

Emotion and Artificial Intelligence

Emotional Robots?

Carlotta Pavese

12.03.13

Outline

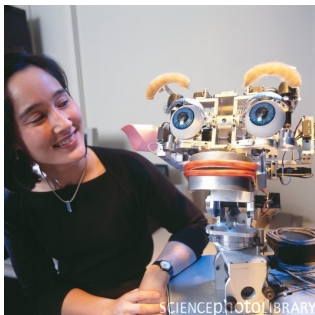
- 1 Introduction
- 2 Emotional Robots

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Cynthia Breazeal

Cast of Characters



- Sc.D. MIT, in EE and CS (2000)
- Associate Professor, Media Arts & Sciences MIT; Founder & Director of Personal Robotics Group at MIT Media Lab
- Author of 2 books, including *Designing Sociable Robots* (2001); 100+ articles
- National Academy of Engineering's Gilbreth Award
- *TIME* magazine's Best Inventions of 2008

Rosalind Picard

Cast of Characters



- Sc.D. MIT, in EE and CS
 - Professor of Media Arts & Sciences MIT; Founder & Director of Affective Computing Group at MIT Media Lab
 - Author of *Affective Computing* (1997); nearly 200 articles
-
- Largely responsible for starting field of Affective Computing
 - Fellow of the Institute of Electrical and Electronics Engineers (IEEE)

Summary of Damasio

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- Biological, evolutionary perspective on emotion

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- This allows the organism to **reliably** produce **complex behaviors** in **important circumstances**
- Emotion is thus a powerful mechanism for coping w/complex environment, scarce resources & high risks

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Damasio's Slogan (From Interview)

We are not thinking machines. We are feeling machines that think. (<http://youtu.be/Aw2yaozi0Gg>)

Damasio and Emotions

Implications for Research on Emotional Machines

Emotional Machines

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- In building emotional machines, focus on replicating **emotional induction, processing & reaction**
- Suppose we really are feeling machines that think, and part of feeling is perceiving emotional reactions
- Then even to understand how cognition works, we must simulate the embodied **emotional reactions** that pervade our interactions

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- **Leonardo** (the robot): http://youtu.be/ilmDN2e_F1c

Emotional Robots

The Road Map

- Human interaction relies heavily on emotion

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- By producing a robot w/emotional **and** cognitive systems, test ideas about how the two interact

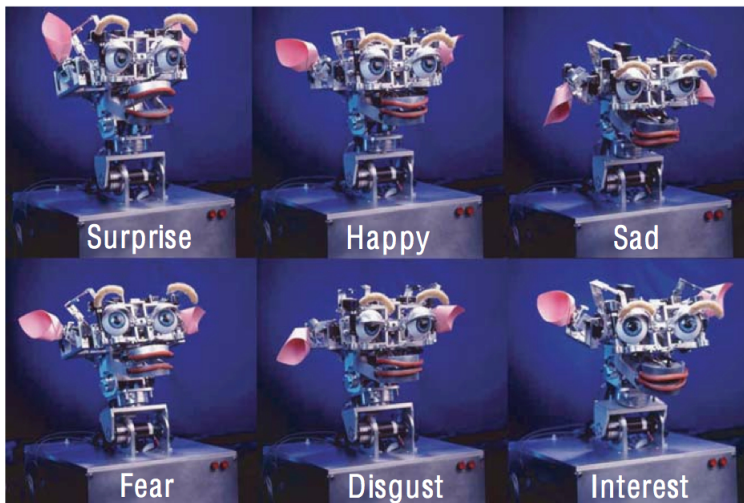
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- Let's look at Breazeal's robot Kismet

