

Transcript

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HELEN: And I'm really pleased to introduce our next speaker, the first speaker of this session, Jana Iverson. (Inaudible words) Jan. Oh, (Laugh) Jana Iverson from the University of Pittsburgh. Jana's background is that she comes from the field of psychology and has studied early development of language, gesture, and motor development. And, um, for... quite a long time, focused on how those systems are intertwined in the course of very early development, and how motor, particularly motor and gesture development, having studied at the University of Chicago for some part of her career, how important those are as early precursors for language acquisition. And then about 10 years or so ago, she turned her attention to studying infants who are at risk for autism spectrum disorder. And that's what she has been focusing on, bringing her expertise and important theoretical models for how motor and gesture and language are integrated in typical development, and looking at this in the context of infants at risk for autism. So we're really delighted A, that Jana brought her expertise, her research expertise into the field of autism, and B, that she agreed to come and speak to us today about her exciting work. (Applause)

JANA IVERSON: Okay. Can everybody hear me okay? No, you can't hear me okay. Let's see. Try that. How's that? Yes? Okay, so basically I have to sit on the lectern. Great; okay. Um, so I really wanna thank Helen for the invitation to speak in this symposium. It's a real honor to be here to share this work with all of you. And I have to say it's also, I'm feeling very humbled at this moment, because there are several people in the room who actually inspired me to begin this work. Um, and so having the opportunity to present it to them is, is really terrific. So thank you Helen very much, and thank you, NIDCD for, for funding this fantastic event.

Um, so here's my... disclosure slide. I too have a job. (Several people laugh) My, my parents didn't think I would get one, but I did. (Several people laugh) Um, (Laugh) I have, I have grants. I get paid for doing courses and seminars, and I review for the NIH. And I also received an honorarium and registration for this convention, which I very much appreciate.

Okay, so I am going to talk about something, um, completely different, um, in the next 45 minutes, which is the problem of the early identification of autism spectrum disorder. So, um, if you are familiar with the diagnostic criteria for ASD, um, one of the things that you quickly realize when you start to think about how can we identify autism or risk for autism at progressively younger ages, is that the diagnostic criteria as they're written make that quite difficult. So, most of the, um, behaviors that are part of the diagnostic criteria fall in to the domains of social and language development. And so therefore, delays in these domains are not immediately apparent. So for example, difficulties establishing peer relations. Well most 6 month olds don't really have peer relations. So, that is kind of ruled out as a, a possibility for identifying autism early. So if you go down the list, you, you notice this, and, and what becomes immediately apparent is that most of the, the behaviors that are part of the diagnostic criteria, delays in those areas of functioning, only become apparent by around the ages of 2 and 3 years. And so therefore, and you all I believe know this problem well, clinicians have to wait a while. I

have 2 to 3 years here, but I would say 18 months at this point. Nonetheless, that's a long period of time. And so there are several reports in the literature of parents who report suspecting a problem with their child's development as early as 12 months of age, and being put into this sort of hold phase, where clinicians aren't comfortable making a call, pediatricians aren't comfortable making a call, and yet parents know that there's a problem. They have no access to services, and so they enter into this kind of period of waiting and seeing. And so this was identified as a significant gap in the existing literature a number of years ago. And so one goal in a new research initiative became to identify early behavioral markers of risk for a later ASD diagnosis. And to try to identify markers that could be iden—that could be, um, observed, preferably in the first year of life. So this is a terrific goal, until you start thinking about how you might execute. So, um, we know, according to the CDC, that the prevalence of ASD in the general population, at least the population of 7 year olds, in areas of the United States is about one in every 68 children. So, we hear more and more about autism, but none the less it's still a fairly low base rate disorder. And so with this prevalence, you would need, in order to do a prospective study where you id—where you recruited infants at birth, and followed them to an age where a reliable diagnosis was possible, you would need to recruit a sample size of about 1400 children to get a final sample of just 20 who receive an ASD diagnosis. And so practically and logistically, this is probably not feasible. And so... back in... uh, I would say the early, the late '90s, early 2000s; an alternative strategy kind of took hold in the autism research community. And this strategy was to study the later born siblings of children who have an ASD diagnosis. And the rationale for this was that the recurrence risk for ASD in these later born siblings, is substantially higher than the risk for ASD in the general population. So, um, a, a fairly recent study conducted by the High Risk Baby Siblings Research Consortium, found that the recurrence risk for ASD in later born siblings is about 18.7%, which is considerably higher than the risk in the general population. And so when you play with that number then, um, you need about a hundred infant participants in order to attain that final sample of 20 who receive an ASD diagnosis. The other thing that has become apparent, I don't know that we necessarily knew this initially, but that, uh, this has become apparent over time as we've done more and more of these baby sibling studies, is that this is a population of infants that's also at risk for a whole set of other delays and developmental difficulties, specifically in the domains of language, motor abilities, and, um, social interaction. And so I'm gonna come back to that a little bit later on.

