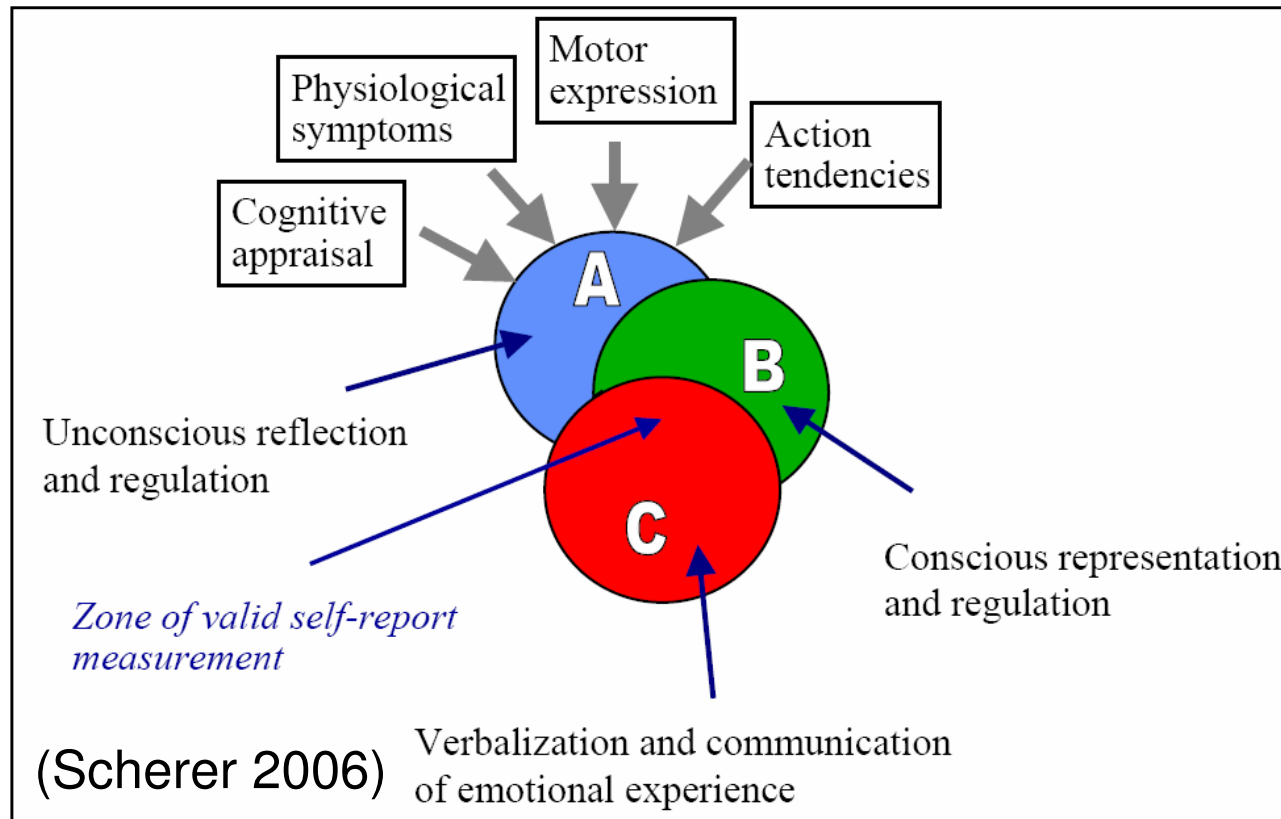
1. Pleasure (Lust – Unlust)
2. Arousal (Erregung – Beruhigung)
3. Dominance (Spannung – Lösung)



- What is the difference between emotions and feelings?
- How many emotions/feelings?

