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

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Bielefeld


"Sparrenburg" Castle in Bielefeld
"Crüwell" house in Bielefeld
"Stadttheater" (city theater) in Bielefeld
Luxembourg
Bern
Schweiz
Polen
Zeiger 52°00'19.57" N 8°34'56.34" E
Übertragung 100%

Bielefeld University

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

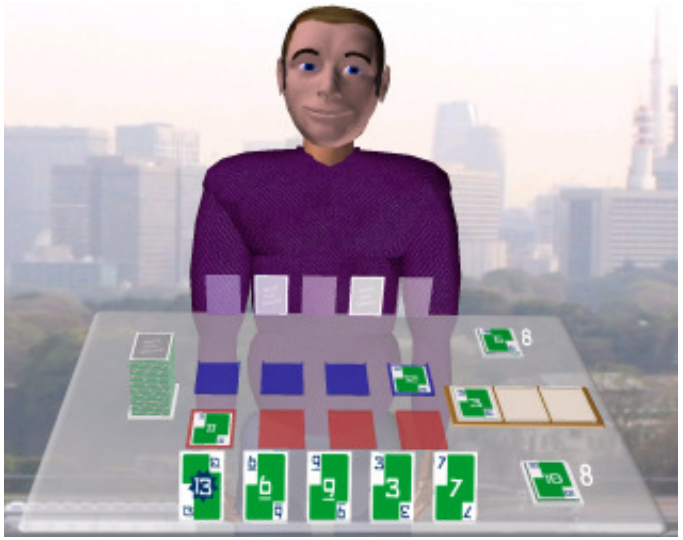
IV. Summary

I. Introduction

The Virtual Human “Max” ..

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

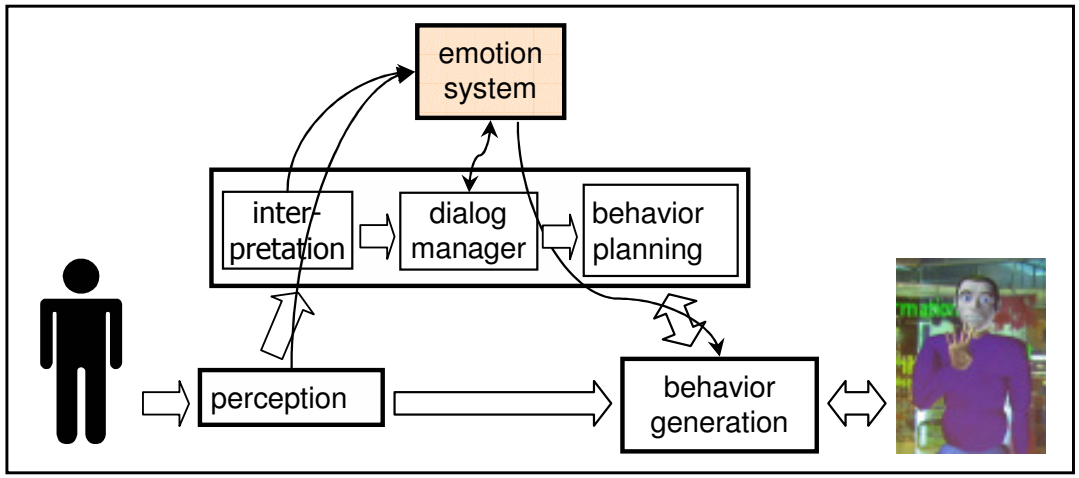
.. as an opponent in a cards game (Tokyo, 2005).
→ A competitive scenario!



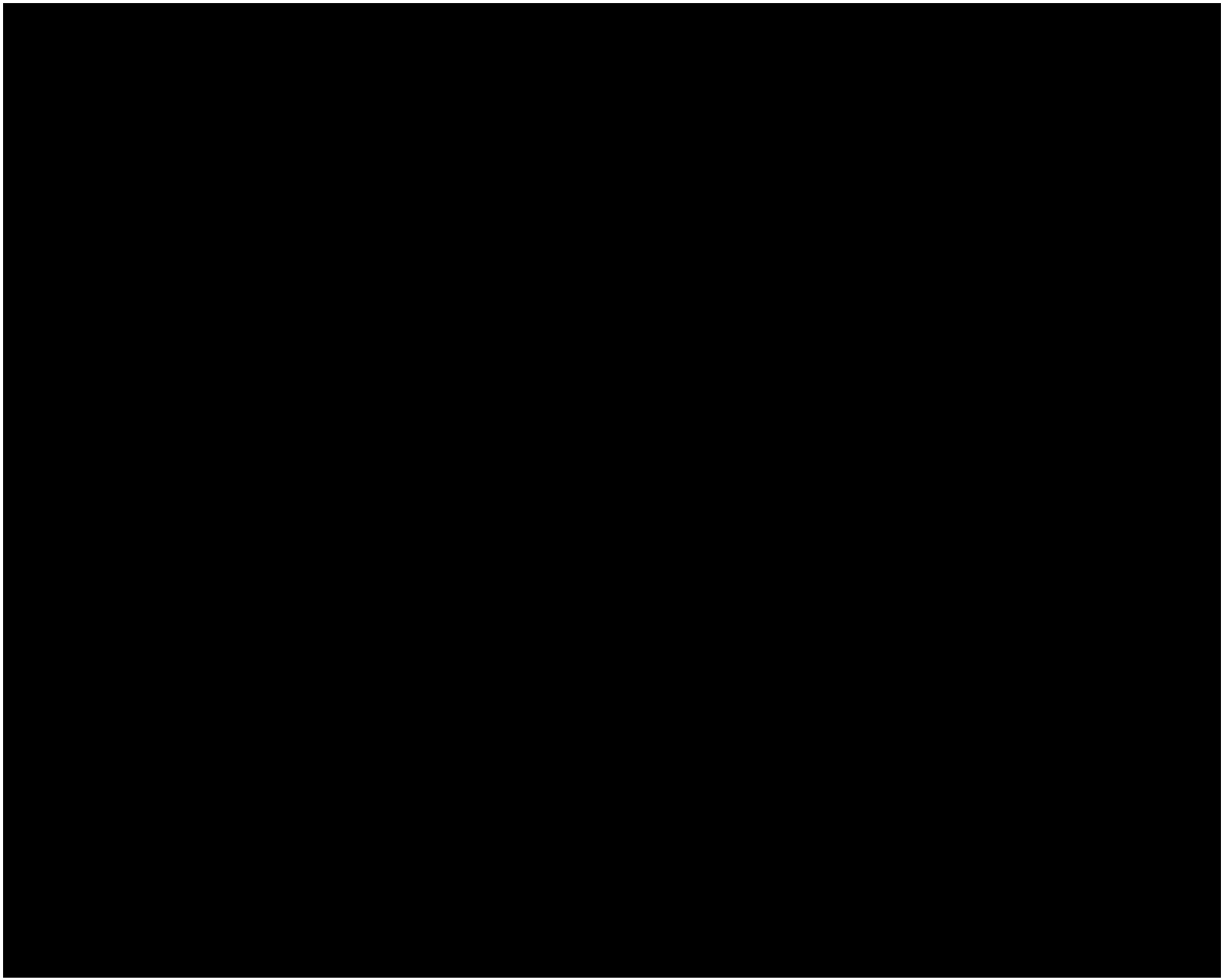
I. a) Smalltalk with Max

Virtual guide scenario since 01/2004:

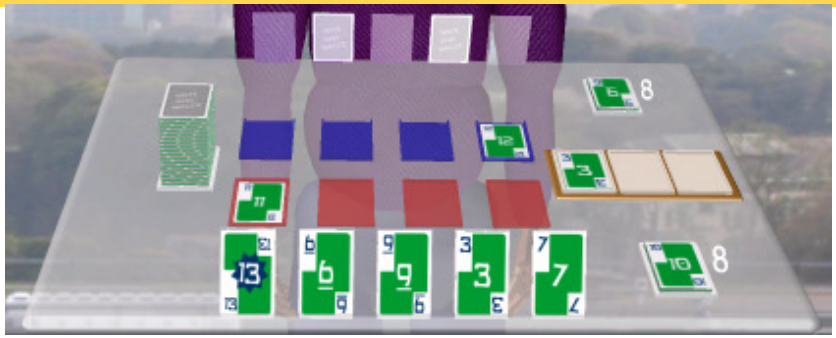
- Emotion dynamics system driven by:
  - perception (video camera)
  - interpretation (keyboard input)
  - dialog manager (BDI-based reasoning)
- Feeds back to:
  - dialog manager (cognitive)
  - behavior generation (non-cognitive)



I. a) Smalltalk with Max - Video

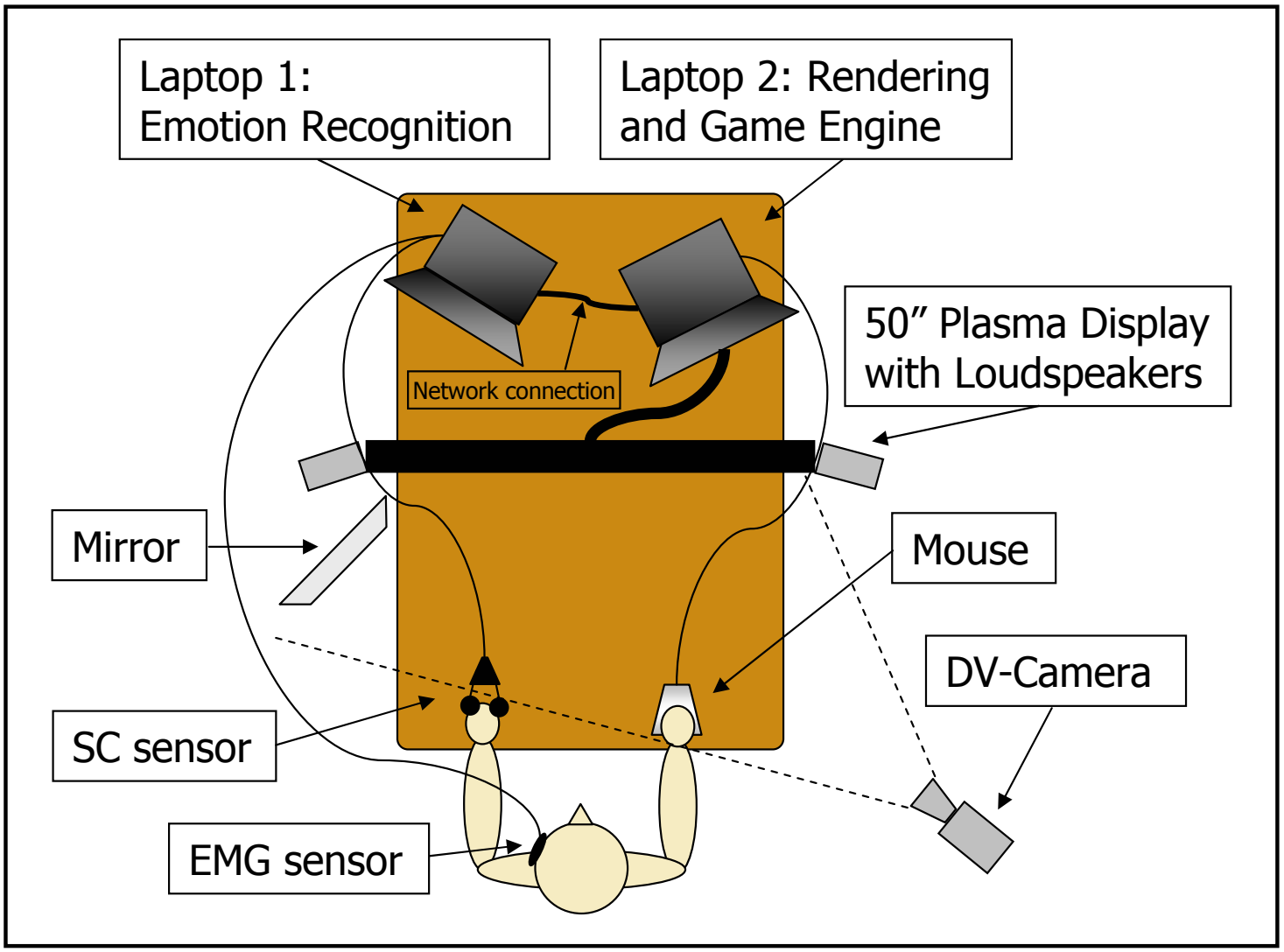


I. b) Competing with Max



- 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