Um, but let me just tell, you, so I'm going to tell you today about, um, two completed studies that have been done over the past, uh, 13 or 14 years. We're finishing up a third cohort right now. Um, so the data I'm gonna tell you about come from these two studies. So the first cohort was our initial pilot study, um, of infants at heightened risk for autism. So we had 21 high risk infants, 3 of whom subsequently received an ASD diagnosis, and we had a comparison group of 18 low risk infants. So these low risk infants were, um, later born siblings of typically developing children. So they all had an older sibling, but they had no immediate family history of autism. The second cohort focused in more depth on high risk infants. So we recruited 80 to this study, had fairly good retention rate. Of that population, 11 received an ASD diagnosis which is a bit lower than the recurrence rate I just told you about, but nonetheless kind of on target. Um, and we also identified in this second cohort, a group of 22 toddlers who did not meet diagnostic criteria for ASD, but who did manifest clinically significant delays in language at 36 months. And that group for us has become a very important clinical contrast group, because it's allowed us to start asking some questions about the specificity of the differences that we've

observed of, in our infants who go on to an ASD diagnosis. And so you'll see data from this, um, this contrast group in a little bit as well.

So our general procedure for both studies is the following: We collect all of our data in infant's homes. So we visited families every month, um, and conducted a 45 minute videotaped observation that consisted of some naturalistic parent/child interaction and also some more semi structured play, We conducted these observations monthly when infants were between the ages of 5 and 14 months, um, and then we followed up at 18, 24, and 36 months. At 36 months, the high risk infants came to campus for, uh, an assessment, a diagnostic assessment visit that involved administration of ADOS, um, and some standardized developmental assessments, and then a final clinical judgment by a clinician who was blind to all previous study data.

So my plan for today is the following: Um, so I'd like to start off, I just wanna give you some snapshots of data, um, from the studies thus far. So a couple of our findings, um, from this research, and then take those findings and try to put them in the context of a larger story about the cascading effects of early motor and communicative delays on infant's environment.

So I wanna start off by talking a bit about some of the other things that we found in the domains of motor and communicative development, and the implications that those have for the early identification of ASD. So I wanna focus today on our findings on the development of upright sitting, independent sitting. So, um... this is research that was done by my student Nina (sounds like Leisenbaum) who came to me courtesy of Helen; thank you Helen, Nina's wonderful. Um, so in her dissertation research, she did a longitudinal analysis of, um, the devel—postural development in, um, heightened, in infants at high risk and low risk for ASD. So the data that I'm going to show you come from sessions, the observations when infants for, were 6, 8, 10, 12, and 14 months of age. The coding was done during a, during 30 minutes of the session that included again the naturalistic and parent/child play. We specifically selected segments where infants were free to move, so infants had to be not in furniture, not held, um, they had to be able to move under their own steam. Um, the coding system was very detailed. I'm known for my disgustingly detailed coding systems. I'm just going to tell you about a couple of aspects of them, the codes that we used. So, um, we coded postures first of all for type. So we identified the onset and offset of postures. The ones I'm gonna tell you about today are lying. So these included both when the infant was lying supine on the back, or prone on the belly. We collapsed those together into the lying category. And then we also focused on sitting. So, those infants in the sitting, were classified as, um, the infant was supported, either by a piece of furniture, by a parent, or by their own hands on the floor in front of them, in the, the tripod sit for example. Or unsupported, meaning the hands were free to move. So no touching anything, the hands free to move. Um, the dependent measure that I'm gonna show you in, uh, the figures that I'll put up in a moment is the, is posture duration, which we calculated as the percent of the observation time spent in a particular posture.

