Infants' Grasp of Others' Intentions

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Birth to Three 7/2014

Making sense of the social world: Intention-reading

- Actions are not only movements through space.
- They are structured by goals and objects of attention.
- Basic building block of social competence.
  - First step in on-line action analysis
  - An early step in the development of "theory of mind".

We could perceive it otherwise….

Take the people around the table. We seem to see husbands and wives and friends and little brothers. But what we really see are bags of skin stuffed into pieces of cloth and draped over chairs. There are small restless black spots that move at the top of the bags of skin, and a hole underneath that irregularly makes noises. The bags move in unpredictable ways, and sometimes one of them will touch us.

Gopnik, Meltzoff and Kuhl, 1999

Intention-reading: Gate keeper for social learning

- **Language**
  - Children learn language by analyzing people's goals and states of attention.
- **Danger, safety, and value judgments**
  - Children interpret the meanings of others' emotional expressions by analyzing others' goals and attention.
- **Acting like one of us**
  - Children imitate the intentionally central aspects of others' actions.

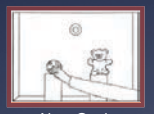
Warneken & Tomasello

Overview of today's talk

- When do infants begin to engage in intention-reading?
  - Initial sensitivity to others' action goals.
  - Emerging ability to recruit this information in the moment, as actions unfold.
- What are the origins of infants' intention-reading?
  - The role of early experience in shaping infants' social knowledge.

Visual habituation as a measure of infants' intention-reading

Habituation



New-Goal

New-Side

- **Habituate** infants to a repeated action
- **New Goal Trials:** disrupt agent-object relation, preserve motion
- **New Side Trials**: preserve agent-object relation, disrupt motion
- By 3 to 6 months of age, infants show selective recovery on New Goal trials.

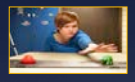
Woodward, 1998; see also Biro & Leslie, 2006; Guajardo & Woodward, 2004; Sodian & Thoermer, 2004; Wellman & Phillips, 2001; Woodward, 1999, 2003

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.

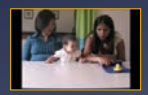
Sommerville & Woodward, 2005; Woodward, 1998, 1999

Infants look longer at goal changes than movement changes



Grasping – 6 months of age

Attention – 8 to 12 months of age



Higher order plans – 12 months of age

Collaborative goals – 13 months of age

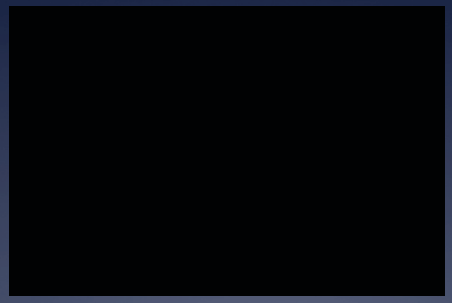
see Woodward et al, 2009 for review

How robust is infants' intention-reading?

- Habituation studies give infants a lot of time to think about the person's intentions.
  - Repeated trials, infant-controlled viewing times.
- But to be socially useful, this thinking has to happen fast.
- Can infants generate goal inferences on-line, as others' actions unfold?

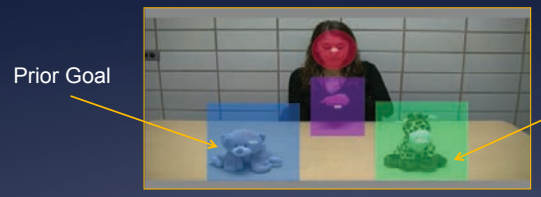
Predicting others' actions in the moment

An eye-tracking gaze trace from a 15-month-old infant



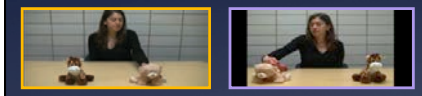
Krogh-Jespersen & Woodward, 2014

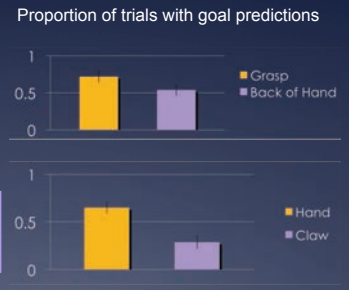
Goal-based predictions



- Predictive fixations:
  - The first look to either the prior goal or the prior location after fixating the hand region

11- to 15-month-old infants generate "smart" action predictions



Cannon & Woodward, 2012; Krogh-Jespersen & Woodward, 2014

Shared goals - Collaboration

Laurie opens the box

So that Annette can get the duck

What was Laurie's goal?