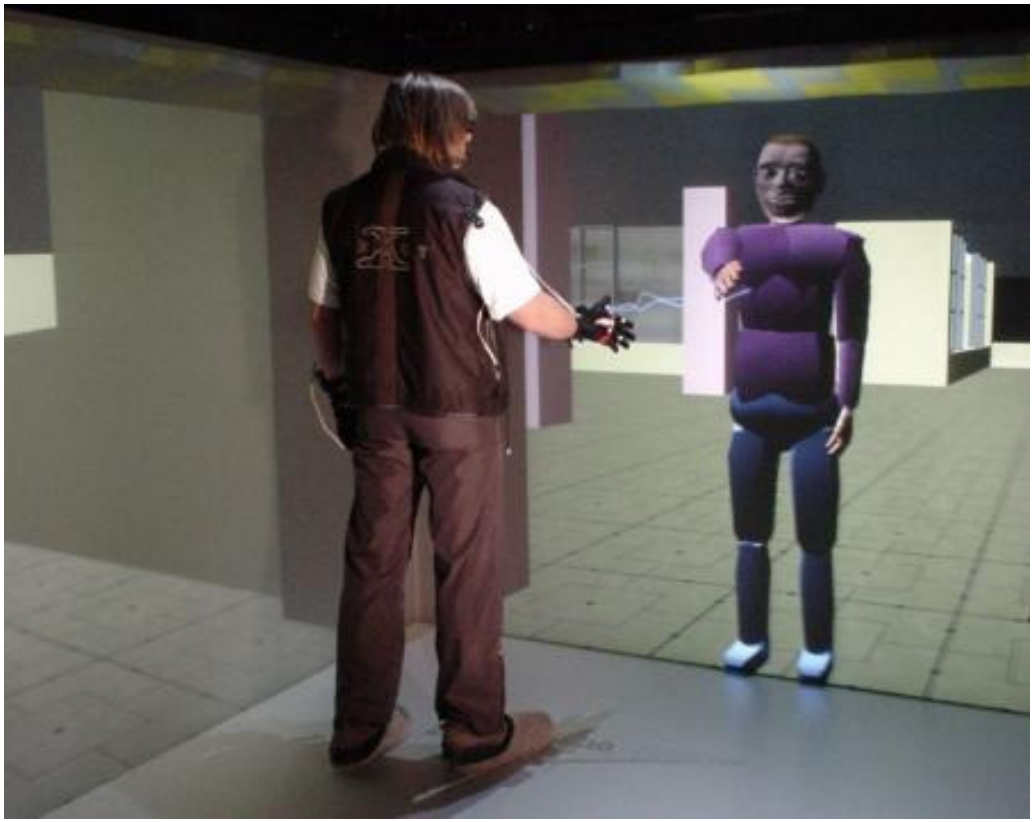
I. b) “Skip-Bo” Setup



I. b) Max plays SkipBo - Video

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)

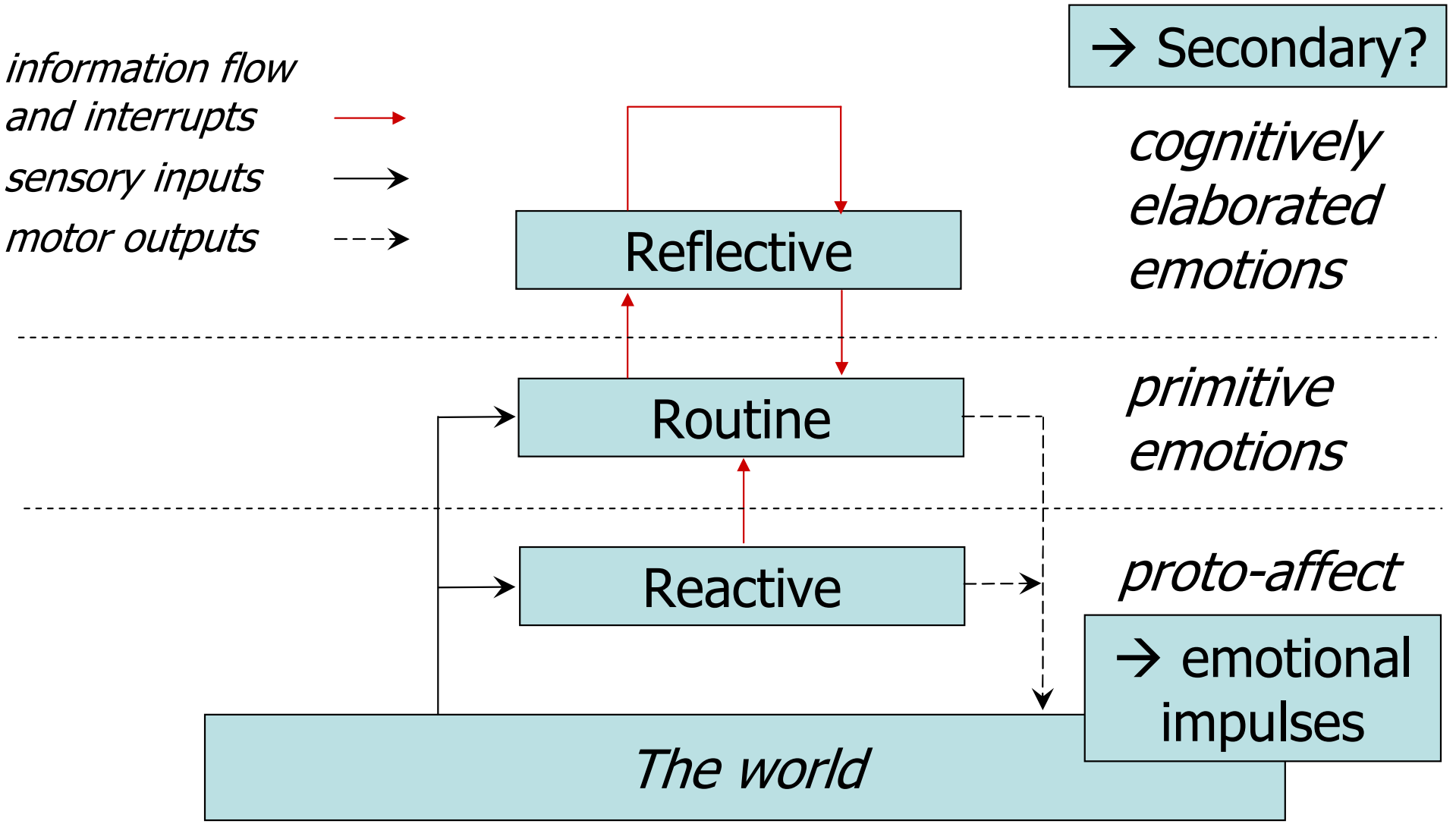
b) Dimensional emotion theories
   - "Gefühlsverlauf" (Wundt, 1922)
   - Conscious vs. non-conscious appraisal (Scherer, 2006)

c) Neurobiological background
   - Primary and Secondary Emotions (Damasio, 1994)
   - The "as-if" body loop of emotions