II. b) Conscious vs. non-conscious

The verbalization problem:



- Most processes believed to remain unconscious (A)
- Even not all conscious representations can be verbalized (B)

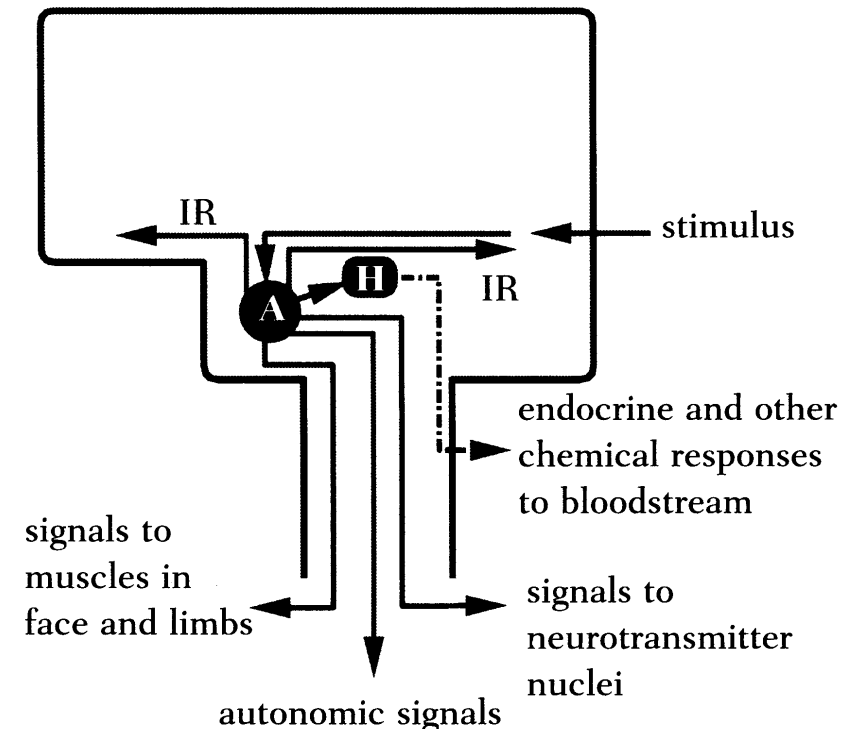
→ Zone of valid self-report measurement lies on top! (C)

II c) Primary emotions (Damasio '94)

Book: "Descartes' Error, Emotion Reason and the Human Brain."

"[...] we are wired to respond with an emotion, in preorganized fashion, when certain features of stimuli in the world or in our bodies are perceived, alone or in combination. Examples [...] include size (as in large animals); large span (as in flying eagles); types of motion (as in reptiles); certain sounds (such as growling); certain configurations of body state (as in the pain during a heart attack)." (p. 131)

- Stimulus activates amygdala (A)
- Various responses ensue:
 - Internal responses (IR)
 - Muscular responses
 - Visceral responses
 - Responses to neurotransmitter nuclei and hypothalamus (H)
 - Hypothalamus gives rise to endocrine & other chemical responses