The box? *Or the duck?*

Henderson & Woodward, 2011

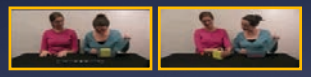
Predicting from collaborative goals (14 months)


Identifying collaborations

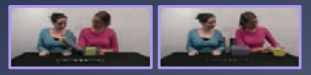
Collaboration involves actions that are complementary and critical to goal attainment and driven by a shared intention.

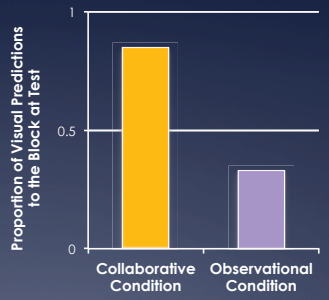
14-momth-old infants predict actions based on shared goals

Collaborative Condition



Observational Condition





Krogh-Jespersen & Woodward, in prep

Infants are socially smart

- Young infants: Initial ability to analyze others' goals evident in infants' "slow" responses in visual habituation tasks
- Older infants: Emerging ability to implement this analysis in "fast" on-line action predictions

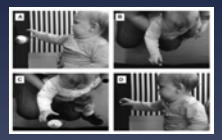
What are the processes that give rise to intention-reading?

- It is often assumed that capacities demonstrated in infants must be innate.
- But there is good evidence that experience matters for infants' intention-reading: Things change.

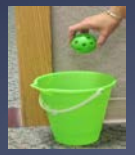
Which aspects of infants' experience might contribute to intention-reading?

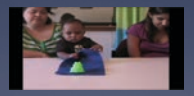
- In the ontogeny of species-typical abilities, it is common for developmental processes to recruit information from reliably present aspects of experience (e.g, language, birdsong, imprinting).
- Two potential sources of information for infants' emerging action knowledge:
  - Information provided by infants' own actions
  - Information provided by interacting with social partners

Infants' actions contain potentially informative relational structure



They are prospectively goal-directed

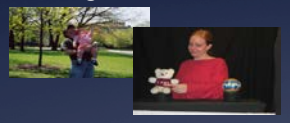


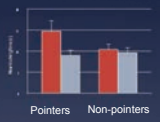


And organized by higher order plans

Infants' intention-reading correlates with their own actions

Pointing





Brune & Woodward, 2007, Woodward & Guajardo, 2002

Means-end action structure

(Sommervill e & Woodward, 2005)

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

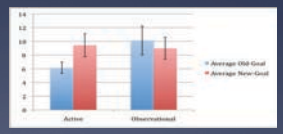
Infants' actions change their sensitivity to action goals: "Sticky mittens" intervention at 3 months

Active Training

Observation Training

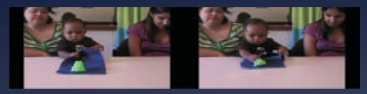
- Active training leads infants to view others' actions as goal-directed
- Matched observational experience does not have this effect.

Habituation procedure

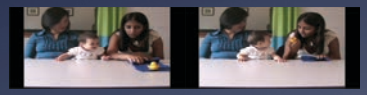


Gerson & Woodward, 2013, 2014; Sommerville, Woodward & Needham, 2005

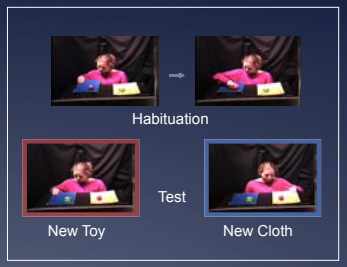
Effects of means-end training at 8 months



Active Training



Observational Training

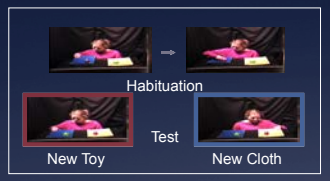


Gerson et al, under review

Before training

Training

After training



•Infants who benefit from active training, respond to the means-end structure in others' actions

