What Should Robots Learn from Caregiver-Infant Interaction?

Yukie Nagai, Osaka University

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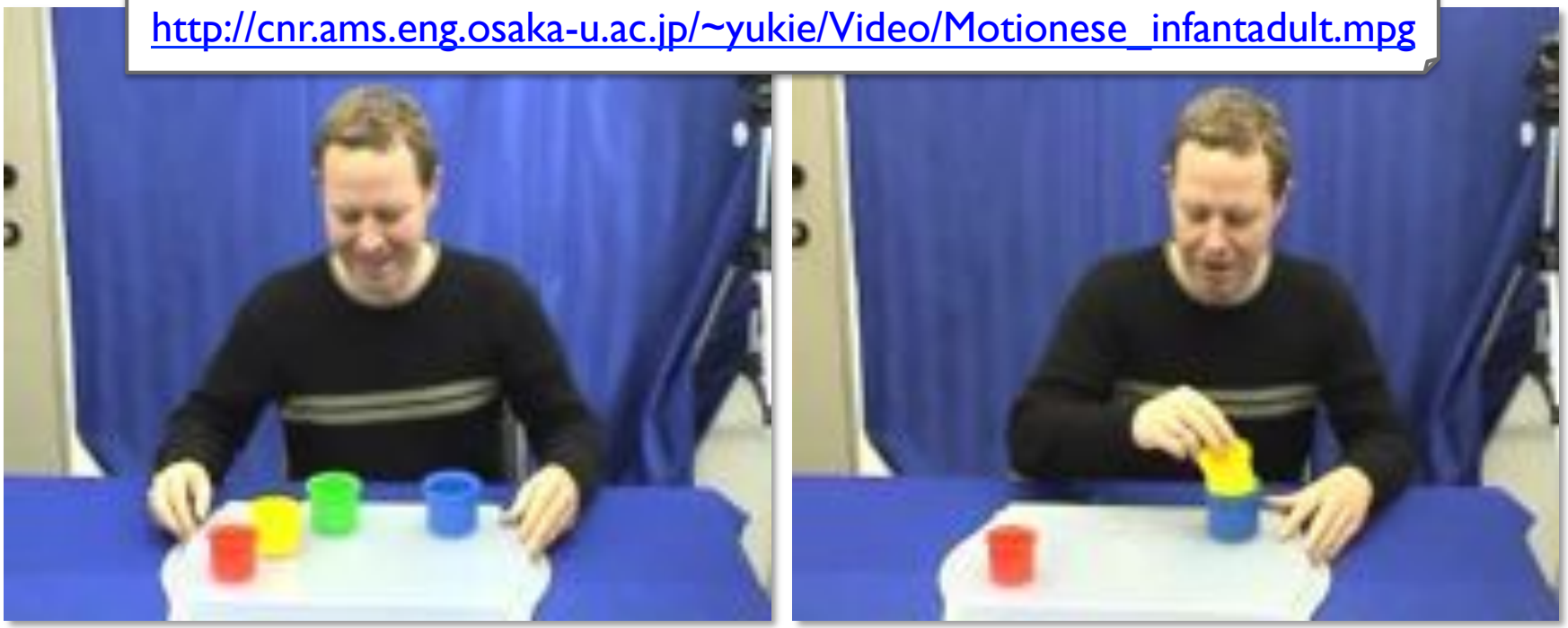
Cognitive Neuroscience Robotics

How Do Caregivers Teach Actions?

http://cnr.ams.eng.osaka-u.ac.jp/~yukie/Video/Motionese_infantadult.mpg



[Rohlfing et al., 2006; Nagai & Rohlfing, 2007-2009]

- Caregivers exaggerate their actions when interacting with *infants* vs. *adults* (i.e., motionese) [Brand et al., 2002].

How Do People Teach Actions?

