

Infants' grasp of others' intentions

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Full disclosure:

- I am not an autism researcher.
- I am a developmental psychologist who is interested in how typically developing infants come to perceive the social world in meaningful ways.
- I hope that what I have to say about typical development will be useful and will spark new dialogue.

Making sense of the social world: Intention-reading



- Actions are not only movements through space.
- They are structured by goals and objects of attention.
- Actions embody intentional relations.
- Basic building block of social reality.
 - First step in on-line action analysis
 - An early step in the development of folk psychology

Overview of today's talk:

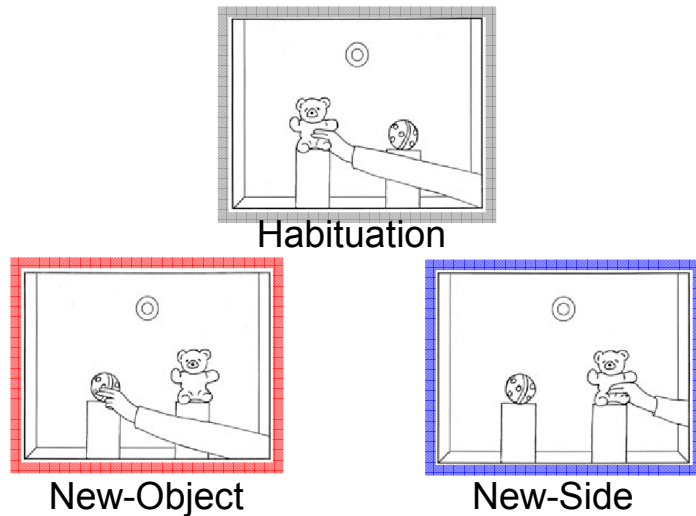
Intention-reading during the first year of life

1. Infants' intention-reading is early-emerging and functionally robust.
2. Origins of intention-reading, two interacting routes for learning about and generalizing action knowledge.
 - Effects of developments in infants' own actions.
 - Effects of interactions with social partners.

Infants' intention-reading is early emerging
and functionally robust

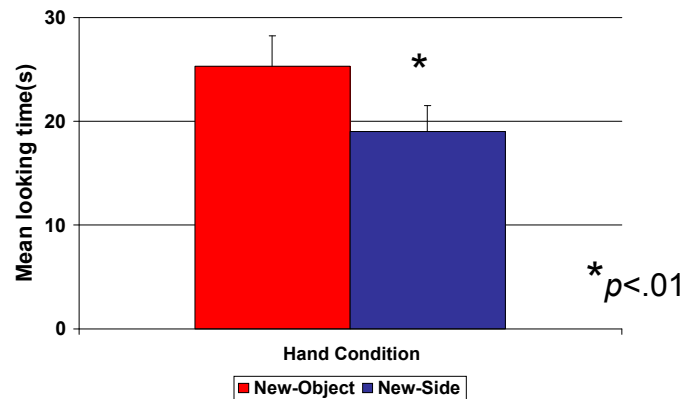
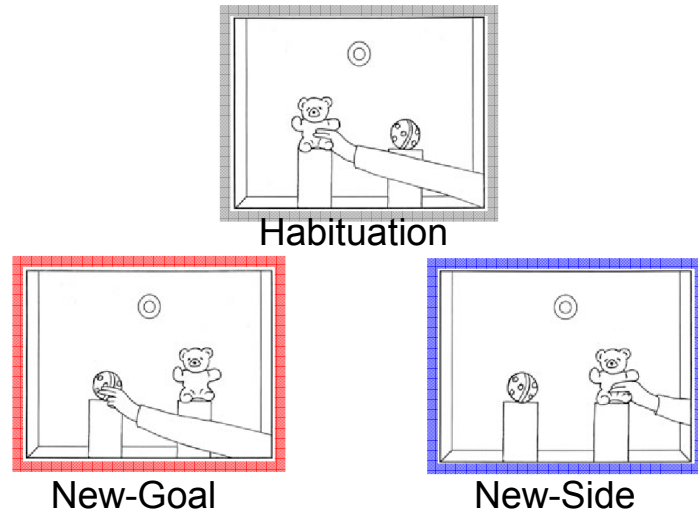


