



# Understanding Humans Through Robots

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Workshop on Robot Anthropology, Bielefeld Univ., August 3, 2012



Cognitive  
Neuroscience  
Robotics

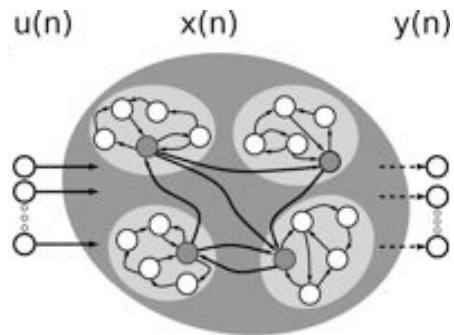
# My Work & My Robots (1999 - present)



# Do Robots Have Human-like Intelligence?

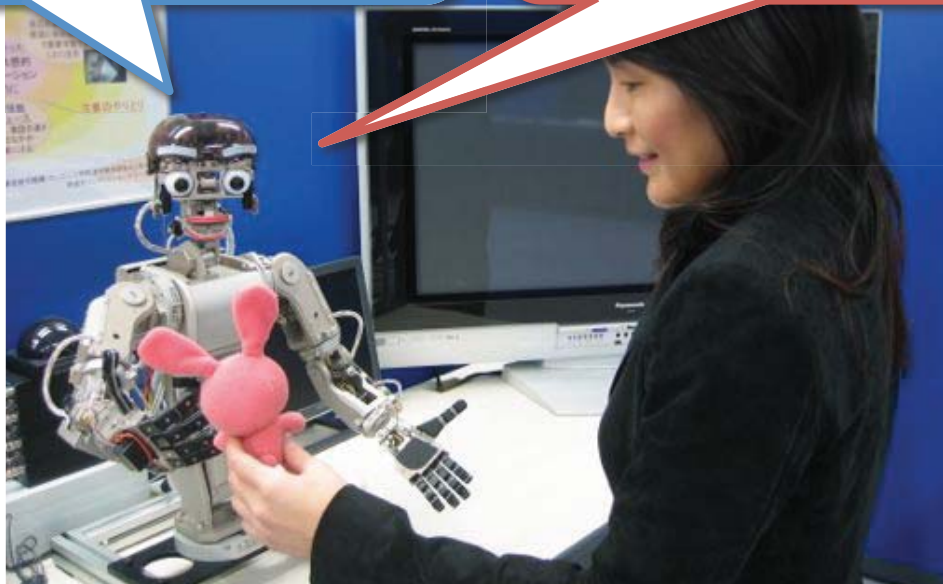
## Programs (how to do)

```
Sub  
ate Sub tbToolBar_Button  
rror Resume Next  
imer.Enabled = True  
ct Case Button.Key  
Case "Back"  
brwWebBrowser.  
Case "Forward"  
brwWebBrowse  
Case "Refresh"  
brwWebBrow  
Case "Home"  
uWebB
```



## Behaviors (what to do)

- Display emotions
- Recognize face
- Share attention
- Show preference
- Be curious
- Learn
- Acquire knowledge
- etc.



# Our Fundamental Questions

What is *human intelligence*?

What makes us *human*?



?  
=



**Creating human** is a promising approach to address these questions.



# BTW...

## An Example of Human Cognition

Ms. Satsuki Ayaya

- Asperger syndrome
- Takes longer time to recognize events



ex.) Feeling “hungry”

- Recognize only after **integrating various lower-level perception**

→ All people may undergo the same process with her ( $\approx$  robots), but

**not conscious.**



[Ayaya & Kumagaya, 2008]

# Two Approaches to Creating Human-like Robots

## Bottom-up approach

- Equip a robot with *minimal set of functions*
- Investigate *how the robot acquires higher cognitive functions* through own experiences
- *Emerging abilities* = nature of human intelligence

Bottom-up

## Top-down approach

- Replicate *human-like appearance and behaviors* into a robot
- Investigate *how the robot is accepted by human*
- *Gap from human* = nature of human beings