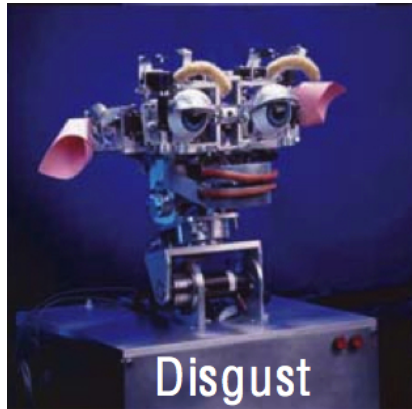
Meet the Many Faces of Kismet

Six Basic Emotions



The Many Faces of Kismet

Striking Resemblance: Disgust



The Many Faces of Kismet

Striking Resemblance: Sadness



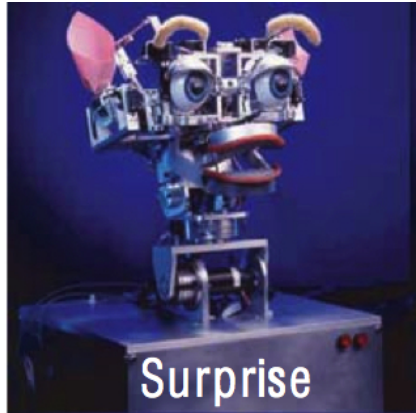
The Many Faces of Kismet

Striking Resemblance: Fear



The Many Faces of Kismet

Striking Resemblance: Surprise



The Psychology Behind Kismet's Faces

The Atoms of Facial Expressions

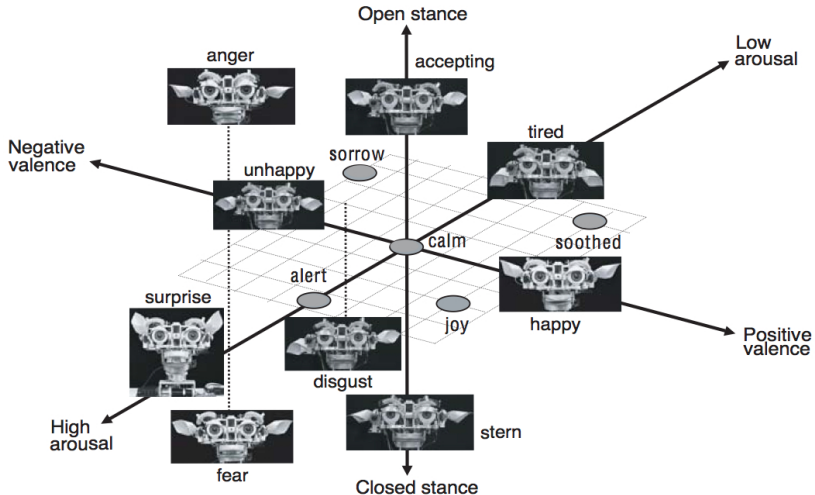
Table 10.1. A Possible Mapping of Facial Movements to Affective Dimensions Proposed by Smith & Scott (1997)

Meaning	Eyebrow Frown	Raise Eyebrows	Raise Upper Eyelid	Raise Lower Eyelid	Raise Lip Corners	Open Mouth	Tighten Mouth	Raise Chin
Pleasantness	↓				↑	↑	↓	↓
Goal obstacle/discrepancy	↑							
Anticipated effort	↑							
Attentional activity		↑	↑					
Certainty		↓		↑		↑		
Novelty		↑	↑					
Personal agency/control		↓	↓			↓		

Up arrow indicates that the facial action is hypothesized to increase with increasing levels of the affective meaning dimension. Down arrow indicates that the facial action increases as the affective meaning dimension decreases. For instance, the lip corners turn upward as pleasantness increases and downward with increasing unpleasantness.

Kismet's Affective State

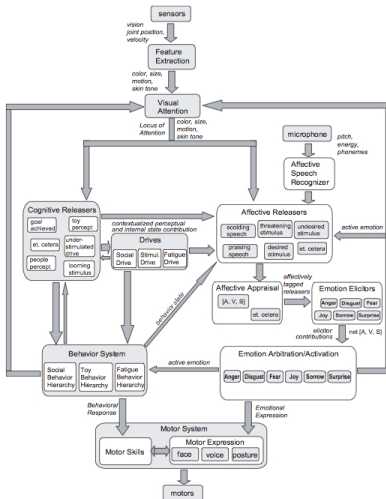
Three Dimensions



Kismet's Architecture

A Network of Specialists

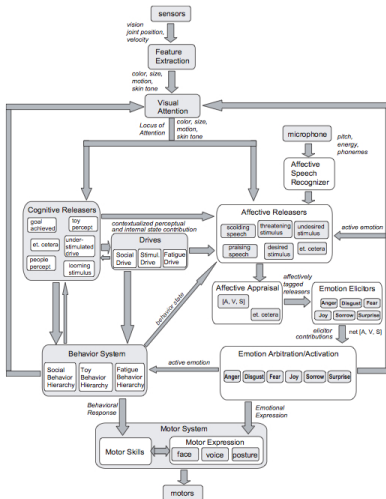
- Cognitive system (gray)



