Affective Computing for Intelligent Agents

Introduction to Artificial Intelligence

CIS 4930, Spring 2005

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Affective Computing

- Affect:
  - *phenomena manifesting itself under the form of feelings or **emotions***
- Affective computing:
  - *Where computers take into account that users have emotions*
  - *… computers exhibit **emotions***

Motivation

(Picard)

- Picard (founder):
  - *"… if we want computers to be genuinely intelligent, to adapt to us, and to interact naturally with us, then they will need the ability to recognize and express emotions, to have emotions, and to have what has come to be called 'emotional intelligence'."*

Motivation (cont.)

(Picard)

- Emotion is essential for
  - Rational decision making
  - Learning
  - Perception
  - Managing sets of cognitive functions

Related Definitions

- Human-computer interaction (HCI)
  - The study of interaction between people and computers
- Human-robot interaction (HRI)
  - The study of interaction between people and robots

Related Definitions

- Social informatics
  - The study of information and communication tools in a social and cultural context
- Emotional intelligence
  - A kind of intelligence that involves the ability to perceive, assess, and influence one's own and other's emotions

Applications
(Breazeal, Murphy)

- **Facilitate collaboration between humans and agents**
  - Make interactions more natural (see Nass)
  - Make interactions more enjoyable
  - Enable social learning (Remember Breazeal?)

Applications
(Breazeal, Murphy)

- Simplify design and control of complex agents
  - Emotions as Performance Monitor (and feedback)
  - Sorting out among multiple processes
    - Knowing what matters
    - Knowing what action to try
    - Correcting errors and recognizing successes

Example: Human-Robot Interaction

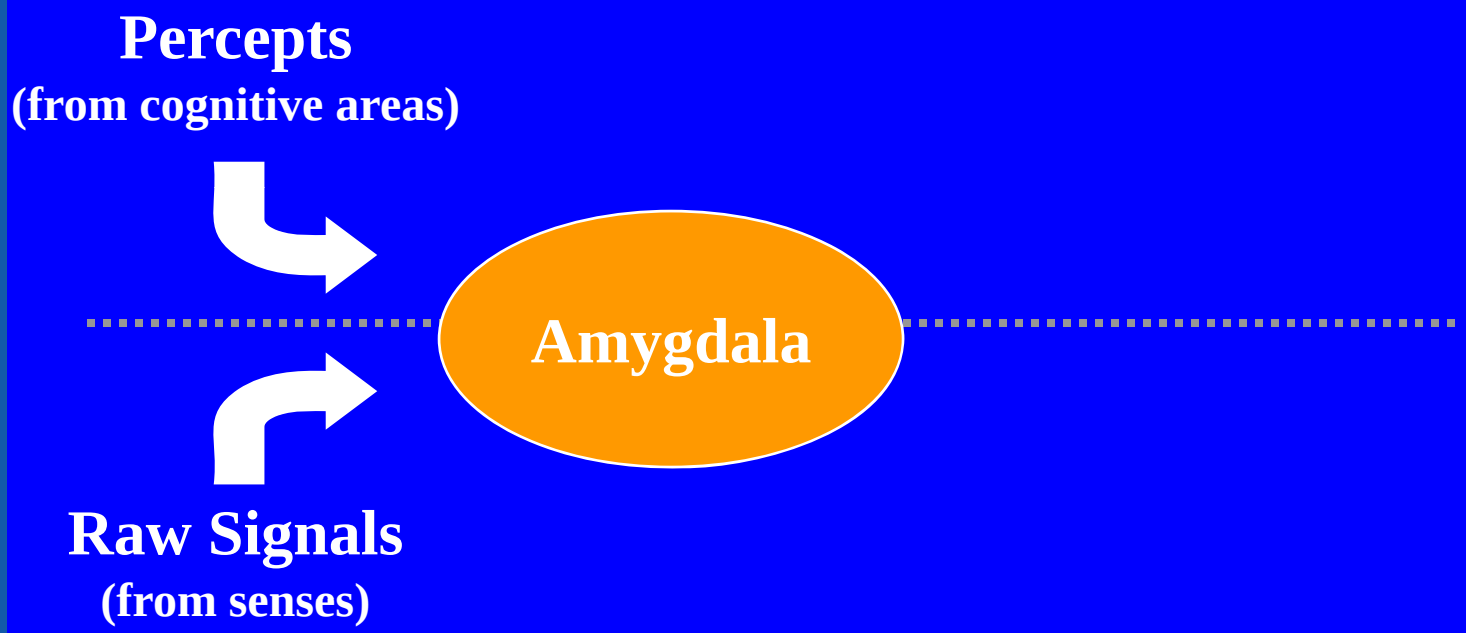
- Robots often have to team with people or work in close proximity

