JESSICA SOMMERVILLE: So this morning we heard Laura give a really beautiful overview of her research program, and my talk today is going to be a little bit different. I'm going to talk about some things that are going to be highly related to what Laura was talking about, particularly at the end of her talk. But because this is like brand new hot off the press work, some of it's actually ongoing as you'll see as the talk unfolds.

I'm going to be focusing on a more kind of specific detail level. So I may tell you about four different studies, three of which are completed, one of which is ongoing. And they all have to do with infants' sensitivity to costs and benefits.

OK. So, as we all know, cost benefit analyses are really central to the decisions we make at both a conscious and an unconscious level. And, of course, there's all kinds of different ways that we make decisions, right? But one of the things that we often do when we're making a decision is we think about what rewards do we anticipate from following a particular course of action, and how do those compare to the costs that we'll incur from performing that same action.

And we will act in a sense to try to maximize the value that we get out of a particular choice. That's true of simple decisions like this, right? This woman deciding what she's going to eat for dessert. And we can also apply these analyses to more complex decisions, like things like where we're going to go to college, what kind of career are we going to pursue, where are we going to live.

OK. One of the things that we heard from Laura this morning is that cost benefit analyses don't just apply to her own behavior and her own decision making. She showed some really neat evidence that these types of analyses form the basis for the inferences that we make about other people and that we make about their behavior.

So that raises the very interesting question of the developmental origins of these types analyses. And that's what I'm going to talk about today, infants' sensitivity to costs and

benefits.

My talk is going to kind of have two different parts. In the first part, I'm going to be talking about cases where infants are observing other people. And what the question that I'm asking there is do infants-- are they able to register the costs that are behind other people's actions?

And then in the second part of my talk, I'm actually going to switch gears, and I'm going to talk about infants' registration and minimization of costs, the registration of benefits, to guide their own behavior, their own decision making. I'm going to talk about a particular test case. And that's the test case of infants' prosocial behavior.

OK. And I want to be kind of specific here. So across all of these studies, I'm talking about cost in one particular way. Of course, there's all kinds of ways you could operationalize cost. But what we've been focusing on so far is physical effort, the physical effort behind an action as a cost. Why would we start here?

Well, there's several different reasons, right? And the basic kind of evolutionary level, it's really important that we can register and that we can minimize energetic costs, effortful costs, right? Our very survival depends on that. We have to metabolically and energetically budget, or we won't stick around, right? So that gives us good reason that that's a good starting place in terms of looking at young infants' ability to register costs and minimize cost potentially.

Another reason is that for decades, scholars have really given a central role to effort in decision-making. And this dates back to the 1940s, the whole in Solomon who postulated the law of least effort. So the idea here is that if there are two lines of actions that lead to equal rewards, we're going to take the path of least resistance, right? We're going to seek to minimize effort.

And then, finally, in more contemporary work that's looked at cost-benefit decision-making, both in adults and in nonhuman animals, a lot of this work comes from the neuroimaging literature. Effort has been a fairly heavily studied cost. So this is a good starting place, because we have a pretty good understanding of how effort and various benefits or reward are integrated at both the neural and a behavioral level, at least for nonhuman animals and for human adults.

OK. So the first question we might ask is, what is the existing evidence in terms of the question of whether infants have a basic ability to register cost behind actions. And there's really two

different ways we could pose this question. We can think about the question with respect to infants own behavior, their own actions. Is there evidence that infants will act to recognize costs and to minimize costs in their own behavior. The other way that we can ask the question is in terms of infants observation of other people's behavior. Do they recognize the cost behind other people's actions.

You know, surprisingly there really hasn't been a lot of work that's looked directly at this when we're talking about infants own behavior, their own decision making. There is some work from the weight perception literature that's looked at how infants interact with blocks of different ways. And so what people will do in these studies is they'll present little babies, nine-month-old infants, with two blocks that look virtually identical. They only differ from one another in terms of their respective weights.