Okay, so what you see here are the fitted curves for percent time spent in lying postures, across the 6 to 14 month age period. So just to orient you to the figure real quickly, the solid line is our group of low risk infants. Um, the broken line is the group of high risk infants who were apparently typically developing at 36 months. So typical language and no ASD symptoms. Um, the dash line is our high risk language delay infants, so no ASD diagnosis but significant

language delay at age 3. And the dotted line is the high risk ASD infants. And so what you see here is that, um... first of all, there weren't any differences between groups on any of the growth parameters. So the shape of change over time, was consistent across groups. But, we had intercept differences, between the HR ASD, and the low risk group in particular at 10 months, and again at 12 months, suggesting that while all of the other groups of infants were spending progressively less and less time in lying postures, high risk infants who went on to an ASD diagnosis were continuing to spend a fair amount of time in lying postures, even at ages 10 and 12 months, when developmentally that's not typical. So they're spending less time, or more time in a developmentally less advanced posture.

So moving on to unsupported sitting. So, the figure is, the figure format is identical. Um, and what you see here is the percentage of time is spent in unsupported sitting across the 6 to 14 month age range. And here you see quite striking differences in the shape of change over time. Um, so first of all, I just wanna point out to you that at 6 months, um, we had significant intercept differences, between the high risk ASD and the low risk group, um, and between the high risk language delay group and the low risk group. So both of those groups of infants were spending significantly less time in unsupported sitting compared to the high risk no diagnosis and the low risk group.

So with regard to growth, what you see is that whereas the low risk group kind of maintained a stable pattern, in terms of how much time they were spending in unsupported sitting, um, across this, this age range, you see this very, um, much – you see a significantly faster rate of instantaneous linear growth in the 3 high risk groups, and a significantly greater deceleration. So that accounts for the extremely sharp increase, in time spent sitting, and then the very quick decline, so this U shaped function. And so what that kind of translates to them, is that at 12 months, we have a significant intercept difference once again, so that all 3 groups of high risk infants are spending significantly more time sitting than are their low risk counterparts. So once again, at 6 months we see, um, the high risk language delay and high risk ASD groups spending less time sitting, right. So, um, because the amount of time infants spend in a particular behavior is a good index of how stable that behavior is for them, what this suggests is that for the high risk language delay group and the high risk ASD group, sitting is not a well, particularly well-established skill at this age. They're not good sitters. Um, but, they quickly kind of recover and catch on, but then they kind of go in the opposite direction. So they're spending even more time sitting at 14 months, when in fact, low risk infants are spending time standing, right; standing and walking in particular. I'm sorry, that was 12 months, not 14 months.

Okay. Um... so then moving on quickly, to give you a snapshot of what we find for communicative development. So I'm just gonna tell you, um, a little bit about results from one of our initial, um, studies, which we then replicated in work with bigger samples. Um, so, what we, what I wanna focus on here is infant initiated communication. So we've heard a lot about the importance of child initiated, joint engagement from Connie, and the importance of kind of spontaneity in children's production. Um, and so that was what we chose to focus on in this study. So what we did was to, in our 45 minute observation, code all instances of, um, gestures produced by infants. Um, so we focused in particular on deictic gestures, so giving, reaching, showing and pointing, the, the big 4 that Liz Bates always talked about. Um, non-word vocalization; so these were speech sound vocalizations, but that weren't readily interpreted by a

parent or by us; and then, um, also words. And these could be either word approximations that were used consistently to refer to the same referent, or real English words.

Okay. And so what you see here in this figure is the mean rate per 10 minutes of overall infant initiated communication. So this is collapsing across gestures, non-word vocalizations, and words. Just to give you kind of the picture from above. Um, the blue line represents the low risk infant. So you'll see, um, here we focused on data from the 13 and 18 month, um, observations. And what you see with the low risk infants is exactly what we would expect to see in typical development. An increase in the rate of spontaneous communication initiated by infants from 13 to 18 months. The high risk infants show a, a much, um, lower rate of change. So the increase for the high risk infants, um, is minimal from 13 to 18 months. And that gave us a significant age by group interaction. Um, and then at the bottom, I've plotted the data from our 3 infants who went on to an ASD diagnosis at 36 months. And what you see is that they really are, um, very much at the bottom of the barrel. So their rate of, in, infant initiated communication is substantially lower than that of certainly the low risk infants, and also of the high risk infants who did not receive an ASD diagnosis. So what this suggests then is that certainly infants who go on to an ASD diagnosis, but also high risk infants who appear to be typically developing at 13 months, begin as, um, infants who initiate communication significantly less frequently than low risk infants.