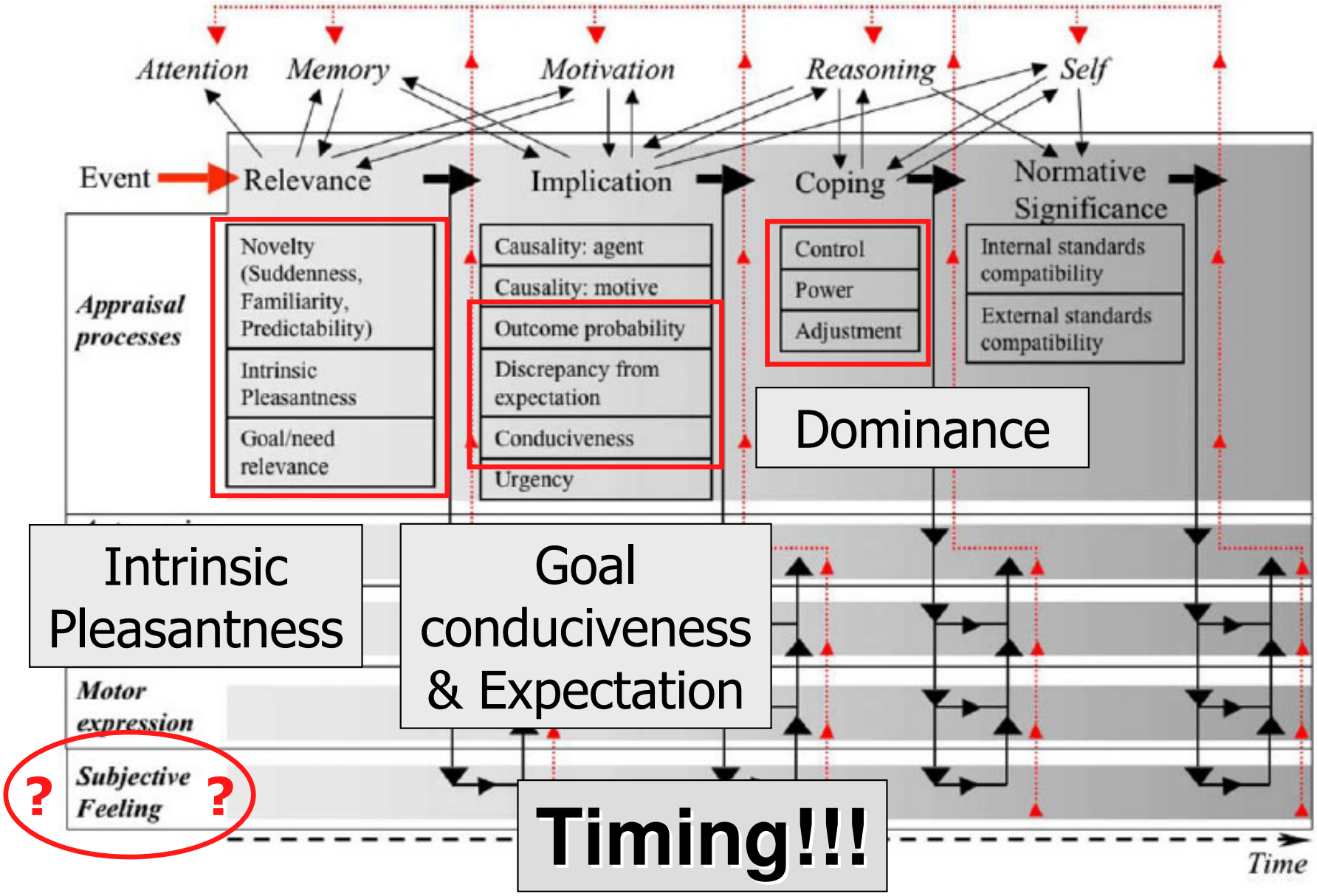
II. a) Affect & Proto-Affect (Ortony et al., '05)

- 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)



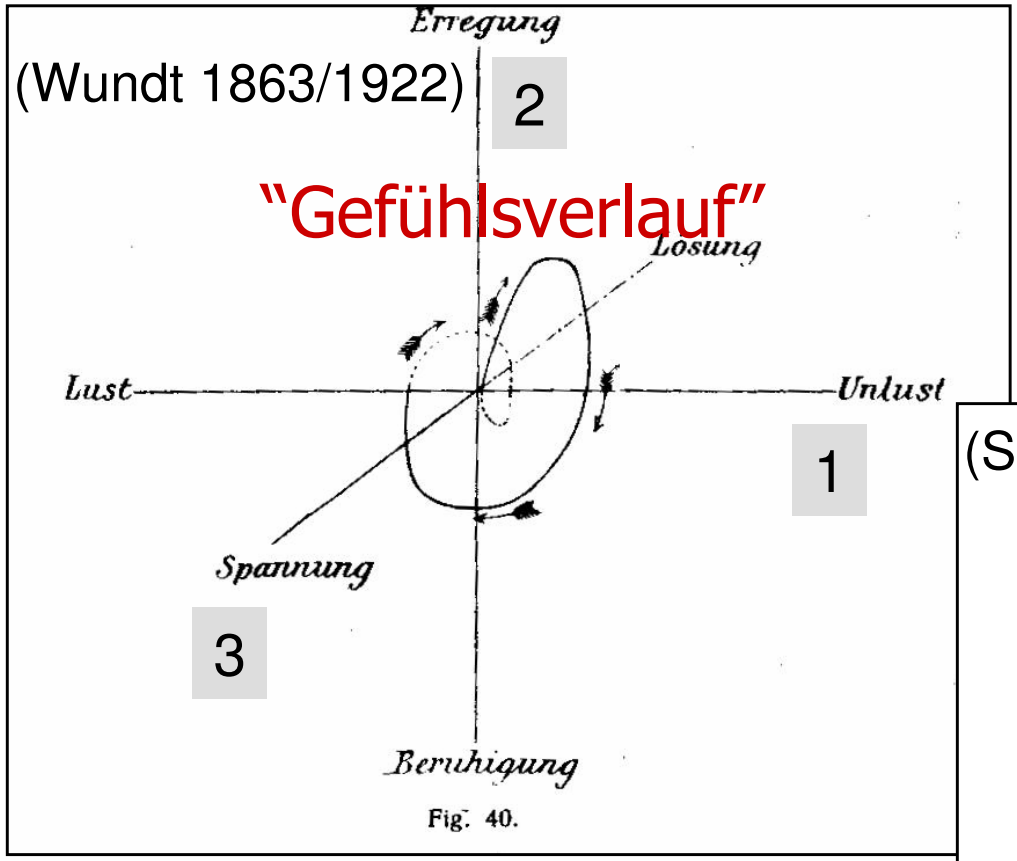
II. a) Component Process Model (Scherer ´06)



II. b) Dimensional theories of emotion

Describing the "diffuse feeling state"?

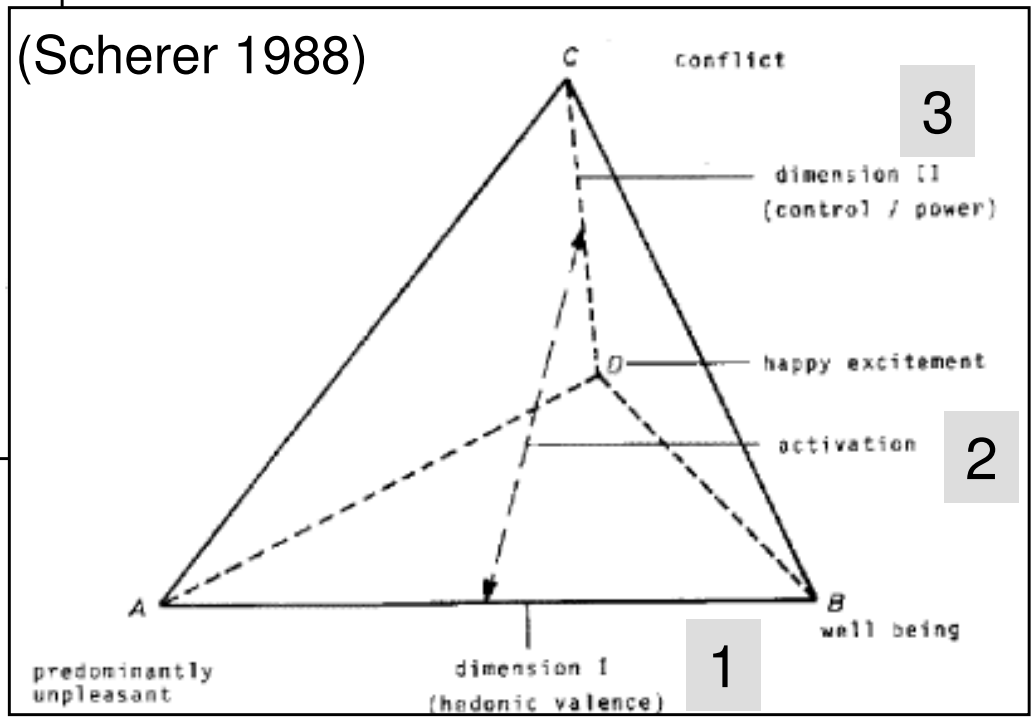
(Wundt 1863/1922)



