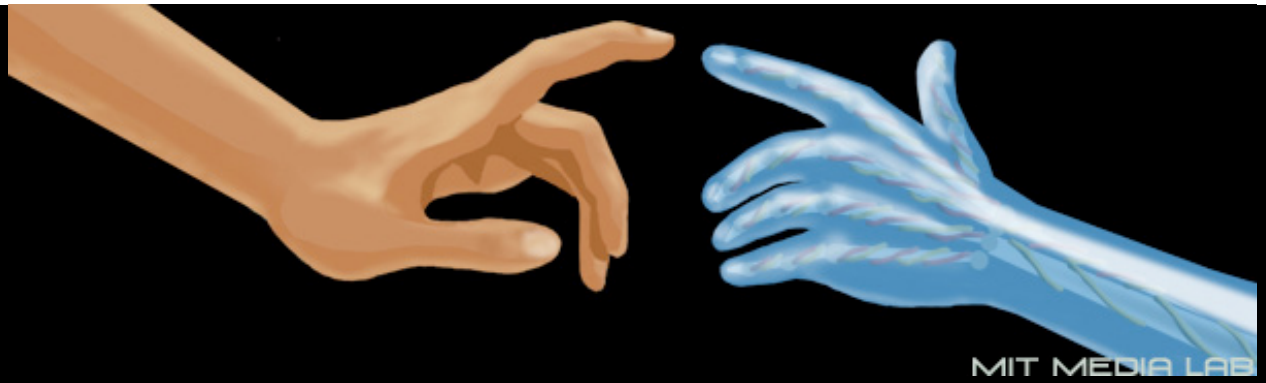

Designing Sociable Robots

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MIT Media Lab

Robots in the real world with real people







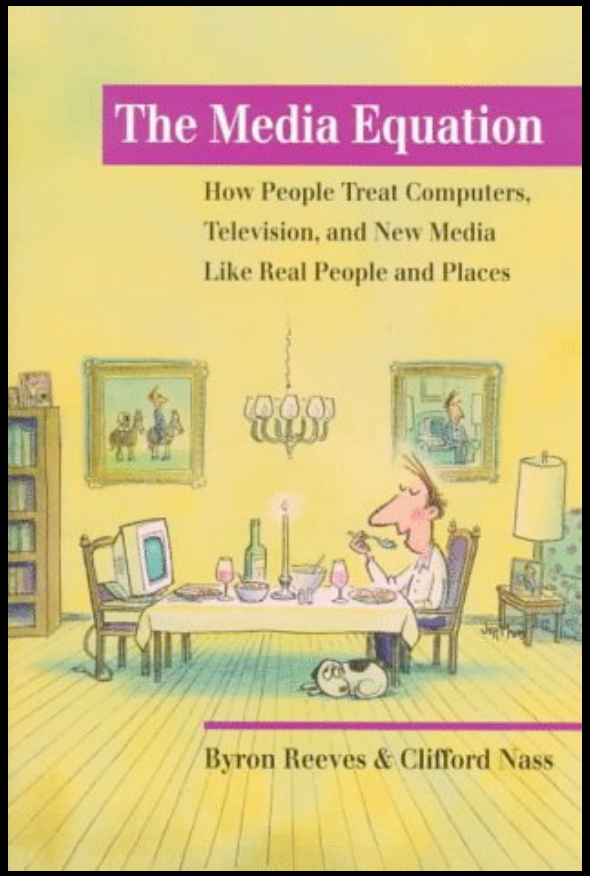

U.N. & I.F.R.R. World Robotics Report (2002)

- Personal Service Robots
  - Assist or entertain people in domestic settings or recreational settings
    - Eldercare and disabled care
    - Toys (10x increase in sales over next 4 yrs)
    - Vacuum cleaners and smart appliances
  - Grow from 176,000 (2001) to over 2M (2005)
    - 1145% increase!
  - Users are not specialists
  - Motivates design of robots that work together with people, complementing and relying on strengths of the other.

Outline

- Social Robot Design
  - Social Responses to New Media
  - Psychology of Design
- Emotion-based interaction
  - Why care about emotion in design?
  - Models of emotion for robots
  - Expressive behavior
- Human-Robot Partnership
  - Human-Robot Collaboration
  - Learning via Tutelage
- Grand Challenges of Social Robots