And what these studies have shown is if you give infants a choice between these two objects, they'll systematically prefer the light object over the heavy object. So one way to think about these findings is what infants are doing here is exactly what we're interested in, they're minimizing the physical cost, right? They're taking the past of-- the path of least effort. One challenge, though, for interpreting these finding is oftentimes in these studies, the heavy blocks that are being used are beyond infants lifting capacity. So what that means is it's hard to know if these results are about infants registering cost per se, or if what we're really getting at is just infants repeating a sort of successful interaction with an object that they've acted on previously.

OK. So Laura talked a little bit about this in her talk today. What about the evidence of registration of costs and other people's actions. And one of the things that Laura mentioned that we know from many, many different studies, is that infants appear to expect efficiency in other people's actions. Laura showed you one example of that. I'll show you a different example of that, which comes from actually a study that Liz did with one of her graduate students.

So here we see someone who's reaching over a barrier in order to get an object. The barrier is then removed. Infants have the expectation that that person is going to reach directly for the object, right, rather than performing that funny arcing motion. So, again, one way to think about these findings is that what infants are doing is they're expecting that the person is going to take the least costly action, right? And, in fact, there's all kinds of costs to this particular arcing motion, right? It's indirect, it probably takes longer, it's probably more difficult, it's more

effortful.

And so we wanted to ask the question, too, to begin with if infants were able to register costs. But unlike in this situation where there's multiple potentially redundant cues that this arching motion is a costly behavior, we wanted to really kind of focus in on situations in which there aren't a lot of overt observable cues to the costs underlying another person's action.

So the way that we did this is we showed infants different actions that look similar on their surface level, but these actions differ in terms of the degree of physical effort that are required to perform them, and the way that we achieve that is by having infants watch people lift objects of different weights, right? So, obviously, heavy weighted objects are harder to lift. They're more effortly costly than lifting a light object.

And what we wanted to know is can infants recognize under conditions where they have really minimal, observable cues, no cues about, for example, straining or sweating or things like that that might be really obvious for figuring out the effort. Will they be able to understand that when someone is lifting a heavy block, that's a more effortful action than when they're lifting a light block.

In addition to that kind of primary question, we were also interested in whether this ability in infants might be individually variable. So this might come as a surprise to you, but infants, like adults, are individually variable. And they're individually variable, of course, in many ways. But one way in which they vary from one another is in terms of how strong they are, right? Just like human adults, right? We're variable in terms of how strong we are.

And we have an idea, or hypothesis, that infants individual differences in strength might actually be important for registering the effort-related costs behind these different lifting actions with different weighted objects. One of the reasons that they might be important is because of core strength gates the type of experience that infants are going to have in their everyday life, right? If you're a strong baby, you can lift heavier objects than a weak baby. You can also lift a wider contrast of range of objects, right?

So we thought maybe there's something about individual differences in strength, particularly, for babies who are stronger where they'll be better at recognizing the differential effort that goes along with lifting actions when you're talking about blocks of different weight.

OK. So let me tell you about the study that we conducted to ask this question. We tested 12-

month-old infants in this study. They took part in a turn taking procedure where we recorded EEG, electrical activity from the brain as it propagates the scalp. And in the course of this task, what they did is they took part in different types of trials.

On observation trials, they would watch an experimenter who would lift these different objects or these blocks, and these blocks looked perceptually identical in terms of size and shape. They were different colors so infants could individuate them and keep track of them, but what varied from trial to trial was exactly how much the objects weighed. So they range from being the weight of a typical bath toy to being quite heavy.

So infants can lift the heaviest blocks, but they're pretty effortful in order for infants to be able to lift them. In the trials where they watched an experiment or interact with these blocks, the experimenter would do things like put the block up on a platform, drop it into a bucket after full type of actions where you can sort of register at least in principle the type of effort behind the action, and then infants would also have the opportunity to act. They could perform the same actions with objects. Infants also for measurement purpose received baseline trials where we're just registering EEG in response to abstract images like a checkerboard pattern, for example.