- Key questions
  - How to divide up responsibilities or roles?
  - How to change them dynamically?
  - How do people like to interact with robots?
  - How do they interact most effectively?
  - Do robots and people need to “understand” each other (e.g., have a shared cognitive model)?

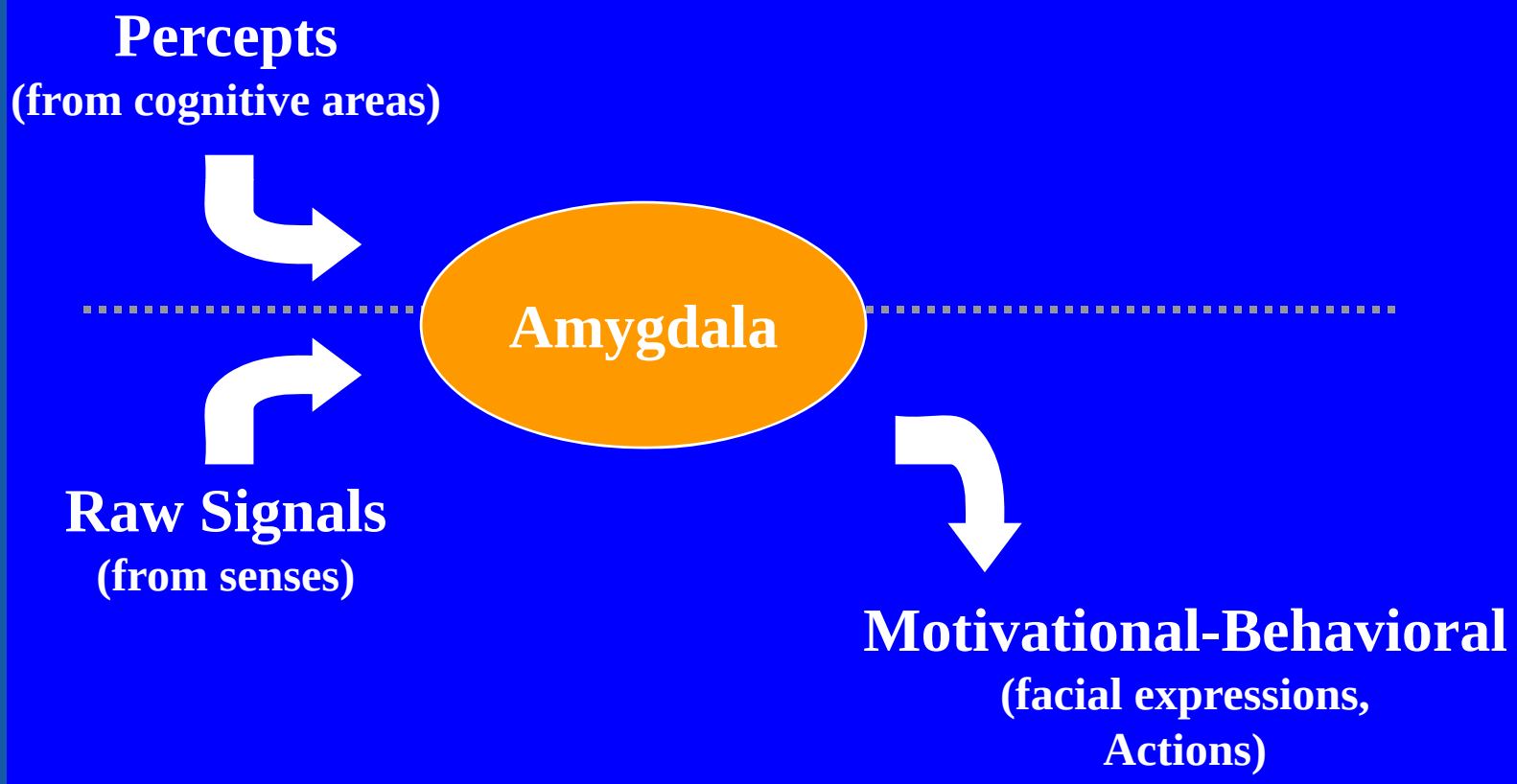
Emotions: Appraisal Mechanism

- *A mechanism for adapting to the world*
  - Unconscious information processing of stimulus significance
  - Leads to a conscious, subjective experience
- Ex., fear
  - See a predator, start running
  - Later, say “I felt scared”
- Ex. Steadfast in cold
  - Reflex is to find shelter
  - Emotions help adapt, overcome reflex