Interpersonal Interaction with New Media



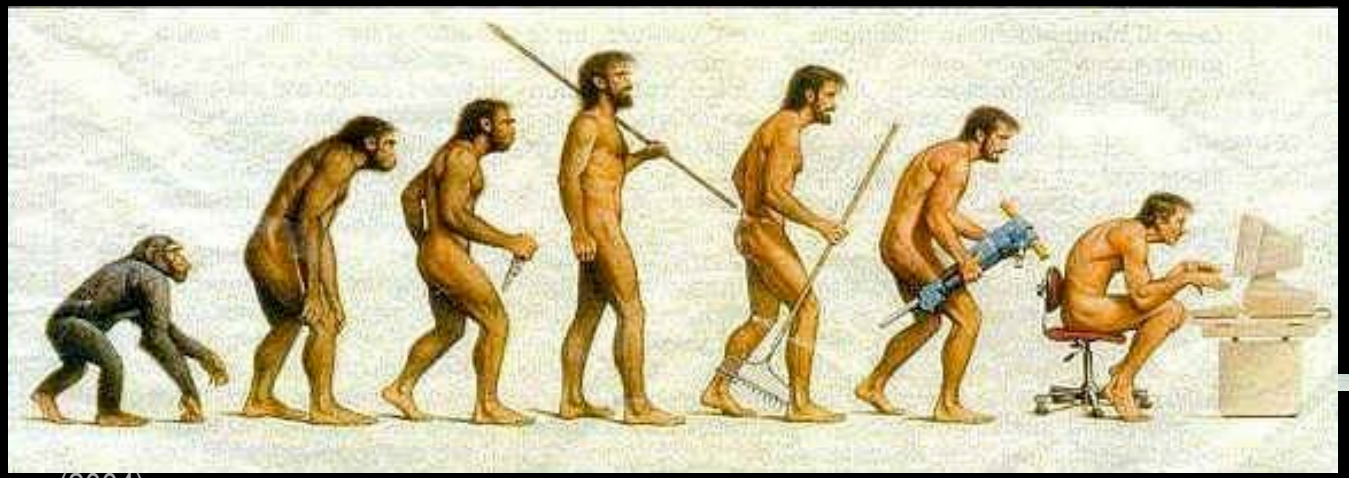
- Computers and new media are perceived as fundamentally social and natural
  - Humans expect media to obey social and natural rules.
  - Rules come from world of interpersonal interaction, and how people interact with real world.

People Treat Computers Like People

- Social and natural responses to media are not conscious
- Even simplest of media can activate rich social responses in humans
- All people automatically and unconsciously respond socially and naturally to media.
  - Can reason around it, but takes a lot of effort to do so!
  - Difficult to "think around" when people are tired, other things compete for attention --- it is difficult to sustain

Why do People do This?

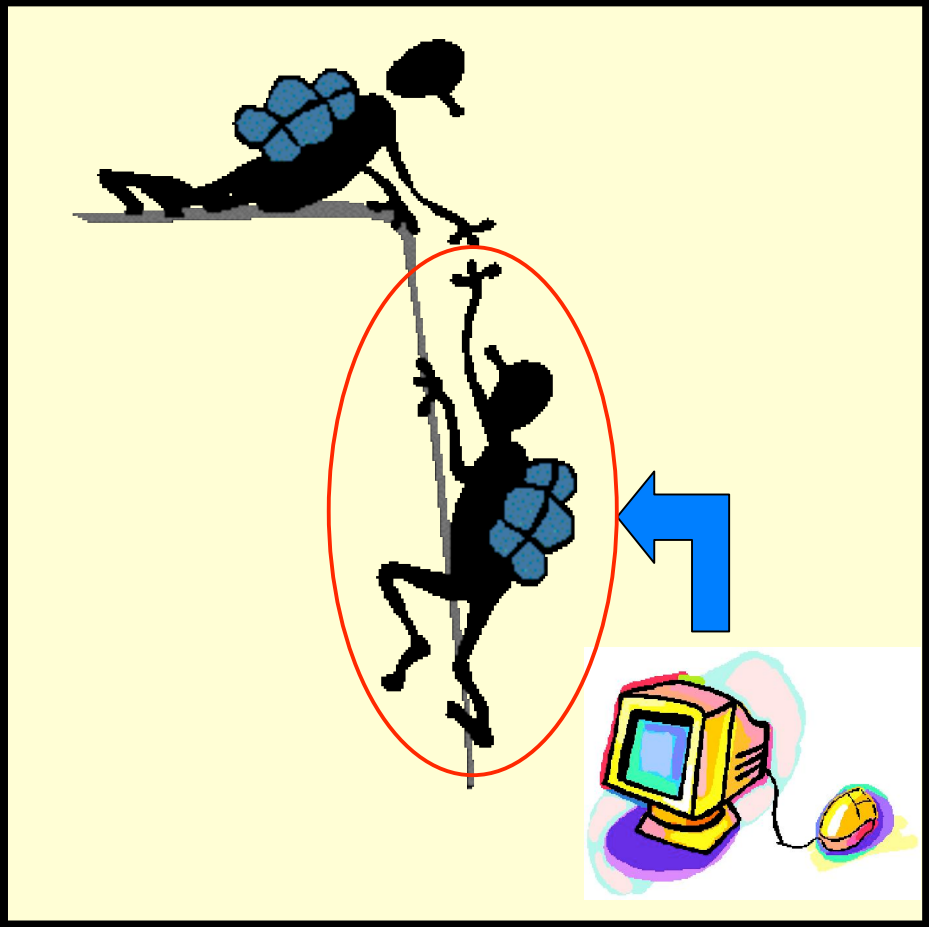
- Says something fundamental about people
- Humans did not evolve with 20th century technology.
  - Brain doesn't have to distinguish real from "seems real".
  - Automatic responses evolved that still are the basis for negotiating life and our social world.
- Any medium that is close enough (i.e., suggest a social presence) will be treated as human, even if they think it foolish and will deny it afterwards.



Consequences

- When media adheres to social and natural rules (conforms to expectations), no instruction is necessary --- people immediately become experts!
  - More enjoyable they are to use.
  - Feelings of accomplishment
  - Sense empowerment
  - Increased competence

An Example…Media and Social Roles



- Classic sociological studies, where replace one of the human subjects with an ordinary desktop computer

Teammates

- People's attitudes and behaviors are affected when they are part of a team
  - People think they are more similar to each other than to those on the outside
  - People admire and respect others in their group
  - Cooperate more with team members and agree more with their positions (group-think)

Making a Computer a Teammate

- Group identity
  - Team has a marker or a name that distinguishes it
- Group interdependence
  - Behavior of each team member can affect all other members

Making a Computer a Teammate

“The Blue Team”

- Human-computer team
  - Name: “the blue team”
  - People wear blue wristband
  - Computer has blue border and a label “Blue Team” on top
  - Told their performance would be evaluated based on their own work and that of the computer.