Okay. So, those are two snapshots. So now what I'd like to do is take those snapshots and try to, to situate them in the context of a larger story that has to do with why these early, early delays might be meaningful.

So... um... there's been a lot of work done on the development of infants of heightened risk for ASD over the past, uh, what would it be, probably 12 to 15 years. A lot. And I think there's still a lot that we have to learn. I also think that we do not, we haven't yet identified reliable predictors of an ASD diagnosis perhaps as we might have liked to at the beginning of this journey. One thing that we have learned from this journey is that there is a lot a variability in the early developmental trajectories of high risk infants who do not go on to an ASD diagnosis. So these high risk infants who end up with more, um, positive developmental outcomes at 36 months, actually don't look so great early on most a the time. So many of them have fairly significant early delays. Some of those infants have delays that seem to resolve over time. So we often talk about infants who we see at 24 months where we might have concerns, where parents might also have concerned, uh, concerns, and then, fast forward one year, at 36 months they look just fine. Age appropriate language, age appropriate social skills, everything looks really good. But then there's also the group that seems to be just consistently delayed, right. So these delays just persist and persist and persist over time. So one of the things that, um, has become of particular interest to me, and to, um, others in, in my group is, what this means. So what does it mean if you're an infant who has an early delay, right? And yet, at 36 months, you actually end up looking pretty good. What's the significance of these early delays, and why should we care about them? Um, and so, I wanna try to convince you that in fact, these early differences matter, and they might actually impact later development in ways that might surprise us. So I wanna try to tell you two stories, by giving you examples.

Um, the first story has to do with how abilities in seemingly unrelated domains might impact, or how, how an ability that emerges in one domain might impact another domain, that we might not think is, is related to it in any meaningful way. So here I wanna tell you the story of the development of sitting and the onset of reduplicated babble, and then also tell you about some newer work where we've looked at walking experience and vocabulary development. Um, and then the second story has to do with what these delays might mean for the language learning environment. So I wanna talk a bit about the communicative delays, so what I showed you a moment ago in that figure, and how that might shape caregiver input. Um, and then I also wanna turn to some work that we've been doing recently looking at, um, the impact of fine motor abilities on maternal labeling in parent/child interaction. Hopefully I'll have time to do all of this. I also did not press the button, so someone's going to have to like wave (Laughs) violently when the time gets close. Okay.

Um, so, okay, on to story one. So abilities in seemingly unrelated domains. So I wanna, um... go back to the data that I just showed you a moment ago on time spent in unsupported sitting, and remind you of these differences. Woops. These differences that we saw at 6 months, right, where, um, the language delay in the ASD group for sure, um, were spending significantly less time in sit—in unsupported sitting compared to low risk infants. But on average, even high risk infants who went on to typical outcomes at 36 months were doing the same, suggesting that as a group, high risk infants, um, ha—experience some delays in the attainment of unsupported sitting.

So... at this point you might be sitting here thinking, um, hello, this is ASHA, this is not the physical therapy conference. Why is sitting relevant to us? Well sitting is probably one of the most important things that happens in the first year. I think sitting is amazing. Um, and I'm here to tell you why. (Laugh) So sitting, interestingly has consequences for vocalization. And I'm sure that many of you know this, but in case you haven't thought about it before, when you sit, as opposed to when you lie on your back or on your belly, you can expand your chest, right. So you, you can when you sit, you can expand your chest cavity. That has implications for breathing, um, and that in turn changes your capacity for extended phonation. So you can phonate for a longer period of time when you're sitting upright, than you can when you're lying, right, on your back or on your belly.

Um, the second thing is that your speech articulators are arranged in a new way, and in a way that's very favorable to you because the mandible suddenly is working with gravity. So you have gravitational forces actually helping you lower your jaw when you're sitting upright, whereas when you're lying on your back, you don't quite have that nice supportive context for, um, for that kind of behavior. And so you combine these factors... with the fact that infants are well known, experimentalists; so they love to try things out, and they love to repeat behaviors over and over and over again. And so, this kind of combination, this constellation of factors, provides them with a whole new set of possibilities for discovering the properties of their vocal tract. So when you're sitting upright, you can vocalize, um, in new and different ways, and you can learn about the properties of your articulators and how they might work with respiration, and with how long you can phonate, in order to experiment with vocalization.