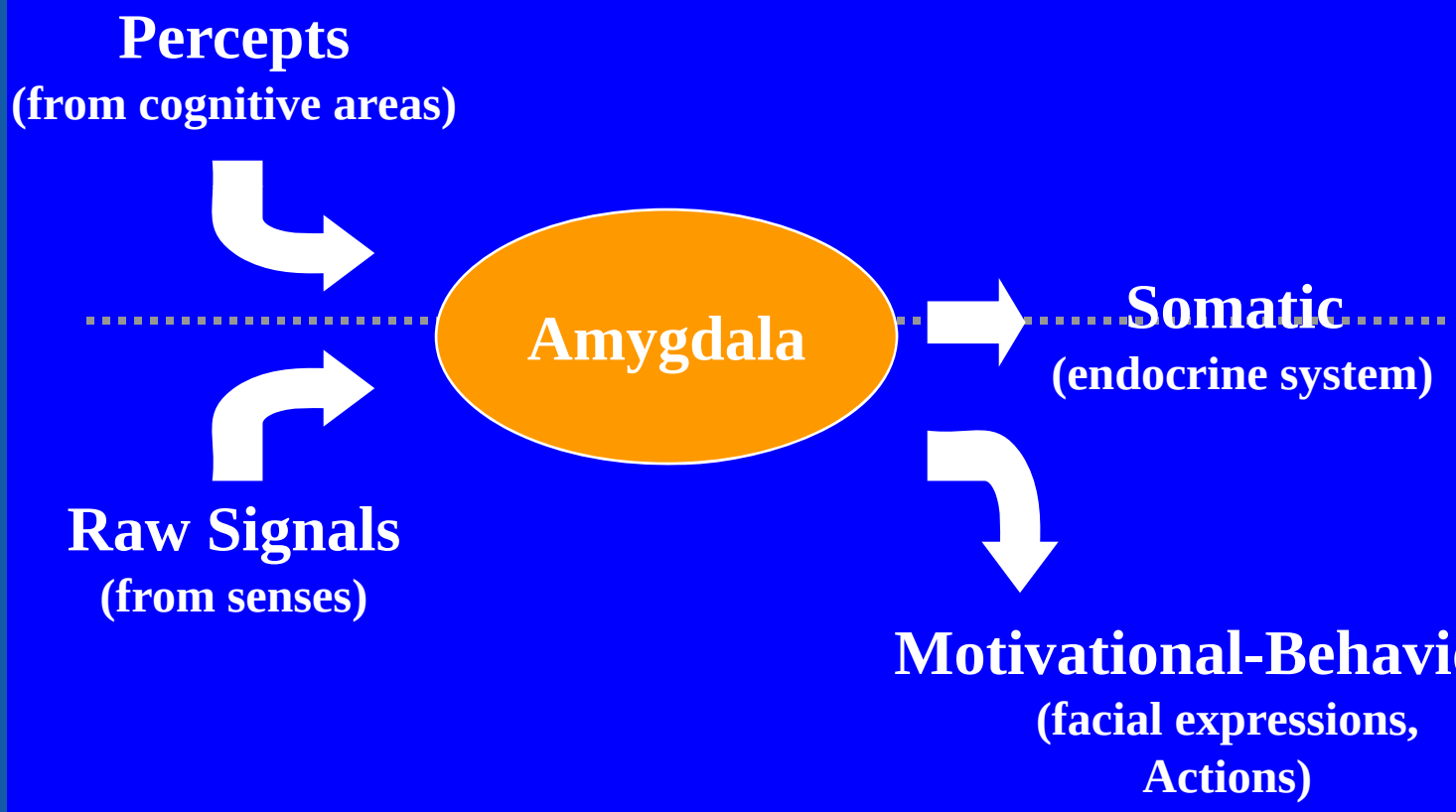
A Simplified Neurological Model
(Scherer, Ortony)



