

Plenary Session: Infants' Grasp of Others' Intentions
18th Annual Birth to Three Institute

Jennifer Boss: Welcome back. For those of you who were with us yesterday and maybe even the day before, welcome back. For those of you who are just joining us this morning, welcome. And welcome to all of the – our colleagues out there who are watching via livestream.

I'm Jennifer Boss. I'm the director of the Early Head Start National Resource Center. And I am pleased to welcome you back here today, and I'm going to just say a few words. We have a few housekeeping notes, and then I'm going to turn things over to Angie Godfrey.

So, just a few notes here for you. The Birth to Three Institute is offering free CEUs this year, so please visit the CEU desk, located near the registration desk in Independence A, B, C, and D, for more information. So please take advantage of that. If you need to get your CEUs, go down to that CEU desk and find out what you need to do.

Another reminder: I said this yesterday and then I went out and I did the exact thing that I said not to do. In your program are sessions; by the sessions, we have a level – levels 1, 2, or 3. Those are the learning levels. Those are beginner, intermediate, advanced learning levels. And then, next to the learning level is the location of the room. That does not mean the room is on that level. So I said that yesterday, and then I walked out to my session and I looked at the program and I said, "Oh, Level 1" – whatever the room was – and I went up to Level 1 and I was looking around. "Where's the Monument Room?" I did exactly what I said don't do. So remember, levels are the learning levels. The room? Look in the back of your program at the map for where the room is located. And I know some of you are going to go out and do the same thing that I did yesterday.

Also – oh, for those of you who tweet... Anybody use Twitter? Yes? Okay, so we want you to be tweeting about the Birth to Three Institute. Join the Twitter conversation with @BTT14. So get on Twitter and start sharing what you're learning.

Also, I don't know if a lot of you have noticed, for your final program – if you pull out your final program, in the very – the centerfold, you have a session guide. This is a really helpful tool to use if you're looking for your session and trying to figure out where it is you need to go. Pull out your final program, open it up to the centerfold, and you can find it pretty easily. Now, there's a note here in your centerfold – the session guide. It has session E12 listed twice on Thursday. Make sure you look on page 30 of your program to find the current information and location for E12 and E13.

Another important note: for those of you who signed up for session C8 today, that has been canceled. So please go find another session that you would like to attend; but C8 has been canceled. And another reminder: I mentioned yesterday that our colleagues from the Region XI AIAN programs, you are invited to a listening session with the federal staff and the T/TA providers; and that meeting is today at 12:30 in the Mint Room. AIAN programs, you're welcome to join the listening session today at 12:30 in the Mint Room. And I believe all of you received an email invitation about that yesterday from the Region XI federal staff. So, please join us for that.

And then, one other note. After each session – I don't know if you all have noticed, but we do not have paper evaluations this year. We're sending evaluations electronically, and we really want to hear from

you about how the sessions are going. We take your evaluation, your feedback, very seriously when we're planning for the Birth to Three Institute, so we're hoping that you will fill out the evaluations. But they're being sent to you electronically after each session, and they're being sent to the people who registered for that session. So if you chose to go to another session that you didn't register for, you're not going to receive an evaluation for that session.

The evaluations are being generated automatically to the individuals who registered for that session, and they're being sent out after each session. So please take a look on your phone or on your tablets or your computers, or go to the data café, and take a few minutes to fill out the evaluations. We really do want to hear from you about how the sessions are going.

Okay, so those are my few housekeeping notes. I'm going to now turn the mic over to Angie Godfrey, the infant-toddler program specialist at the Office of Head Start, and she's going to say another few words of welcome and introduce our next speakers. Thank you. [Applause]

Angie Godfrey: Good morning, everyone. How are you today? Awake? Good. Good morning. I want to thank you again. Yesterday, I thanked all of you for coming in such a busy, busy time, and I thank you again today for coming. It really is a wonderful conference and I'm going to talk a little bit about that as – in a few minutes.

But first, we talked a lot yesterday, all of us who spoke from the federal office, about partnering and partnership and how important it is for the work; and it's certainly something that I believe in. And, every day, I work with two wonderful partners at the Office of Head Start, and I just wanted to introduce them. They're here. David Jones, who's the home visiting program specialist. [Applause] And Sarah Merrill. Sarah, someone told me you were way in the back and I can't see with the light. Where are you? Oh, Sarah! [Laughter] How far back could you get? Sarah Merrill is the other infant-toddler program specialist at the Office of Head Start, and she's doing a lot of work with professional development.

And for me, it's so wonderful to have Sarah and David to work with because they are such a powerful voice for babies and toddlers. And as we walk through the halls... And often, we – we also have... I have a third partner, Christina Benjamin from the Early Head Start National Resource Center, who works very closely with David on home visiting and also supports all of us on the days she's over there. When people see us coming, they go, "It's the baby people." And we love that because we want people to think "babies" whenever they see us. So, I'm grateful every day for Sarah and David and the work that we do over at the Office of Head Start.

I'm also grateful every day for the Early Head Start National Resource Center. When I left yesterday, I was so aware of how we've grown over the past 20 years; [Clears throat] aware of the ability of each of us, regardless of if we're a classroom teacher, if we're a home visitor, or if we're a program manager... I have something caught in my throat. I just have to get my water real quick. I don't know what it is, and I don't want to lean against this. Okay; maybe that will help.

That each of us has grown, and one of the reasons we've grown is because of the work of the Early Head Start National Resource Center. I loved the plenary yesterday, I read all about Amanda's plenary today, and I think that this is a unique experience because of the ability of the Early Head Start National Resource Center to bring us the science of how babies and toddlers develop and to bring it in the most useful way.

We know there's a lot of research out there. Early Head Start was founded on research. There was an – you know, a national advisory committee that worked hard to understand how babies develop and what early care and education should look like for infants and toddlers, and that's how Early Head Start came about. We are a national laboratory. We are the leaders in early care and education for infants and toddlers. And our ability to do that, and do it as well as we do with quality, is our ability to integrate science into practice. And what you do that's so amazing is you listen; you take the science in.

You work with wonderful TA specialists. Many of them are in the audience today. They've been to your programs. They bring so much to your programs to ensure that the science becomes practice, that all that you know about how brains develop and how babies learn is nestled in your understanding of relational learning, in your ability to nurture and hold babies and their families every day. And I know it's hard work. It is such hard work. But I also want you to know that not only is Early Head Start a gift, but so are the resources and people who are here to work with you and so are the resources that you are for each other.

So that's – that's what I left with yesterday, Jennifer. I always have to give you my reflection as I leave, so I just wanted to share that with you. And again, thank you all, because it's just an amazing opportunity that you have, that we have, to listen to the scientists in the field and then to put into practice what they tell us.