OK. So what are we interested in here? So, in this particular study, we were looking at the suppression of a particular oscillatory frequency called sensorimotor alpha, or some people call it mu attenuation.

So we know that at rest, neurons in sensorimotor cortex fire spontaneously and they fire in synchrony. And what that means is we get these large amplitude EEG oscillations in the alpha frequency band. When the motor cortex is activated in remote motor cortex is activated, and that happens, of course, when we act. It also happens when we watch other people act. What you see is you see a suppression in sensorimotor alpha.

So many people recently have been interested in suppression of sensorimotor alpha new attenuation from the perspective of looking at the mirror neuron system. More broadly and for our purposes, we're really just thinking about this as a measure of sensorimotor cortex activation. So greater suppression equals more sensorimotor cortex activation.

And our question here was whether infants activation sensorimotor cortex wouldn't vary as a function of watching people lift blocks of different weights. Would you get greater activation when people were lifting heavier objects? Which would, of course, be a sign that infants were

distinguishing between different actions on the basis of effort.

OK. So in addition to looking at that, we also gave infants a group strength assessment. OK. So let me tell you a little bit about the grip strength measure, only because it took us several years to come up with this so I feel like I need to talk about it a little bit. So we wanted to measure infant strength, and the way that we did that is by measuring infants' grip strength.

But, of course, the challenge here, if you're an adult, right, and you want to measure an adult's grip strength, you just get something called the dynamometer, you have an adult squeeze a bulb or squeeze the hand grip and then you get this nice force reading from that, right? And that all works very smoothly with adults but, of course, you can't just hand that to an infant and say, squeeze as hard as you can, that doesn't work, obviously.

So what we did here is we had an experimenter who had a toy, the infant had the same toy. The experimenter would squeeze her toy, and what we hoped is that this would motivate infants, or lead infants, to squeeze their toy. Their toy, in contrast to the experimenter's toy, had both a hidden sensor embedded within the toy, which led to playing Old McDonald, which, of course, infants greatly like, right? They find that very enjoyable.

And it also had a hidden pressure sensor within it. So we were able to get-- or to measure how hard infants squeezed the toy. Now, the trick here was we want to get infants strongest squeeze, right? So what we did is we set up our device so that each time the infant squeezes it, they have to squeeze harder to get Old McDonald to play. And, of course, they want Old McDonald to play, right? So they're motivated to keep doing that. So that's how we record infants' maximum grip strength. We like essentially keep going as long as infants will allow us to do that, basically.

There are some other things that we measured. We measured infants weight. Our motivation for doing this is that an adults' strength and weight are highly correlated. They were in our sample so that kind of helps to validate or grip strength paradigm. And there were things like general motor maturity that we measured, gross motor skills. We measured how frequently infants lift blocks within the task, because we want a control for these in our analyses. We're wanting to look specifically at the effective grip strength.

OK. OK. So let me tell you a bit-- the first thing that we looked at. So I'm going to show you a series of scatter plots that look at the relation between sensorimotor alpha suppression, and infant's grip strength. And these are plotted as a function of the weight of the block. And these

are when infants are observing other people.

So the thing to know is we're talking about suppression, so you're looking for negative scores. More negative scores mean more suppression. And we had a particular hypothesis about how this would go, or idea about how this would go. We thought that when the blocks were relatively light, grip strength would be less of a good predictor of sensorimotor alpha suppression. And the reason for thinking that is that whether an infant is relatively strong or relatively weak, they all probably have lifetime experience lifting relatively light objects.

However, where strength really comes into play is as objects get heavier, right? So stronger infants, very likely, have a greater lifetime history of lifting heavier objects. So our prediction was that these two things would be increasingly tightly integrated as block weight goes up. And, in fact, that's exactly what we found. So there's weak relations when the block is light, when it's that heavy block-- we call them the heavy and the super heavy block-- there's a tighter relation. And you see the strongest relation here when the block is extremely heavy. And these analyses control for things like infants in task lifting experience, their weight, their motor development scores.