Making a Computer a Teammate

“The Green Computer”

- Human working alone using a computer
  - Person wears a blue wristband
  - Computer has green border and a label “Green Computer” on top
  - Told their performance would be evaluated based solely on their own work and the computer was only there to help

A Collaborative Task: Desert Survival

- Scenario: your airplane has crashed in the middle of the desert. No sign of water, but some items are salvaged from the wreckage. Rank these 12 items for their survival value: flashlight, jackknife, magnetic compass, sectional air map, etc.

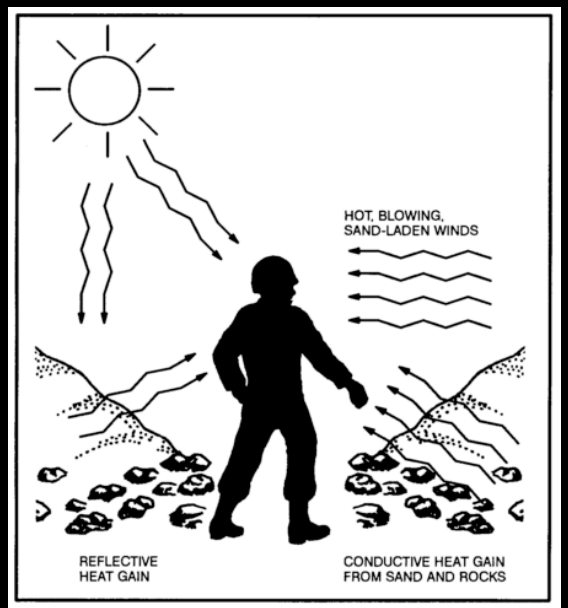


Figure 13-1. Types of heat gain.

Results: Changes in Attitudes

- When on the same team, subjects thought the computer teammate:
  - Was more like them
  - Solved problems in a similar manner
  - Agreed more in their ranking
  - Information was more relevant, helpful, insightful
  - Presentation of information was friendlier

Results: Changes in Behavior

- When on the same team, subjects behaved differently with computer teammate:
  - Feelings of cooperation were enhanced
  - Human tried harder to reach agreement
  - Human more open to attempts to change answers
  - Human Changed answers more to conform to computer

Take Away Message

- It's really simple to create a team, simply a name will do
- But its far more powerful when people are asked to rely on media for their own success
- Team membership will influence how people think, feel, and behave

Status and Human-Machine Teams

- Status/role in human-computer relationship
- One-down status
  - Computer is only a tool and user is dominant and in control.
- One-up status
  - Computer as dominant. It takes charge and absorbs most of the work as possible --- e.g., wizards, guides, etc.

Status and Human-Machine Teams

- One-across status
  - But… findings suggest balanced status is preferable --- e.g., computer and users as peers, teammates, etc.
  - Human feels dependent on computer without feeling superior or inferior
    - Being on same team encourages people to think that the computer is more likeable and effective
    - Promotes cooperation and better performance

Human-Robot Teammates: A Study

- Human-Robot Collaboration study (Hinds, Roberts & Jones, 2004)
- Examine effects of status and appearance on human-robot collaboration
  - Reliance upon robot
  - Cede responsibility to robot
- 3x3 *Wizard of Oz* study
  - Human, human-like, machine-like
  - Superior, peer, subordinate

Robot Teammates: Hypothesis

- Hypothesis: people will rely more on and cede responsibility more to human-like robot partner
- Why?
  - Perceived common ground
  - Shared identity

…Make human more confident in estimate of robot's knowledge and abilities

Findings: Affect of Appearance

- People willing to cede more responsibility to human-like robot
- People willing to attribute more credit to human-like robot
- Little difference in attributing blame
- Little difference in people's willingness to rely on robot

Findings: Effect of Status

- PEER condition: strong positive relation in willingness
  - To rely on human-like robot
  - To attribute credit to human-like robot
- SUPERVISOR condition:
  - Feel less responsible
  - Assign significantly less credit to robot
  - More likely to attribute blame (Dilbert effect)
- SUBORDINATE condition:
  - Retained more responsibility for the successful completion of task for machine-like robot