Mostly three dimensions:

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

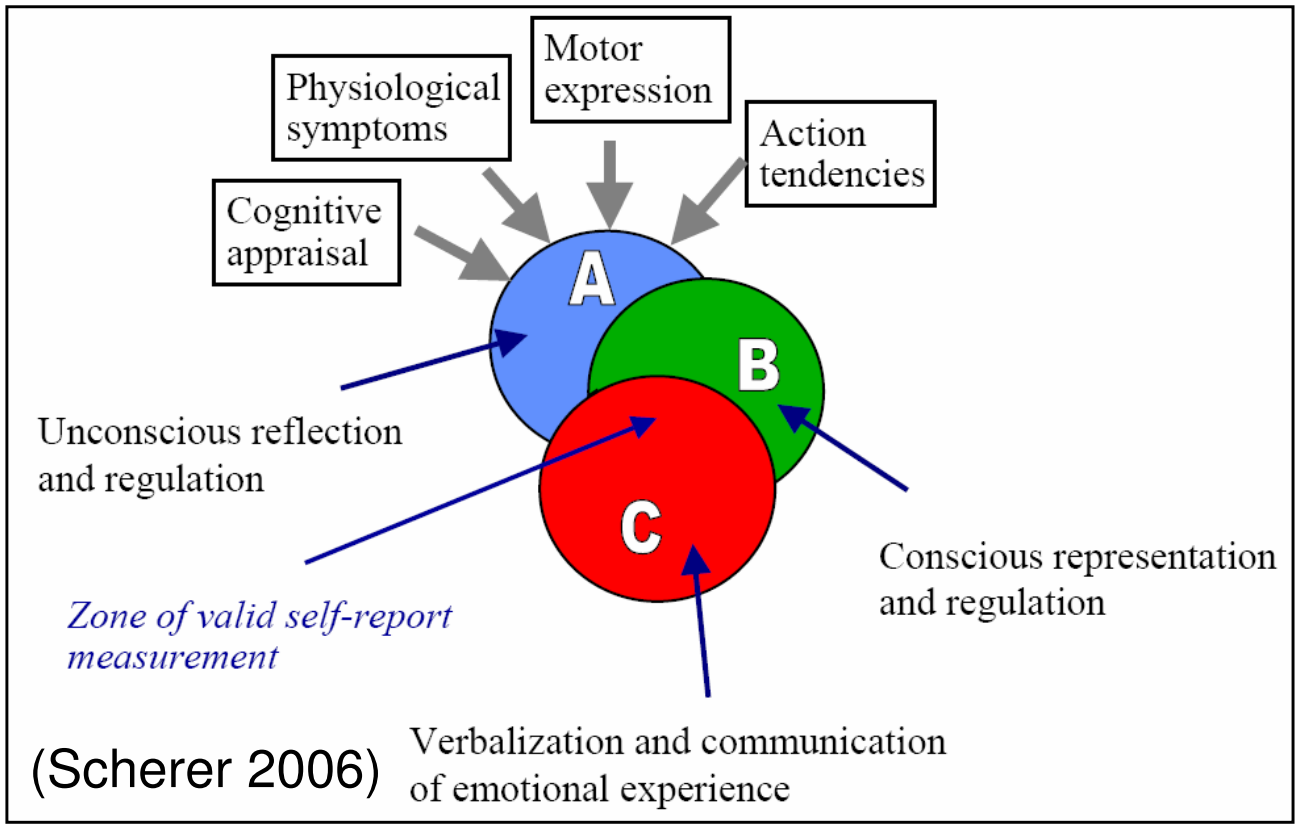
(Scherer 1988)



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

II. b) Conscious vs. non-conscious

The verbalization problem:



(Scherer 2006)

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

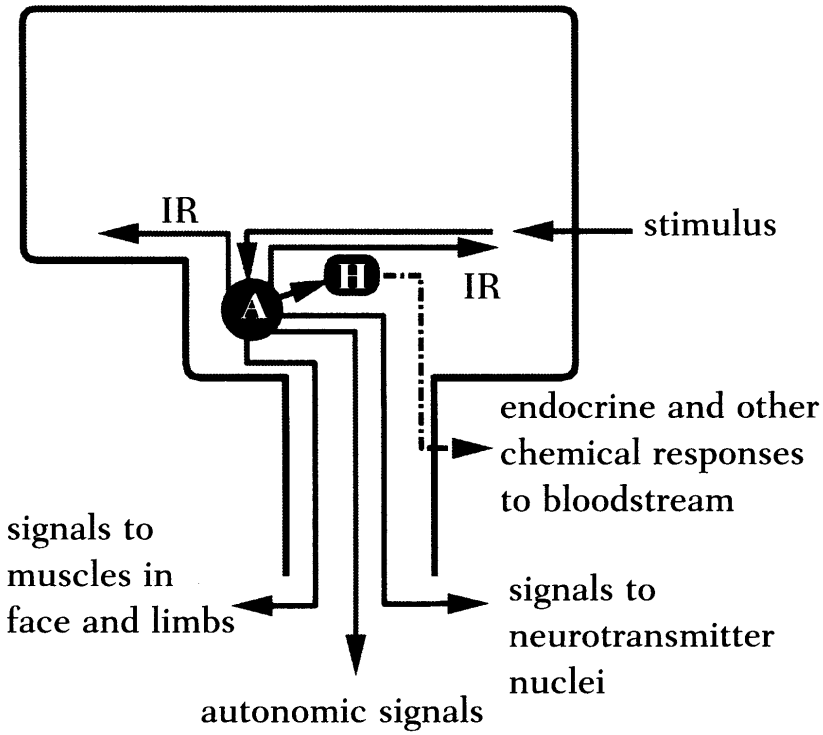
→ Zone of valid self-report measurement lies on top! (C)

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



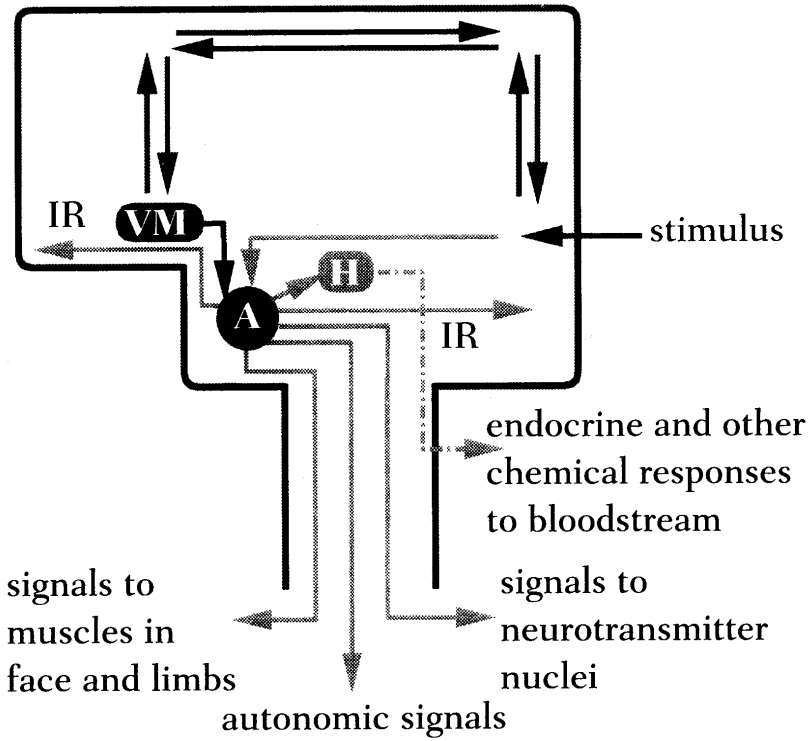
II c) Secondary emotions (Damasio ’94)

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!