So the next thing we wanted to know is we wanted to know whether there was any evidence that suppression of sensorimotor alpha would be greater in cases in which the block is heaviest versus the block is lightest.

So this is really our index, or our measure, of whether infants are differentiating when they're watching other people act on objects, whether they're differentiating the degree of effort that goes along with lifting the object as a function of block weight.

So what I'm going to show you is change scores. So more negative means that you're seeing increasing sensorimotor alpha suppression for heavy versus light blocks, and these are plotted as a function of infants' grip strength.

So what you can see here is that for the weaker babies, the lower grip strength babies, you're not really seeing any systematic change from the latest block to the heaviest block. But you are for the stronger infants.

So what these findings suggest to us is that the stronger infants appear to be differentiating these actions on the basis of the weight of the object that the person is lifting, the weaker infants aren't.

OK. So what do we know from this data. Well, we have some evidence that activation of sensorimotor cortex as indexed by suppression of sensorimotor alpha, while babies are watching other people lift blocks of different weights, varies as the function of the weight of the block, right? So this might signal that infants are able to recognize that different actions have different degrees of physical effort that go along with them.

And we also see that the ability to make this distinction is tied to infants own strength, their own grip strength. And our interpretation of this is that this might have to do with strength being a rate limiter, or a facilitator, or the type of experience that infants previously have with objects of different weights. And, in particular, the stronger infants might have more experience with lifting heavier objects. They might have more contrastive experience, which allows them to better recognize, or better differentiate, the degree of physical effort that go along with different actions when you're talking about lifting objects of different weight.

OK. So that's part one.

So I think what these data tell us is that in this context, infants have a means of registering effort related costs. I think where they go above past data is that they tell us that infants can do this under conditions in which they have minimal behavioral cues. So we think back to that reaching action, right? There's all kinds of cues that this is a costly action, right? There's all kinds of ways that it differs from a direct reach. In this situation, we're talking about actions that are really minimally different from one another.

What I want to do now is I want to switch gears and talk about kind of the flip side of the coin. And that is infants use of costs and benefits, or reward, to guide their own behavior. And I'm going to be specifically focusing on the test case of infants prosocial behavior.

So many of you may know this already, but infants are highly prosocial, right? There's been a lot of studies on this recently, and all of these studies have kind of come down on the conclusion that starting in the second year of life, infants will do things like help people achieve their goals, they will share toys or objects with other people, they're comfort people in distress.

But there are questions and debates that are hotly contested about early prosocial development, and I just want to bring two of them to your attention.

OK. So one question is, when does infants or children's prosocial behavior become selective

or strategic, right? So we know that by preschool age, early school age, children's prosocial behavior is somewhat selective, meaning that there are some people, for example, that infants are more likely to help than others, right? And children are-- not infants, children-- children are more likely to help under situations where they are perhaps reputational concerns involved. But what we don't yet know is whether this is true of very early prosocial development.

So what is the developmental course like? Do kids start off being selective and strategic? Or do they only get there over time with development? That's one question.

There's another related question that has to do with what is the underlying motivation for prosocial behavior, right?

So the kind of generous interpretation of infants prosocial is actions, children's prosocial action, is what is going on here is infants are motivated by empathic concern, right? They care about other people's needs, they care about other people's desires. And in these experimental context, what they're doing is they're acting to meet another person's needs, they're acting out of empathic concern.

But there's also other reasons why infants, or anyone, for that matter, might behave prosocially, that might have to do with social affiliation biases, social motivation, that might have to do with wanting to see a goal being completed, et cetera, right?

So one of the ways that we can start to get traction on these issues is by looking at the impact of various costs on infants' prosocial behavior. And somewhat surprisingly, this is not a terribly well studied topic as of yet.