So with that, I want to introduce another person who is just an amazing person. I'm grateful every day to have the opportunity to work with Amanda Bryans. I've worked with her since I've come to the Office of Head Start. She is an unofficial baby person. [Laughter] She – she is. She's the director of the Education and Comprehensive Services Division, and she's really a birth-to-5 person and – and does help us understand birth-to-5 in a way that we all strive to understand, to improve the work. But she works across all of the content areas.

She supports all of us in our daily work, and she truly is an advocate for all aspects of delivery. When I walked into Amanda's office yesterday, she was grappling with a transportation question. And then we got off that and we had a conversation with someone who wanted to discuss infant and toddler assessment, and so we had a phone call with him. And Amanda just, in a seamless way, kind of crosswalks all of the areas of Early Head Start and Head Start, and I appreciate it every day, and it's my privilege to introduce her. [Applause]

Amanda Bryans: Thank you, Angie. This is complicated here with the step and the...

Angie: Just don't lean on it.

Amanda: Don't lean on it. All right, well, that's almost a sure thing that I will lean on it. Thank you so much for that lovely introduction. And your words, too, Jennifer. It's such a privilege to be here. I'm really glad to see you. I do note some empty seats, so I don't know... The 8 a.m. kind of thing? That? Ugh. All right.

So I agree with Angie that it is such a great privilege to work in Head Start and Early Head Start, and part of what we really do is to work hard to constantly push the envelope around learning from research. Also, learning from experience and using common sense to try to integrate what we're learning from research and our experience in order to deliver ever-improving services for infants and toddlers and their families, right? Don't forget common sense; okay?

I guess one of the things I've been thinking about a lot... And I love about Angie that she – every time we have any kind of a meeting or a conference, or even a conversation, she reflects and thinks about what it means with regard to her work, and I think that is such an amazing attribute.

One of the things I've been thinking a lot about is how complex little human beings are and how little we really know, yet, about infant development. We keep thinking we know a lot and we make big proclamations about what babies do or don't do. They used to be practically blind, and now they can see; you know? They used to not really understand anything, and now we know the incredible value of bathing them in language, as other people have said.

We are increasingly aware of their ability to interact with their environment, their sensitivity to what's going on around them, the degree to which they are able to attach to the people who are loving them and taking care of them. The more we know about them, the more we know they can do. So I think, again, that speaks to the importance of kind of common sense and the whole landscape of learning about infant-toddler development. They are just amazingly complex.

One thing that I've become newly aware of is how much they may experience and remember that we have no – no awareness of because they don't yet have oral language skills; right? And I don't know how it works in their brains, but I knew a child who had a somewhat traumatic experience as a 2-year-old. And, you know, people were around, supporting her and helping her, and, you know, I think we said and did good things; but when she was 4, she had this enormous outburst where she explained what had happened when she was 2. And she could never engage people in the way that she needed to until she got the oral language to do it. So that was just such an eye-opening thing for me, because her kind of – the timing of what she – people's misunderstanding of how much she really understood because she hadn't – didn't yet have the language skills.

One of the most unique things about Head Start is our recognition of parents as experts in their own children, right? So, I think that is something we need to share with the world. Parents know their own children better than anybody else, and they're more invested in their children than anybody else is going to be. They're going to be with those kids, it used to be until they were 20 or 21, but now it seems to be until they're 28 or 29, or beyond. [Laughter] I was going to tell you, you know, "Early Head Start, happy birthday and welcome to adulthood!" But then I said, "Oh, no, we're only 20. We've got another..." probably decade, Angie says; right? So, welcome to young adulthood. [Laughter]

So one of the things I hope... One of our kind of sacred responsibilities, I believe, in Head Start and Early Head Start is to push up what we know about human development to our colleagues throughout the whole span of education. A lot of times... One thing I know about becoming a baby person is the more I learn the more I say we need to work harder on this with preschoolers, too. Children do not turn 36 months and lose the need for a secure attachment relationship that gives them the freedom to go off and learn and explore and develop, right?

Audience: Right.

Amanda: So you all know about that. We need to make sure that our colleagues in preschool know some of the very fundamental things we know about babies. Then, we need to make sure our colleagues in the K-12 world understand that, while you need a balance of child-directed and adult-directed activities in early childhood, the same thing you need in school.

And, most importantly, parents are experts in their own babies and preschoolers, and they're still experts in their – their children in the world of K-12, and equal partners at the table. So I think, sometimes, in Head Start and Early Head Start, we get ourselves a little backed into kind of a defensive corner where we're explaining, you know, what we do and what we don't do. We've got to really start to promote what we know from our years of experience, why it works, and how – how it can be done with our colleagues.

Okay. Well, I have a short... Oh, this is hard to read. Okay. Well, I have a short story, and some of you may have heard it before, but it's a really compelling story to me. I love parent stories especially, but also staff stories. So this was a story directly from a parent a couple of years ago, an Early Head Start parent, and she was unique. But every single Early Head Start parent is unique. And her story was that she was a pregnant teenager and she wanted to get her high school degree, and she was in this – in this high school where they weren't going to let her out of class in order to nurse her baby. So she was very unhappy about that.

So, you know, she's a little bit unique that she was willing to, you know, look for other options because she wanted to nurse her baby so badly. So she found – so I think her pediatrician said, you know, "There's another high school where they have this program, the baby can be right there, and I know they'll let you breastfeed the baby." So she enrolled in that other high school and in Early Head Start, which was available there. And yes, indeed, they were very happy to make sure she had time to feed her baby.

And she talked about how much she learned from Early Head Start and how much it helped her in parenting her baby and continued to help her as she went beyond high school to college. And, you know, she gave this really moving talk about her experiences that, at the end, I had been, you know, thinking a lot about my stories and whether they're really fair because I find these stories that seem important, but they're not representative; right? They're individual. They're anecdotal. They're qualitative, descriptive kind of things about one person's experience.

So maybe I'm just kind of talking about the one person who does that and not – not what happens for more people. So I said something like that to her, like: "Do you think you're really unique as a parent? Was it because you wanted to – you knew the importance of breastfeeding or you wanted to breastfeed so badly that you had this experience?" She was finished with college and starting her own business. And her eyes kind of filled up and she looked at me and said, "I don't know, but when I crossed the stage to get my diploma for high school and looked behind me, the other seven girls who'd been in Early Head Start with me were getting their diplomas, too."

So that's the story I wanted to tell. And the last thing I want to say is: be healthy and be brave, and go on and do your work. Thanks a lot. [Applause]

Jennifer: Thank you, Angie and Amanda. And Amanda, I love that story. What a great story to end on. It just underscores how critically important this program can be for families. And I will remind you all that we always have – at the Birth to Three Institute, we have a parent plenary that we think is so critically important to showcase, for all of us to hear from – directly from parents their stories and the impact that this program has had on them. And it's those stories that help you keep remembering how important and how critical the work is that we all do, so thank you for that.