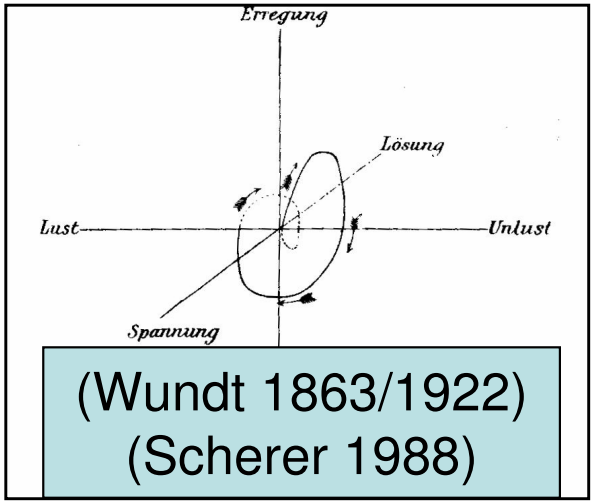


III. Implementation

a) Emotion dynamics simulation (Becker et al., 2004)
   - Implementing the "subjective feeling state" grounded in the Physis of the virtual human.

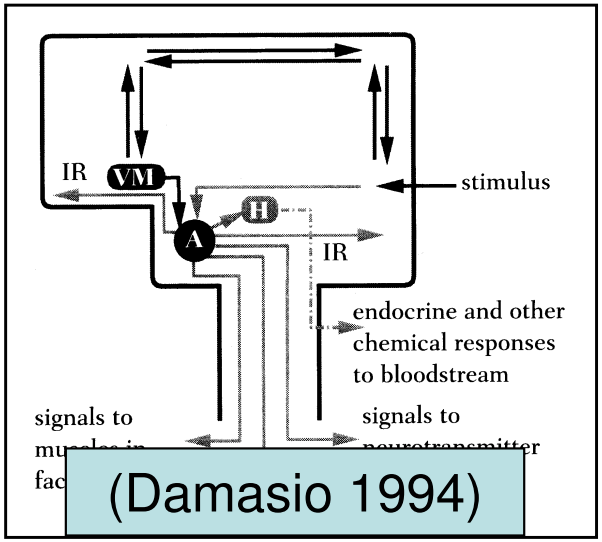
b) Non-conscious and conscious appraisal (Becker et al. 2006)
   - Non-conscious appraisal based on "intrinsic pleasantness" (Scherer 2001) & proto-affect (Ortony et al. 2005)
     → Primary emotions
   - Conscious appraisal based on BDI-based reasoning about "goal-conduciveness" (Scherer 2001)
     → Secondary emotions

"Gefühlsverlauf"



(Wundt 1863/1922)
(Scherer 1988)

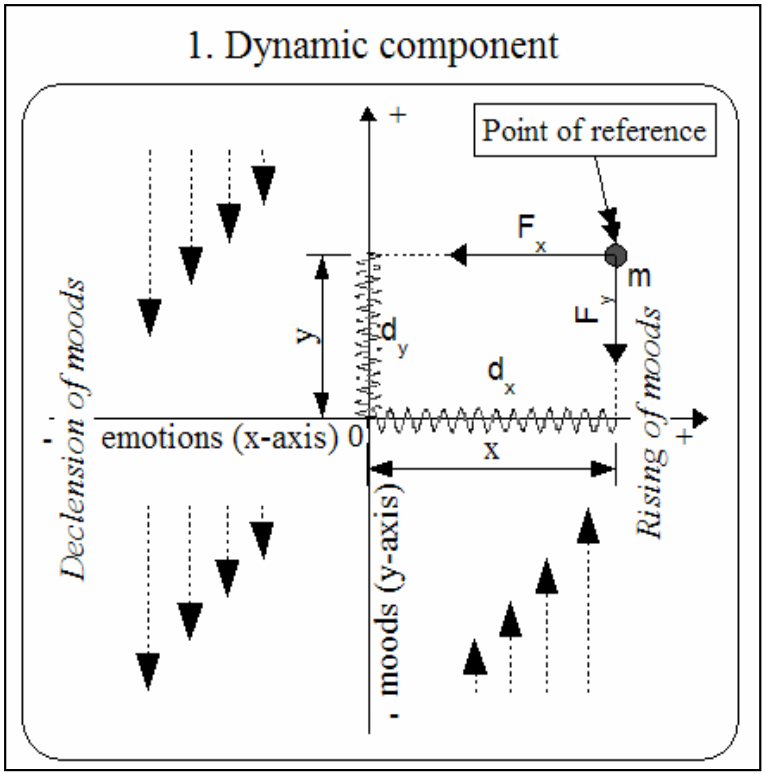
"Secondary emotions"



(Damasio 1994)