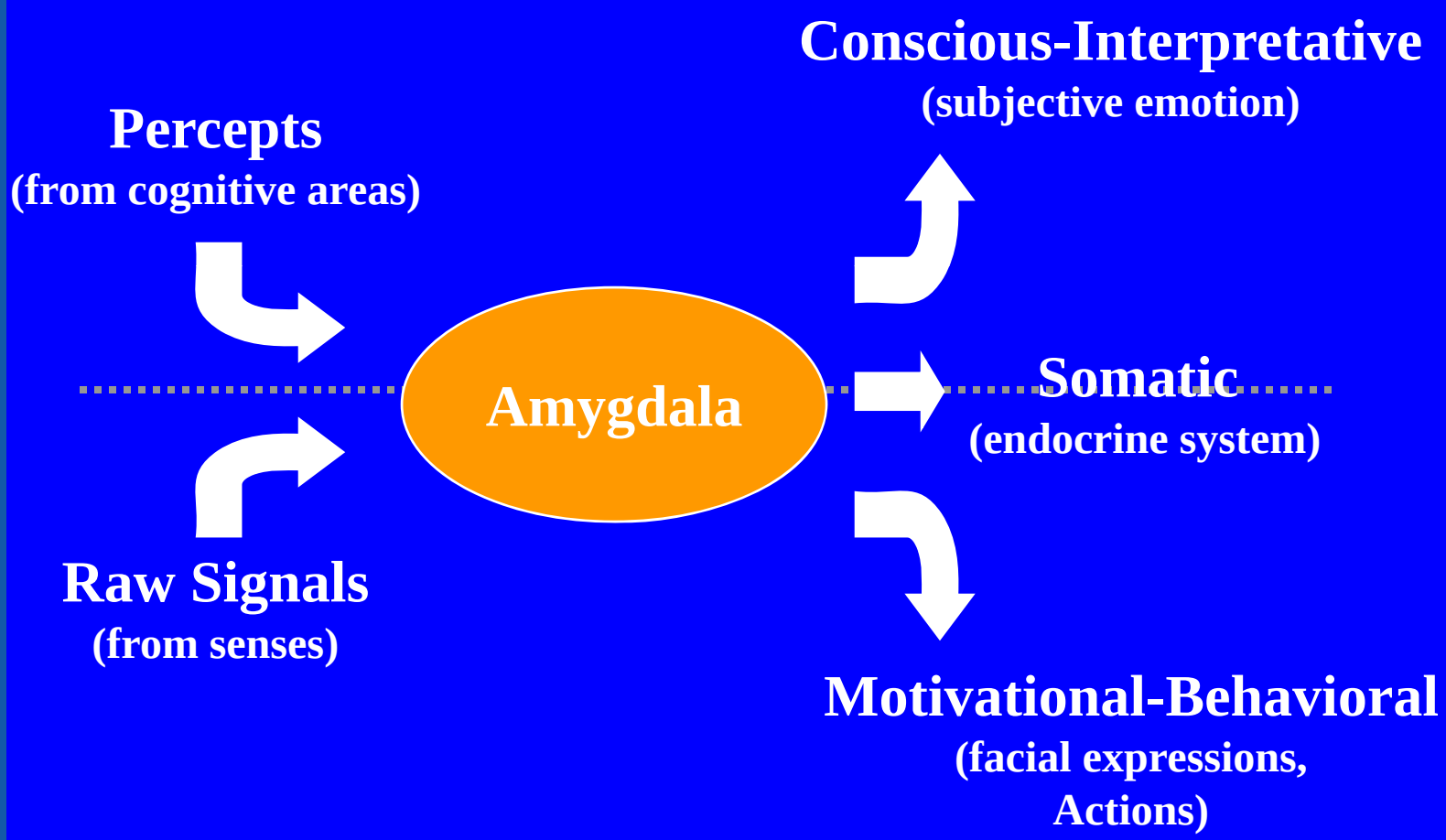
Can Rapidly Change Behavior



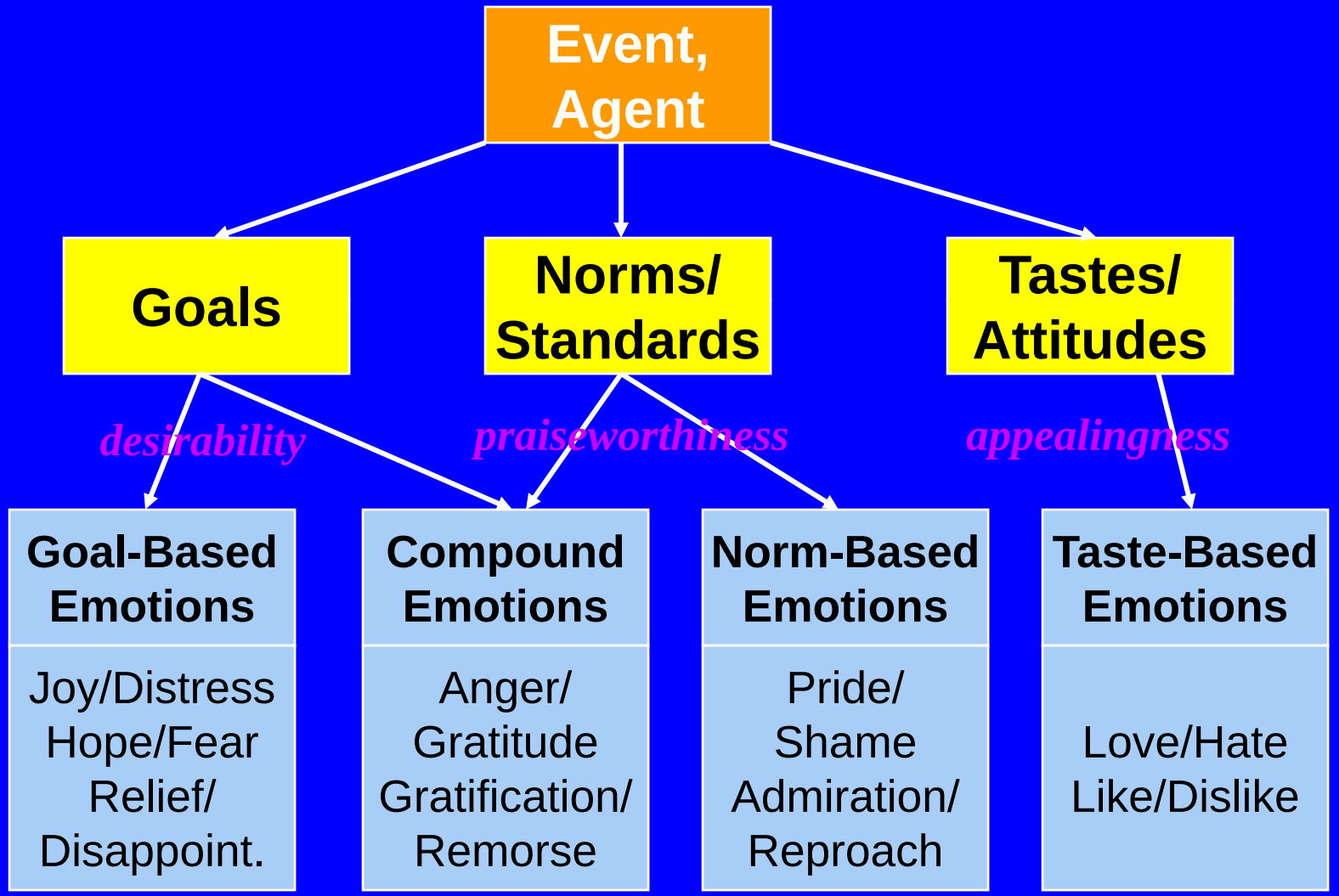
Can Cause a Physiological Response



Can Lead to a "Feeling"



Appraising What? *(Ortony)*



Subjective Nature of Emotions

- "Fuzzy" subjective experience
- More of a spectrum than a single state
  - Joy/distress
  - Hope/fear
- This spectrum can be broken into
  - Valence (where it is on the positive or negative side of the spectrum)
  - Intensity (what the value is: a little? A lot?)