Visual habituation as a measure of infants' goal encoding

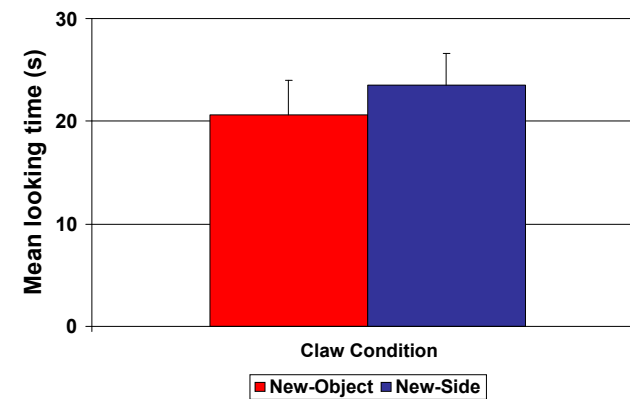
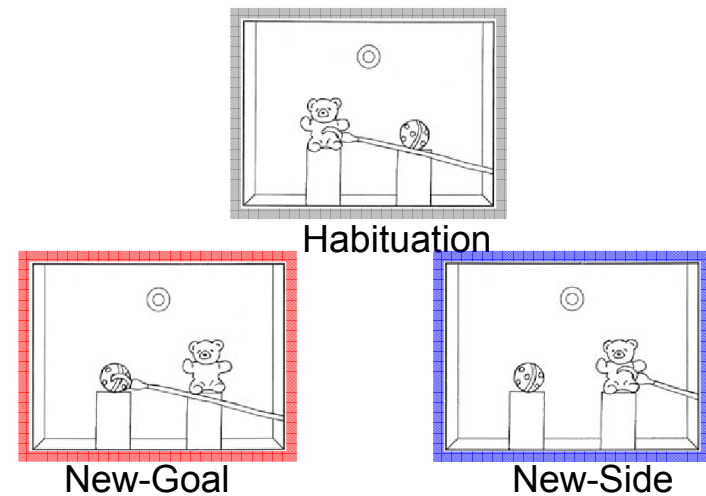


- **Habituate** infants to a repeated action
- **New Goal Trials:** disrupt agent-object relation, preserve motion
- **New Side Trials:** preserve agent-object relation, disrupt motion
- Reveals infants' encoding of the relational (goal-directed) structure of action

Hand Condition



Claw Condition



6-month-old infants

Woodward, 1998

Infants look longer at goal changes than movement changes



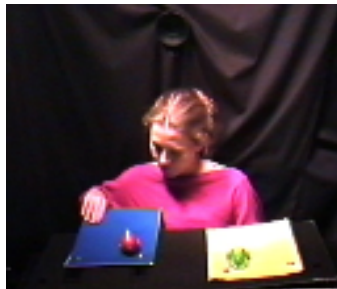
Grasping

(Guajardo & Woodward, 2004; Sodian & Thoermer, 2004; Wellman & Phillips, 2001; Woodward, 1998, 1999, 2003)



Attention (looking and pointing)

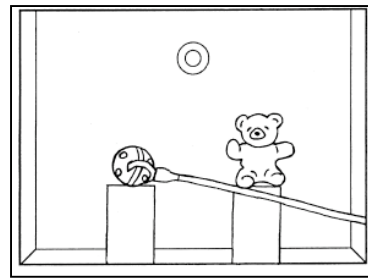
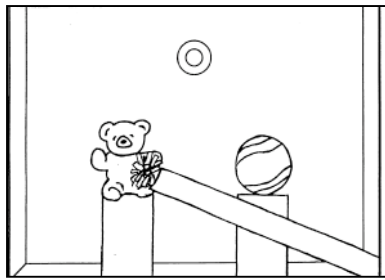
(Luo, Ok & Johnson 2007; Phillips, Wellman & Spelke, 2002; Sodian & Thoermer, 2004; Woodward, 2003; Woodward & Guajardo, 2002)



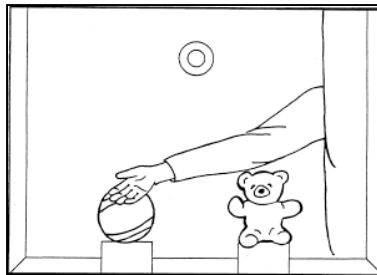
Tool use (means-end sequences)

(Hofer et al., 2005; Sommerville & Woodward, 2005; Sommerville et al., 2008; Woodward & Sommerville, 2000)

Infants' intention-reading is selective for the well-formed goal-directed actions of agents



- Infants do not respond to “goal” changes when the moving object is not readily identified as an agent.



- Infants do not respond to “goal” changes for the ambiguous or nonfunctional movements of agents.

How robust is infants' intention-reading?