Human-Centered Design Applied to Social Robots

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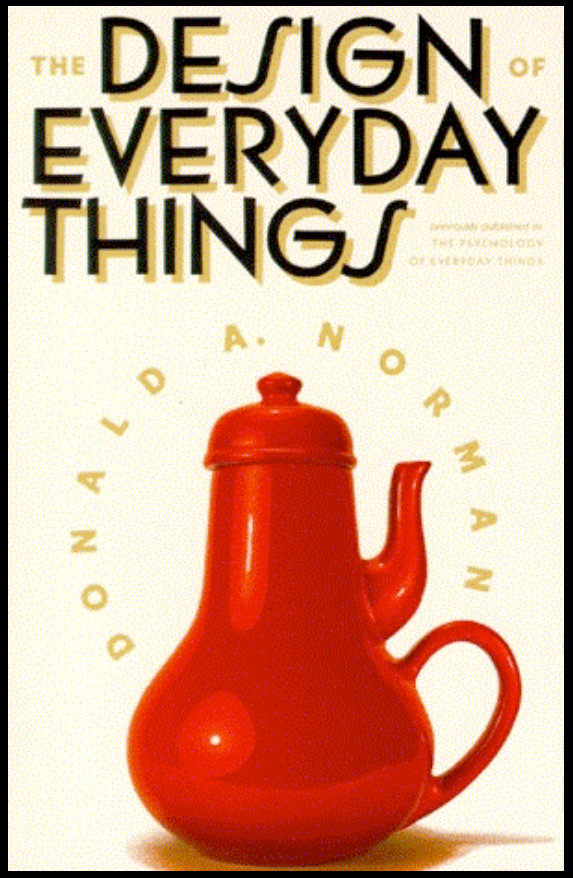
Psychology of Design



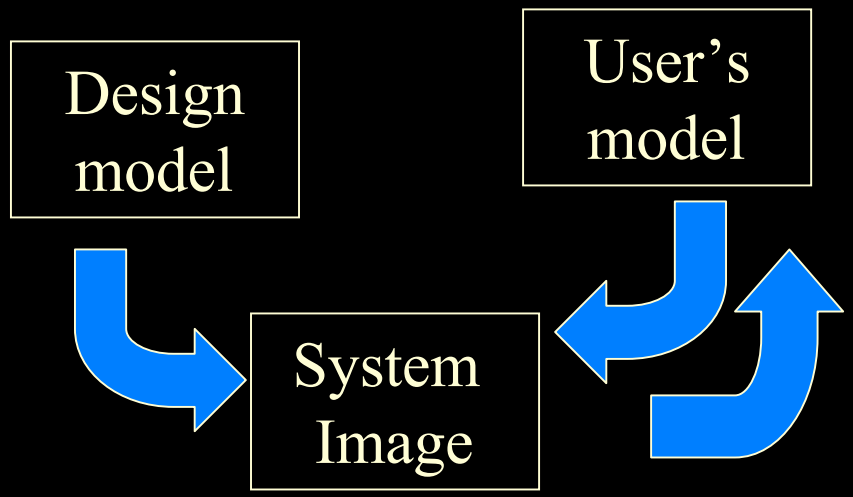
Don Norman

- Human mind is exquisitely suited to make sense of the world and people
- Use Natural Cues
  - Indicate what parts to operate and how
  - The mapping between intended and actual operations is intuitive
  - The effects of the operations are apparent
- Just the right things need be visible to avoid gadget overload

Mental Models (Don Norman)

- Mental models are the models people have of themselves, the environment, things with which they interact
- People form mental models through experience, training, instruction
- Mental model of a device is formed largely by interpreting its perceived actions and visible structure (its system image)

Communicating Mental Models



Designer communicates mental model to user through the system image

- Design model: the designer's conceptual model
- User's model: the mental model developed through interaction with the system
- System image: How the device looks and behaves

Principles of Good Design

- A good conceptual model allows user to predict the effects of our actions
- Good design communicates an appropriate conceptual model using natural cues
  - Affordances
  - Mapping
  - Feedback
  - Causality

Principles of Good Design

- Good design exploits natural mappings
  - Physical analogies (spatial, etc.)
  - Cultural standards (social, etc.)
- This is especially important when problems arise
  - Provides a deeper understanding of how it works
  - Allows person to make reasonable corrections

Affordances

- Affordance refers to the perceived and actual properties of the thing that determine how it could possibly be used
  - A chair affords (“is for”) support, and therefore affords sitting
- Provide strong clues for the operation of things.
  - Buttons are pressed
  - Levers are pulled, etc.

Mapping

- The relationship between two things
  - E.g. the controls and their movements --- their effects on the world
- Steering Wheel: Turn clockwise to go right
  - Visible
  - Closely related to desired outcome
  - Provides immediate feedback

Feedback

- Sending back to the user information about what action as been accomplished
- The effects of the operations are apparent
- Bridge the gap between execution and evaluation

Causality

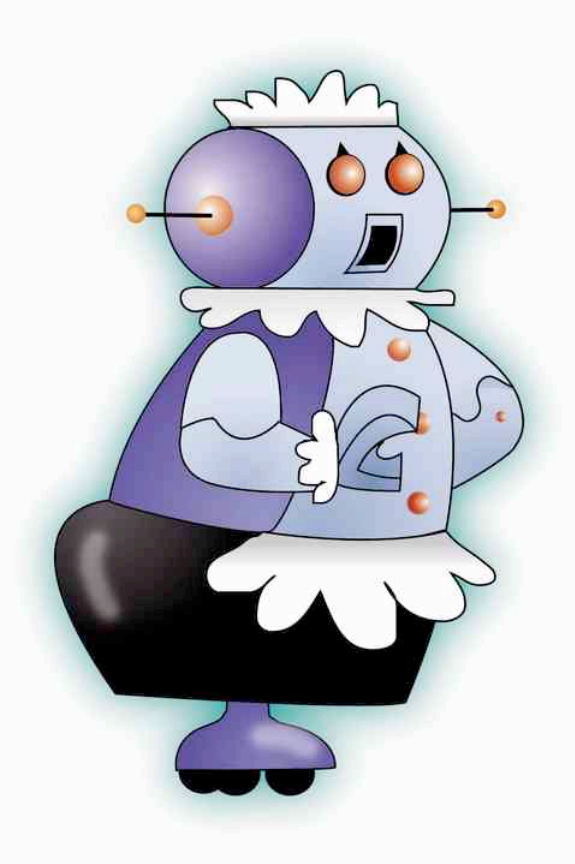
- Something that happens right after an action appears to be caused by that action
  - False causality results in superstition
  - No visible result conveys ineffectiveness of action, often causing repetition with regret