I want to switch now to introduce our plenary speaker. So the last day, and maybe two days – two days if you've been here with us since Monday, we spent a lot of time really thinking about and talking about how young children learn. And we had a wonderful presentation yesterday morning from our plenary speaker, really kind of getting into the science of how young children learn, and we're going to continue that this morning.

And I'm really pleased to introduce Amanda Woodward. Dr. Woodward is the William S. Gray professor of psychology at the University of Chicago and was a founding member of the Center for Early Childhood Research. She completed her undergraduate degree at Swarthmore College in 1987 and her doctoral degree at Stanford University in 1992. She joined the faculty at the University of Chicago in 1993. Professor Woodward's research investigates social cognition during infancy and early childhood. In particular, she and her students are interested in how children reason about and learn from the actions of other people.

Professor Woodward is the chair of the psychology department and the president of the Cognitive Development Society. She is a fellow of the American Academy of Arts and Sciences and the American Psychological Association and the Association for Psychological Science. Professor Woodward's research has been recognized by a number of awards, including the Ann L. Brown Award for Excellence in Developmental Research, the APA Boyd McCandless Award for an early career contribution to developmental psychology, and the John Merck Scholars Award.

Please join me in welcoming Dr. Amanda Woodward. [Applause]

Dr. Amanda Woodward: Thank you. Okay. Great. Okay. Oh, good. I think I don't need to use this. Well, thank you very much. It's a real pleasure to be here. I am also a baby person, so it's really nice to be in a room full of baby people. And I'm honored that I was invited here to tell you about my research.

So my research starts from the observation that human infants and young children grow up in intensely social environments. They grow up surrounded by other people; and other people are critical, of course, for their survival and for all aspects of their development. And I've been interested in how it is that children develop the ability to – to operate in this complex social environment and how they develop the abilities to take the information from others that they need to, and how – and that starts with the ability to make sense of other people's actions in the right terms.

Much of my work has focused on what I take to be a fundamental sort of foundational aspect of social cognition; and that is knowing that other people aren't just physical objects, they're not just bodies moving through space, but other people are intentional agents. Our actions are driven by our psychological states. So, for example, it means understanding that when someone acts – when somebody, say, reaches for something – that's not just an arm moving through space, but that's a reach directed at a goal object or organized by an intention.

So I'm going to talk about that ability, that understanding that other people are intentional agents, as "intention-reading" during this talk; sort of looking at the physical person and seeing more than just the physical person. And we can think of that as meaning that babies understand that actions are not just movements through space, but they're actions that are structured by goals and objects of attention. Just to illustrate: in this picture, you see a woman and her son. You don't just see two physical entities, right? It's obvious to you, for example, that this little boy is paying attention to something. That fact is as

obvious to you as the stripes on his shirt. You don't have to think hard about it. It's immediate. We perceive it in the social world. I'm interested in how babies get that.

When babies look at this scene, do they see two agents connected to each other and connected to the world? Do they see two physical entities in space? Okay. Oh, and I want to say that I think this aspect of social perception, it's a basic building block for development. And some recent work has shown that it's actually a predictor of later – say, in preschool age, when children develop explicit abilities to talk about other people's mental lives. The baby precursors to this, of seeing intentional structure in other people's actions, predict those later developments. Okay. It's so obvious to us that that little boy is paying attention to something, that his mom is paying attention to him, that I want to just point out that we could see it otherwise; right? We could look at that scene and see something else.

I love this description. This is from Alison Gopnik, Andy Meltzoff, and Pat Kuhl's book, and they're describing a family sitting around a dinner table. And they write: "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." Right? That's a description of what I'm looking at right now. [Laughter] "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."

It sounds horrifying, right? And so, when I began research on this topic, I sort of – the question I was asking was, "Do babies look out at the world and see bags of skin stuffed into cloth, draped over chairs, or do they see something else?" Right? Okay. What I want to convince you of is that, for typically developing babies, they never look out at the world and see bags of skin stuffed into cloth, draped over chairs. They see something else.

Okay, so this ability to see others as intentional agents, one of the reasons we know it's important for early development is the vast body of research showing that early learning – the learning that happens during the second year of life when so much important information is getting into the mind of the child – is mediated by thinking about social partners' intentions. For example, when children – you know, 1- and 2-year-old children learn language, we know that they do more than just kind of remember the words they hear or map them onto objects that are present in the environment. They listen to the person who's talking, they assess what she must be intending to tell them, and they use that information to interpret the word that she's using.

So there's just beautiful work showing that understanding intentions is the foundation for language learning early on. The same kind of reasoning happens when children evaluate messages – emotional messages from others; social referencing, for example. When children take information from an adult about what's safe or what's dangerous, what's interesting or what's disgusting, all of that emotional information that 1- and 2-year-old children are picking up on from others, they're doing the same kind of reasoning. They look at the person who's emoting, they think about what she's attending to or intending to communicate, and they use that information to guide their inferences about the significance of the emotional message.

The same kind of reasoning happens in children's imitation. So imitative learning, which I think you probably heard about in yesterday's plenary. Children's – young – 18-month-old children are prodigious imitators. That's a really important kind of social learning that they're doing. And that imitative learning

is filtered through their analysis of what the person must've been intending to do; right? Okay, so we know that this intention-reading is a critical foundation for early development.

Okay. Oh, just to illustrate, and because it's early and we need movies to perk us up, here's a video from Felix Warneken and Mike Tomasello's work that I think gives you a sense of what this intention-reading looks like online. So I'll play it and talk about it. There's no soundtrack. I'll just narrate it to you. Okay. So here's Felix Warneken, and he's acting as if he has a problem. The problem is his hands are full and he can't open this cabinet. There's an 18-month-old baby watching this scene. Felix is being very inept. The baby gives it some thought.

Audience: Aw!

Dr. Woodward: Yeah, that's the reaction. [Laughter]

[Laughter and applause]

So... That might look familiar, right? So... Felix and Mike Tomasello have just beautifully documented that young children, toddlers, have this propensity, this drive, to want to help and to be part of an enterprise. And this lovely example, I think, illustrates the importance of intention-reading. So that baby was watching Felix, and if he had just been thinking, "There's a large object moving toward the cabinet with some books in his hands," nothing would've happened. The baby had to think, "That guy – he's trying to get the books in there. He needs some help." So an analysis of Felix's intentions was just essential, right? Okay. So where does this come from?

So what I want to talk about today is my attempts to look at: What are the origins of this really critical aspect of social cognition? How early can we find evidence that babies are thinking about other people's intentions? And I want to talk a bit about the different kinds of tools that we've used to ask that question experimentally, and some of the findings that we've had over the years that indicate that we can trace this aspect of social understanding to very, very early in infancy. And then, I want to turn to the question of: What are the factors that enable this aspect of social cognition to emerge? Where does it come from? What are the experiences that young babies have that promote this kind of thinking?