So there are some studies that are both with infants and with children, where people have looked at the impact of personal cost on prosocial behavior and, usually, the way personal costs are operationalized is in terms of, let's say, an infant is tested in a paradigm where they need to help someone else, or share an object with someone else. And they might be required to give up their own object versus an object that's just sitting there in the lab, right? Presumably, their own object has higher personal cost.

Now, we don't really know when personal costs start to impact infants' prosocial behavior, because there's been a lot of mixed evidence. And, particularly, in infancy, there's, as of yet, no systematic evidence that high personal costs actually reduce infants' prosocial responding.

What about the question of energetic physical effort related costs? Well, again, here, this is

really an understudy topic. So there's one existing study that has looked at infants helping under kind of minimal physical effort cost. And it's a little bit hard to know what to make of that study because we know that infants helping behavior is still present under those conditions, we just don't really know how it compares to conditions where the physical costs are low.

OK. So we started off by asking a really super simple question about infants prosocial behavior, and that was whether the anticipated physical effort that goes along with prosocial responding influences infants prosocial responding. In particular, when the effort is high, does it increase, or rather, decrease infants prosociality.

OK. So we tested 18-month-old infants in this study. Start by telling you about the critical test phase, it was a helping task. An experimenter was on the opposite side of the room. She needs a block in order to complete a tower that she's building. What happens before that is all infants take part in a training phase. They're faced with these vinyl blocks. You'll see a video clip in a moment. And these vinyl clocks have-- blocks have been rigged by us so that they range in weight. There's five of them, they're different colors, so infants can keep track of them.

During training, what happens is the experimenter plays a game with an infant where they get them to drop each block into a bucket. Babies like to do that, it makes a cool noise, right? And, really, this training phase serves two purposes. The first purpose that it serves is we want infants to learn how much each block weighs. The second purpose that it serves is we want to be able to record what is the heaviest block that infants are capable of lifting. All right.

In the test phase, as I told you, the experimenter's on the opposite side of the room, she's building a block tower, she needs a block to complete it. There's a single target block available to infants and what varies between our two conditions is the weight of that block.

So for half of the babies, the lightest block of the training blocks is left behind. And for the other half of the babies, the heaviest block that infants are capable of lifting has been left behind. So we're contrasting effort here in terms of the weight of the block that infants have to carry across the room to help the experimenter. So we're looking at infants block retrievals.

The other thing that we recorded was a parent report of infants walking experience. So these are 18-month-old infants, they can all walk. On average, they've been walking for six months so they're all experienced walkers. But there's individual variability in terms of how long they've

been walking for. So why was this important?

Well, here was our underlying logic. Imagine that you and a friend are going on a hike, you're both equally strong, you can both lift 60 pounds. But your friend is an expert hiker and you're a novice hiker, right? And you both have to carry a 60 pound backpack up the hill.

Well, despite the fact that you might both be equally strong, if you're the novice hiker, that's probably going to be more effortful for you to get that backpack up the hill than it is going to be for your friend or your buddy.

So we had a particular prediction that what we would see is a relationship between parent reporter walking experience, and infants likelihood do this-- likelihood to help the experimenter by carrying the block across the room, and that this would be selective, or at least stronger, for the high effort condition.

OK. So let me show you a couple little video clips here so you can get a flavor of the procedure. This is just showing you the test phase, so it's exerted from the test phase. There's one thing I want to explain a little bit. So you can see up here there's this striped bucket here. And the reason that we have there is-- that there is because we want the experimenter to be unaware of the target block that is left behind, so they're naive to the infant's condition.

It looks like from the infants' perspective that they can see the target block, but they actually can't. They don't know if they're in the high or low effort condition. So this is the baby who is tested in the low effort condition.

[VIDEO PLAYBACK]

I'm going to use these blocks to make a tower. These blocks can go here. This one can go here. And this block can go-- oh, no. Oh, no, I'm missing the block I need to finish my tower. I'm missing my block. Ah, oh, there it is, Joelle look. The block got moved on your blanket. Can you bring me the blocks so I can finish my tower?