Social Expression
(Breazeal)

- We show emotions to
  - Share control between agents
    - Taking turns
    - Expressing intent
    - *Does this require a shared cognitive model?*
  - Invoke a response
    - Communicate intent and confirm message was sent and received

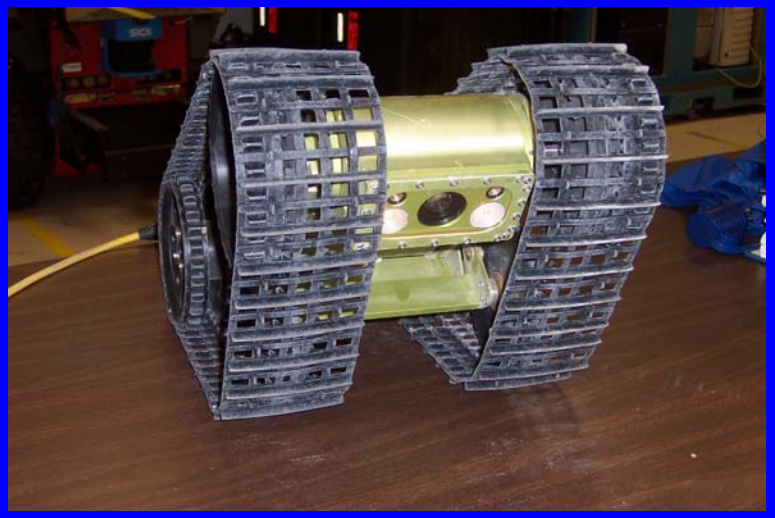
Bodemotes Research
(Bethel)

Research Questions:

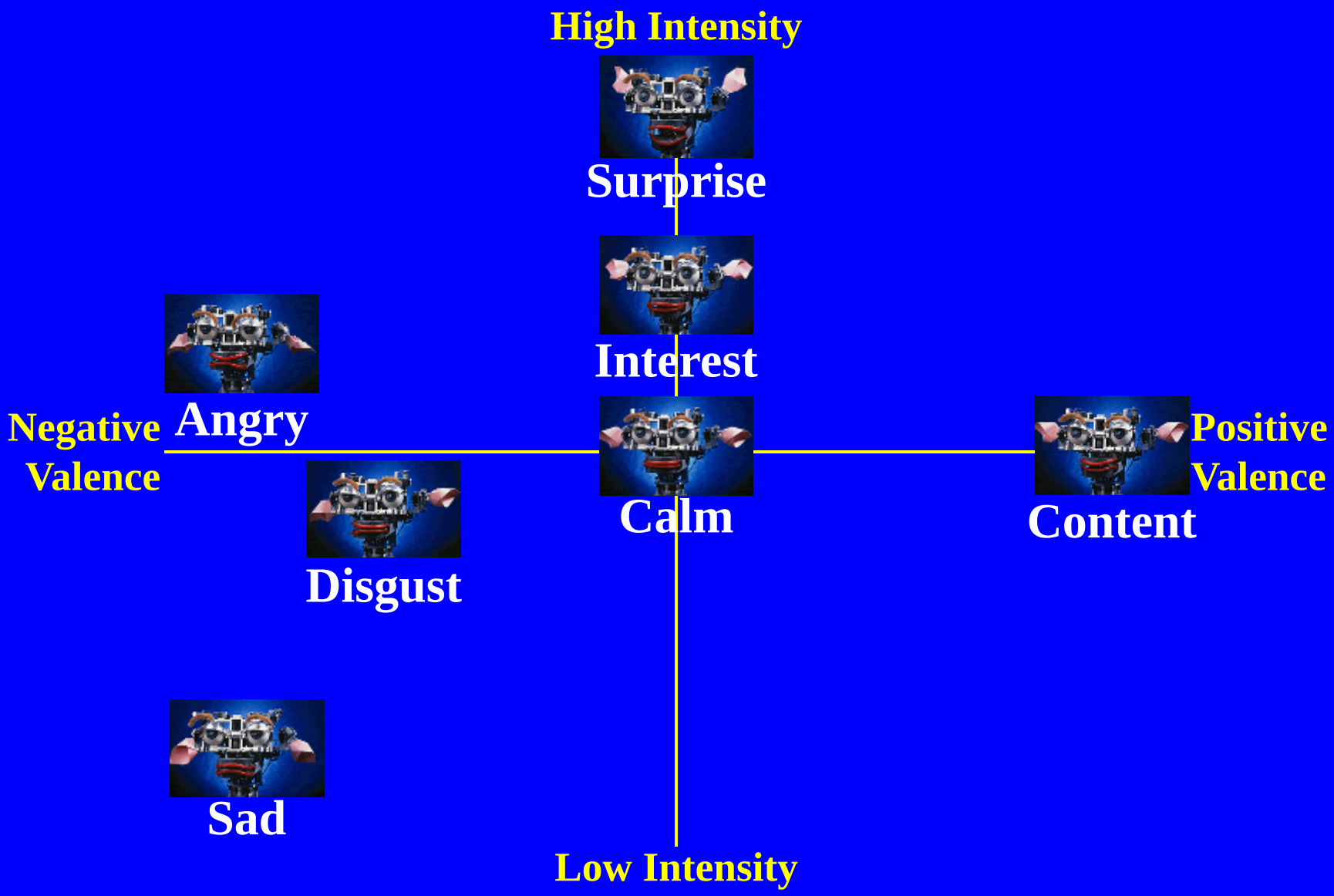
- Can a robot without a face display affect to human observers?
- What kinds of inputs can be used to determine an emotional output?
- How do we display emotion without the use of a face?