And so we have some evidence in fact. Um, this is again from Nina Leisenbaum's dissertation, that sitting, um, does provide a supportive context for the production of reduplicated babble. So... this was, um, an analysis. This is an age held constant analysis. So, um, and this is done without regard to risk. Um, I'll come back to that in a moment. But what she did was compare 6 month olds, who could sit independently to 6 month olds who could not sit independently. And so what she found was that, um, while there was no difference between the two groups in how much they vocalized, and how often they vocalized, there was in fact a significant difference in the rate of reduplicated babble, which was higher among the sitting infants than it was among the non-sitting infants. And this also help at the level of individual infants, so that 41% of the sitters, but only 9% of the non-sitters produced any reduplicated babble, um, during the 30 minute observation.

So, to bring this back to what this means for infants at risk, one thing that we find, have found fairly consistently is, that there are, there is, um, much greater variability in the age of attainment of reduplicated babble among high risk infants compared to low risk infants. So what I've shown you here is, median ages of onset for reduplicated babble among high risk and low risk infants, you'll see that high risk infants on average begin to babble about a month or so later than, um, than low risk infants. So this is, you know interesting, but probably not worth writing home about, since it's still within the, the typical range for the onset of, of this behavior. But what you see is that there's a much longer tail at the, at the later ages, so that about half of the infants in each of these cohorts, started to babble at a late, an age that was significantly later than the age of babble onset for the low risk infants. And in fact, if you look at the ranges for the high risk infants, you see there are infants who were starting to babble well past the 10 month mark, which is considered to be kind of a, a red flag for risk for later language difficulties.

Okay. So another example, um, has to do with the relationship between walking experience and vocabulary development. So, um, a long time ago, there was a lot of discussion in some work done by Liz Bates and colleagues about why walking had nothing to do with language. And a lot of time was spent kind of ruling out motor maturation as an explanation for change in language. And this was a very influential point of view for a long period of time. Um, and one of the kind of major pieces of evidence that was, that was cited was that there wasn't any correlation between, um, the age of onset of walking and other kind of language milestones. And that's certainly an important finding, and it has held for a very long time. But I think that there's pro- there's a more nuanced view of the relationship between walking and language that we could consider which doesn't really have to do with whether you do one or the other, but has to do with what walking can give you. Um, and what walking experience provides you with that's useful for language learning. And so I wanna tell you a little bit about some work that we've done recently to look at that.

So just by way of background. Um, there's an emerging line of research that suggests that walking is a really powerful organizer for communicative development. So a number of things happen when infants start to walk. One is that there are pretty substantial changes in the quality of their social bids, but of course not in their frequency, um, that have to do with whether they carry an object to, um, an, an adult. Right? So walking infants, um, more often produce moving social bids where they carry an object with an arm extended to a caregiver, than do crawling infants. Now crawling infants can do this. This is not a total floor effect. But for walking

infants, because they have their upright, and they have their two hands free to move, this behavior is supported, right, in ways that it's not for crawling infants. Um, and work by Eric Wally in particular has suggested that there are, um, substantial qualitative shifts in language development that happen after the onset of walking. Um, and so, we found this very interesting, because we're very interested in, in thinking about what it is about walking, and the, the... the experiences that walking provides you that might, um, have an influence on language development. And so we, um... recently published a paper where we used our data from the McArthur Bates Communicative Development Inventory. Um, and what we did was to... first of all align time, not with regard to infant chronological age, but with regard to walking experience. So that's what you see in this figure. So the dotted line at 0 represents the final session where the infant was only crawling. So, the session one of what with, uh, the session one month afterwards, represents one month of walking experience. Um, two months afterwards represents two months of walking experience. And the negative numbers represent sessions before the onset of walking. Um, and what we were able to do then was to, um, fit a piece-wise hierarchical linear model that allowed us to look, uh, to compare the overall base rate in growth, and this is in, um, words understood, so word comprehension. We get exactly the same findings for words produced, but just for the purposes of simplicity, I'm gonna show you words understood for now. So we're able to compare baseline change in words understood across, um, the 7 time points, with, um, the piece of the, of the curve that come—that, that falls between the final crawling visit and, um, the visit with 3 months, with 3 months walking experience. Did that make sense? Okay.