[END PLAYBACK]

All right. Sorry, we exerted a little bit early. He goes over and he gives her the block. OK.

OK. Now let's watch a baby in the high effort condition. Remember, the only difference between these two conditions is the weight of the block that's been left behind. OK.

[VIDEO PLAYBACK]

I'm going to use these blocks to make a tower These blocks can go here. This one can go here. And this one can go-- oh, no. Oh, no, I'm missing the block I need to finish my tower. I'm missing my block. Ah, oh. There it is, Rose. The block got left on your blanket. Can you bring me the block so I can finish my tower?

[LAUGHTER] Can you bring me the block? Rose, can you bring me the block so I can finish my tower?

No.

[END PLAYBACK]

So it's a little hard to hear what she was saying, but if you couldn't hear it, she was saying, no, thank you. So she said, no. No, thank you. No, thank you. OK. So that's a-- pretty illustrative of the procedure.

OK. So what did we find? So here's infants' rates of helping in the low effort condition. In the high effort condition what you can see. So infants help much more frequently in the low effort condition than in a high effort condition.

Here's what we found with respect to infants' walking experience. A walking experience, how long an infant has been walking predicts infants' likelihood of helping in the high effort condition. And what this tells us is that for each month of additional walking experience, infants are twice as likely to help.

Now, what we can see here is that infants are less likely to help under high effort conditions, right? So infants prosocial behavior is influenced by the effort related costs of prosocial responding. And a critic, I guess, could say, well, maybe it's that-- it's not that infants are going by the effort, it's maybe that they're not able to help in the high effort condition. We don't think that that's the case, because infants have given us evidence that they're capable of lifting that block, right? That they're later-- later tested with in the high effort condition. But the next condition I'll show you will also kind of speak to that.

And the important-- another important thing to recognize here is that infants seem to be recognizing these costs at an objective level. I think Laura called this in her talk an agent independent level, right? As a function of the circumstances of the situation, right? And they're

also recognizing costs that at a more subjective level in terms of their own capabilities and how that influences the particular cost. In this case, it's their amount of walking experience, how expert a walker they are.

OK. So what we wanted to do next is to find out whether if when infants are presented with these high effortful helping situations, whether infants helping behavior would vary as a function of the motivational benefits of prosocial responding.

Now, it's been pretty firmly established that early prosocial responding appears to be immune to extrinsic rewards. So what that means is if you test a baby in one of these helping paradigms and you say, good job, way to go, good job. That's actually not going to increase their subsequent helping behavior. If anything, it will decrease it. But that doesn't mean that more intrinsic rewards don't influence how infants perform on these particular tasks.

We know from some prior work that infants by this age have certain affiliated biases, right? They have biases for individuals who share their preferences, who share the-- who like the same things that the infant likes. They prefer to play with those people who-- than people who don't like the same thing that they like. And they also have-- possess affiliated biases for people who could be-- said to share sort of in-group member characteristics, right? So infants, like people who speak in native-- their native language over a nonnative language speaker. And, of course, these affiliated biases might have important functional consequences, right? They might be important for cultural learning.

So what we wanted to know in this next study is whether we could kind of push around these intrinsic benefits for infants to see if their behavior would change under these high effort helping conditions. The way that we did this in this particular study is prior to the test procedure, the helping task, we had infants take part in this little task where they were given one-- two toys. They could choose between the two toys.

This happened on three different trials, different toys each trial. Infants would make a choice. And then the experimenter would subsequently show that she liked one toy and disliked the other toy. And the really simple manipulation between these two different conditions was whether the experimenter liked the same toy as the baby, or whether she liked the other toy. So did she share the infant's preferences, or did she oppose their preferences, right?

And we would think in terms of the data on infants affiliative biases, that they would prefer to interact with someone who shares their preferences.