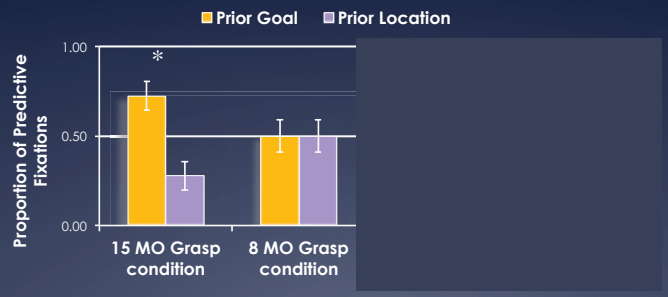
•Observational training did not influence infants' susbequent responses

Gerson et al., under review; cf. Sommerville et al., 2008

- Active experience supports infants' intention-reading in habituation experiments
- Does active experience also affect infants' ability to rapidly implement intention-reading?

Action predictions at 8 months

Effects of acting on 8-month-olds' goal prediction



Krogh-Jespersen & Woodward, in prep

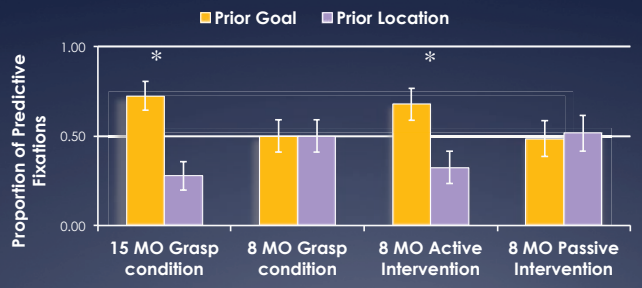
Active experience and goal prediction at 8 months

- 8-month-olds do not respond systematically in the goal prediction eye-tracking paradigm.
- But what happens if they first get active practice?
- If active experience helps, would observational experience also help?

Active experience

Observational experience

Effects of acting on 8-month-olds' goal prediction



Krogh-Jespersen & Woodward, in prep

Infants learn about action from their own actions

- Engagement in concrete actions supports insights in infants about intentional relations.
- Simply watching others' actions does not provide infants with "portable" information in the same way

Neural bases of infants' intention reading

- In adults, and in non-human primates, motor system activation occurs when watching others' actions.
- Infants show similar neural responses, but it is not clear what the functional significance of this activity is.
- To find out: Integrate neural measures of motor system activity with behavioral measures of goal-based reasoning in infants.

Neural activation

Behavioral measure of goal analysis

36 7-month-old infants

Neural measure: EEG mu-desynchronization

- 6-9 Hz over central recording sites
- Suppression relative to baseline
- Occurs during both the execution of an action and the observation of someone else's action

Filippi, Thorpe, Fox & Woodward, under review

Behavioral measure: Goal imitation

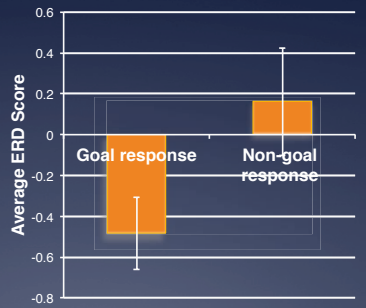
•In this paradigm, infants tend to select the actor's prior goal.

•But responses are variable, sometimes they choose the other object.

•We used this variability to ask whether neural activity **during action observation** selectively predicts subsequent goal-based responding.

Motor system activity during observation predicted infants' propensity to imitate the actor's goal

- Suppression occurred prior to goal-responses
- But not prior to non-goal responses
- Infants were equally attentive on both kinds of trials



- Infants were attentive, watching a person move in all cases.
- They went on to produce a clear motor response in all cases.
- But neural activity varied depending on the KIND of response infants subsequently produced.
- Motor system activity selectively predicted goal-based responses in infants.

A link between infants 'actions and action understanding

- Producing actions, but not observing them, supports infants' analysis of goals in others' actions.
- Neural activity in the motor system selectively relates to infants' tendency to respond to others' action goals.
- Concrete actions support abstract insights about the intentional structure of others' actions.

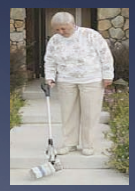
A good start, but how far will it get you?

- Information from one's own actions is useful, but limited.
- Fluid social reasoning requires inferring others' goals, even when others do things you haven't done before.
- Is the knowledge gained from self action useful in these cases?
- Possibly: First person action knowledge could serve as a base for analogical extension in making sense of novel actions.