Um, and so when you look at this, so we, these are the data now from our low risk infants and our high risk no diagnosis infants. And this replicates exactly what has been reported before by Eric Wally and colleagues. So you see you know kind of this slow change, um, prior to, um, the onset of walking, but then a very sharp increase in the rate of growth. And it's a significant change. So, um, infants, after the, after, um, the onset of walking, infants acquire something like, um, 16 words above and beyond the base rate of growth, right, that they show across this, this whole time range. So... this, this is very nice; it replicates what's, what's in the literature. But now the question is, okay, well what about infants, um, for infants who we know, have delays at 36 months? So... here I've added in green, the data from the high risk language delay group. And so what you see here is that while their overall base rate of growth is somewhat lower, it's a, it's not significantly different, it's not statistically different from, um, the high risk no diagnosis, and the high risk, um, no, the low risk group. But, the rate of change following the onset of walking is attenuated. So they show much flatter growth, following walking onset. And the most striking difference is in the infants who go on to an ASD diagnosis. So not only are they slower in acquiring new words, or words and comprehension, but they also don't seem to reap the benefits of walking in the same way that the other 3 groups of infants do. So, disclaimer here, walking is not going to explain word learning. It's a piece of the puzzle. But what I think is important is that for the high risk ASD infants, so we know that these are infants who have vulnerabilities in language learning, right. We know that they're vulnerable. Um, and so, when they experience, and when they have different experiences in walking, and I should also add, these infants are older, when they begin to walk. We've controlled for that in the analysis. So this holds, um, regardless of that. Btu they still, even though they're older, are not taking advantage of walking in the same way that the other 3 groups of infants are. So you, you kind of

take this vulnerability, and then you add to it these other kinds of differences, and that may then kind of create a developmental trajectory that's going to look quite different over time.

Okay, so, um, the take home point then is that early motor opportunity—abilities create opportunities for exploration and for interaction that might be important for the development of vocalization and language. So that delays in these abilities, and differences in infants resulting experiences, might be related to delays in vocal and language development.

Okay. So now to move to, um, the language learning environment. So, um, I wanna start off by talking about how communicative delays in infants, might shape caregiver input. So... I've showed you before, our data on differences in infant initiated spontaneous communication. So this is, um, a kind of a deeper look at those data where I've actually, I've plotted the median number of gestures produced by low risk infants, and these are high risk no diagnosis infants. So all of these infants looked apparently, uh, to be apparently—apparently typically developing at 36 months. The gestures are classified as give requests, um, and points, shows. And so what you see here is that, first of all there's a ton a variability among the high risk infants. Um, there's no difference in, the, uh, no statistical difference in the numbers of give requests gestures, produced at 18 months. But there is a significant difference, um, in the number of point show gestures, such that high risk infants produce many fewer pointing and showing gestures than do their low risk counterparts.

So were then interested in the question of how, of how mothers responded, and, and what impact this might have on the input that children receive. Um, so... we found first of all that there were no differences in mother's responses to their infant's gestures. So both groups of mothers were equally responsive to their infant's gestures. They responded to about 80% give or take, of their infant's gestures, and that that didn't vary across gesture types. So this held for both give request, and point show gestures.

Um, the next thing that we looked at was the content of mother's responses to their infant's gestures. And in particular we were looking for what we call translations. So we were interested in when an infant gestured, did the mother in her response provide the label for the referent of the infant's gesture. So if the infant for example held up the ball, did mom say, "Oh, that's your ball; let's play ball." That would be considered a translation. Or did she say something like, "Look at that!" That would not be a translation. So we required a concrete noun. Um, and so... what we found was that there weren't any group differences in overall proportion of infant gestures that received, uh, translation as a function of group. But what was important was that, um, mothers were much more likely to translate pointing and showing gestures than they were giving and reaching gestures. So there was a main effect of gesture type. So, that's important then. So on the left you see the data I just showed you, the main effective gesture type. On the right are the data from the infants that I should you before. So high risk infants are producing many fewer pointing and showing gestures, exactly the types of gestures that are likely to elicit a maternal translation. And there's ample literature that talks about how powerful those moments where infant is attending to an object and adult provides a label for that object, that those are kind of magic moments for word learning. And so, um, I think the take home message here is that high risk infants give their caregivers many fewer opportunities to provide these kinds of

translations, and so therefore, get fewer of them, get fewer of these beautifully table—tailored labeling moments in the input that they received.