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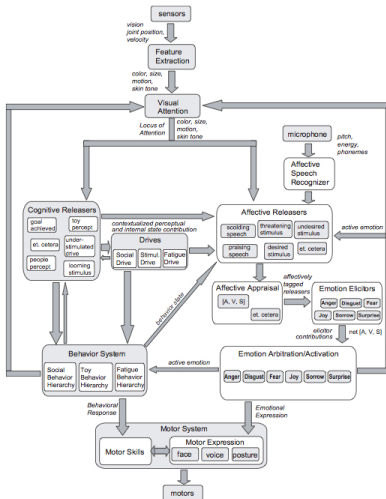
- Cognitive system (gray)
- Perception, drive, behavior & motor systems



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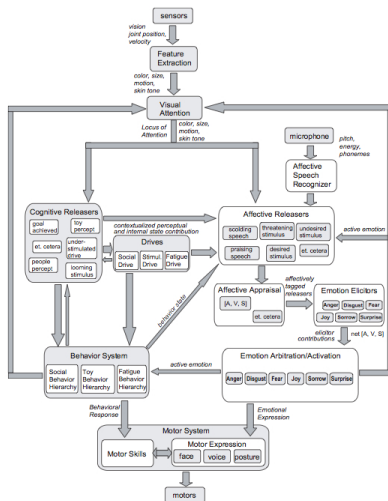
A Network of Specialists

- Cognitive system (gray)
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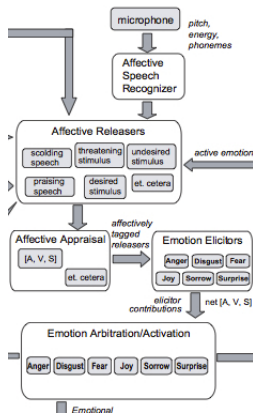


- Cognitive system (gray)
 - Perception, drive, behavior & motor systems
- Affective system (white)
 - Speech detection, categorization, evaluation, elicitation

Kismet's Architecture

In Focus: the affective architecture

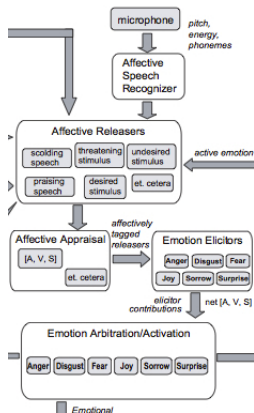
- Affective speech detection



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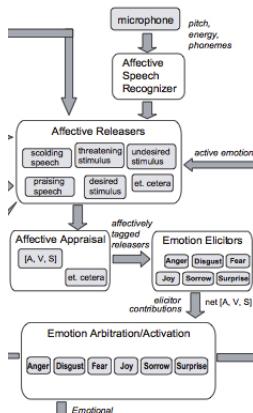
- Affective speech detection
- Affective categorization