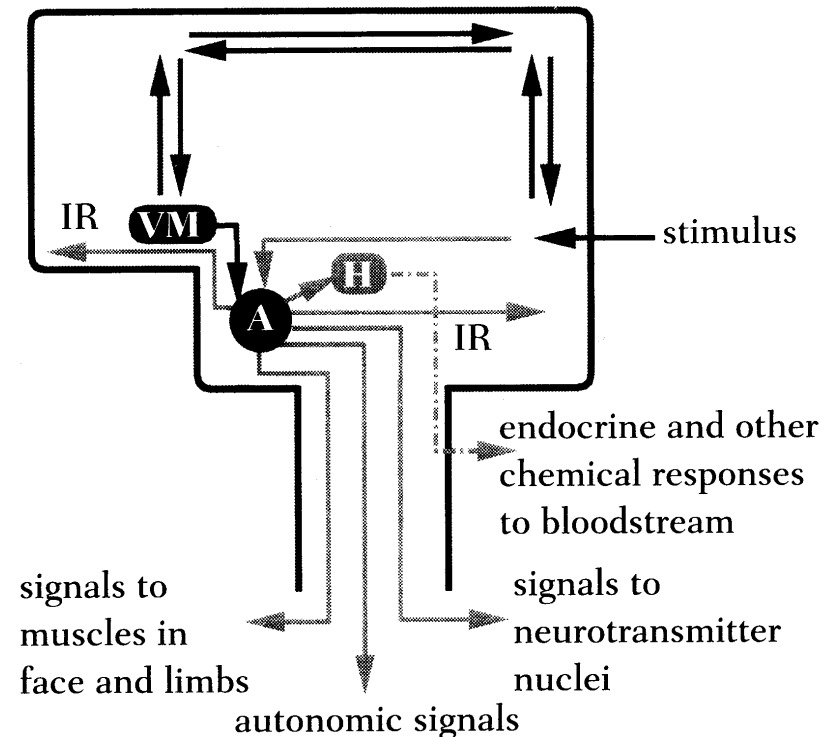
II c) Secondary emotions (Damasio '94)

Book: "Descartes' Error, Emotion Reason and the Human Brain."

"[..] I believe that in terms of an individual's development [primary emotions] are followed by *secondary emotions*, which occur once we begin experiencing feelings and forming *systematic connections between categories of objects and situations, on the one hand, and primary emotions, on the other.*" (p. 134)

- Stimulus activates amygdala (A)
- Stimulus is analyzed in the thought process
- Secondary emotions utilize the machinery of primary emotions

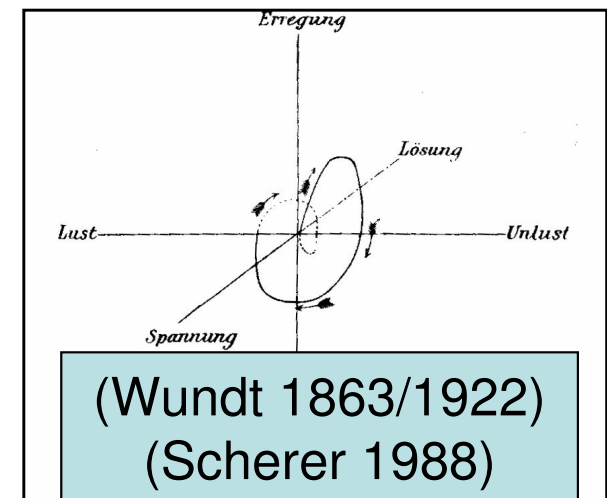
→ The "as-if" body loop of emotions might be applied!



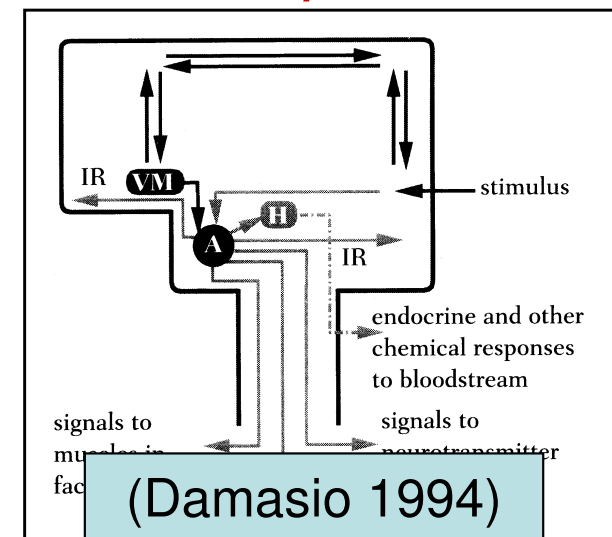
III. Implementation

- a) Emotion dynamics simulation (Becker et al., 2004)
- Implementing the “subjective feeling state” grounded in the Physis of the virtual human.
- b) Non-conscious and conscious appraisal (Becker et al. 2006)
- Non-conscious appraisal based on “intrinsic pleasantness” (Scherer 2001) & proto-affect (Ortony et al. 2005)
→ Primary emotions
 - Conscious appraisal based on BDI-based reasoning about “goal-conduciveness” (Scherer 2001)
→ Secondary emotions