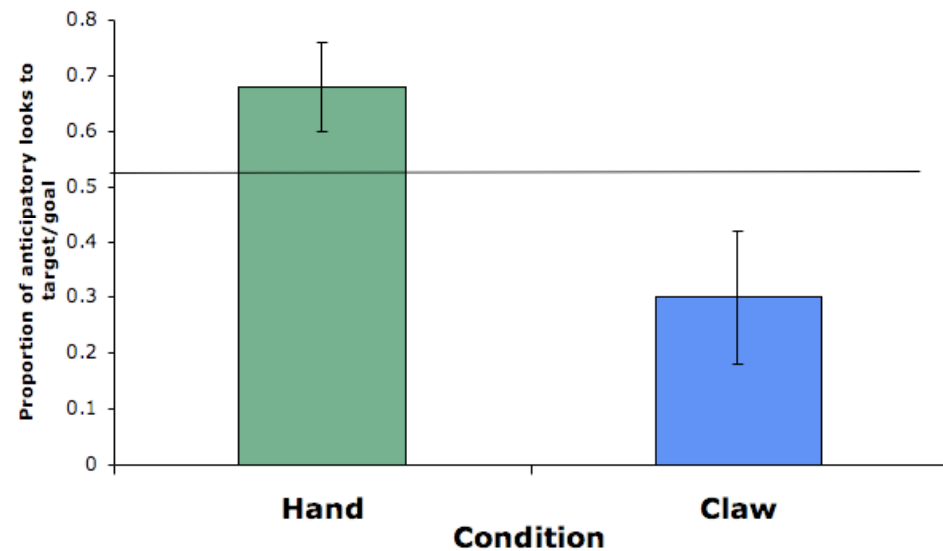
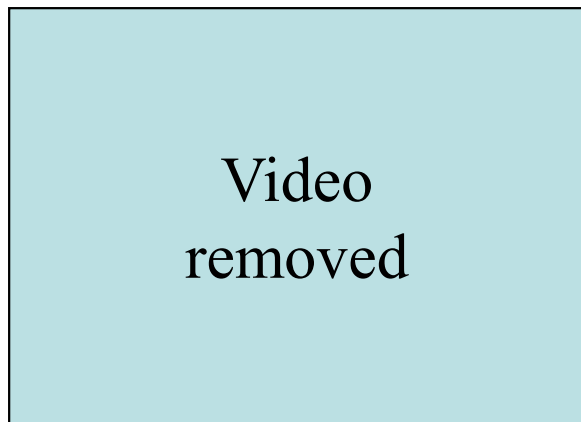
- An analysis that influences not only passive visual responses, but also active responses to others' actions?
 - Goal-based predictions
 - Goal imitation

Do infants generate goal-based predictions?



- Visual habituation responses do not reveal whether infants predicted that the agent would maintain the same goal.
- Eye-tracking can provide a direct measure of visual anticipation
 - Familiarize to a completed grasp.
 - Test probe: objects in new positions; truncated reach.

11-month-old infants' goal prediction



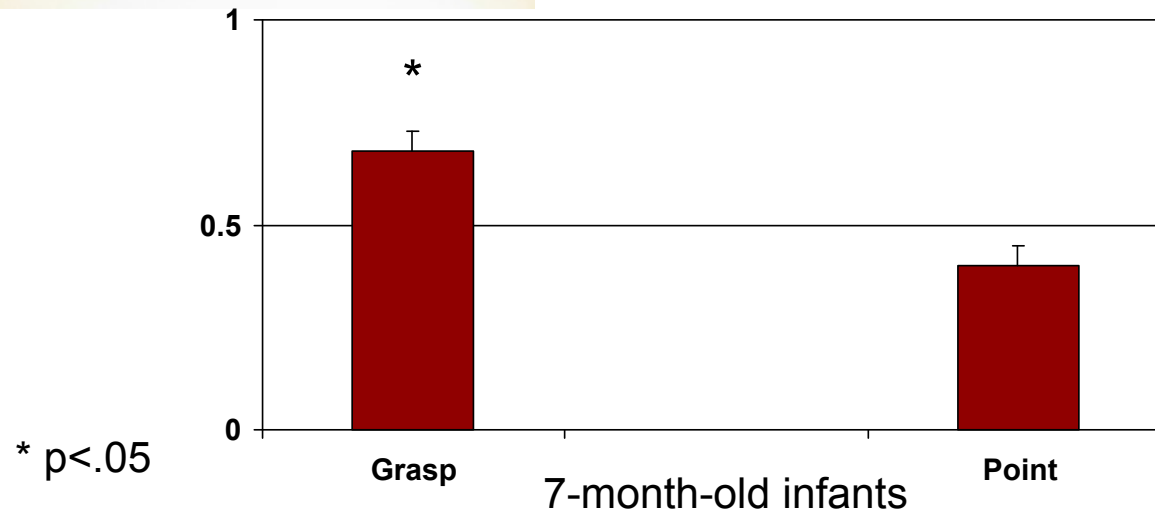
Cannon & Woodward, in preparation

Does goal analysis drive overt social behavior in young infants?