Bodemotes Research (cont'd)
(Bethel)






Breazeal: Kismet



From: http://www.ai.mit.edu/projects/sociable/facial-expression.html

Multilevel Process Theory of Emotions
(Leventhal and Scherer, 1987)

Failure to make progress on tasks/goals changes emotional state which then produces multilevel response

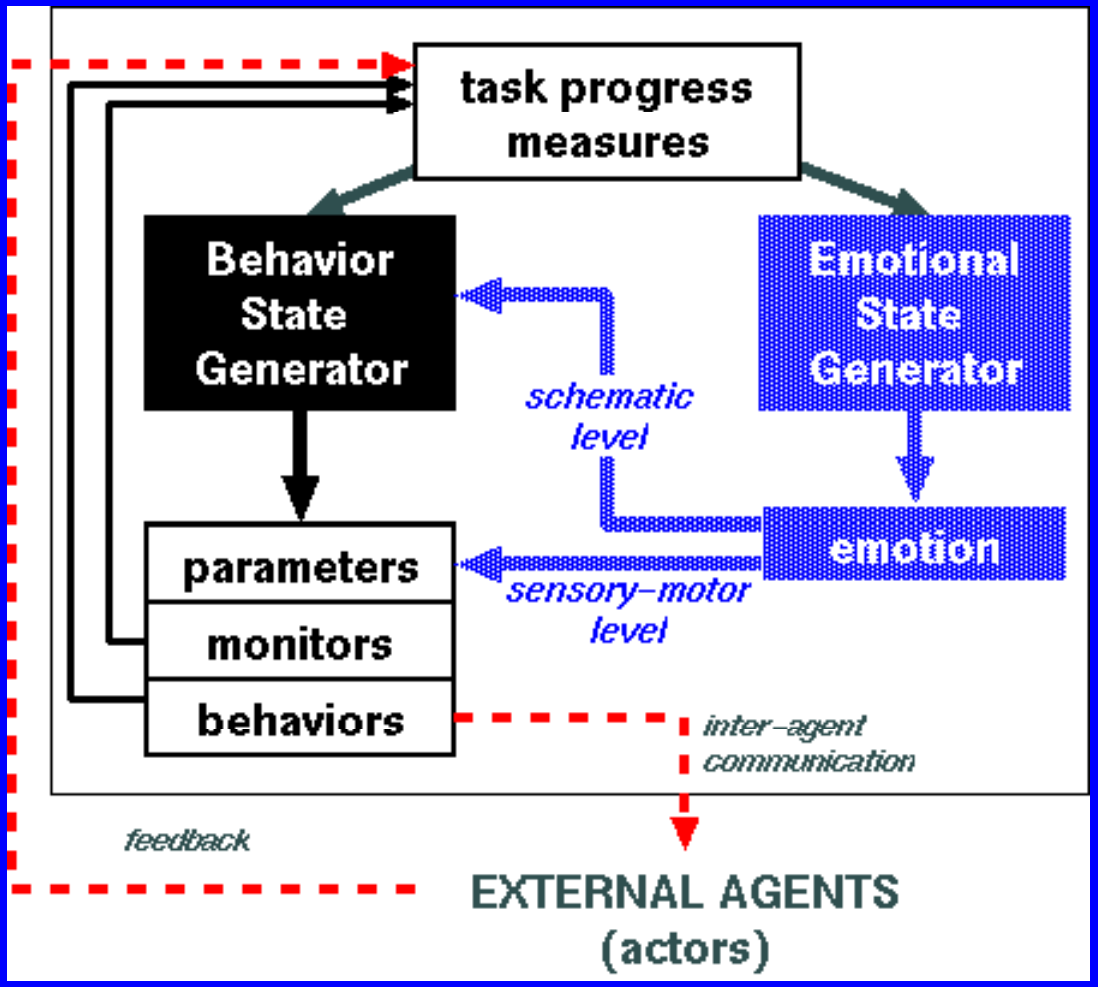
Levels: Emotional Processes

- **Sensory-motor**
  - Sensed or internal events produce emotion which changes an agent's behavior
  - Example: pain causes an aggressive response
- **Schematic**
  - Emotions control which behaviors are active through prototypical schemas
- **Conceptual**
  - Agent reasons about emotions and projects into the future

Case Study of Multi-Process Theory: USF Waiters

- Hors D'euvres Anyone? Event
  - Cover the most area while serving food at a reception
  - Fully autonomous
  - Interact with humans
- Approach
  - Two robots, one with more sensors than the others
  - Sensor-endowed robot is **waiter** because can interact with people better
  - Less-endowed robot acts as a **refiller**, bringing trays upon request to maximize coverage by waiter
  - *1999: people trapped refiller (deadlock)*

With Emotions



ESG uses a FSA to provide feedback: sensory-motor level "tweaks" parameters, while schematic level triggers alternative instantiations (escalating behavior)

The set of possible behaviors remains the same, but the activation and dynamic adaptation make it more reactive and opportunistic

Results: Hurried Refill

- Claims
  - The Task Monitor has indicated a condition that requires the Refiller to hurry up.
  - Waiter sends a “Hurry” message to Refiller
- Demonstrates
  - Refiller has a *sensory-motor* level change affected by a change in ESG (speeds up).

Results: Intercept

- Claims
  - Waiter has a *Schematic* level change, e.g. SERVE to INTERCEPT.
  - Task Monitor recognizes the "condition" that the Refiller is not going to arrive in time to avoid the Waiter having to wait without the required resource.
  - This "condition" leads to the Emotional state change.