A Social Model for Robots

- "Personality is a form of conceptual model, for it channels behavior, beliefs, and intentions into a cohesive, consistent set of behavior. (*This is a fairly dramatic oversimplification of the complex field of human personality and of the many scientific debates that take place within that field*.) By deliberately providing a robot with a personality, it helps provide people with good models and good understanding of the behavior…."
- "Personality is a powerful design tool, for it helps provide humans with a good conceptual model for understanding and interpreting the behavior of the robot and for understand how they should behave in interaction and in giving commands."

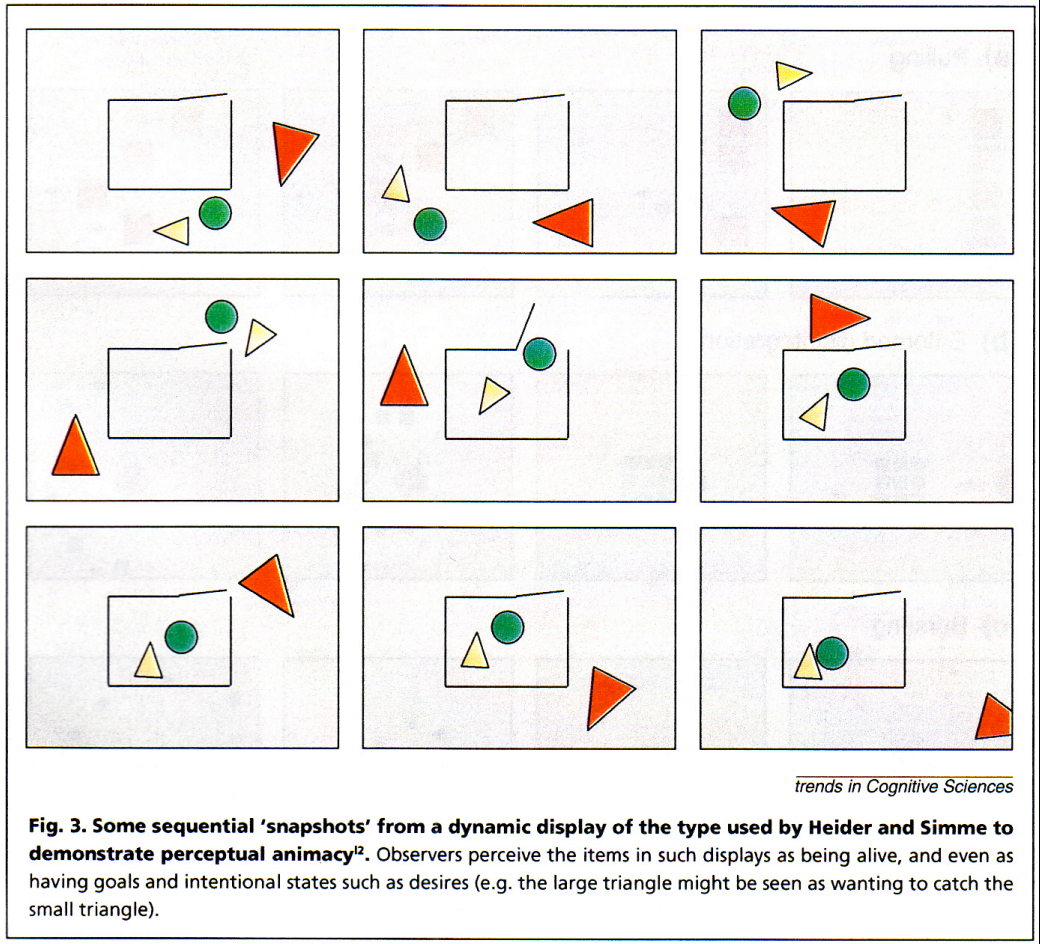
Don Norman
How Might Humans Interact with Robots?

A Social Model for Robots



- Steuer (1995) identified characteristics that cue people to interact socially
  - Natural language
  - Interactivity
  - Human social roles
  - Human-sounding speech
  - Human-like physical characteristics