http://cnr.ams.eng.osaka-u.ac.jp/~yukie/Video/SocialRobot_02_subject.mpg

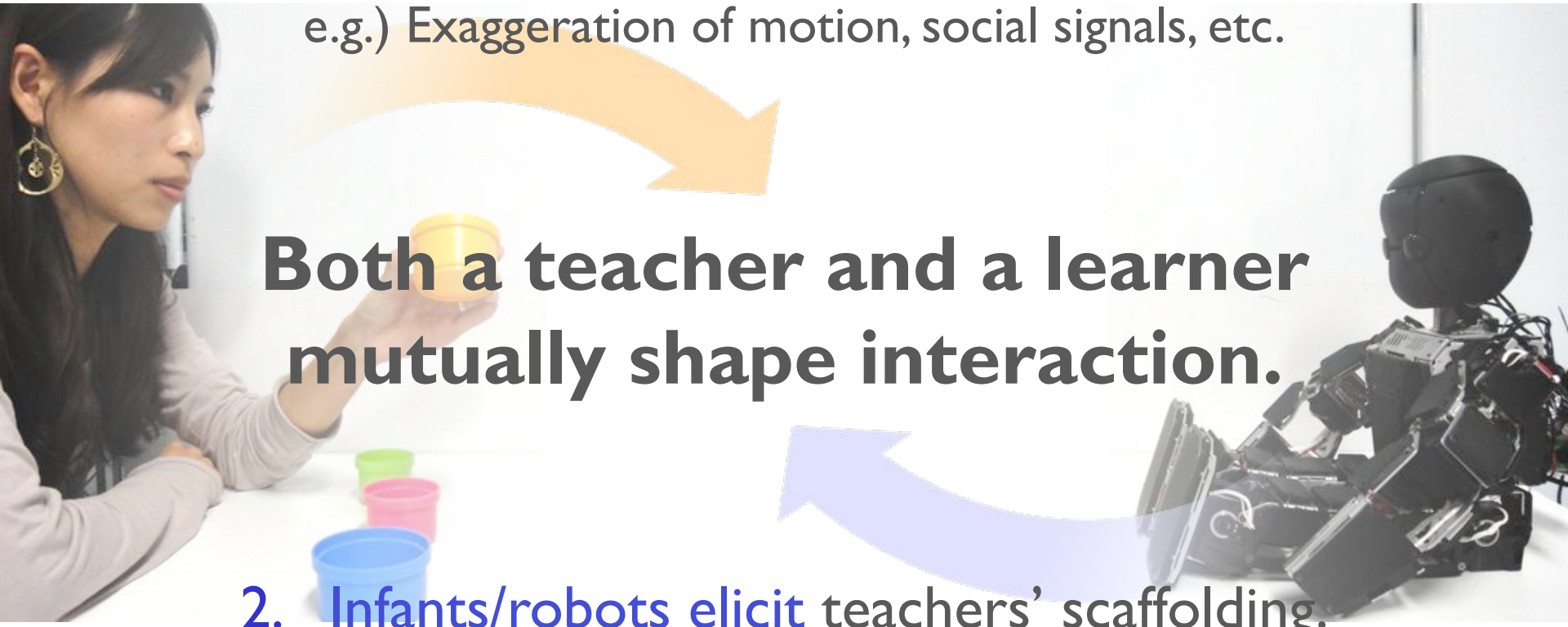
[Muhl & Nagai, 2007; Nagai et al., 2008]

- People tend to exaggerate actions directed to robots.

Take Home Message

1. Teachers guide infants'/robots' learning.

e.g.) Exaggeration of motion, social signals, etc.



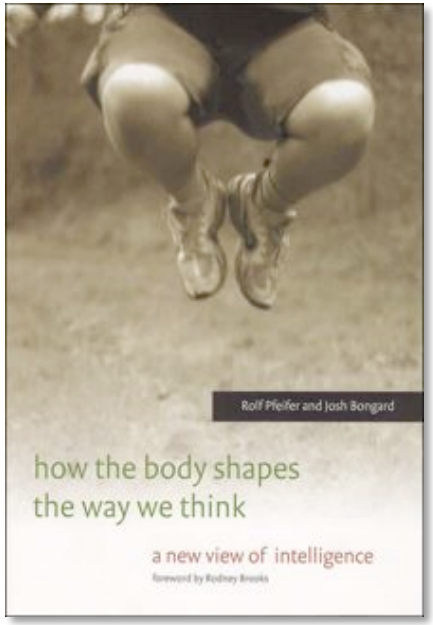
Both a teacher and a learner mutually shape interaction.

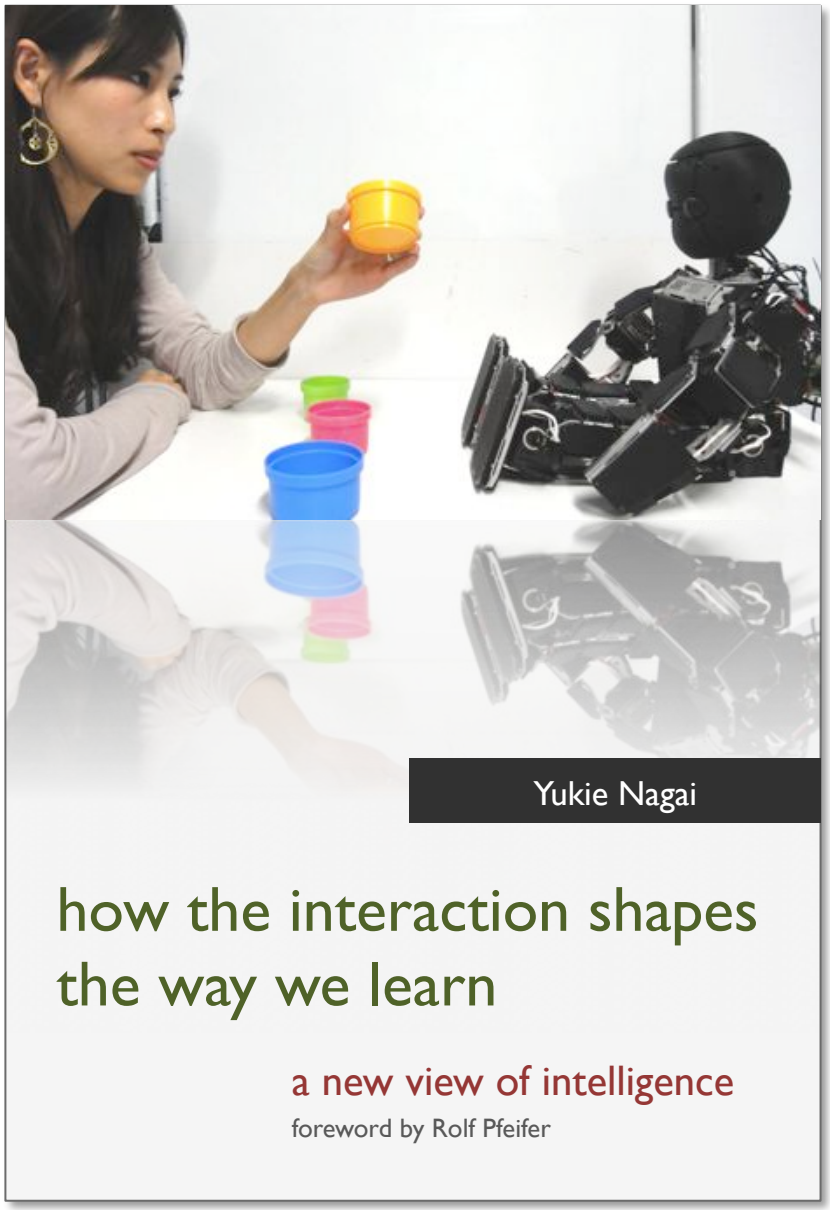
2. Infants/robots elicit teachers' scaffolding.