Grasp Condition



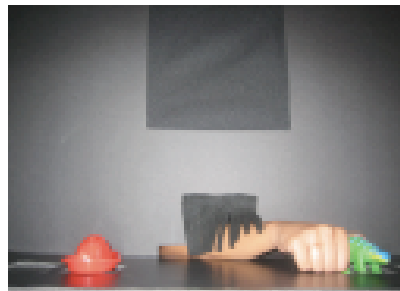
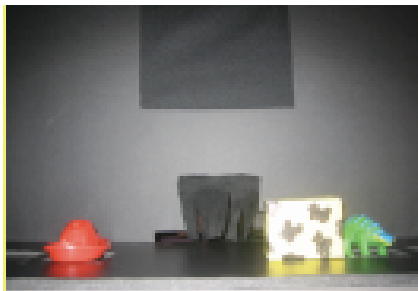
Point Condition



Infants' goal imitation is selective the well-formed goal-directed actions of agents



- Familiar (grasping) actions but not ambiguous manual contact (Hamlin et al., 2008).



- Actions of hands but not the actions of self-propelled boxes (Mahajan & Woodward, 2009).

Interim Summary

- Infants' sensitivity to action goals emerges early and is functionally robust
 - Goals that structure individual actions
 - Goals that structure chains of action
 - Collaborative goals that are shared across individuals
- During the first year, it is evident in their
 - encoding of the goal structure of others' actions
 - predictions concerning others' actions
 - imitation of others' actions

Developmental origins of intention-reading



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How do infants come to discern intentional relations?

- **Facts that any developmental account must explain**
 - Intention-reading is automatic and universal in adults.
 - It is critical for survival and for the development of basic human abilities (language, culture, morality), and therefore likely the product of natural selection.
 - It emerges early in infancy.
- **Two kinds of accounts that could explain these facts**
 - **Innate “intention” module:** Universality and early emergence reflect innately specified intention-reading systems.
 - **Innately based learning system:** Universality and early emergence reflect universal and early aspects of experience.

Do early, universal aspects of infants' experience contribute to intention-reading?

- In the ontogeny of species-typical abilities, it is common for developmental processes to recruit information from reliably present aspects of experience (e.g, language, birdsong, imprinting).
- In some cases this information is reliably present because it is self-produced (e.g. Gottlieb's ducklings).
- **A proposal:** infants' experience coordinating their own goal-directed actions informs their perception of others' actions as goal-directed.

Potential contribution of self-produced actions

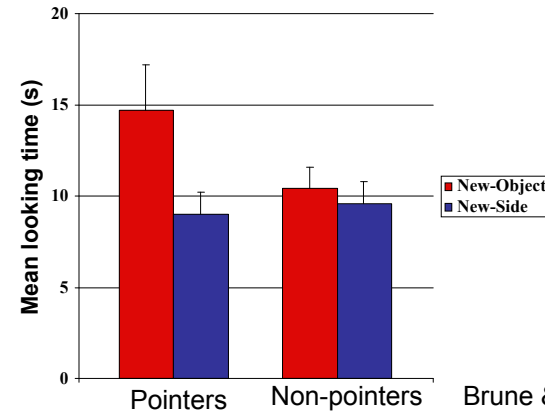
- Long-held hypothesis that first person agency provides insight into others' intentions, because we know the goals that structure our own actions.
- At least two (non-mutually exclusive) ways in which this could be true
 - Analogical extension from self to other
 - Shared neurocognitive representations (e.g., “mirror neurons”)
- A first test of either of these possibilities is to ask whether infants' own actions influence their perception of others' actions

Investigating the effects of infants' own actions on their perception of others' actions

- Two strategies
 - First seek naturally occurring correlations between action production and perception: Guides hypotheses about which aspects of experience could contribute to intention-reading.
 - Then, seek to isolate the effects of action production on action perception via experimental interventions: Tests causal effects of action on action perception.