“Gefühlsverlauf”

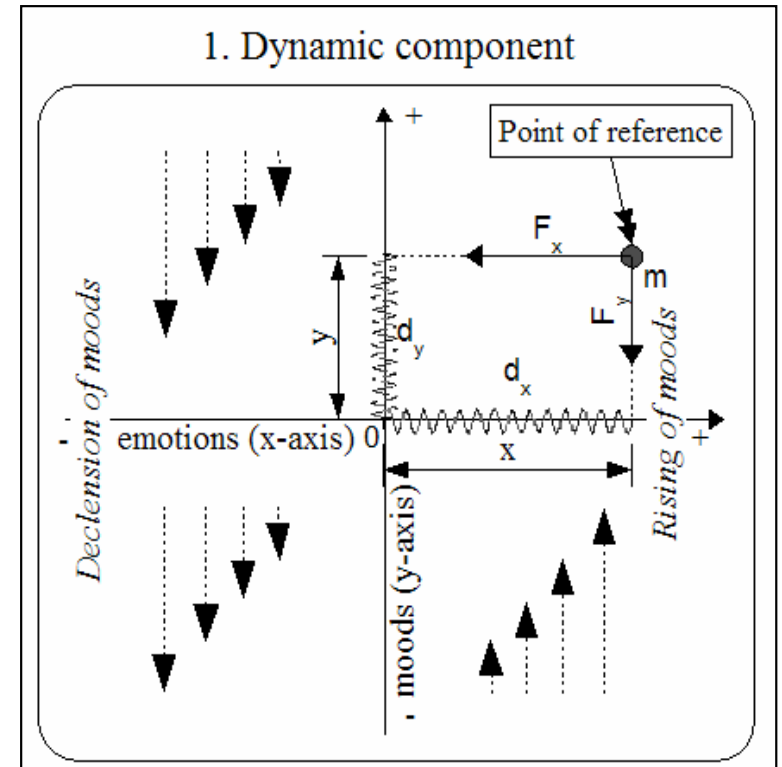


“Secondary emotions”