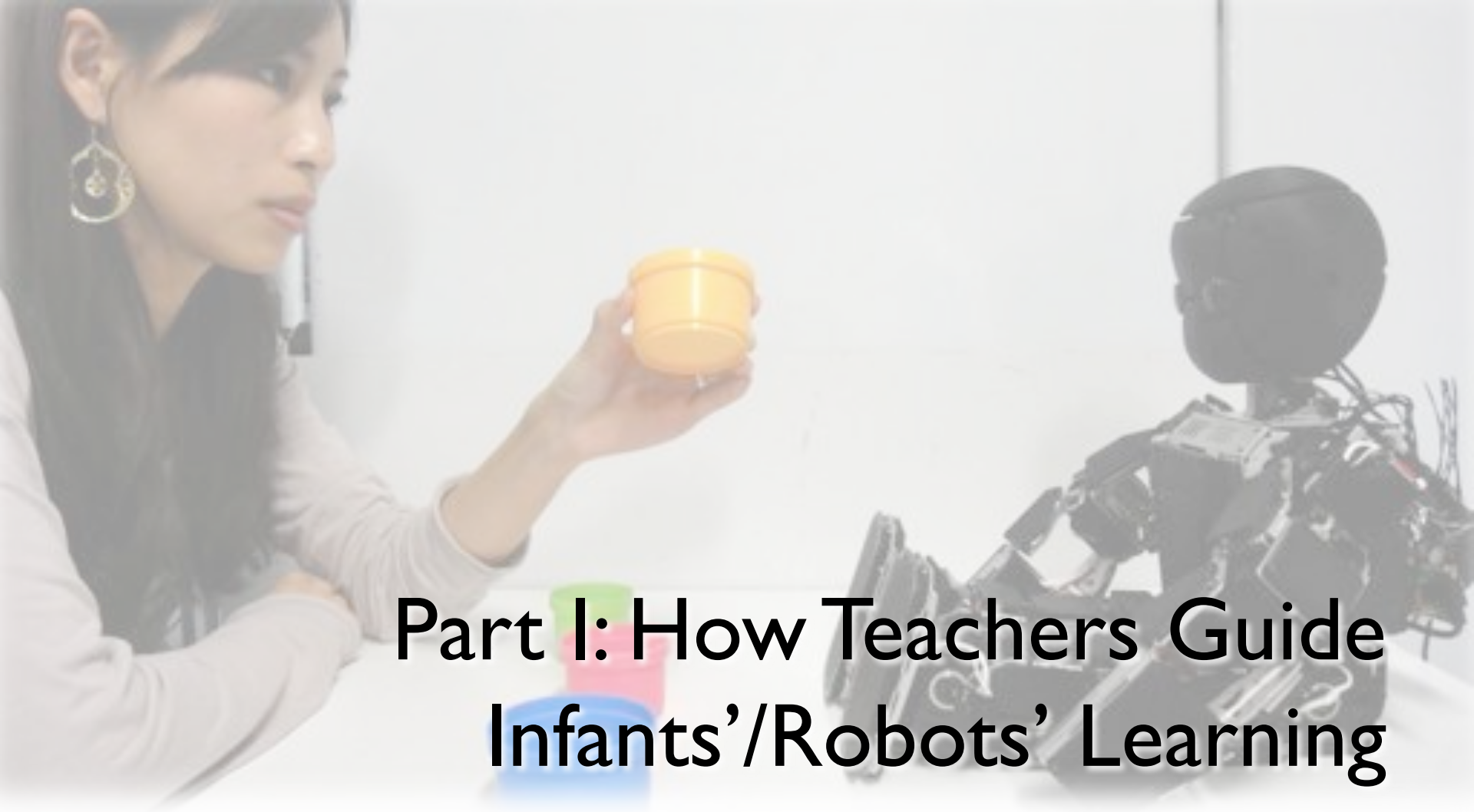
e.g.) Immature perception and actions, etc.