Infants' goal encoding correlates with their own actions

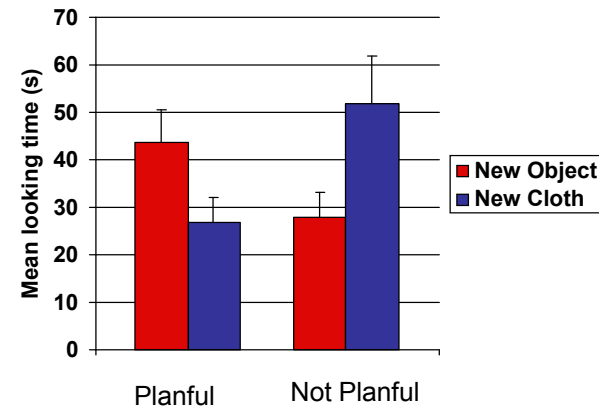
Pointing



Brune & Woodward, 2007, Woodward & Guajardo, 2002)

Means-end action structure

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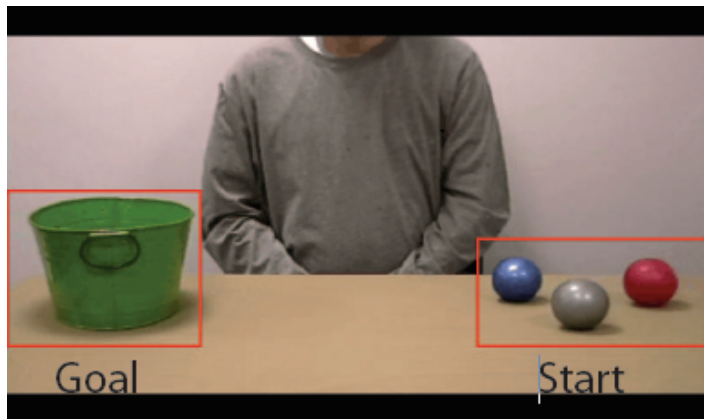


(Sommerville & Woodward, 2005)

Relations between acting and action anticipation?

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- Infants, like adults, visually anticipate the outcomes of others' actions (Falck-Ytter et al., 2006).



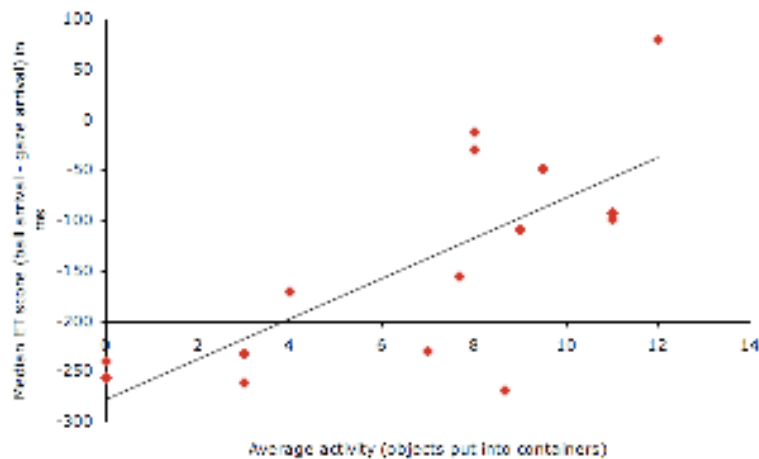
- At 12 months, does infants' own action engagement predict their action anticipation?

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- 12-month-old infants spontaneously anticipate the end point of containment actions.

- Infants' visual anticipation correlates with their own propensity to put objects into containers.

- This relation is strongest when infants' own actions come first.



Cannon, Woodward et al., in preparation

Experimentally induced effects of acting on infants' intention-reading

- Infants' own actions **correlate with** their understanding of others' actions
- But do their own actions **influence** their understanding of others' actions?
- Intervention studies address this question
 - Manipulate infants' experience producing goal-directed actions
 - Assess the effects of this on their perception of others' actions