Okay, so, here's the question. We see this woman. Do you see... I wanted to ask: Do babies – when they see this kind of scene, do they see a woman with – an object with its arm outstretched, or do they see a woman who's trying to get that green dinosaur. Right? How do babies see it?" And, of course, I'm asking this question of people like this, who can't talk to us; right? Can't fill out a questionnaire, can't push the buttons on the computer. We have to be creative in thinking about how to figure out what's going on in the mind of the infant. And the field has developed lots of tools for asking these questions.

Here are some examples, and I'm going to talk about all of these today. So let me tell you what these pictures are about. We see a picture of a little boy who's engaging in some problem-solving, pulling a cloth to get a toy. Babies' own actions and – are a really fruitful source of information about what they're thinking and understanding. We certainly use that method. Underneath that picture is the picture of a baby who's involved in what's called a "visual habituation" experiment, where researchers are using the patterns of visual attention – how long the baby watches a scene – as information about what the baby's understanding.

Then, we go to the baby with the funny thing on her head. That's – that's an EEG cap. That's a device for measuring the electrical current that's spontaneously generated by the brain. It's a tool that neuroscientists and psychologists have used for over 50 years, actually, as a way to understand what's happening in the brain, and it's a method that we can use with infants. Many of the tools that neuroscientists use to study the human brain, we can't use with babies. So functional magnetic resonance imaging is a very popular tool with adults, but unfortunately – or, well, it's just the way it is. In order to use it, the participant has to lie absolutely still in a very noisy machine. That's never going to happen with a baby. But we can use EEG, and I'll talk a little bit about our use of this method to see what's happening in the infant brain.

And then, the final picture is a baby watching a video display in a machine that's called an eye tracker; and this is a computer display that has embedded around it infrared light sources and infrared cameras that monitor the baby's pupil and cornea and compute exactly where on the computer screen the baby is looking. And so, you can get very fine-grained information about how babies attend to events and you can use that information to figure out, in some ways, what they must be thinking. So these are all the tools we have at our disposal if we want to get inside the mind of the infant.

Okay. So I want to tell you about some old work, and then we'll use that as a jumping-off point for some of the newer things that we've done. So when I first wanted to ask, "Do babies have any sense that other people are intentional agents and that other people's actions are directed at goals?" I used a tried-and-true experimental method: the visual habituation paradigm. The idea is that babies, just like adults, if you show them the same thing again and again and again, they get bored and they look at it less and less and less.

That's called "habituation." If you show babies something new or different from what they've been watching, once they're habituated, you'll see an increase in attention. There's something new to see, so there's longer looking. And you can just use that very simple, easy-to-measure response, "How long does the baby watch?" to try to figure out what they think is important or interesting or inherently sort of important about a situation.

So what – I hope you can see in the top boxes. What we showed babies in this experiment is an event in which a person reached for an object – really simple event: two objects, a teddy bear and a ball, and a person reached through the sort of side of a puppet stage and grasped one of the objects. In this picture, it's the teddy bear. And the question we wanted to ask is, "Baby, what are you seeing here? Are you seeing somebody who has a goal – she's reaching for the bear – or do you see an arm moving through space that stops in a particular location?"

And so we showed babies that event again and again and again, and then we made some changes. And what we're looking for is whether babies show an increase in attention to what we're changing in the event. And if we see an increase, then we know that babies think whatever we've changed matters, right? Okay.

So, we habituate infants to this repeated action. And then, in tests, there's two kinds of events. We move the toys, we switch their positions, and then we're able to show babies two kinds of test events. One, the person moves her arm in just the same way she moved it before, but now there's a new goal; right? So if babies are thinking about actions just as physical movements, this is kind of the same old thing. If they're thinking, on the other hand, about actions as being directed at goals, this is a big change. Her goal has changed; now, she wants the ball.

And we can also show babies another kind of test event. Now – the new side test event, where the person reaches for the same old object – she's still grabbing the bear – but she has to move her hand in a new way in order to get there. So again, if babies are thinking about human actions as movements, this should be kind of new. The person's moving in a new way. On the other hand, if babies are thinking about the person's actions in terms of goals, this is the same old thing. Right?

So we can look at differential attention to new goal versus new side trials as evidence for how babies were thinking about the original reaching event. And what we've found, over the years, in experiments that use this logic is that babies show a very marked increase in attention when we change the goal. They really notice that. If we don't change the goal, but change how the person moves, they don't respond. That's just the same old thing.

So they're sort of construing this event in the way we do. When they see the woman grasp the bear, they're thinking, "She wants the bear." When what she wants changes – now she wants the ball – that's big news. When her goal doesn't change – she still wants the bear – it doesn't really matter how she moved to get there; the goal is the same.

Okay. Importantly, it turns out that this way of responding that babies show us is specific to human goal-directed actions. So we can show babies different kinds of control events where, for example, it's an inanimate object that moves through space like – one of the studies we used – we had a poster tube with a sponge at the top, a sort of interesting object that moved toward and contacted the teddy bear, or a mechanical kind of robot claw that goes in and grabs the object. And babies don't respond to those events in the way that they respond to human actions. They don't show this attention to the goal object.

We can also show babies uncoordinated things that people do, like sort of accidentally dropping your hand on top of a toy; right? That doesn't look intentional to us. Turns out, it doesn't look intentional to babies, either. So babies – or infants, by 3 to 6 months, are quite good at figuring out, at least in some cases, which actions are goal-directed and which actions are not.

Okay. So, over a couple of decades now, we've found that this sensitivity to the goal structure of action, this ability to read intention from action, emerges for actions like grasping by about 6 months; in some cases, earlier. For more complicated actions, or actions at a distance, like attention, sort of knowing when somebody turns to look at something, there's something out there that she's looking at, that she's connected to something; right? Like we know that that little boy is attending to something.

We see evidence for babies understanding that by 8 to 12 months of age. There's higher-order plans. So suppose you have a complicated goal, like you need to grab a cloth so that you can pull the cloth to get the thing that's on top of the cloth; that's a kind of higher-order plan. We have evidence, and I'll give you an example of it later, that babies are engaging and thinking about those kinds of higher-order goals by the time – at least 12 months, possibly earlier. And then, sometimes, we have goals that are shared with other people, like we each work together to attain a common goal, and I'll show you an example of this later. By early in that second year, we see evidence that babies are thinking about those kinds of goals when they watch other people interact.