Kismet's Architecture

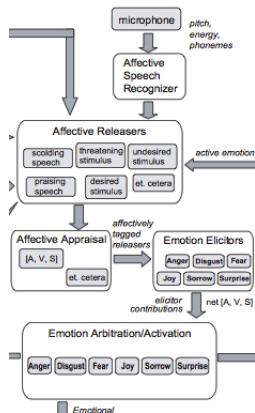
In Focus: the affective architecture

- Affective speech detection
- Affective categorization
 - Visual input too



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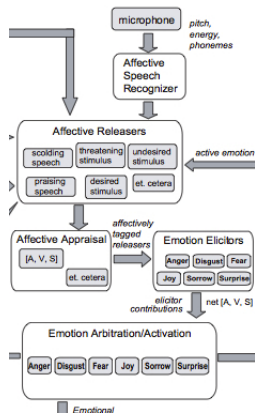
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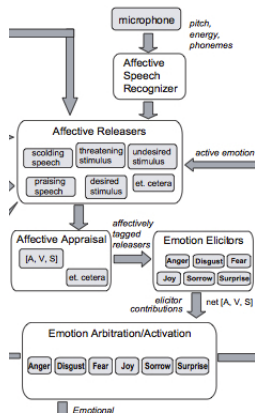
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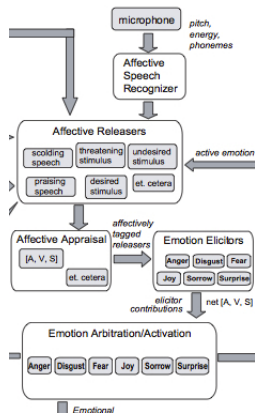
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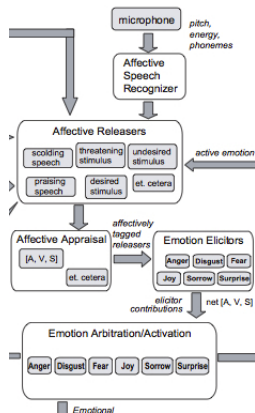
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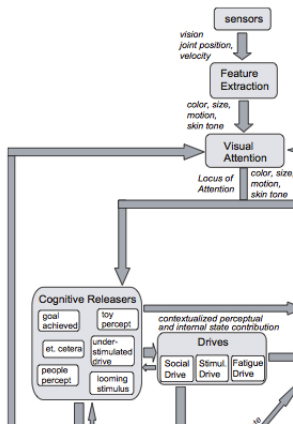


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- Emotion arbitration
- Output result to behavioral & motor systems

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In Focus: the cognitive architecture

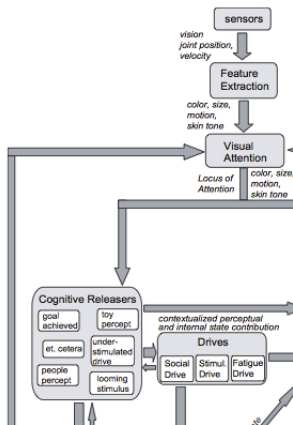
- Visual feature detection



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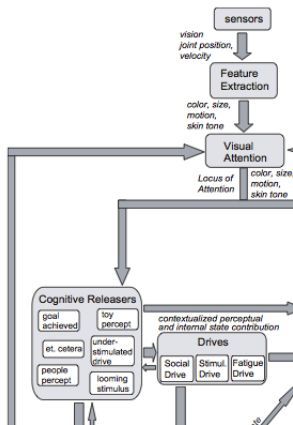
- Visual feature detection
 - Color, size, motion



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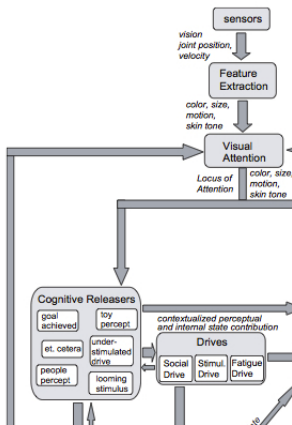
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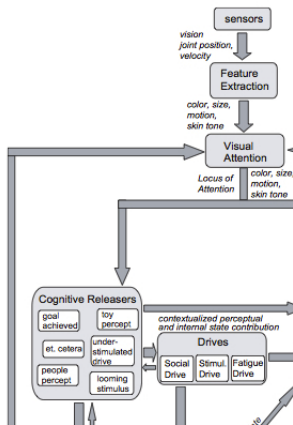
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 - Toy, people, boring thing, done