- Demonstrates
  - Emotional state change from *Concerned* to *Frustrated* causes Waiter to have a *schematic* level change.
  - This modification of behavior proactively avoids deadlock situation

Results: GoHome

- Claims
  - Waiter has a *Schematic* and *Sensory-motor* level changes in response to *Anger*.
- Demonstrates
  - Waiter experiences *Anger* when Refiller is unable to successfully complete its assignment. Waiter essentially ‘fires’ the Refiller. Changes from SERVING to GOHOME.
  - Waiter avoids deadlock by completing resupply itself.
  - Waiter travels at the fastest speed possible.

Emerging Applications

- Games and interactive web-bots
  - "Uncanny valley"
  - Creating believable behavior

Lifelike human model by Andrey Kravchenko

Humanoid robot developed by Dr. Hiroshi Ishiguro

Review Questions: Affective Computing

- Define affective computing
  - *Where computers take into account that users have emotions*
- What is HRI?
  - *How humans and robots interact with each other*
- Give two uses of affective computing in artificial intelligence.
  - *Control or self-regulation*
  - *Naturalistic interfaces*
- Can you have an emotional response without being conscious of it?
  - *Yes*

Review (Cont.)

- What is valence and intensity of an emotion?
  - *Valence is where the affect is on the emotion's spectrum*
  - *Intensity is how strong the emotion is*
- What are the four types of emotions in the neurological model (Scherer and Ortony)?
  - *Goal-based, compound, norm-based, and taste-based*
- What are the three layers of the multi-level process theory of emotions?
  - *Sensorimotor, schematic, conceptual*

Review (Cont.)

- What did the following systems contribute in terms of emotions?
  - Kismet
    - Social interface
  - USF Waiters
    - Self-regulation, implementation of multi-process theory of emotions

Affective Computing

- Materials responsible for:
  - Lecture notes
- Assignments associated with this topic:
  - None
- Objectives:
  - Define Affective Computing
  - Describe why social informatics is important in intelligence