Okay. So that's a sort of old body of work. Recently, we've been using this eye tracking methodology to ask, "How rapidly are babies able to engage in this kind of intention-reading?" So the thing about social life is it imposes time pressure. When you're interacting with another person, you've got to respond in

the moment in order to keep the interaction going, right? So, for example, studies with adults have shown that – and you probably know this from phone calls where the technology isn't working – if there's even a short delay – like a one-second delay inserted in a conversation, right? – you talk and you have to wait a second before your partner hears what you've said, the conversation just falls apart, right?

Social interactions require a kind of tight temporal structure. So it's good that babies can engage in intention-reading, think about other people's intentions, but we need to know how quickly they can do it because, to be really socially skilled, you've got to do this thinking quickly. Well, eye tracking offers us a way to look at that because we can look at how babies generate predictions very rapidly in the moment. Okay.

So I want – so this is, again, a baby looking at an eye tracker. I'm going to show you an event – a film from a study that we did using the eye tracker, and I'll talk you through it. Very nicely, the eye tracker can generate a video for us that's the stimulus film that the baby watches with a little red dot on it that shows us where the baby's looking at any point in time. So let me just show you this, and I'll talk you through it.

Well, let me just say, this is going to use that same logic I talked about in the habituation experiment, where a baby sees somebody reach for an object – that's the person's goal – and then the objects switch positions. And the question we're asking is, "What does the baby think the person is going to do now? Is she going to keep acting on that same goal or is she going to move in the same way?"

Okay; so, here's the video. That's a little stimulus to get the baby's attention. You can see the red dot grows as the baby watches it. We give... And here's the movie. We just let the babies get used to the fact that they're seeing this woman reach for things. You can see the baby's attending to her actions, looking at her hand and her face and the object. Okay, here's a lady who can reach for things on both sides of the stage. Now, here's the setup trial. She's going to reach for that little bear. Okay. Now, watch quick. Here's the test trial. Object in a new place, baby looks at her hand, and the baby launches a prediction.

Did everybody see that? Okay. Is that... So – so... There was a baby who, in the moment, was predicting, "Gosh, things are in a new place here. I know what her goal is. I know what she's going to do." Right? Okay. And you can see how rapid that was. Okay, that was a 15-month-old infant.

This is just a little bit about how we analyze the data. We look at these, what we call "regions of interest." We look at the objects, the baby's attention to the objects in the hand, and we look for cases where the baby looks to the woman's hand and then looks to one of the two toys. It's where we get our data. And what we find is that, when babies see sensible human reaching actions, they generate goal predictions quite systematically; that's the yellow bar in these graphs.

And when they see something else, they don't generate goal predictions. So if they see the woman do something strange, like lay the back of her hand on the object, they're sort of random. They don't know what to predict. If they see an inanimate object... So, in the bottom panel here you see we've got a reaching hand event versus a claw, the sort of mechanical object that moves in and touches one of the two toys. When babies see that, they actually generate the opposite prediction. They think the claw is going to keep moving in the same way it's moved, which, if you think about it, is a reasonable

expectation for inanimate objects. Machines kind of tend to move in the same way again and again. They don't have goals, right?

So we can see that, even in these in-the-moment visual predictions, babies are using an analysis of human intentions in the right places to generate smart predictions. Okay. Recently – recently, we've been looking at sort of more complicated kinds of intentions. So reaching for a things, those are important actions, but they're very simple. What about more complicated intentions?

So I'm going to tell you about a scenario where we have a socially shared goal, sort of involving a collaboration. So there's two women in this little cartoon, one – and there's an object in a box and they're solving a problem together, which is getting the object out of the box. So, in the first frame – in the second frame there, the woman in red, Laurie, opens the box, and then Annette reaches into the box to take the toy out of it; right?

So that's a collaboration; and we understand, as adults, as we watch this, that these two women actually have the same goal. They're doing different physical actions, but all their actions are directed at the goal of getting the duck, right? So what we can ask is: What do you think Laurie's goal was, you know? What do you think she was up to? The only thing Laurie ever touched was the box. And so, at one analysis, you might think, "Oh, she just sort of wanted the box." But if you understand the collaboration, you know that, in fact, her goal was the duck, not the box. Right? Okay.

So we put that logic into the eye tracker; and I'll show you the event. You can watch the baby watching the setup event. Oops. Sorry. Here we go. Okay. So here's our two ladies. We've got one woman, she's going to open the box. The baby's watching that, watching her, watching the box, and the other woman's going to take the object out of the box – the block. Okay. They're happy with each other. [Laughter] Okay. There's the collaboration setup.

Now, we're going to ask the infant: "That woman who opened the box, what was her goal?" And the way we're going to ask that is by just showing that woman and the two objects; and she begins to reach and the question is – what we're asking the baby is: "What's she going to reach for?" Remember, they've only ever seen her act on the box. So if they have a pretty simple expectation, they might think she's going to reach for that box. On the other hand, if they know about the collaboration, if they're understanding the collaboration, they should expect she's going to reach for the block.

Okay. Here she is. Her hands come up, baby looks at her hands, and... Did you see? Generates a prediction that she's going to reach for the block. Okay. So, these were 14-month-old babies – so, pretty young – and they're able to engage, again, very rapidly, in a very short timescale, an analysis of the – of the shared goals.

I want to tell you about a control condition that we ran, because I think it illustrates the subtlety of the kind of analysis that babies are doing here. So we all know that collaborations require some preconditions, right? So, for a collaboration, a shared goal, to be happening, both people have to be active – they have to be doing something, and they have to be doing something that matters for getting the goal, right? So if you're at a baseball game and you're excited and you're cheering, you're not actually collaborating and helping to win the game. You're interested and you're there and you're watching, but you're not really sharing the goal; right? So, audience members aren't collaborators even though they're around.

So we showed babies – to see whether babies can make this distinction... Do they think that, you know, if you're there, sort of present, is that enough for you to share a goal? Or are they really thinking about what's each person contributing to the collaboration here? We showed babies... Whoops! Uh-oh. Where'd it go? Here we go.

We showed babies this – in another group this event. Oh! It didn't work. I'm so sorry. I lost the movie. It's the same event, but one person does all the work. Right? So one person grabs the box, opens the box, takes the object out; the other just watches as a happy audience member. And then we asked: "What do you think about the audience member? What was her goal?" And the answer is: babies aren't sure what her goal should be.

So when we have a true collaboration where both people are engaged in the effort, we see babies very systematically launching predictions that are appropriate for the collaborative goal. In this onlooker situation, where we think we – you and I – probably wouldn't know what the onlooker's goal was, babies don't, either; they're not sure what she's going to reach for. So, again, this tells us that babies are tracking lots of details of the interaction. Who did what matters to them in analyzing and thinking about people's goals.

Okay. So, I hope these examples have begun to convince you that babies are socially smart. By 6 months, possibly younger, babies begin to see others' actions as being goal-directed. They're not just physical movements through space. And a few months later, by early in the second year, babies are able to use this knowledge to generate very rapid responses to other people's actions.