Movement and Animacy



trends in Cognitive Sciences

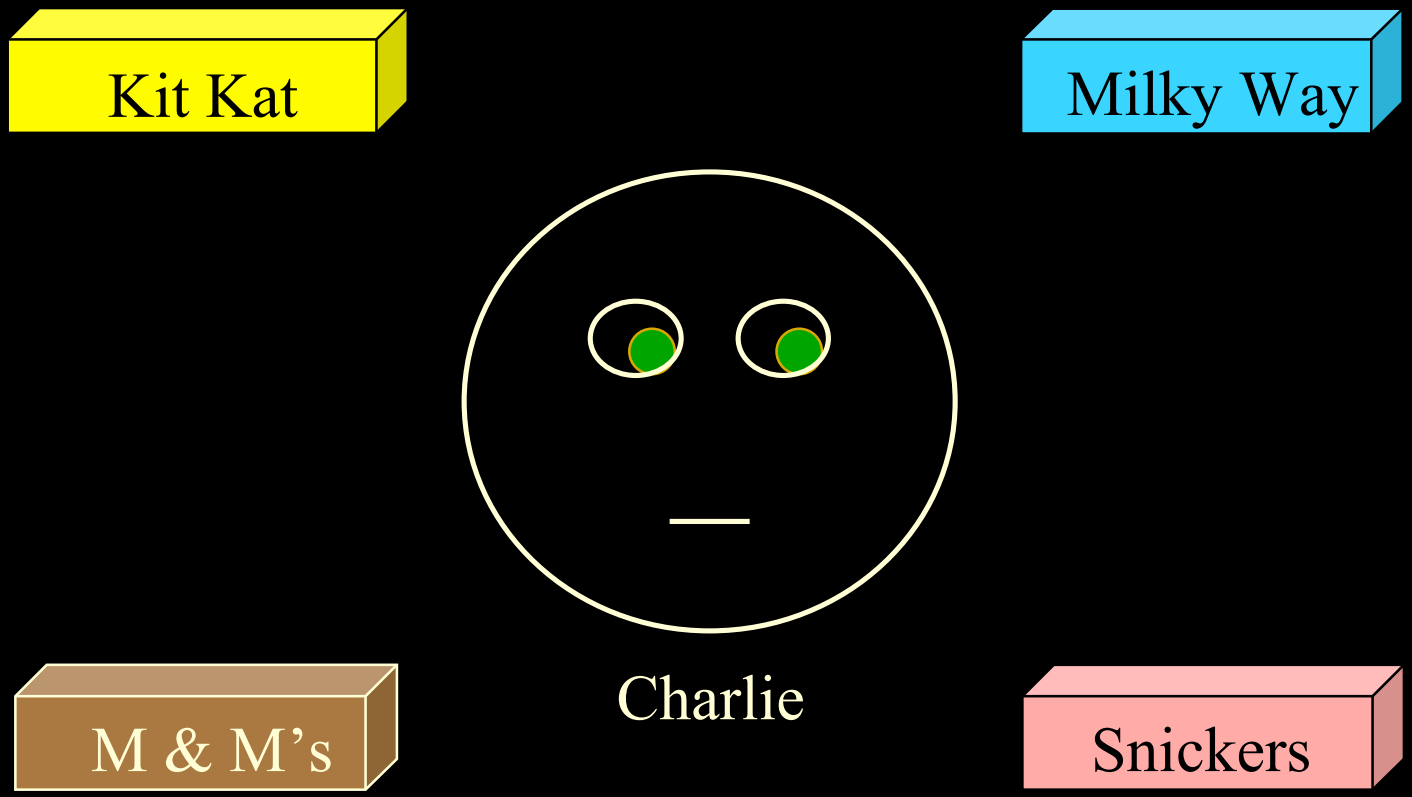
Fig. 3. Some sequential 'snapshots' from a dynamic display of the type used by Heider and Simme to demonstrate perceptual animacy[12]. Observers perceive the items in such displays as being alive, and even as having goals and intentional states such as desires (e.g. the large triangle might be seen as wanting to catch the small triangle).

Reading (Visual) Behavior, Reading Minds

(from Baron-Cohen, 1994)

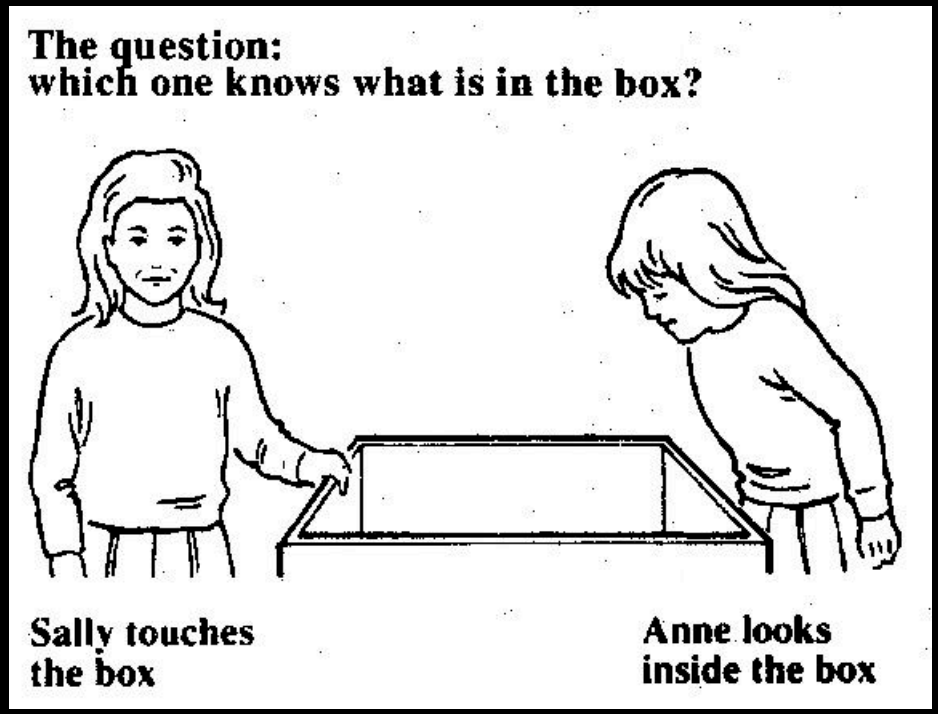
"Which one is thinking?"