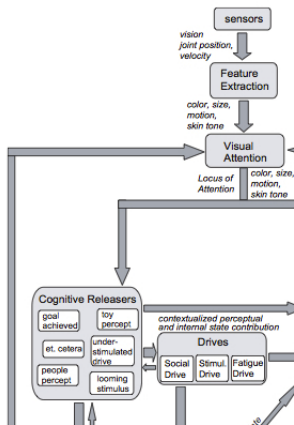
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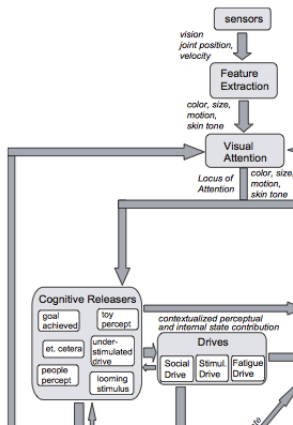
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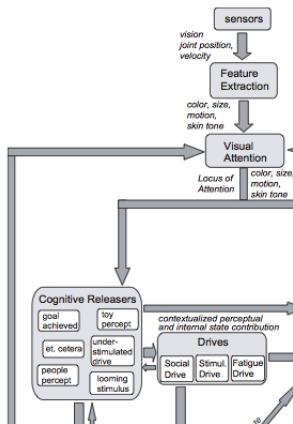
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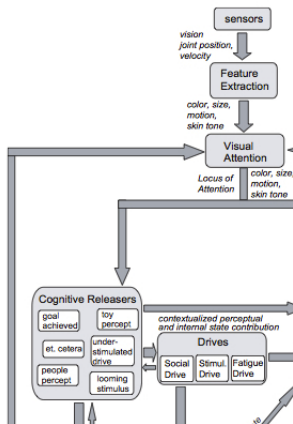
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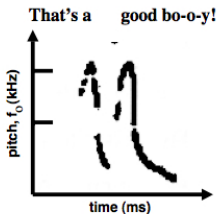


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- Drives satisfied/frustrated by some categories

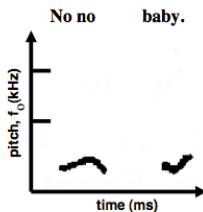
Kismet's Emotional Input

Detecting Emotionally Significant Tones

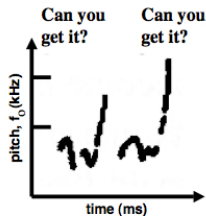
Approval



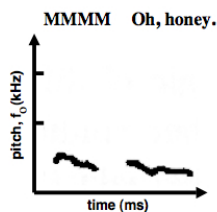
Prohibition



Attention



Comfort



Characteristic contours in mothers' speech (Fernald 1989)

Kismet's Emotional Performance

Detecting Emotionally Significant Tones

Table 10.3. Overall Classification Performance Evaluated Using a New Test Set of 371 Utterances from Five Adult Female Speakers Ranging in Age from 23 to 54 Years

Category	Test Size	Approval	Attention	Prohibition	Comfort	Neutral	% Correct
Approval	84	64	15	0	5	0	76.2
Attention	77	21	55	0	0	1	74.3
Prohibition	80	0	1	78	0	1	97.5
Comfort	68	0	0	0	55	13	80.9
Neutral	62	3	4	0	3	52	83.9
All	371						81.9

Reflecting on Kismet

Why Facial Expressions

Kismet's Expressions (Breazeal & Brooks, p.306)

“...It is certainly possible to use other information-based displays to reveal the internal state of the robots: flashing lights, laser pointers, graphics, etc.

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“...It is certainly possible to use other information-based displays to reveal the internal state of the robots: flashing lights, laser pointers, graphics, etc. However, people would have to learn how to decipher such displays to understand what they mean. Furthermore, information-based displays fail to leverage from the socio-affective impact and intuitive meaning that biological signals have for people.”

Reflecting on Kismet

The Message

Reflecting on Kismet (Breazeal & Brooks, p.307)

“As robot builders, we shall continue to design integrated systems for robots with internal mechanisms that complement and modulate its cognitive capabilities to improve the robot’s overall performance.

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“As robot builders, we shall continue to design integrated systems for robots with internal mechanisms that complement and modulate its cognitive capabilities to improve the robot’s overall performance. Several of these mechanisms may be close analogs to those regulatory, signaling, biasing, and other useful attention, value-assessment, and prioritization mechanisms associated with emotions in living creatures.

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“As robot builders, we shall continue to design integrated systems for robots with internal mechanisms that complement and modulate its cognitive capabilities to improve the robot’s overall performance. Several of these mechanisms may be close analogs to those regulatory, signaling, biasing, and other useful attention, value-assessment, and prioritization mechanisms associated with emotions in living creatures. As a consequence, we will effectively be giving robots a system that serves the same useful functions that emotions serve in us – no matter what we call it.”