And I think, actually, one of the ways that we see evidence of this is in the ways that children in the second year are becoming much more socially confident – right? – much more able to respond appropriately to other people's actions, in the way that that baby did in the Felix Warneken and Mike Tomasello video. Babies can assess what people are up to and respond in the moment, appropriately. And you see that in lots of ways emerging at about – you know, in that second year between 18 and 24 months.

Okay. So, that's a little bit of evidence that babies are thinking in the right ways about other people's actions. And since I'm a developmental psychologist, the next question for me is always: "Well, where did that come from? What is it that enables babies to engage in this important kind of social thinking? Where does that come from developmentally?" And in my world, the world of early cognitive development, there's this common assumption, which is that if babies do something smart, that ability must be innate, right? It must be that we're just born being able to do that.

And I push against that conclusion because I think that stops us from asking the important questions about the factors that contribute to development. If we assume that something is innate, well we don't have to do anything about that, it's just there. Right? But, in fact, we know that for everything that emerges in development, it's not that simple. It's always an interaction between the baby and their environment that drives development; and I'm really interested in those interactions.

And, in fact, in the case of intention-reading in infants, there's really good evidence that experience probably matters. And the evidence is that things change. Even in the first year of life, babies go from being able to think about intentions in pretty simple cases, like where people reach for things, to being able to think about pretty complicated kinds of intentions, like collaborative, shared goals. And that changes over the course of about a year or so.

So we know that there's change. And so, one question we can ask is: "What factors seem to be driving that change in early development?" In fact, if you think sort of broadly about how developmental processes work, it turns out that developmental processes often recruit or draw on information that's reliably present in the infant's environment, even for abilities that are absolutely essential for survival and very likely to be the product of natural selection; right?

So, take birdsong as an example. For some species of birds, being able to sing the right way is essential for finding a mate and reproducing. And the whole birdsong system is clearly something that's a product of natural selection. Right? It's there. But interestingly, it's not innate. Birds have to learn their songs. And so the song system, in developing, makes use of the fact that birds are always going to grow up around other birds. They're always going to hear a song. And so, you don't have to build that information into the baby bird's brain. You can make use of the fact that that information's going to be there in the baby bird's environment.

The same thing is true of some kinds of imprinting. So, for example, baby ducks, when they hatch – the moment they hatch, they have to follow their mama duck if they're going to survive. Absolutely critical. And baby ducks do that. They follow their mama duck the moment they hatch. It turns out that that response depends on something – an experience the baby duck creates for itself right before it hatches.

There's beautiful work that a man named Gilbert Gottlieb did some years ago. So, right before they hatch, baby ducks stick their beaks up into the air sac in the egg and they make little peeping noises. And Gottlieb wondered whether that was – that mattered for anything. So what he did is, for some eggs, he went in and he froze the vocal chords of the baby duck so that when it stuck its little beak into the air sac, no sound came out. And it turned out that those baby ducks didn't show the imprinting response after they hatched. So it turned out that this experience that the ducks create for themselves was essential for their later imprinting response, their later propensity to follow the mama duck; right?

So these examples illustrate that development is very smart; it's very frugal. It makes use of information that's there in the environment for setting up important abilities. And so, I wondered whether something like this might be true for infants seeing intentions in others' actions. Maybe there's information that's present reliably in babies' experiences that could provide a foundation for understanding others' actions as intentional.

And so the two aspects of experience that I focused on are the fact that babies themselves, in early life, are acting on the world. In fact, there are sort of revolutions in babies' ability to control their own actions in playful ways in the first year or two of life, so that could be a very rich source of information for them. It's also the case that babies depend on others for survival and, therefore, are always – are interacting with social partners. That could be another source of evidence for the development of intention-reading.

So I'm going to talk a bit about each of these; I hope, given time. Okay. So I want to start by just telling you why I think babies' own actions could provide them with information about action in general, could help them understand action as driven by intention. So you all know, of course, that when babies are born, they're very motorically limited, right? Newborns can't control their head movements very well. They certainly can't control their limb movements very well. And lot of what's happening early in infancy is gaining control over your body movement, right? That's what is happening for young babies. But even

at the very earliest stages of motor development, babies' actions are directed – are sort of organized with respect to goals; crudely, but – but beginning.

So picture – the top picture here, that's a man named Claes von Hofsten, a Swedish developmental psychologist who did some really gorgeous foundational work that showed us just how well-organized even very young infants' actions are. Von Hofsten showed, for example, that even newborn babies, if you hold up an interesting object in front of them, they direct a limb movement approximately at it. They're trying to get their hands – they're not very good at it, mind you, but they're trying to get their hands on it even from the beginning.

Von Hofsten did these beautiful experiments with babies a little bit older, where he had them in an infant seat and there was an object that would translate through space like this. It would go like this in front of the baby and babies would try to catch it. And what he looked at is: "How do babies aim their arm movements?"

And what he found is babies would launch an arm movement at the place where the object would be when their hand got to it; right? They were anticipating where the object was going to be by the time their hand got to it. Again, they weren't great at it, but they were showing some ability to anticipate what was going to happen in the future and directing their actions at that anticipated future state.

Another way that we see this is in how babies pre-shape their hands to anticipate the object they're going to grasp. Now, we do this. You might not be aware of it, but if you're reaching out to grasp a little thing, like an M&M – right? – as your hand approaches the little object, your fingers close in so that they're about the right distance apart to grab that small object. If you're grabbing a larger object, like a coffee cup, your hand opens up as you reach toward it, anticipating the size of the object you're going to grasp. It turns out that babies' hands do the same thing.

So you can see that in the four-frame picture there, babies reaching for objects of different sizes and orientations and their hand shape anticipates. Before the hand gets to the object, their hand is shaped the right way for the thing they're going to grab. Okay? So this tells us that babies aren't just kind of blindly flailing about. They've got a plan, and the plan is structuring their actions as they – as they deploy them.

Another example is work by a woman named Rachel Keen, where she gave babies an object – a ball. And in some cases, the ball was put down and the baby would reach for it; and in some cases, the babies were going to throw that ball. So they're going to pick it up and throw it; kind of a crude action. In other cases, the task was to pick up the ball and place it in a little container; so a kind of more demanding, fine-grained action.

And what Keen found is that when babies were first reaching for the ball – the first action, before they were going to place it or throw it – the dynamics of their reaching varied depending on what they were going to do. So if they were going to throw the ball, the first action was fast and crude. Grab the ball, throw it; right? If you're going to place the ball in a tiny container, even the first action on the ball was slower and more controlled; right? So you carefully pick it up and then you place it. Again, showing us that babies' own actions are organized by plans, right? When they start acting, they know where the end is going to be, and that changes everything about the action going forward.