Top-down

# Examples of Bottom-up Approach



CB2 developed by Asada ERATO Project, Japan

# Self-Other Recognition [Nagai et al., 2011]

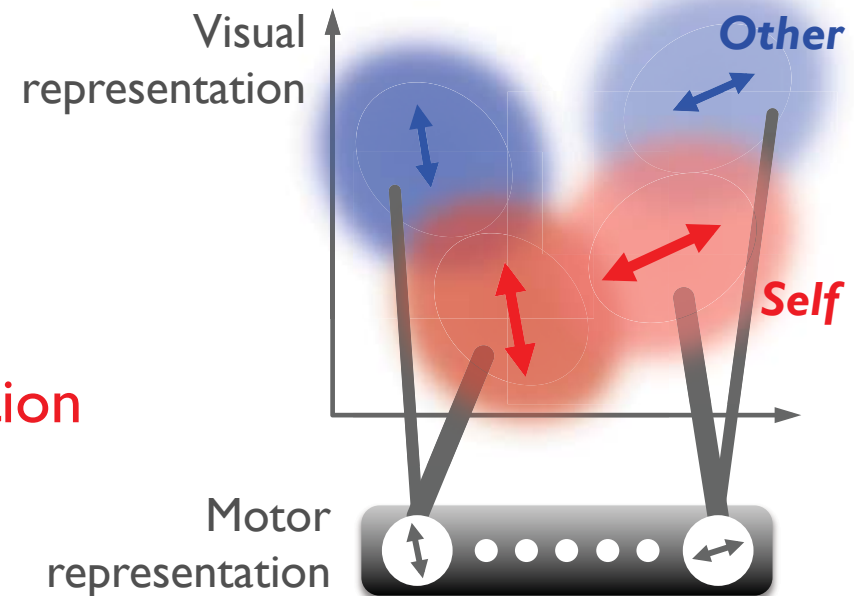
## Questions

- What is self? What are others?
- How do we know others are “like me”?



## Key ideas

- Self = **higher** spatiotemporal **contingency** vs. others = **lower** contingency
- Immature perception in early development → **non-differentiation** between self and other



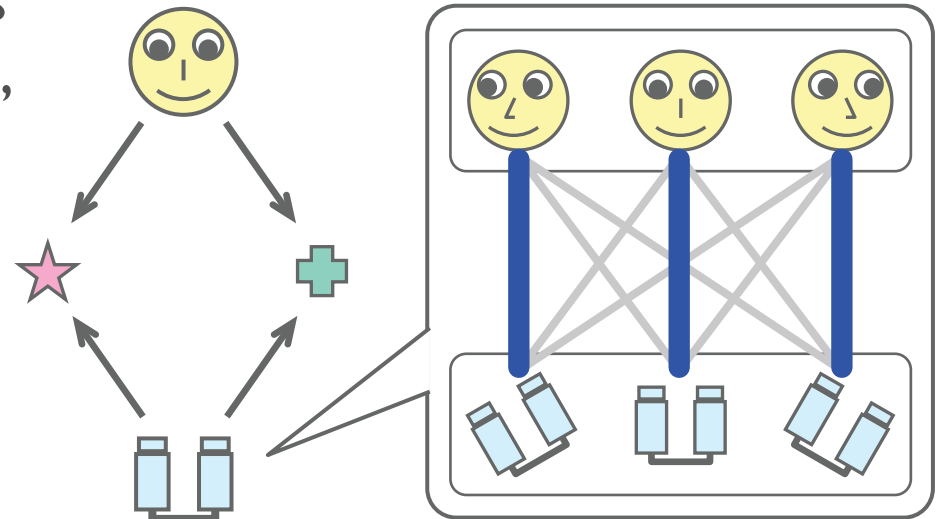
# Joint Attention [Nagai et al., 2003]

## Questions

- Why do we follow others' gaze?
- Is there an inherent ability for it?

## Key idea

- Learned through experiences
- **Contingency** between others' gaze and the location of interesting events
- Lead to **theory of mind**



# Bottom-up Approach Tells Us

- Importance of **experiences and learning**
- Connections between **neural activities** and **cognitive behaviors**
- Nature of human intelligence

... though still a part of human intelligence ;-)



Bottom-up

# Example of Top-down Approach

Photo: Osaka University

The woman's identity ...