Okay. So, one more example. Um... that has to do with, so this is some newer work. I'm gonna show you data, um, only on an initial study that we've done with typically developing infants, but I'll talk about the extension to high risk infants in a moment. So this has to do with the relation, the potential relationship between fine motor delays and caregiver input. So one thing that we've observed, is that in high risk infants, fine motor skill in a second year, and this is, um, a composite measure that's a parent report, predicts expressive language scores on the Mullen, at age 3. And this is controlling for nonverbal cognition. So you can see the relationship there. It's, it's, um, it's nice and tight. And so we were interested in thinking about why that might be the case. And so there's a whole variety of possibilities. But, um, one thing that we settled on was that infant fine motor skills might have an impact on the language learning environment because the object manipulations, the, the way the infants manipulate objects might shape the input that they receive. So why is this important? So there's been a lot of research on word learning. Much of it has taken place in the context of the laboratory in very well controlled situations, beautiful, experimental designs. But the natural learning environment presents, as people have talked about, um, a variety of different problems. So infants hear a lot of stuff, and there's a lot a stuff around them. and, and in fact, most of the time, there's really a whole lot a stuff around them, and they have a problem of kinda trying to figure out how these things all go together. Um, and so one important way that infants can isolate an object, from the bazillion other toys that are around them, is that they can grasp it. Right? And so, um, there's been a gorgeous line of work done by Linda Smith and Chen Yue at Indiana University, where they looked at the relationship between infant looking and object manipulation and parent language. Um, and one of the many findings that has emerged from this work is that infants are more likely to learn words for objects that they're holding as parents labeled them. So this is in a very controlled laboratory setting, and we were interested in thinking about how this might play out in the real world. So, one a the things is that, you know, this sounds good, and it probably plays out very nicely in a lab, where parents don't have competing influences on their attention, where they can focus on what their child is holding. So in order for this to kind of work out well, in order for grasping and parent labeling to kind of coordinate, caregivers have to kinda pay attention to these things. So they have to pay attention to what their child is doing with an object, um, and then produce a label at the appropriate moment. So, babies looking at a ball, getting ready to eat the ball, and parent says "You've got the ball!" Right? So we think about these as kind of the right label at the right time kind of moments.

So, um, we did an initial longitudinal study, a very small study to look at this. So this is, um, Kelsey West's Master Thesis. So, the data were from 13 typically developing infants and their mothers who were videotaped at home, um, during a toy play session. Importantly, they all played with the same toys, right. So we brought the same bag of toys every single time, and just told them to play as they normally would. Um, and so from these videotapes, we first of all coded, um, infant object manipulation, which we classified as sensory motor, so things like banging, shaking, mouthing, and so on. Functional play, taking a spoon and putting it in the bowl, um, and, and just plain holding an object without doing anything with it. we transcribed all maternal speech, I should say Kelsey transcribed all maternal speech, and identified all

instances of labeling, which was production of the concrete noun, and then she looked at the coordination of maternal labeling with infant's object manipulation.

So, um, just by way of general, uh, background. So between the 10 and 14 month age range, we found that maternal input really didn't change that much in terms of its frequency, and in terms of the proportion of utterances, that contained labels. What did change though, and this is not surprising, is the, is the proportions of time the infants spent manipulating objects. So as infants got older, they spent more time engaged with objects, and they spent proportionately more time engaged in more complex object manipulation like functional actions.

So then turning to what happened to the linguistic input. So, um, the first thing that we did was look at, was compare maternal input when infants were versus were not manipulating objects. So, um, from this comparison, we learned that when infants manipulated objects, mothers actually talked less. But those utterances contained a significantly higher proportion of labels. So, fewer words, but more words that provide a lot of bang for your buck.

Um, so here what you see is, the proportion of, um, of maternal labels, in a variety of infant behavior context. So you see the proportion of maternal labels that were produced. When the infant was both hold and looking at the object, so that's the red line, when they infant was just holding the object, that's the blue line. When the infant was just looking at the object, that's the black line. And when the object was not in the infant's possession, and was not being looked at by the infant. And you see that the, the difference is quite striking. So mothers were most likely, especially at 12 and 14 months, to provide labels when infants were both holding and looking at an object, compared to all other possible conditions.

And finally, how infants were manipulating objects really mattered. So what you see here is the proportion of labels that corresponded to objects that infants were both holding and looking at, because that was the vast majority of the labels. Um, as a function of infant manipulation type. So, functional play, that's the red line, sensory motor play shown in the blue line, and passive, which is the infant just holding the object. So, mothers tended to label when infants were doing something with the object. Right? So, um, and this changed over time, especially for functional play. So labels were most likely to occur, when infants were holding and looking at the object, and when they were doing something with it. Either, manipulating it via sensor motor activity, or through, um, functional play.