Infants took part in the same helping task as they did in the first experiment. To streamline the procedure, we used the medium block weight that infants have been capable of lifting in the first study. The other thing that we did is we added a post-test phase. So we excluded any infants who were not capable in the post-test of lifting the target block or a heavier block, right? So we know for all of these infants in the sample that they can lift the block. The question is, do they help the experimenter.

OK. So we again looked at infants' helping behavior, we looked at their walking experience. The other thing that we did in the study is we looked at infants helping as a function of the response period. Whether helping occurred in the-- rates of helping in the first half of the response period versus the rates of helping overall in the response period. And our motivation for doing this is that we thought that if there are differences in the degree of motivation to help, you might see early differences in the response period, right? So early on, infants might differentiate across the conditions. But these might attenuate over time.

One thing I forgot to mention is that in the course of the response period, infants receive prompts at certain intervals in order to say, can you get me the block, right? So the question is with these prompts will any early differences that we see attenuate over time?

OK. So here's what we can see. This is the first half of the response period. Infants in the shared preference condition are significantly more likely to help the experimenter than infants in the nonshared preference condition, right? So when there are intrinsic rewards associated with engaging in high effort behavior, infants are more likely to help the experimenter. And the other thing that we saw is that infants walking experience significantly predicts helping behavior in the nonshared preference condition. So when the motivational benefits are low, these subjective costs seem to exert a stronger-- a stronger role, have a stronger predictive value, than when the motivational consequences-- or, sorry, motivational benefits are high.

And then here, this just shows you infants' helping behavior but, now, as a function of the overall response period. You can see they're still numerically different, but they start to come together, right? So the differences are really driven by what's happening early in the response period.

OK. So these findings suggest that infants willingness to engage in high effort-- high cost helping is motivated or affected by intrinsic motivational factors. Infants are more likely to carry a heavy block to help someone who shares their preference. One thing I want to point out

here is that these findings help us sort of interpret what's going on in the first experiment, right? If the first experiment was explained by the fact that it's a lack of ability versus a lack of effort, we shouldn't get these findings, right? Because the effort is equivalent across these two conditions here. And what simply varies are the kind of motivational benefits.

OK. So, now, I want to tell you about a study that we're just in the middle of conducting. I think it's really exciting and interesting. I'd be curious to get your thoughts. So we're literally mid data collection, but I think I have enough data to tell you what's going on so far.

So, now, we're trying to expand the scope of benefits that we're looking at, right? And as we sort of alluded to earlier, we don't-- really don't know as of yet, or we don't know very much, about what cost counts as a cost and a benefit for infants, right? That's something that we actually have to figure out to determine empirically.

There's been some recent studies that have shown that three- and four-year-olds, perhaps paradoxically, when they're tested in sharing tasks, are more likely to share with a rich recipient than a poor recipient, right? And that is paradoxical in the sense that, of course, the rich recipient has less of a need than the poor recipient. But, perhaps, unsurprising in the sense that there's something self-serving, right, like it might be in your self-interest to affiliate with people who have a lot of resources versus people who have few resources.

In our study, what we did, is before infants got the helping task, we demonstrated to them that one individual had more resources than the other individual. It's a really simple manipulation. What they did is they saw two individuals are sitting at a table. They both had these like transparent fish bowl looking balls, and on each trial they have different goods in the fish bowls.

So what happens is that one individual always has lots of stuff, right? On one trial it's animal crackers, the other trial it's these cool little balls. The third trial it's these cool, flashing little blingy rings. And the other person has very few. But they both do exactly the same thing during this first phase. What they do is they take turns-- we counterbalance everything, of course-- they pull out three objects one at a time and, they say, hey, baby, look at all my toys, right? So they're both doing the same thing, exactly the same thing. What differs is the kind of resource contacts, right? One of them has a lot of stuff. One of them only has three things, right?