I'm going to show you an example of the final thing on the slide in just a second, which is by the time babies are about 9 to 12 months, they engage in this behavior that even Jean Piaget described 100 years ago. They can do means-ends problem-solving. Confronted with a problem that requires acting on a tool or a means in order to obtain some ultimate goal, babies can construct a plan and play out a well-organized solution; again, telling us that babies' own actions are organized by intentions from early in life. Okay.

When we were first thinking about this idea, whether a baby's own actions might provide information for understanding other people's actions, we just did some correlational studies. We brought babies in who were transitional in their social reasoning and transitional in their own actions. And the short story is here that we found correlations. So babies' own action abilities predicted how they were going to respond in our social-perception tasks.

So that was initial evidence that there's some connection here. But to really understand the connection, you have to intervene. You have to go in and make a change in babies' actions and see if that changes how they respond to other people's actions. And so, we've done that in a couple of ways.

One is using something called "sticky mittens." So, young infants aren't good at reaching for objects, right? You hold up an object in front of a 3-month-old baby and they flail their arms around, but aren't often very successful at actually attaining it. We discovered if you put big Velcro mittens on a baby and hold them up in front of an object that has the other side of the Velcro on it, they – their flapping movements now pick up the object for them. The Velcro helps them do that, and they can learn to control that a bit. So having had some practice with the Velcro, babies look at the object and basically go "flop!" and pick it up with the mitten.

What we discovered is that experience – that active experience of using the mittens changes how babies respond in our visual habituation experiments where they watch other people reach for things. It basically leads them to respond to those actions like older babies do, to see the goal structure in those actions. And, interestingly, we've discovered that it matters that the baby is the one who's doing the action. So if you just show babies a bunch of examples of somebody else using a Velcro mitten, they don't get that much from it. It doesn't help them understand the meaning or the intention behind the action. If they do the action themselves, it helps them do that.

I want to show you an example of this idea in the context of another experiment that we've done with slightly older babies, where we're asking about understanding higher-order means-ends plans. And let me just show you. So here's a baby – an 8-month-old baby encountering a problem. There's going to be an interesting toy on the end of a cloth and she's not going to be able to reach it, and her initial approach to the problem is not so well-organized.

Okay. Here she is. Here's the duck. That's all very interesting. It's not clear, right? She has to think about it. There's a cloth. Playing with the cloth. And at the very end, she notices, "Oh, there's a duck!" [Laughter] Right? Okay, yeah. But, unfortunately, she loses it. Okay. Then – well, so, 8-month-olds, in general, aren't great at solving problems like this, but they are ready to learn.

So we then went on to give this baby a demonstration. "This is how this problem works, baby. Let's see if you can figure this out." Okay. So we show her something's at the end of the cloth. You can pull the cloth and then you can get it. She thinks that's interesting. [Laughter] And then, we give her a chance. She thinks about it. And then, watch. Yeah.

Audience: Bravo! [Applause]

Dr. Woodward: Bravo, right? Okay. So there's a baby who's able to put it into action. We give her a few practice trials like this, and then we give her just some test trials at the end, and you can see that she is a pro. Knows exactly what to do. "No problem. I know this." [Laughter]

Okay. So, this provides you with evidence of how well-organized babies' actions can become. This is an 8-month-old infant. We went on to then test babies in this study in a visual habituation paradigm that was asking, "Can you understand when other people are using claws to get toys? Do you understand the higher-order plan in their actions?" And the short, take-home message is yes.

So babies who learned, babies who were able to improve – just like the baby you saw, right? – babies who benefited from that training in their own actions went on to understand what other people were up to when they pulled claws. Babies who weren't yet ready – developmentally ready to benefit from that training, they didn't. Right? So it – the baby's own – where they are in the moment and what they're ready to learn definitely contributes here. And just like in the study with the mittens, another group of babies who just got to watch somebody else solve a whole bunch of problems didn't take anything away from that that they could use. So really, engaging in the actions yourself is critical for babies, right?

Okay. So active experience supports infants' intention-reading. Okay. Just in the interest of time, we see the same kinds of effects in eye tracking studies. So 8-month-old babies are not that great at solving the rapid eye tracking task that I showed you before with 15-month-olds. But if we give them some active experience reaching for things – like this – right before the eye tracking task – just getting to pick things up, right? – they do better. And babies who have passive experience get to watch people reach for things but don't get to reach themselves, like this baby. They watch, it's interesting, but they're not doing the reaching. They don't benefit.

Okay? So, again... Oops! That's just the data. I won't go through the details, but you can see that 8-month-olds spontaneously aren't systematically generating the right kind of prediction. With this active intervention, they're doing it quite robustly. They're able to generate the right prediction in the eye tracking task. But the baby who just watches passively doesn't benefit; okay? Okay, great. So, babies are learning a lot from their own actions.

They're learning a number of things. One of the things they're learning, one of the things they're getting, is understanding of the structure of intentional action in general, and that's knowledge they can take with them to use to think in a social setting about what other people are doing, what other peoples' intentions may be.

Okay. I'm going to talk a little bit about neural evidence. So, for a while, we've been wondering if we can get a sense of what the underlying neural mechanisms are. And there's this interesting thing. When you and I watch other people's actions, the areas in our brain that are about motor control, that are about our own actions, become active; right? Some people call this "neural mirroring." It's the idea that we're using our motor system in some way to think about other people's actions.

It turns out that babies – we can see the same thing. If we do an EEG recording in infants, we can see that when babies watch other people's actions, their motor systems are active, too. And so, we've used

that EEG to ask whether that activity in babies' brains when they're watching other people's actions is related to their thinking about other people's goals.

So, I'll talk you through this. So the idea is babies watch somebody acting. In this top slide, you can see there's a person and she's reaching for one of two toys and the baby is watching that person. And then, the bottom picture is the infant who's observing, and you see she's got an EEG cap on so that we can record her neural activity. And these are 7-month-old infants. Just to show you what it looks like, this is a portion of the experiment where the baby is reaching herself. It's a really brief clip just to show you what it looks like. So the baby's got the cap on, there's an object that we give her the chance to reach for, and she reaches for it. So it's pretty – pretty simple. [Laughter] Okay.

So we look at this particular neural signature that's been identified in infant brain recordings that tells us that the motor system is active. It's basically a kind of frequency band that's over the areas of the brain that are associated with motor control, okay? It's called "mu desynchronization," is the component we look for. And we're interested in whether that neural response relates to times when the baby is thinking about the person's goal.

So these are 7-month-old babies; they get a bunch of trials where they see a lady reaching for things. And our assumption here is that babies are variable, right? When you're first learning something, you do it sometimes but not all the time. You're not reliably able to do it yet. And so, we're exploiting that variability. Sometimes when babies watch somebody act, they're going to be able to understand what her intention is. Other times, they might not; right? They might not quite get it.