# Extension of Self [Watanabe et al., 2009]

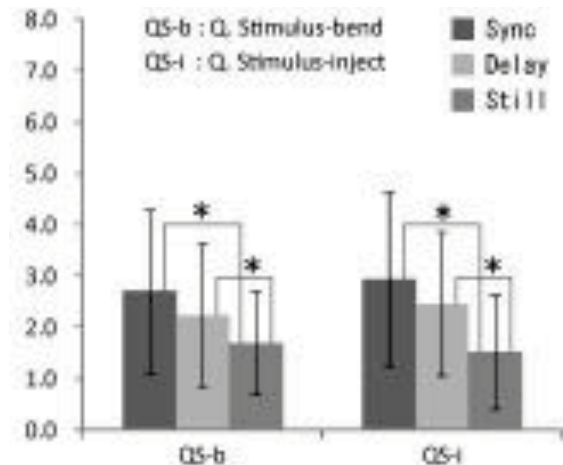
## Questions

- Can an android become an extension of our body?
- If yes, when and why?

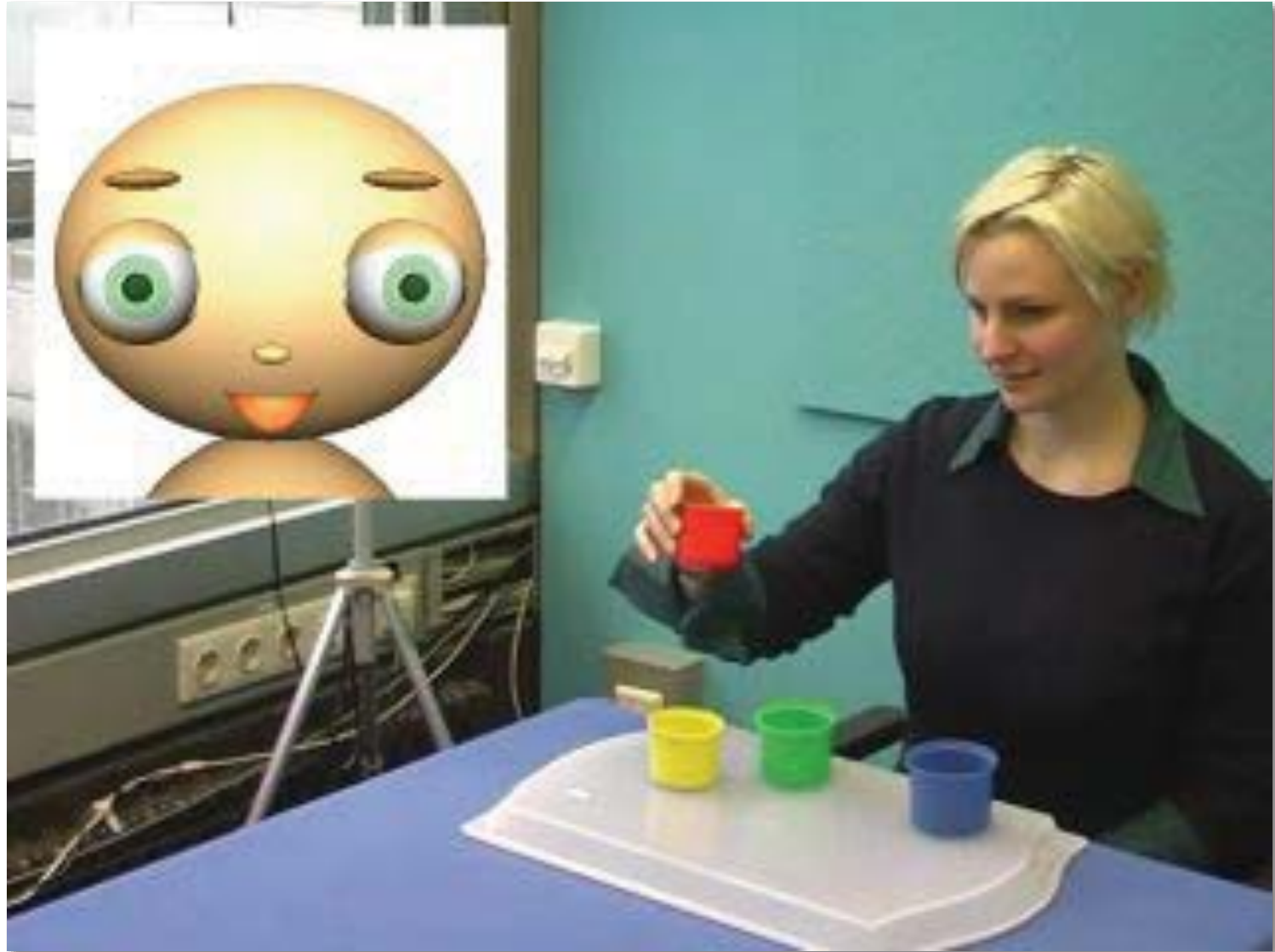


## Result

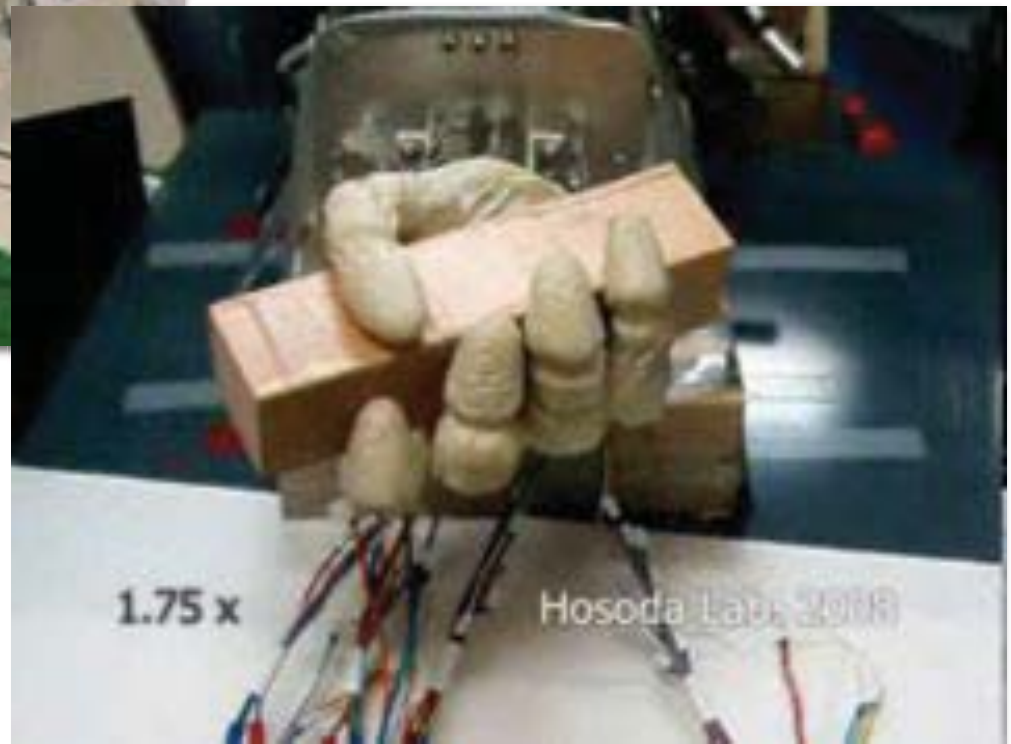
- Android's motion **synchronized with our body movement** (i.e., contingency) → stronger feeling of an extension of self



# Sharing Visual Attention [Muhl & Nagai, 2007]



# Roles of Embodiment [Koh Hosoda and colleagues]



# Top-down Approach Tells Us

Top-down

- Unconscious process of human cognition
- Roles of contingency, visual attention, embodiment, etc.
- Nature of human beings

... though still a part of human intelligence ;-)



# Conclusion



# Our Fundamental Questions

What is *human intelligence*?

What makes us *human*?



?  
=



Bottom-up and top-down approaches to **creating human** answer these questions.



# Take Home Messages

- We have to understand “**what human is**” before asking “what robots cannot do”.
- A large amount of human cognition is **unconscious** but may **undergo the same process with robots**.
- **Variety of robots and approaches** should be taken into account when we discuss Robot Anthropology.





**Thank you!**

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