To Be UNpublished…

Inspired by …







Part I: How Teachers Guide Infants'/Robots' Learning

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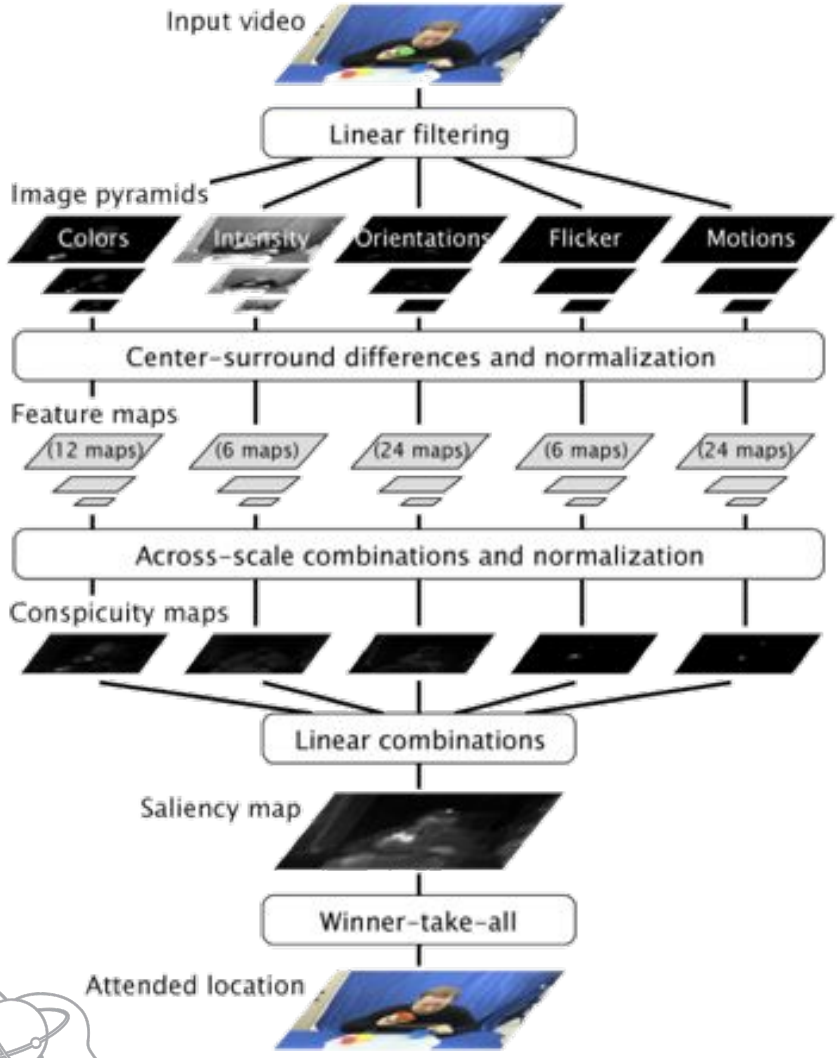
From Attention to Learning



- Young infants learn based on bottom-up attention.

  [Frank et al., 2009; Golinkoff and Hirsh-Pasek, 2006]

- Saliency-based attention

  [Itti et al., 1998; 2003]

  - Saliency = difference from surroundings (e.g., color, edge, motion)
  - No task or context knowledge
  - Similar to young infants

Where Model Attends?

http://cnr.ams.eng.osaka-u.ac.jp/~yukie/Video/Motionese_saliency.mpg

Experiment [Nagai & Rohlfing, 2009]

Question:

- When and what caregivers emphasize?
- Where the saliency model attends?

Method:

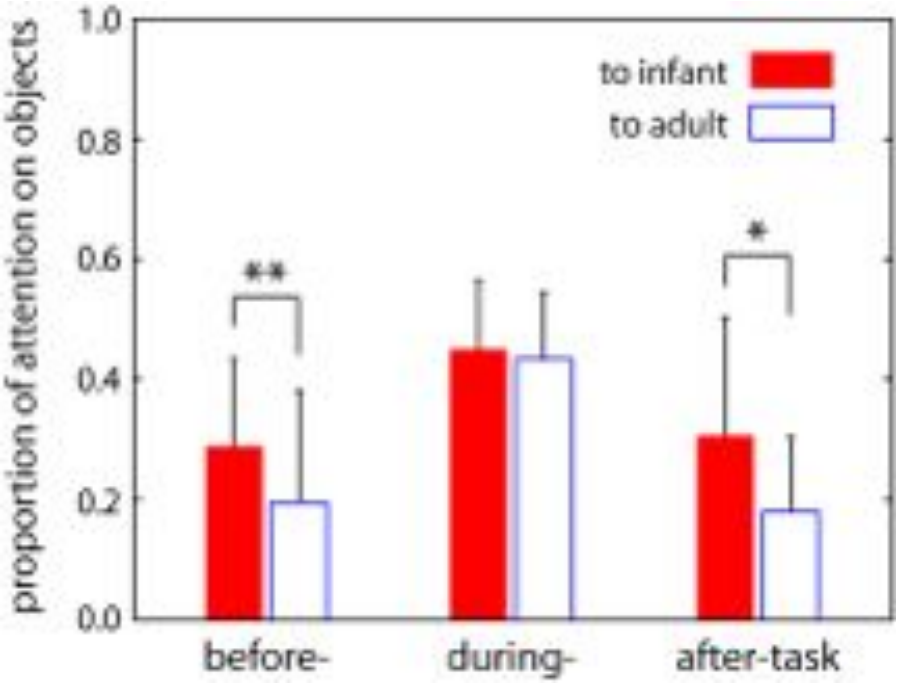
- Comparing attended locations in:
  - *Infant*-directed action
  - *Adult*-directed action