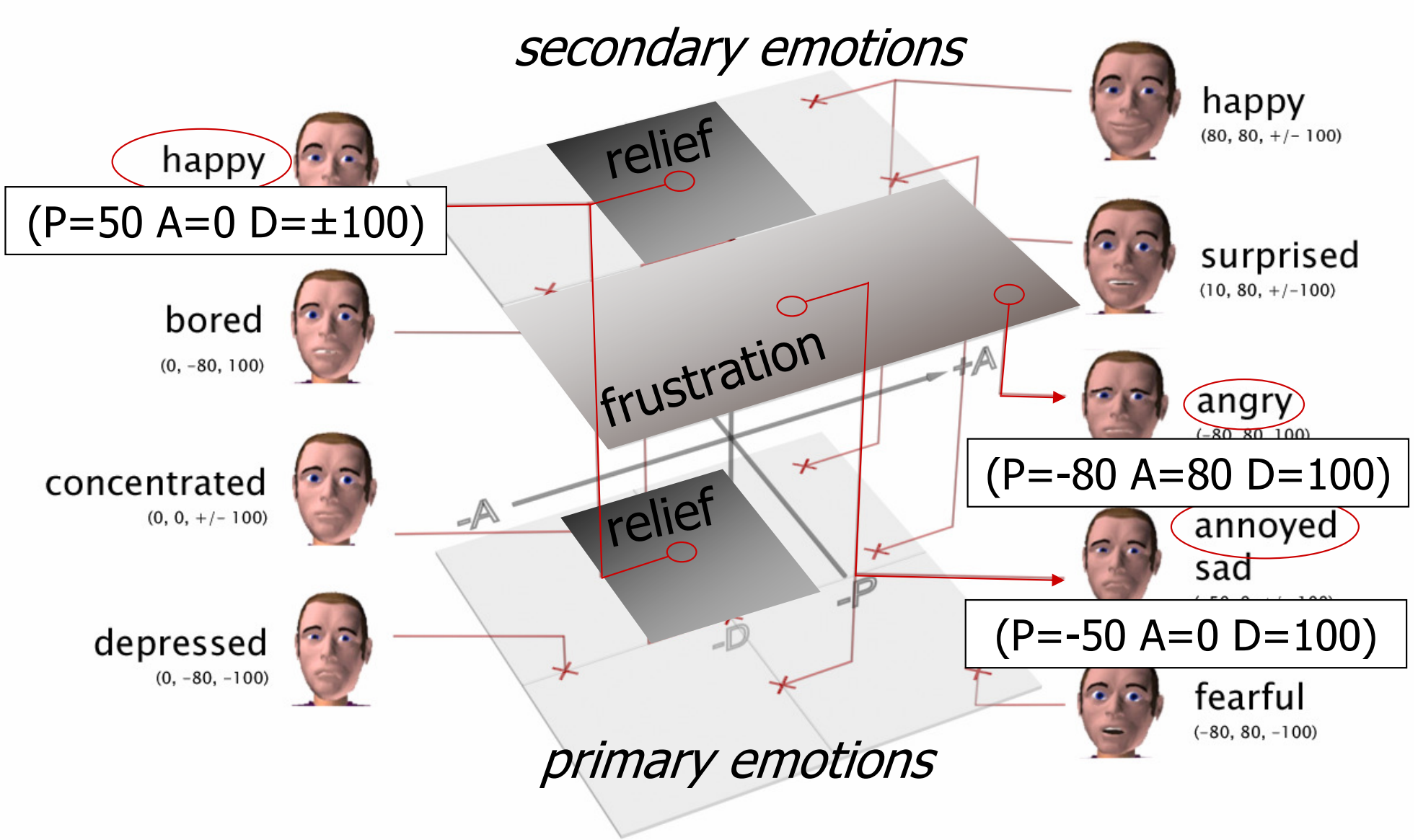
III. a) Emotion dynamics simulation

- 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

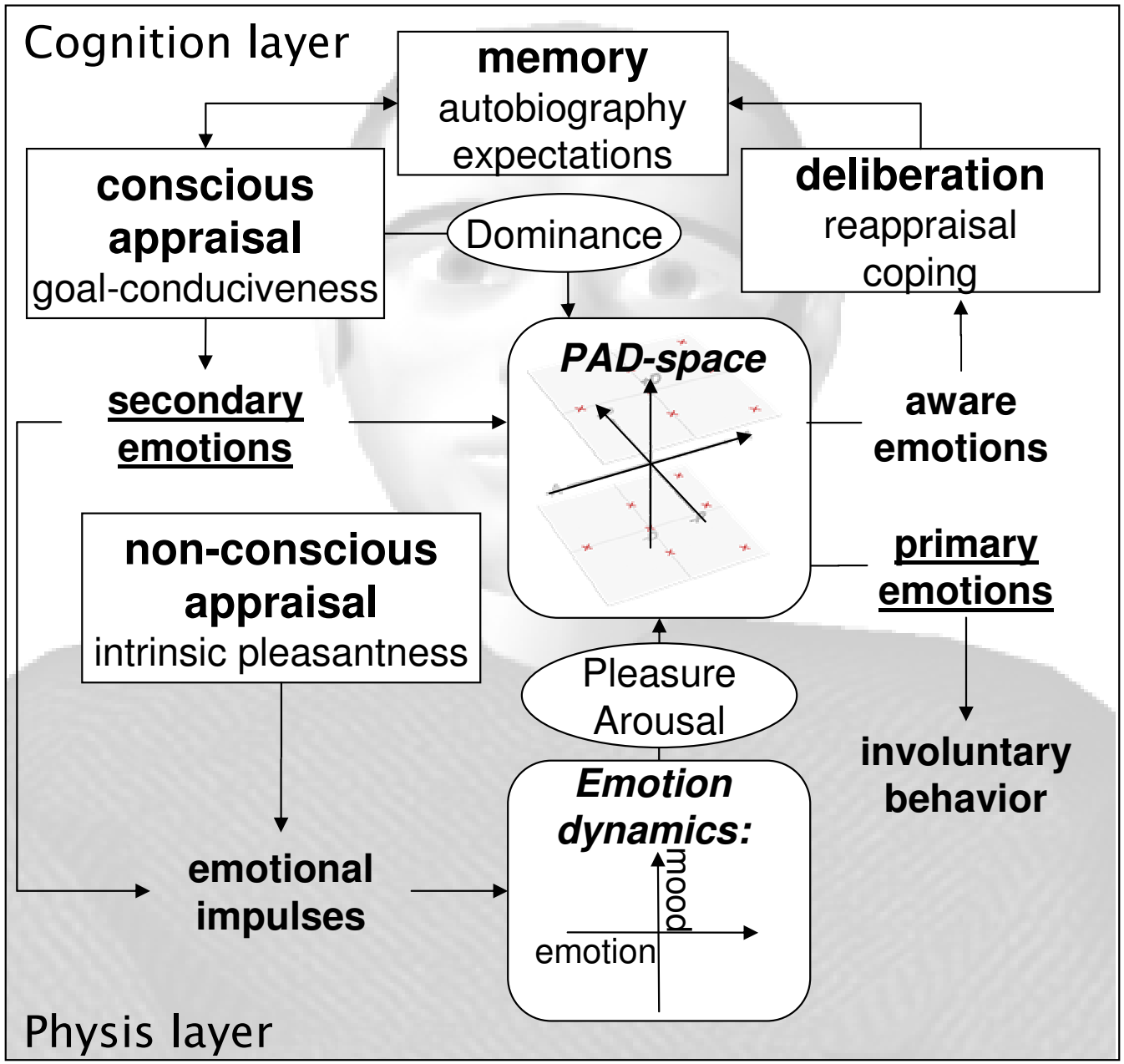


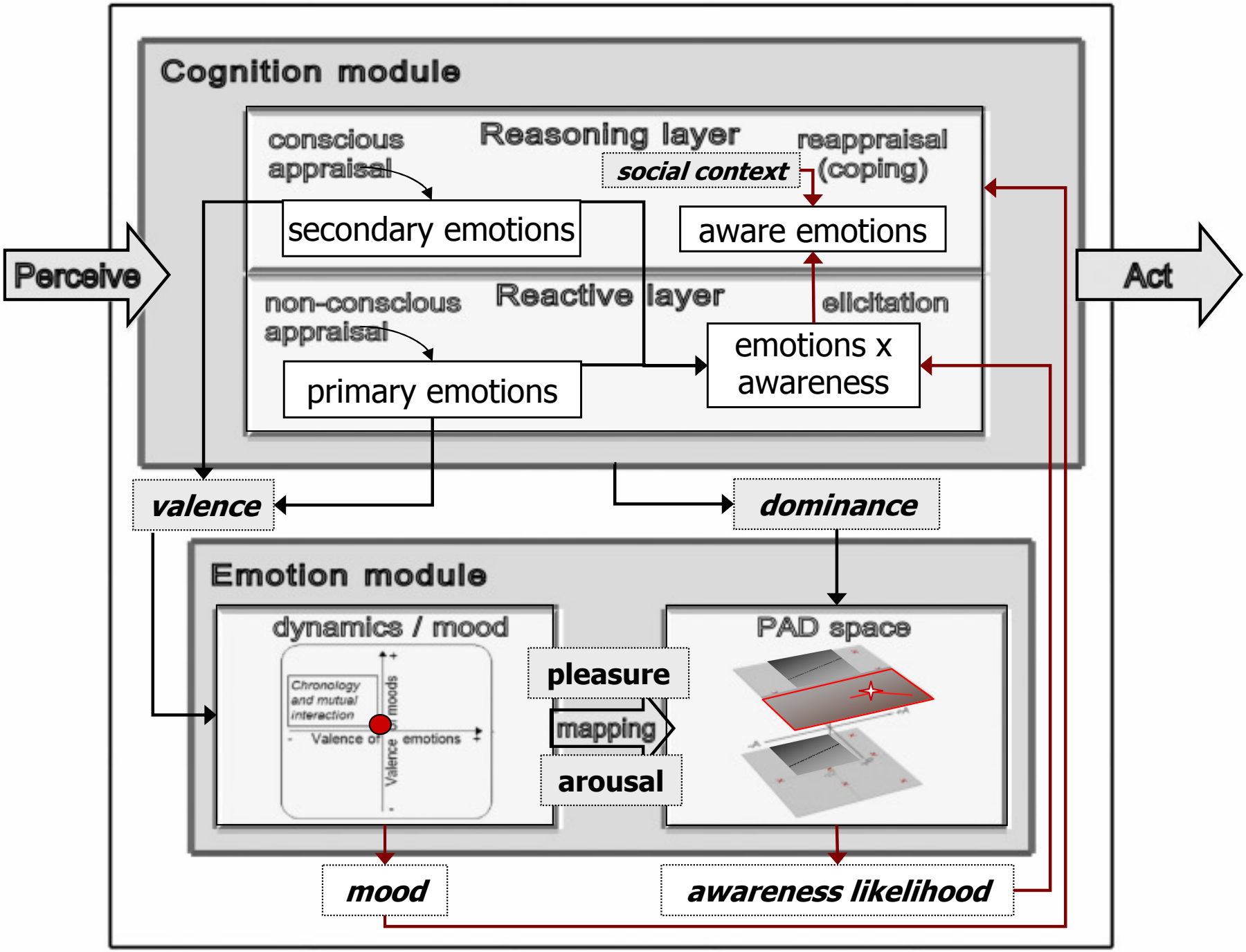
→ Assuring mood-congruency of emotions

III. a) PAD-space

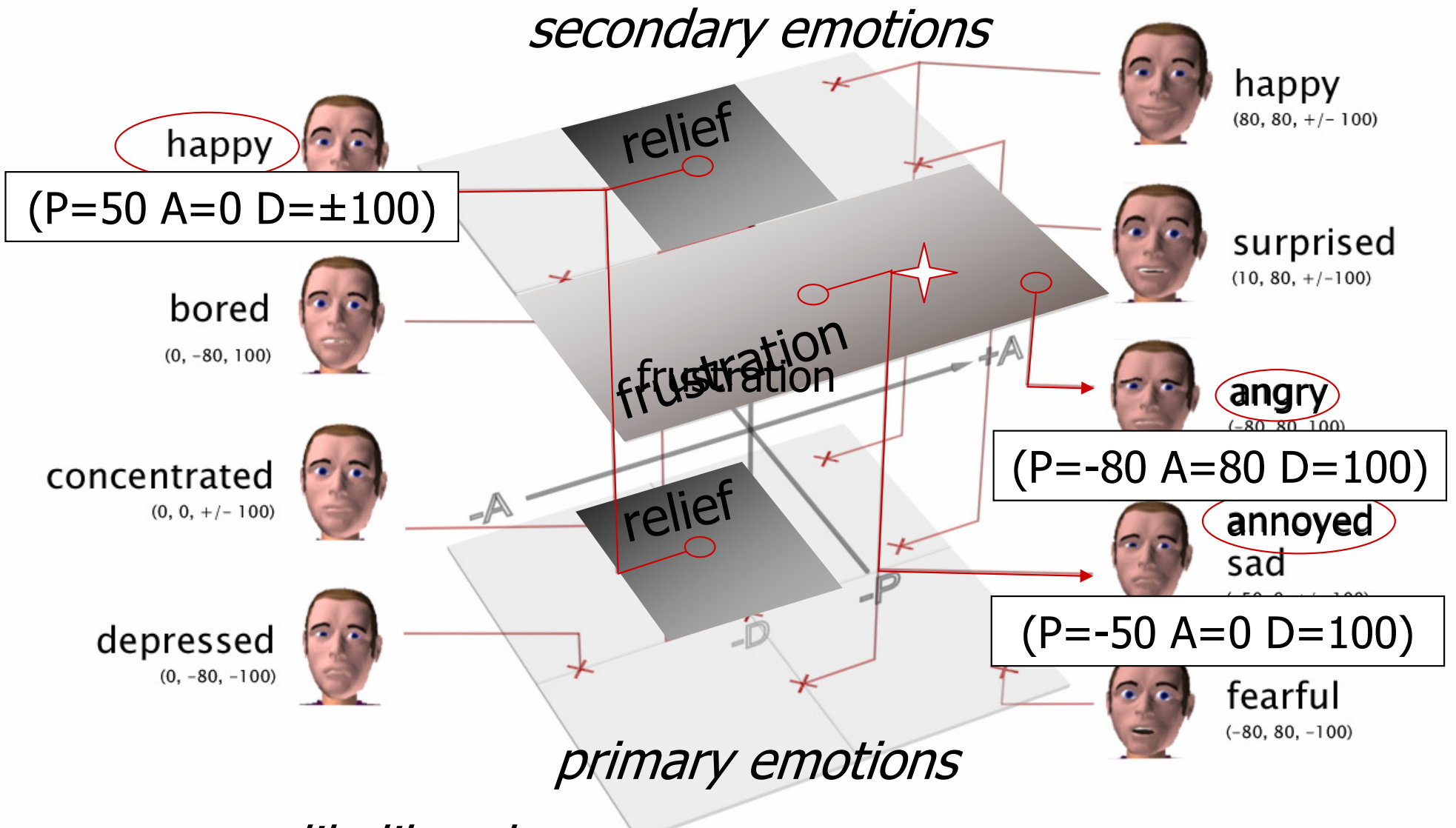


III. b) Non-conscious & conscious appraisal




Cognition module
conscious appraisal
Reasoning layer
reappraisal (coping)
social context
secondary emotions
aware emotions
Perceive
Act
non-conscious appraisal
Reactive layer
elicitation
primary emotions
emotions x awareness
valence
dominance
Emotion module
dynamics / mood
PAD space
Chronology and mutual interaction
Valence of moods
Valence of emotions
pleasure
mapping
arousal
mood
awareness likelihood

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?

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

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