“Sticky mittens” intervention

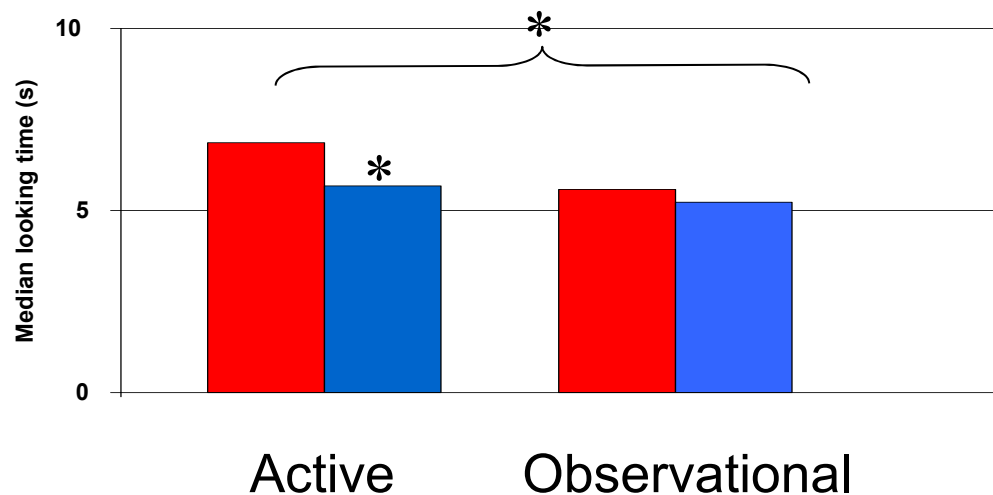
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Active Training

Observation Training

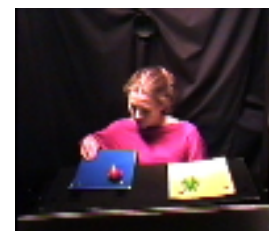
- Active training leads infants to view others' actions as goal-directed

- Matched observational experience does not have this effect.

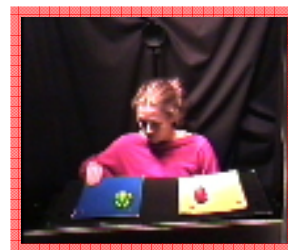


Effects of means-end training at 8 months

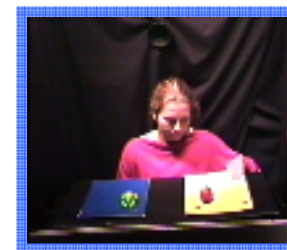
Photos of training
Procedure removed



Habituation



New Toy



Test

New Cloth

Before training



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Training



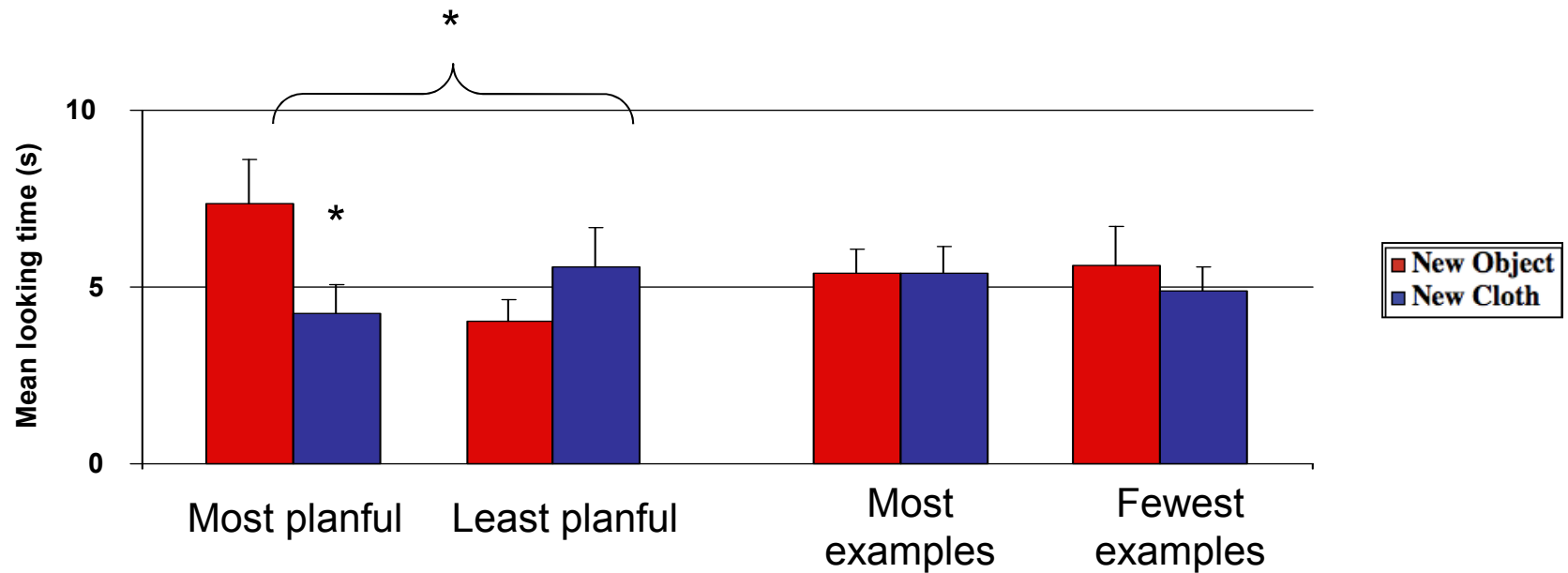
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After training