Subjects:

- 15 parents of 8- to 11-month-old infants

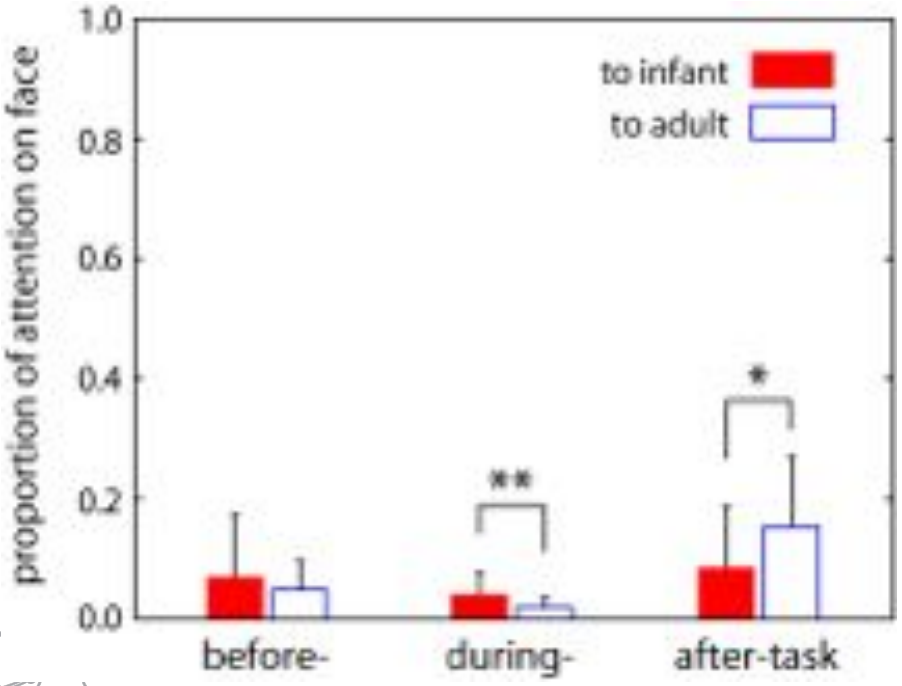
Result 1: Attention to Objects

- Highlight initial and final states (i.e., goal) of cups
  - Take long pause before and after task
  - Underline where cups are located



Result 2: Attention to Parent's Face

- Frequent social signals indicating significant events
  - Pause cup-handling movement
  - Talk to and smile at infants



Summary of Part I

- How teachers guide infants'/robots' learning
  - Significantly modify their actions
  - Highlight important information in the actions (e.g., goal and sub-goals)
  - Guide bottom-up attention to the important information

Part 2: How Infants/Robots Elicit Teachers' Scaffolding

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Factors Inducing Motionese

- Infant's age
  - 6-8 m > 11-13 m > Adult
    [Brand et al., 2002]
- His/her appearance
  - Simulation of baby-like face
    [Muhl & Nagai, 2007; Nagai et al., 2008]
  - Baby-like face > infant > adult
    [Vollmer et al., 2009]

→ What about feedback from a learner (e.g., gaze, gesture)?

Experiment [Nagai et al., EpiRob2010]

Question:

- How the visual attention of a robot influences teachers' action?

Method:

- Comparing actions directed to a robot with:
  - *Bottom-up* attention
  - *Top-down* attention

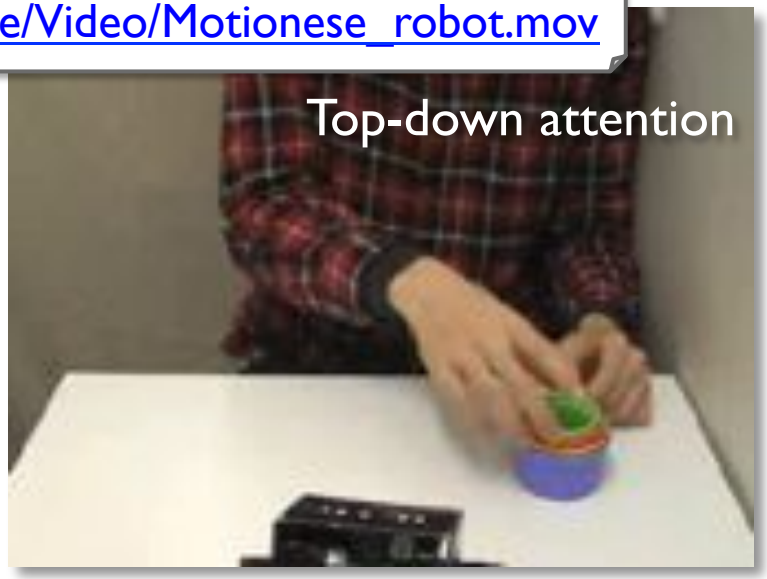
Subjects:

- 16 university students

- 45 cm of tall
- A camera attached to the head

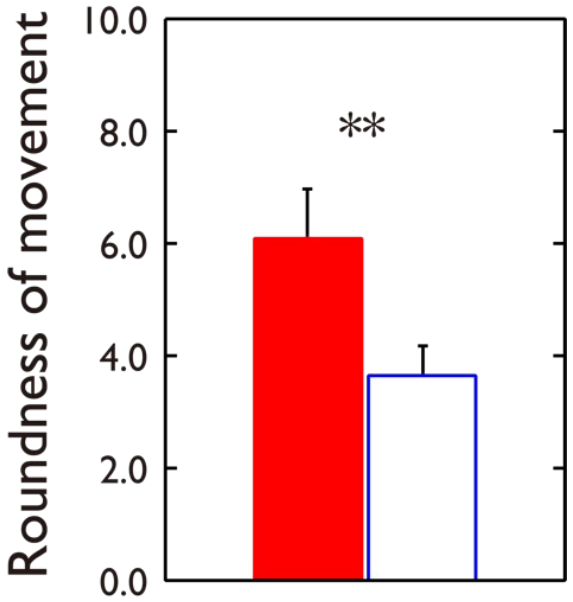
Two Conditions

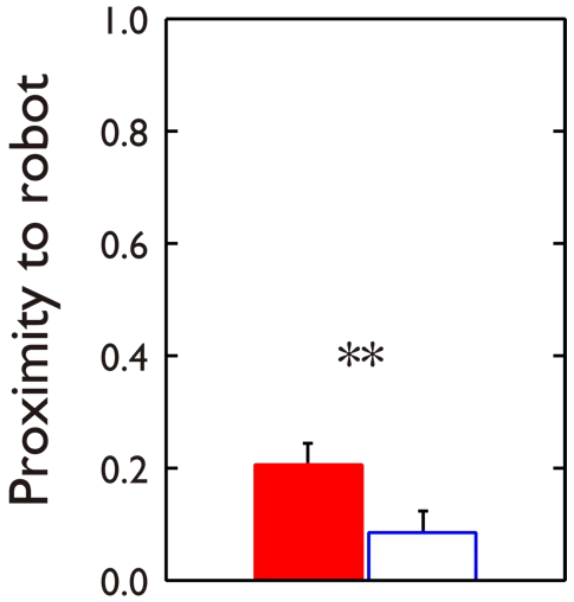
http://cnr.ams.eng.osaka-u.ac.jp/~yukie/Video/Motionese_robot.mov



- Saliency model [Itti et al., 2003]
  - Look at the most conspicuous location
  - Don't know the goal
  - Younger infants (8-11M)
- Wizard of Oz
  - Anticipate the goal and the next action
  - Know the goal
  - Older infants (12-24M)