And so, we wanted to figure out what are those times. And so we used a really simple behavioral response that we know 7-month-olds show, which is that babies tend to reproduce other people's goals. So if a 7-month-old baby sees a person reach for an object, they have some tendency to reach for that object themselves when given the chance. They reproduce that person's goal. But it's only some of the time, they do it. So babies see a lady reach for one of two objects, then we give them the chance to reach for one of those objects themselves. And being 7-month-olds, sometimes they reproduce her goal, they grab that object; sometimes they grab the other object.

And what we do is we take the neural signal apart. And so, we look at what happened before the times when babies gave us the right answer and what happened before the times when babies didn't give us the right answer. Do we see a different neural process happening in those two situations? And the answer is we do. So the nature of this brain response is it's a suppression, or a negative response, so that you want to see is below-zero values. That means the brain response is happening.

And what we find is, when babies give us the right answer, they show that neural response in their motor system; and when babies don't give us the right answer, they don't show that neural response. So that tells us that this neural signature, the motor areas in the brain, are differentially active when babies are engaging and thinking about other people's goals; okay?

So, together, this body of work tells us... Well, just – let me just back up. So babies were paying attention, they went on to reach for things, and the only difference is what did they reach for. Did they reach for the right thing or the wrong thing? And we saw that motor system activity in the brain selectively predicted which answer they were going to give us; okay? So, together, this body of work tells us that acting – producing actions, but not observing actions, supports infants' analysis of other people's intentions. And neural activity in the motor system itself, in the brain, selectively predicts

babies' reasoning about other people's actions. So, together, this tells us that infants' own actions give infants information that they can use to make sense of other people. Okay.

All right. This last bit – I've got about 10 minutes – I'll do quickly. So this body of work has, I think, shown us that the actions that babies engage in early in life are critically important for them. They're certainly critically important for lots of reasons. One of the reasons is they support social perception in infants; right? So I think that everybody who has engaged with babies and cared for babies has the sense that babies have this spark in them. They have this energy; they want to go out and act and explore.

And, of course, good infant care involves allowing babies to have those opportunities, and this work just illustrates one of the reasons why it's important to do that. Right? But as we did this work, we began to wonder – you know, learning by doing yourself is really important, but the thing about social reasoning is you often have to make sense of stuff that you've never done yourself, right? And that's particularly true for babies. There's lots of actions that babies aren't able to or aren't allowed to engage in that they probably need to understand when adults do them.

So, what happens there? Are babies' own actions at all useful to them in this regard? And the idea we had here is that maybe they are. So there's – maybe they are in that your own actions could provide you with a way, a reason, a method, for seeing analogical similarities. Your own actions could provide a base for analogical learning. Here's the idea. Here's a baby that's good at reaching, knows a lot about reaching, and then one day he sees his grandma do something that he's never done himself and that's a bit unusual, which is to use this claw to pick up her newspaper in the morning; right? The baby hasn't had a chance to use the claw. Is he going to be able to take anything away?

Well, maybe he can think to himself, you know, "When she uses that claw, it's sort of like when I reach for things." There's an analogy there; and maybe that analogy could support some insight into what she's up to when she uses the claw. In developmental psychology, the idea that people use analogies to extend their knowledge is very common and, in fact, it's been shown to be the case that infants and young children in other domains, like numbers and space and language, exploit analogies like this quite readily.

And so, our question was whether analogies could operate in the context of actions. The idea is that when babies interact with other people, that interaction sets up, potentially, the conditions to see an analogy. It's easy to make an analogy if you have one thing and the other thing side-by-side, two instances. You can compare them and you can see how they're similar. So imagine a baby who's interacting with somebody who's doing an action they've never done before. That co-action, acting while somebody else is doing something, could enable babies to see an analogy.

And we tried to create that – that situation in our laboratory using a claw – somebody using a claw tool. Babies haven't used claw tools. They don't know what we're up to when we use claw tools. Can we help them understand by embedding the claw in a social interaction? Basically, what we did is we just handed babies a bunch of toys using the claw. That set up the conditions where the claw and the baby's reach happened at the same time. The baby was organizing her actions with the claw's actions. And we thought that that would be the instance – that would be the situation that would support learning.

We did some control conditions where babies didn't have that experience but got to see the claw, got to touch the claw, got to see people using the claw, but didn't have that co-action where they're reaching at the same time the claw action is happening. And to just – so there were three – several conditions.

The alignment condition here is the critical one, where babies' own actions happen at the same time as the claw's actions. And then, we did this imitation procedure that we had used in the EEG as our measure of goal understanding. Will babies tend to reproduce the goal of the experimenter's actions when she's using the claw to grab things?

And the quick answer is, when babies have first engaged in this alignment condition where they're acting at the same time as the claw, subsequently, they understand the claw's actions – the person's use of the claw as goal-directed; right? So they're able to use that experience to make sense of what she's up to. But other conditions that involve touching the claw or watching people use claws but don't have this alignment of own actions with the claw, don't have this effect. So this initial evidence that babies' own actions provide a way for them to extend analogically what they know in the context of interactions with other people.

Okay. So, let me finish up. So I hope what I've begun to convey to you is that infants' own actions provide rich learning opportunities for social understanding. Action experience shapes infants' intention-reading because it allows them to connect their own goals and their own intentions with the actions of social partners. And it can occur – this kind of learning can occur just in the context of infants' own actions and problem-solving in the world; and it can maybe most powerfully occur when babies are coordinating their own actions with social partners – right? – in the context of jointly acting on the world.

And what's nice and important for all of this is that these experiences, acting on the world and acting with others, are present in babies' environment. They're opportunities for them to learn, right? In fact, if you think about it, in a rich social environment – in a good social environment for babies, joint action is pervasive. It happens all the time, right? Babies are ready to learn from this very pervasive aspect of their early lives.

So, let me conclude. I hope I've begun to convince you that babies are – maybe you knew already and I've just told you what you already know – babies are socially smart. They're perceiving the right kind of structure in the social world, and this ability is critically driven by their experiences, by their own engagement in intentional action, and by their engagement in interactions with social partners. These concrete sort of everyday experiences that babies have support abstract inferences about what other people are up to, what other people's intentions are. Okay. Thank you. [Applause]

Jennifer: Please join me in saying thank you again to Dr. Woodward. [Applause] You have – you've given us a lot to think about and, I think, you know, a lot more information about the capacities of babies being so far greater, as Amanda said, than what people used to think many years ago, and the importance of those social partners – being you – who are taking care of babies in the rich environments that you set up in your care with young children. So thank you so much, Dr. Woodward. Thank you, everyone. Enjoy the rest of the day. [Applause]