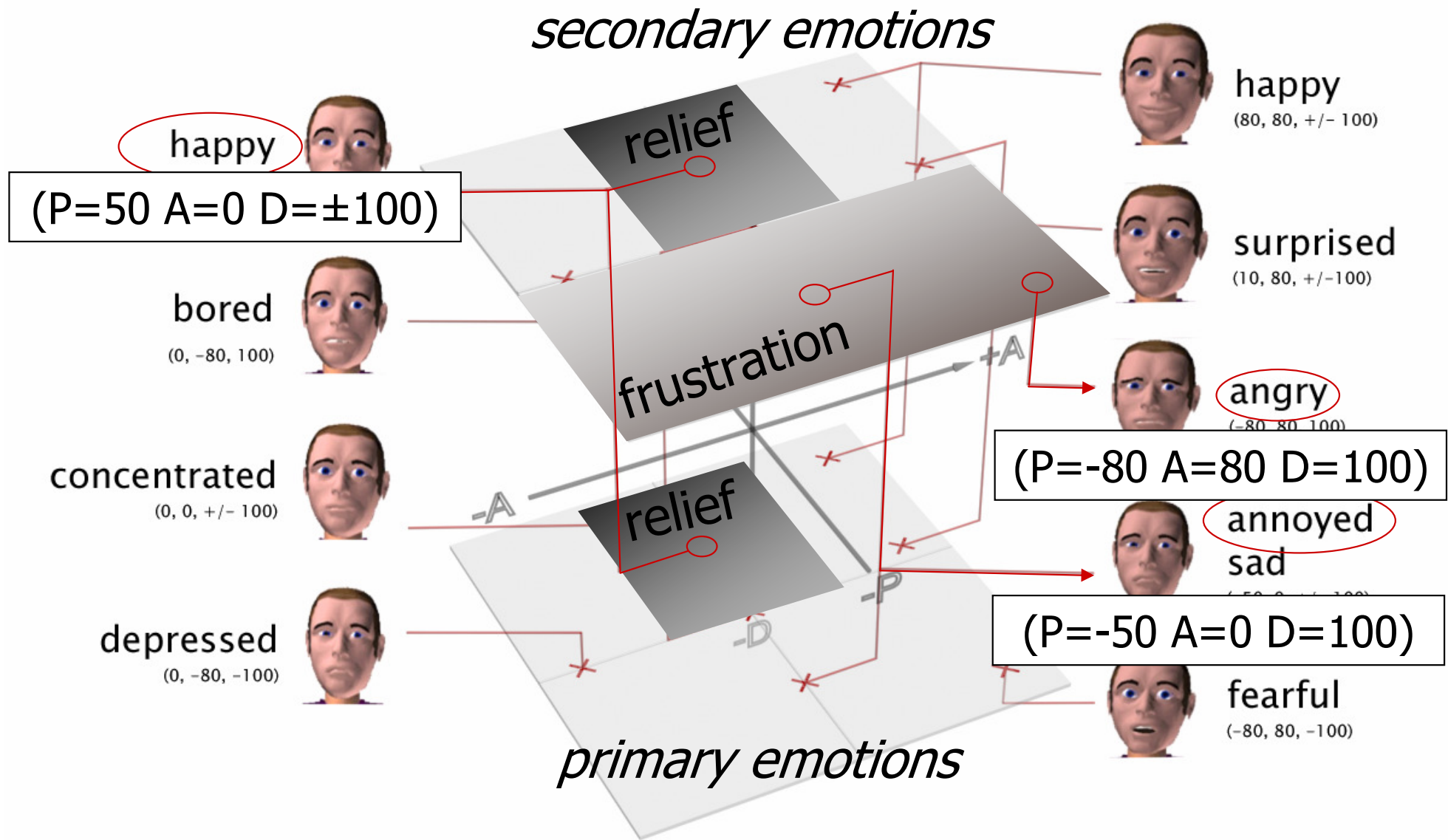
III. a) Emotion dynamics simulation

- Valence of emotion coupled with valence of mood
- Concept of boredom added to increase believability of the virtual human
- Simulation of two spiral springs to implement dynamics of emotions
- Aspects of personality traits can be modeled in emotion dynamics parameters