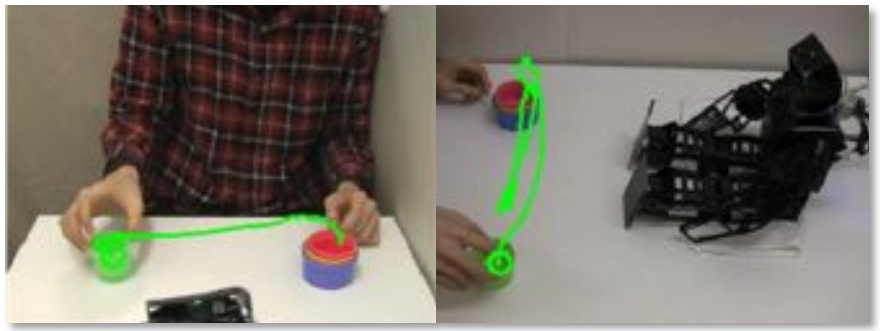
Result 1: Spatial Action Modifications



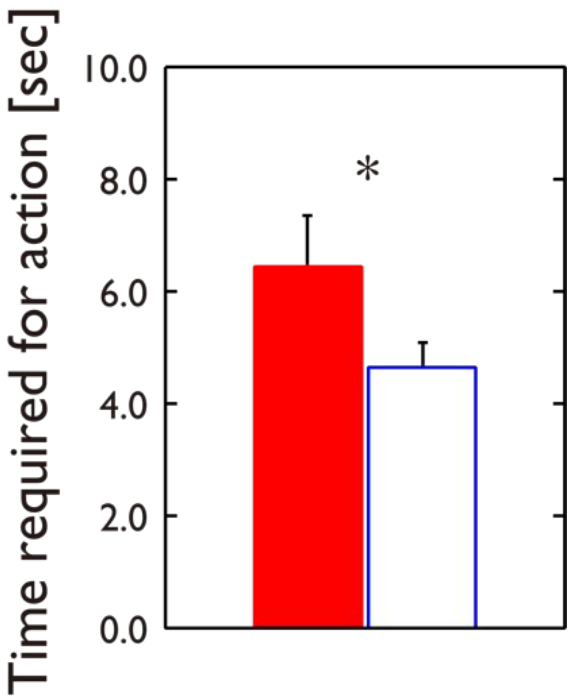


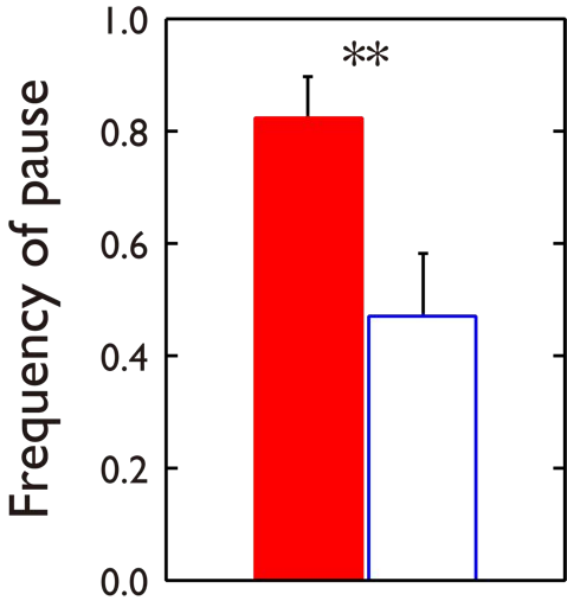
Saliency model

Wizard of Oz



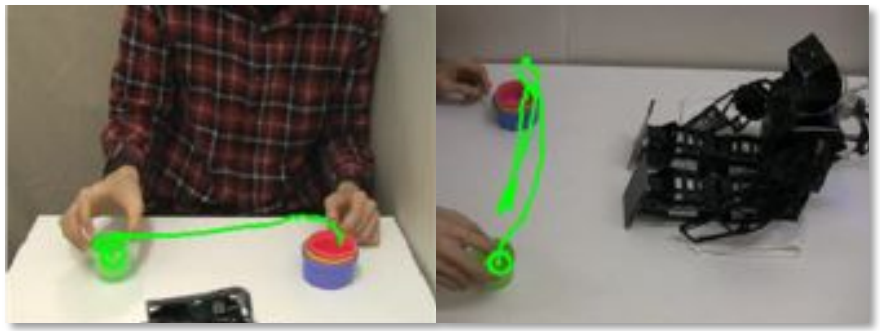
Result 2: Temporal Action Modifications





Saliency model

Wizard of Oz



Summary of Part 2

- How infants/robots elicit teachers' scaffolding
  - Respond with immature attention
  - Exhibit undifferentiated (or no)categories of actions
  - Induce teachers to exaggerate actions

Conclusion

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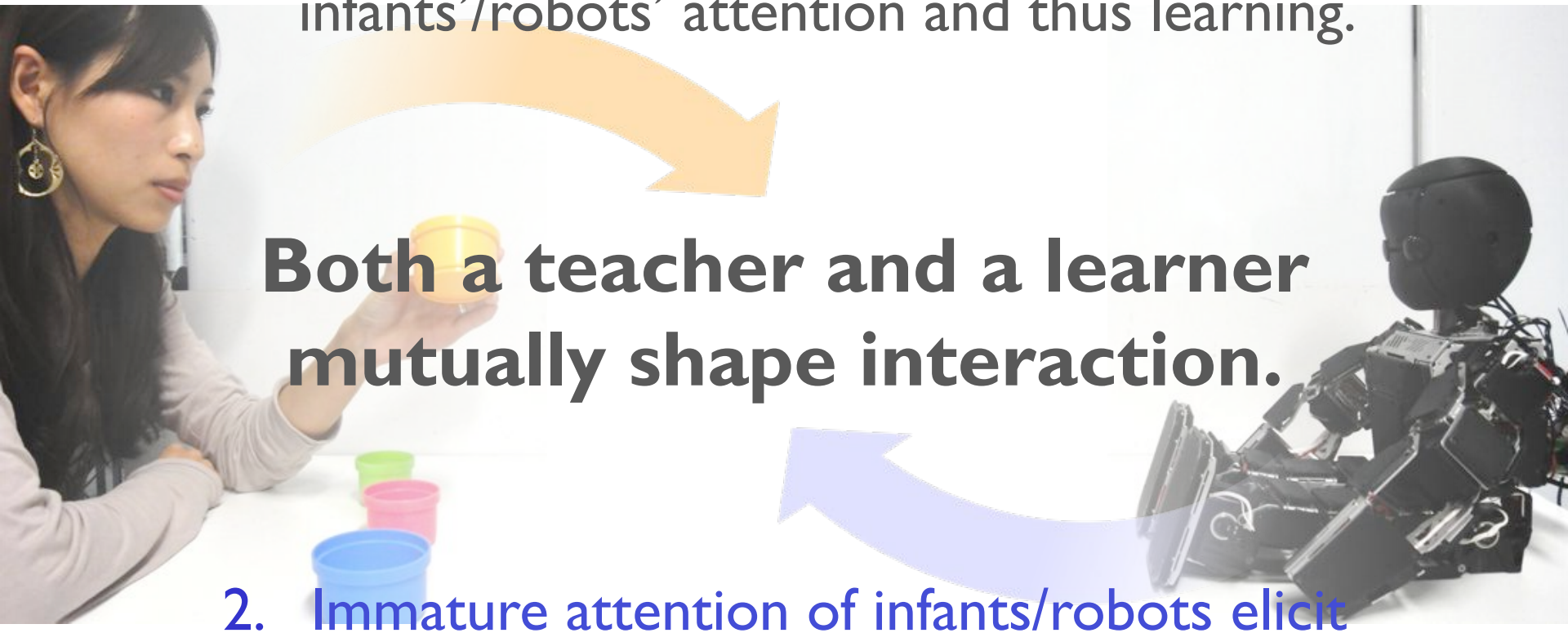
Take Home Message