And we do that on repeated trials, because we're trying to give babies the impression that, generally, this person has more stuff than the other person. OK. So then we test infants in the helping task. This helping task is a little bit different than the one I just told you about, because now we're pitting these two experimenters against one another. The experimenters in the helping task have equivalent need. They both, like Miranda was doing earlier, are building this tower, right? They're missing a block, they need a block to complete their tower, right? The only thing that differentiates the experimenters is what happened previously. One person had a lot of stuff, the other person didn't have very much stuff.

And the other thing that we're manipulating here is whether the infant has to engage in equally effortful actions to help the two experimenters, or whether helping one of the experimenters is more effortful. And the way that we've operationalized this so far in this study is by varying how long the baby has to walk. So, in one case, the person is within a few feet, in the other case, they're across the room. OK.

So let me show you the data, first, for the equal effort condition. So these are-- this is-- what this graph shows you is who the baby is helping. And what you can see here is when effort is equivalent, infants are systematically helping the person who has more resources. They're helping the rich experimenter, right?

So now the question becomes, what happens in cases of unequal effort? And as I said, this data is still coming and we're still testing this, so the condition that we started with, given that we have this initial pattern, is the condition where the rich experimenter is the one you have to walk a long way to. And the poor experimenter is the one you have to walk a short way to. And here's what we see. It flips.

So I think what this suggests is that infants are both weighing the costs of the action they have to perform, and the intrinsic motivational benefits as defined by these sort of things that might be important for social affiliation.

OK. So what implications does this have for infants' prosocial behavior? Well, it suggests that it may be the case that cost benefit analyses underlie infants prosocial behavior. In particular, their helping behavior.

And I also want to take us back to two of the questions that I raised earlier. One was about the selective nature of early prosocial behavior, the strategic nature. And the other was about the underlying motivation. So think in terms of the selective strategic question, on the one hand,

we can say, fairly early on at 18 months, infants' prosocial behavior is strategic in the sense that what they seem to be doing is minimizing costs and maximizing motivational benefits.

And in terms of the motivation, I think what these findings tell us, and this is not to say that infants are never motivated by empathic concern, they're never motivated by other people's needs, but there are other things that come into play here. So infants' underlying motivation to help is influenced by a tendency to want to affiliate with particular individuals.

OK. So I told you a little bit about infants registration of costs in the actions of other people, their use of costs and benefits to guide their own prosocial behavior. I just want to close by kind of raising some questions that I think we should be interested in pursuing in the future.

OK. So this came up earlier, right? So one thing that we have to understand to understand infants' behavior is to understand what acts as a cost for infants and what acts as a benefit for infants. And I think the thing that's really important to point out here is it won't necessarily be what we think as adults, right? It won't be intuitive to us, right?

And the classic example that we can think about is, you know, you buy your child this toy, you bring it home from the store, you're so excited to give your child this cool snazzy toy, and all they want to do is play with the box, right? So what that shows us is we're not good models, necessarily. We have to kind of determine this empirically. We can't necessarily use our own intuitions to figure this out.

Another question is how are costs read, right? So in the first study I showed you that infants' experience potentially is important, or factors that gait infants' experience, right? But that's in a situation where there aren't a lot of observable cues to effort.

So I think it may be the case that there's some variability here. Some costs infants may require experience with in order to figure out what is the cost, right? How much of a cost is this? And maybe there are other costs that infants can more readily read from the get go.

And then, finally, I think at some point, we need to ask whether infants and, potentially, children are sensitive to other types of costs beyond effort. Also, if they have a kind of higher level category of cost. So one thing that's really interesting in the literature on nonhuman animals is that there are just so simple neural systems that are responsible for effort reward decision-making, and for delay reward decision-making.

But, obviously, we, as adults, can group these things together, or I wouldn't be able to give this talk today, and Laura wouldn't have been able to give her talk today.

So one of the things we have to start to understand is when did those things kind of come together in service of this larger category of cost.

OK. So I'm going to stop there and ask for questions.