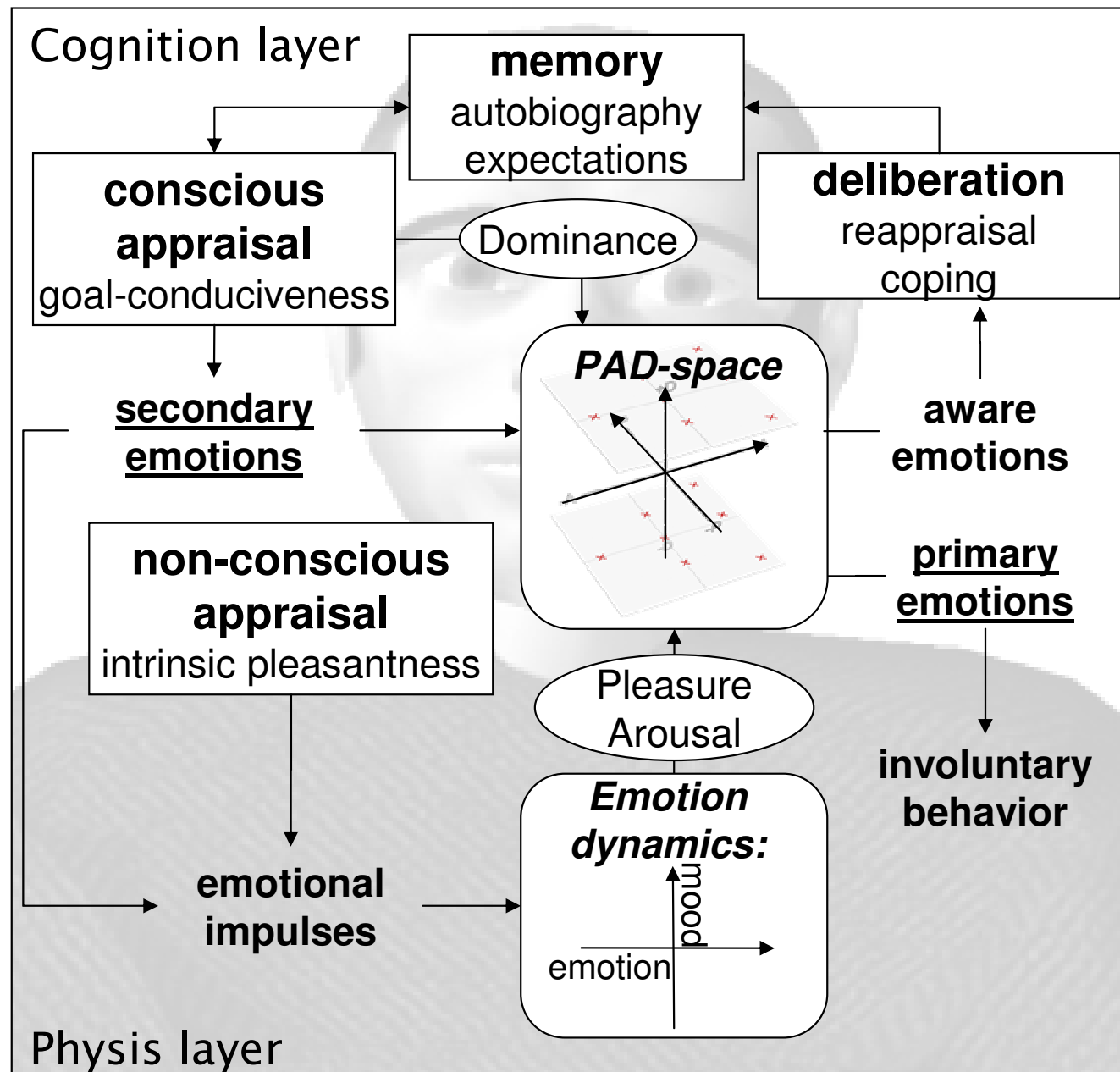


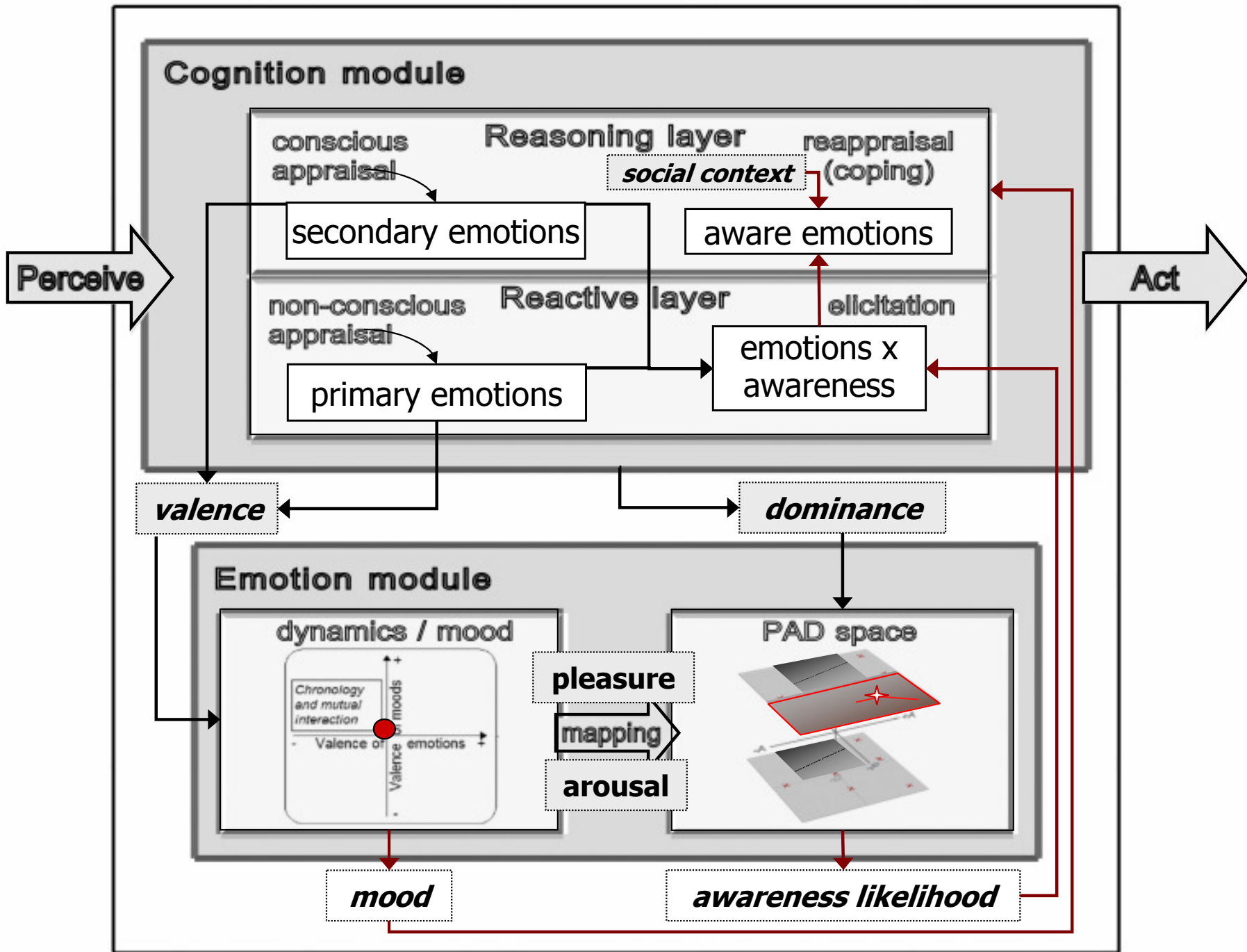
→ Assuring mood-congruency of emotions

III. a) PAD-space

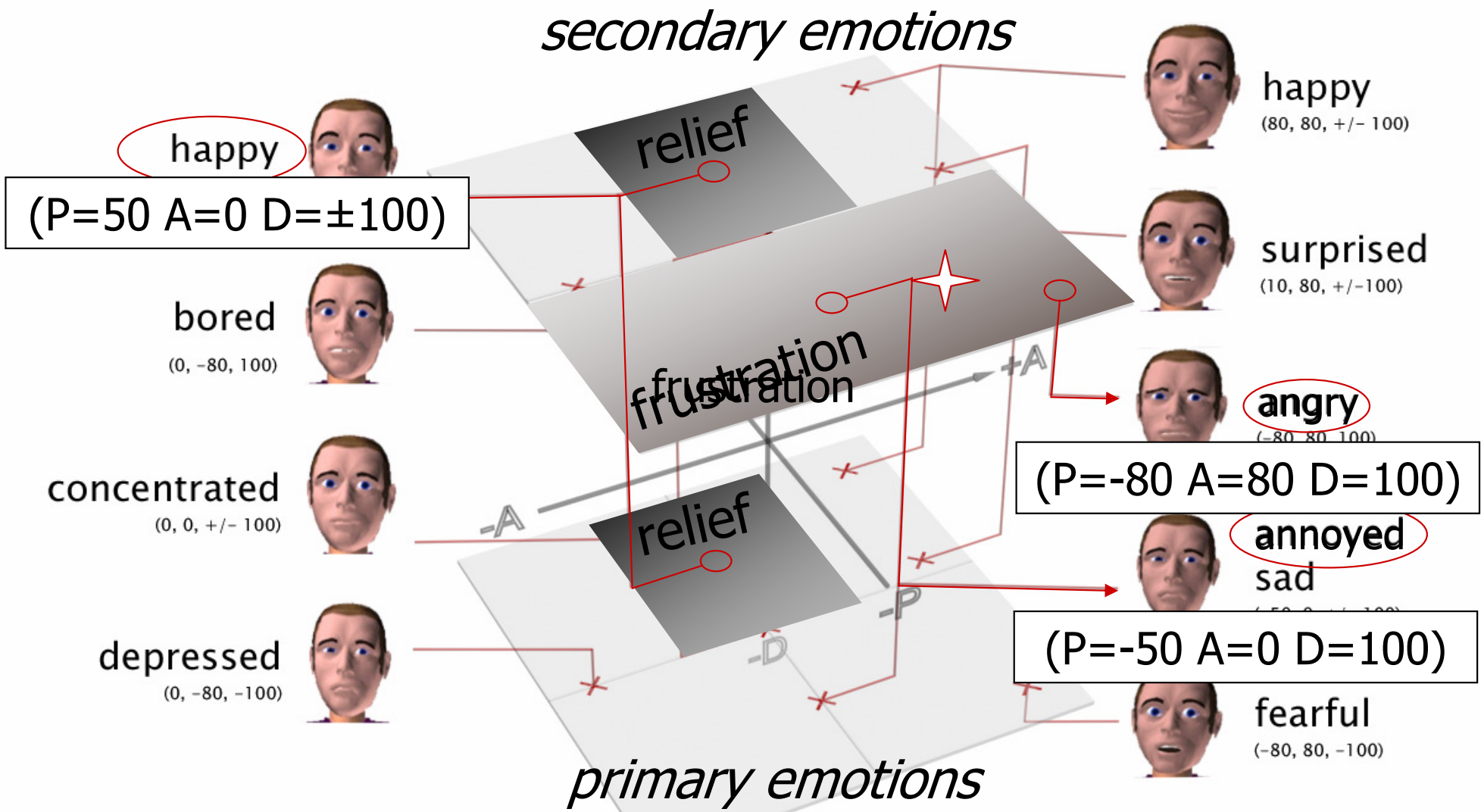


III. b) Non-conscious & conscious appraisal





III. b) PAD-space (in detail)



awareness likelihood = (0.3 * , 0.2 * , 0.6 *)

IV. Summary

Modeling Primary and Secondary Emotions, HowTo:

- Primary emotions as reactive responses to stimuli:
 - No memory, no expectations, no higher-order cognition involved
 - “Intrinsic pleasantness” (Scherer) leads to “Proto-affect” (Ortony)
→ emotional impulse for emotion dynamics system
 - Direct elicitation of primary emotions
→ PAD-space (Wundt)
- Secondary emotions are “cognitively elaborated” (Ortony)
 - Conscious (re)appraisal based on memory & expectations (Scherer)
→ BDI-based reasoning also for coping
 - They “utilize the machinery of primary emotions” (Damasio)
→ PAD-space as “awareness filter”
→ Facial expression of “relief” triggered by primary emotion “happy”

IV. The future?



The making of the
robot "Sonny"
("I, Robot", 2004)

Repliee-Q2 (University of Osaka)
(Repliee-Q1expo, 2005 in Aichi)