1. Teachers' exaggeration of actions guides infants'/robots' attention and thus learning.



Both a teacher and a learner mutually shape interaction.

2. Immature attention of infants/robots elicit teachers' exaggeration of actions.

The Power of Scaffolding!

http://cnr.ams.eng.osaka-u.ac.jp/~yukie/Video/Scaffolding.mov

Achieve the goal with
appropriate scaffolding ☺

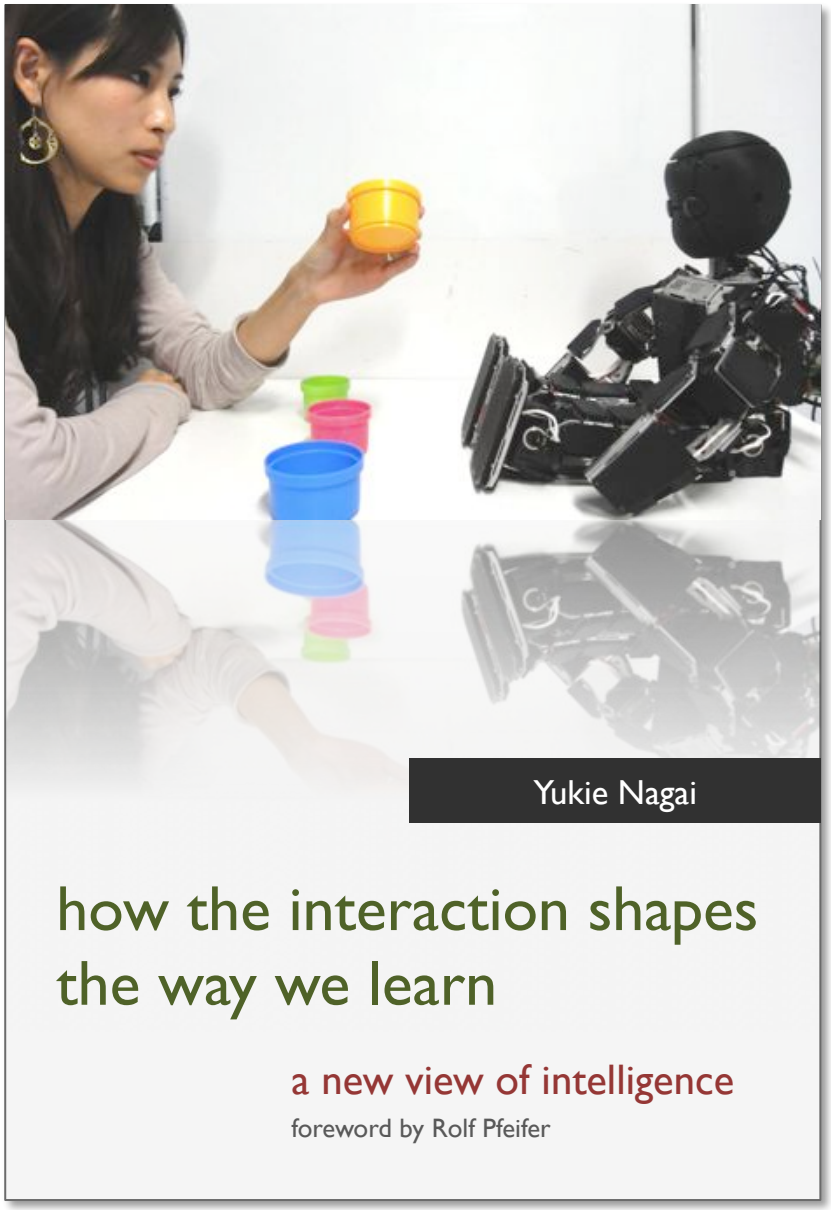
Puzzled by
inappropriate scaffolding ☹

(Videos adapted from YouTube)

Thank you!

yukie@ams.eng.osaka-u.ac.jp
http://cnr.ams.eng.osaka-u.ac.jp/~yukie/

To be UNpublished…



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