Detecting relational similarities in action

- Goal-directed actions are structured by the relation between agent and goal.

- Using familiar actions to gain insight into novel ones requires detecting relational similarity.
  - My reaching actions are goal-directed.
  - Her tool-use actions are goal-directed.



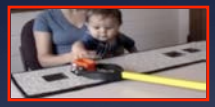
A prediction

- Conditions that facilitate analogical learning should support infants' extending knowledge from familiar to novel actions.
- Social interactions provide exactly these conditions:
  - The infants' actions are coordinated with those of the social partner
  - Sets the stage for comparison of novel actions with the infants' own actions

A test case: The Claw

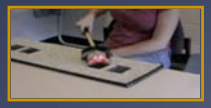
- Young infants do not readily encode claw movements as goal-directed.
- They do not generate goal predictions for claw movements.
- Can we change how infants view the claw's actions?

Effects of aligning own actions with others' novel actions: 7-month-old infants



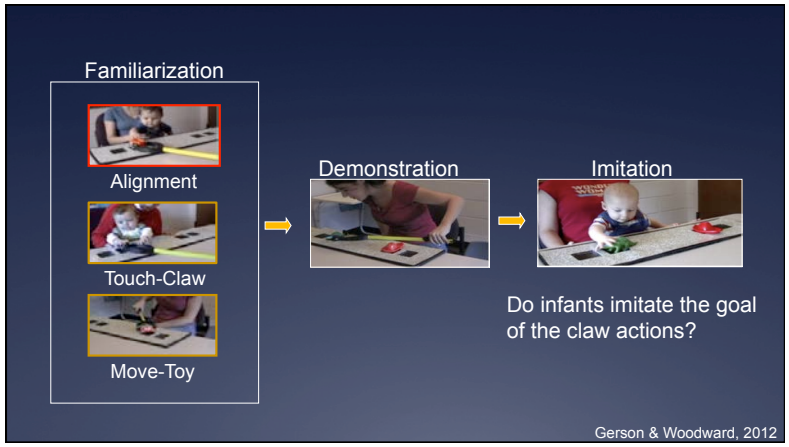
Alignment Condition
- Infant and claw grasp toy at the same time.

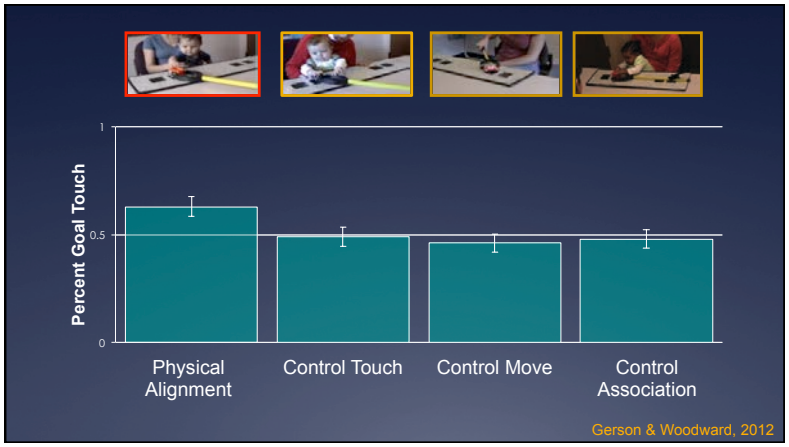
Touch-Claw Control
- Infant explores claw, but no toy is involved.



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

Gerson & Woodward, 2012





- Young infants are resoundingly uncertain about the goal-structure of claw actions.
- Yet a brief interaction that provides support for analogical learning leads them to understand this action.
- Coordination of the infants' own actions with those of the person using the claw is key.

Infants' own actions provide rich learning opportunities for social understanding

- Action experience shapes infants' intention reading because it allows infants connect their own goal representations with the actions of others.
- This can occur when infants engage in actions themselves.
- Or when they coordinate their own actions with those of others.
- Both of these experiences are ubiquitous in infants' lives.

Joint action is pervasive

Conclusions

- Infants see intentional structure in the social world.
- This ability is shaped by infants' concrete experiences
  - Infants' own actions
  - Infants' engagement with social partners
- These concrete connections support insights about abstract, intentional structure in others' actions.

Acknowledgments

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