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Effects of means-end training on 8-month-old infants' analysis of observed actions



*
 $p < .05$

Active Training

**Observational
Training**

The fingerprints of infants' actions are all over their intention-reading

- Infants learn from their own actions.
- When infants engage in goal-directed action, they glean insights into the goals that structure others' actions.
- Observational experience does not provide them with “portable” information in the same way.

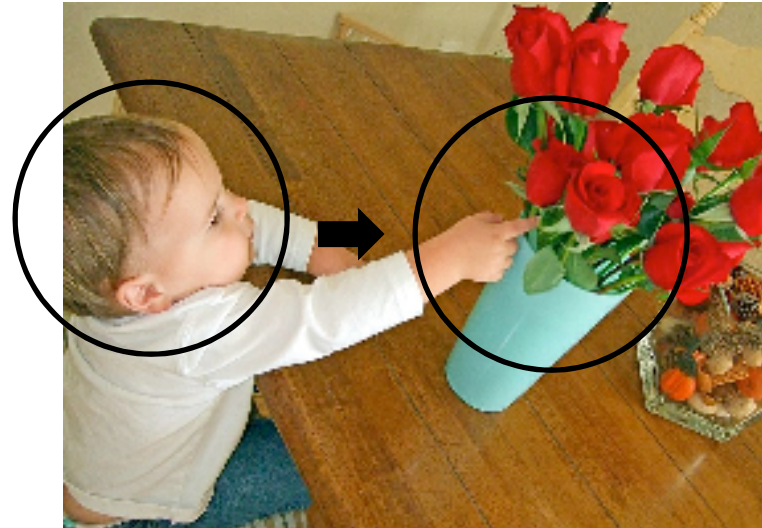
A good start, but how far will it get you?

- Information from one's own actions is useful, but limited.
- Fluid social reasoning requires inferring others' goals on-line, even when others do things you haven't done before.
- How do infants get beyond these limits?
- One possibility: by using their initial action knowledge as a base for analogical extension



Analogies are a challenge

- Detecting the relation between agent and goal is key to understanding intentional actions
- This goal-relation may differ perceptually for one's own and others' actions
- **Difficulty: Making an analogy between perceptually dissimilar instances**
- **Solution: Physical alignment of the exemplars supports conceptual alignment and analogy formation**



A prediction

- Physical alignment of their own actions with an other's novel action should facilitate infants' detection of goals in novel actions.
- That is, social interactions in which the baby's own actions are directed at the same object as the action of a social partner should support intention-reading.

A test: The Claw



- Young infants do not readily encode claw movements as goal-directed.
- They do not generate goal predictions for claw movements.
- They do not show goal imitation for claw actions.
- Can we change how infants view the claw's actions?

Does aligning novel actions with the infants' own actions support intention-reading?

Photos of
training
procedures
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Alignment Condition

- Infant and claw grasp toy at the same time.

Touch-Claw Control

- Infant explores claw, but no toy is involved.

Move-Toy Control

- Infant views the claw moving toys; no alignment with own actions.

Gerson, in progress

Familiarization

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Alignment

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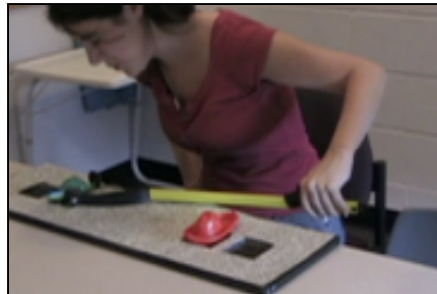
Touch-Claw

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Move-Toy



Demonstration



Imitation

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Do infants imitate the goal
of the claw actions?