“Which candy does Charlie want?”



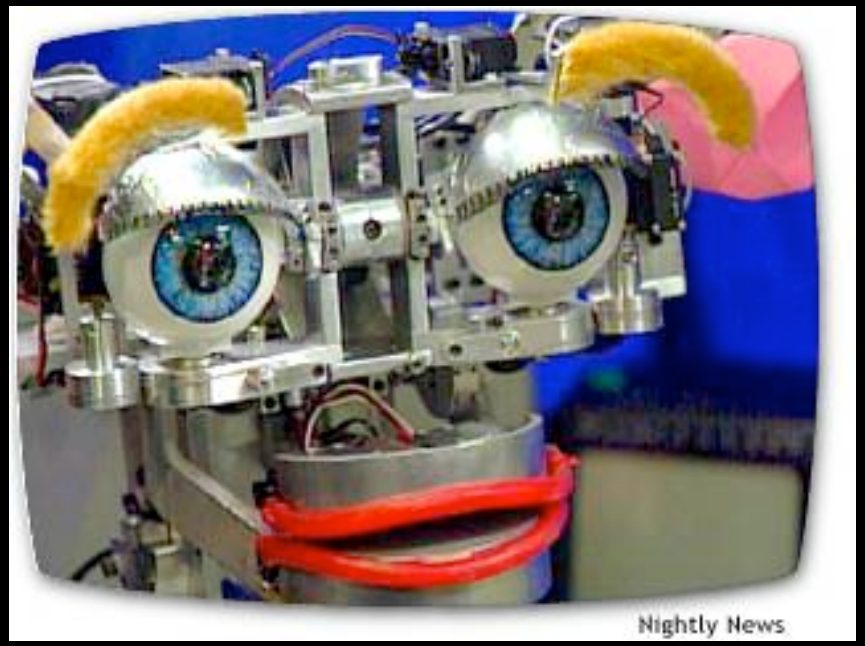
(from Baron-Cohen, 1994)

Seeing leads to knowing



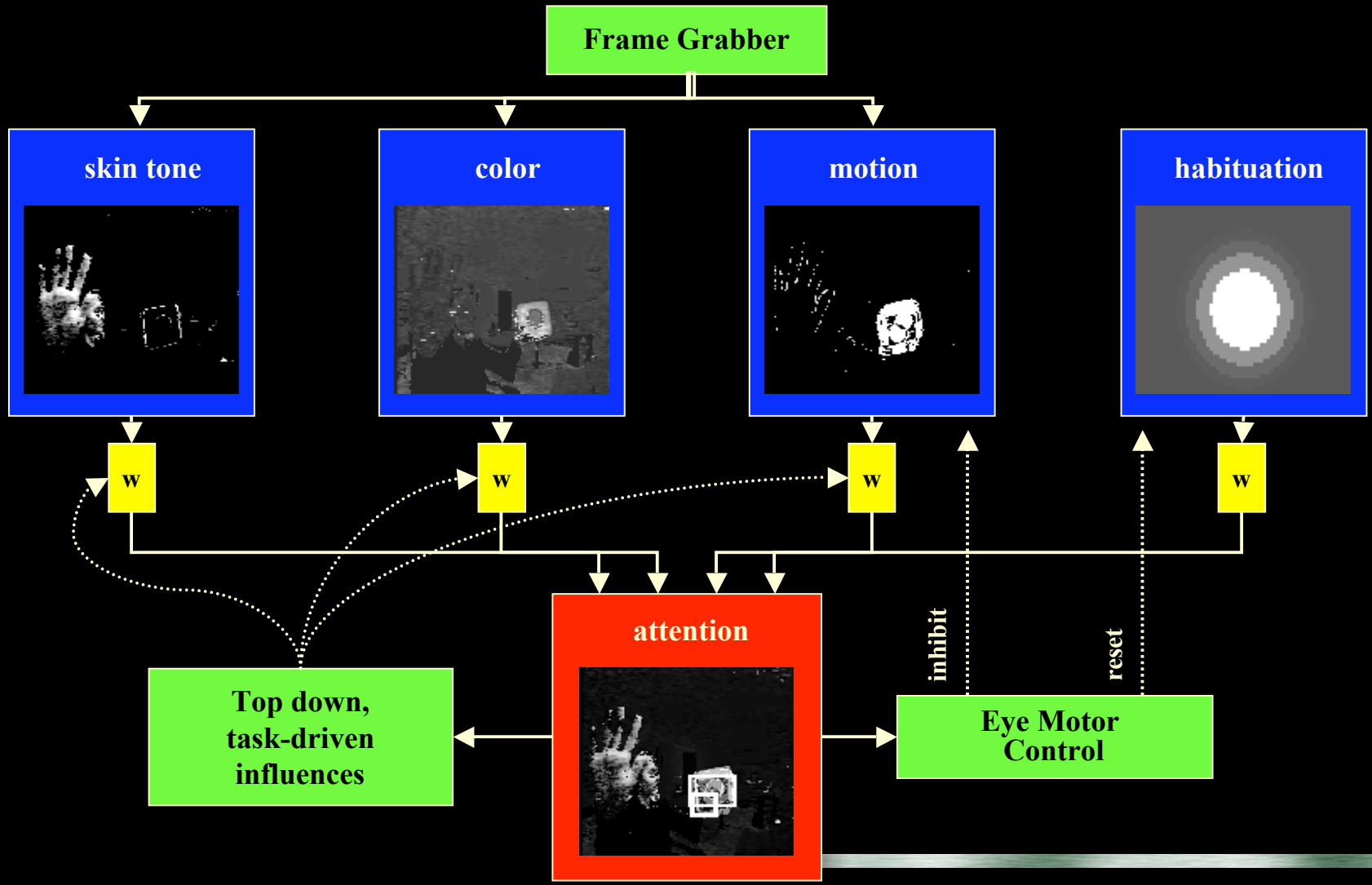
(from Baron-Cohen, 1994)