Gerson, in progress

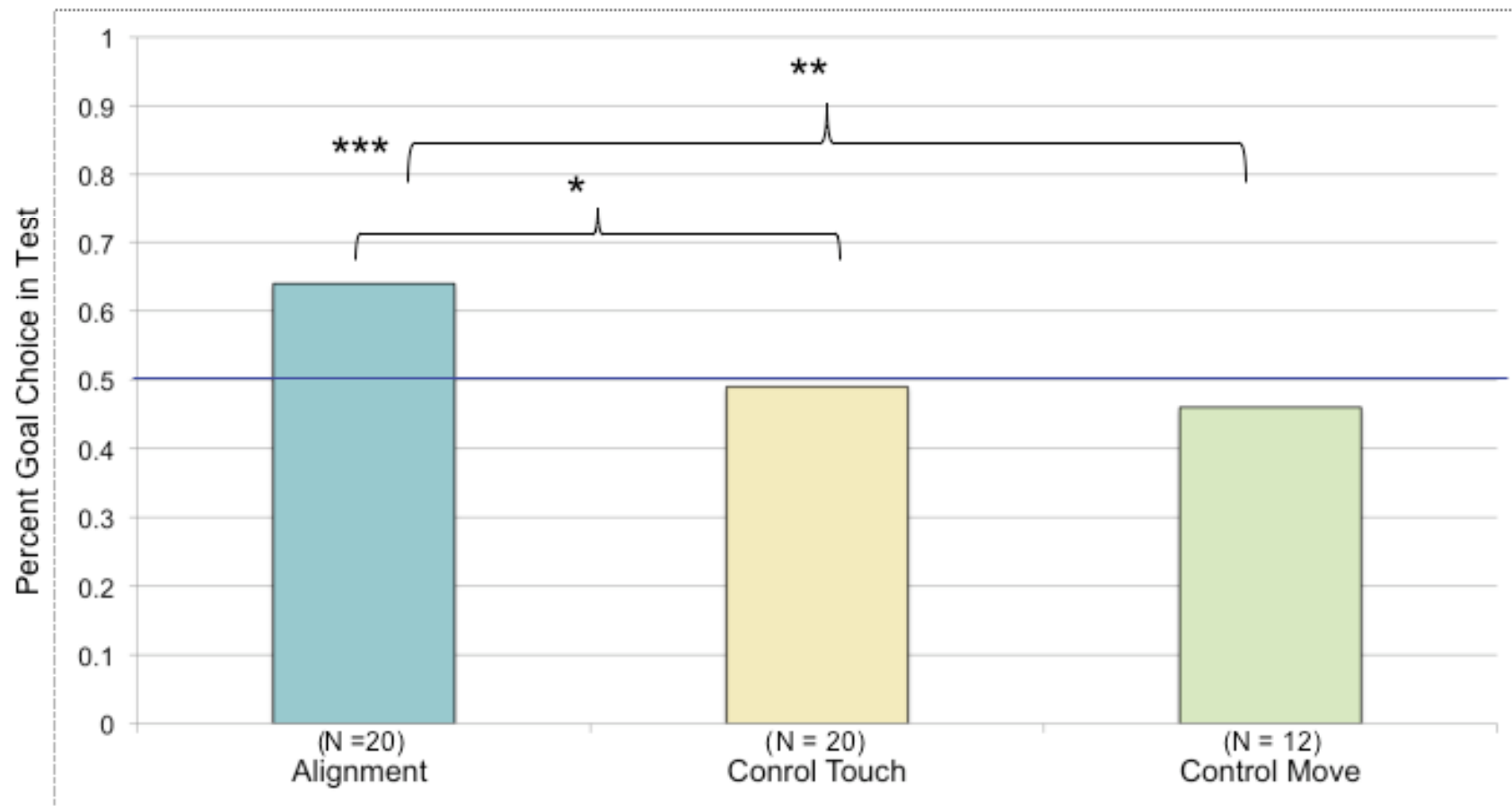
Alignment Condition

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Touch-claw Control

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Move-toy Control



Joint action sets the stage for learning about others' actions

A brief opportunity to coordinate their own actions with those of the claw shifted 7-month-old infants' perception of the claw events as goal-directed.

Joint actions can allow infants to see the similarities between their own actions and the (novel) actions of others.

Similar to Barresi & Moore's (1996) view of joint attention and triadic understanding, but extended to the earlier coordination of manual actions on objects.

Conclusions

- Infants' intention-reading draws structure from developments in their own action production.
- The benefit of self-produced action representations may chiefly be that they provide a powerful base for analogical extension.
- Social interactions, and joint action in particular, may provide powerful support for generalizing goal knowledge to new events.

- The origins of intention-reading rest (at least in part) on two kinds of early, and universal experiences
 - Learning to act
 - Acting with others



Acknowledgements

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