An Example Applied to Social Robot



- Mental Model
  - Social
- Affordances
  - Face, eyes, features
- Mapping
  - Natural Attention Cues
- Feedback
  - Gaze & interest
- Causality
  - Responsive to human and environment
  - Responsive to internal states

Attention System exploits Natural Mappings



Mapping: Visual Attention Cues What Matters

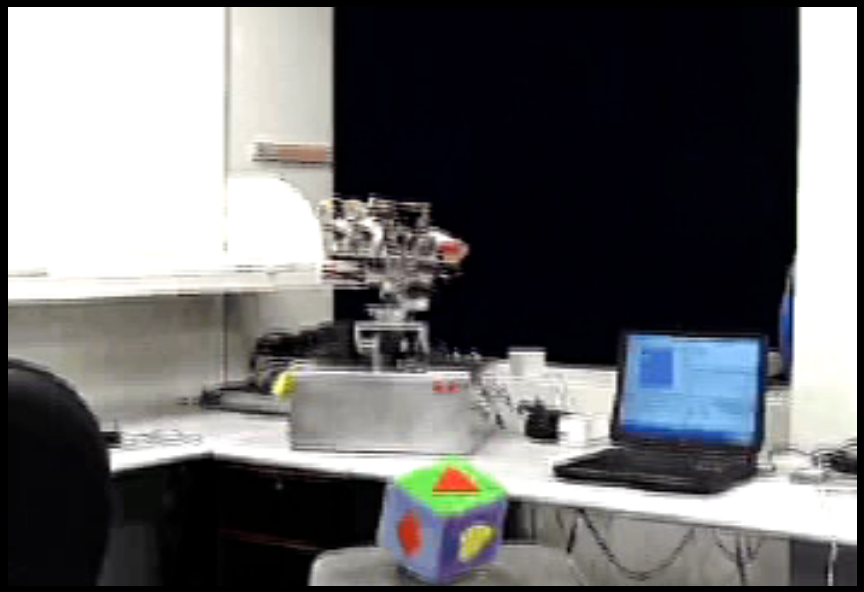
“Seek toy” –
low skin gain, high saturated-color gain
Looking time 28% face, 72% block

“Seek face” –
high skin gain, low color saliency gain
Looking time 80% face, 20% block

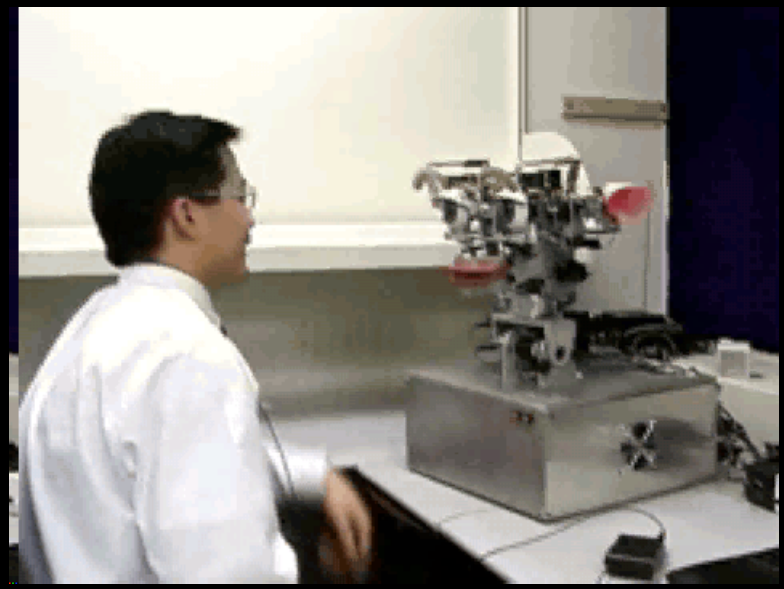
Feedback & Causality

stimulus category	Stimulus	presentations	average time (s)	commonly used cues	commonly read cues
color and movement	yellow dinosaur	8	8.5	*motion across centerline,* *shaking,* *bringing object close*	*change in visual behavior,* *face reaction,* *body posture*
	multi-colored block	8	6.5		
	green cylinder	8	6.0		
movement only	black&white cow	8	5.0		
skin toned and movement	pink cup	8	6.5		
	hand	8	5.0		
	face	8	3.0		
Overall		56	5.8		

Directing Attention



Visual Search



Referential Looking

Summary

- Good design considers how the human mind understands the world
  - Lessons from HCI, usability, etc.
  - Can be applied to social robot design
- Autonomous robots readily evoke a social model
- Impacts human behavior and attitudes
  - Can offer advantages when designed accordingly
- But important differences exist and must be understood