So, what this suggests is that infant's object manipulation shapes the input that they hear. So infant, infants looking and holding an, at an object is a powerful cue for maternal labeling, a, a powerful elicitor of maternal labeling, and how infants manipulate the object also seems to influence maternal labelling behavior.

So we know from a variety of studies, um, done in fact by people in this room, so Becky Landis group has been kind of a leader in this, in this area. The in, the high risk infants engage in less and less sophisticated object manipulation. And so, the open question that we would like to tackle next, is how this impacts the language input that they receive.

Okay, so, to wrap things up. Um, so what have we learned? Well one thing that we've learned is that infants who are at heightened risk for ASD, both who do and who do not eventually receive an ASD diagnosis, show tremendous variability in the course of early motor and communicative development. Some of these infants are indistinguishable, from low risk infants. Some infants exhibit delays, and there most severe delays do in fact seem to be apparent among the infants who later receive an ASD diagnosis.

A second thing that we've learned is that the variation, this variation in infant motor and communicative development, seems to have cascading and far reaching effects on the emergence of behaviors, and other domains. So I told you the story of sitting and reduplicated babble, and the other story of walking and vocabulary development. And also on infant's learning environments. So we talk about how infant gesture production and delays in gesture production, specifically of pointing and showing, um, might impact caregiver input, and we also talked about how infant's object manipulation might share caregiver's labeling of those objects.

So I just want to leave you with, um, a final, um, big picture thought. So, when we think about, the emergence of developmental delays, and I've put up here language delay as an example. We often talk about these as being characteristics of the child. So there's a child who exhibits delays in the initiation of joint attention. And that child becomes a child who has a language delay. So this is you know kind of the, the traditional conceptualization of what delays are. They, they tend to be quite child centered. Um, I actually think... that it's very productive, both, well and, and headache inducing, (Laugh) but it's productive, um, from a research point of view, and it's also extremely productive from the point of view of intervention, to think about cascading develop—developmental effects. And to think about, um, the fact that when an infant exhibits delays in behaviors that are the component skills of joint Attention. So eye gaze, um... vocalization, gesture production, that those things then of course kind of come together and yield a delay in the, um, in the emergence of joint attention. But the emergence of joint attention then has impacts beyond the child. So delays in joint attention have an impact, an important impact on caregiver behavior. And that impact on caregiver behavior then kind of circled back to the child. So when a child is delayed in initiating joint attention, caregivers have to work ultra-hard to keep an interaction going, right. You don't have a whole lot of things to talk about because you don't have contributions from the child so much. You alter what you say to the child, right, and what you say to the child, often doesn't happen in a nice moment of shared attention. So often the time, you're kind of sitting there like narrating the scene, right. Um, and... that also then kind of shapes your overall impression of the child's developmental level. So you, you know, you have this sense that you're interacting with a child who is not at a level comparable to his or her peers. And so all of those things then kind of shape caregiver behavior and caregiver interaction with the child, in ways that may not necessarily be beneficial for a child who might actually need a little bit more, and who might actually need a caregiver 2 for example, translate a giving or a requesting gesture, right, because that's what I can do. Um, it might not be what you would typically go with, but under these circumstances, that actually might be something that would be beneficial.

So I leave you with that, um, and I look forward hopefully to discussing that more with you during the, the Q&A. Um, I have many people to thank. So, um, the agencies that fund this research. Uh, Nancy Menchu, Diane Williams who's here today who has been a tremendous

resource during, um... during all of these projects. Um, I am very privileged to work with a fantastic team of people who make this research possible, and we owe a special debt of thanks to the families who have very generously shared the first 3 years of their children's lives with us. And thank you all very much. (Applause)

MARGARET: Alright, uh, if we could get this mics going. Or that mic, I found it. I found it. Thanks so much. Um, alright, yes, Karen.

Q: Hi I'm Karen Chenausky from . .

JANA IVERSON: Karen. (Laughs) . . .

Q: Beth Israel Deaconess Medical Center . . .

JANA IVERSON: Nice meeting you. (Laugh) Yes . . .

Q: We've messaged before. Um, I, following Emily, I'm going to ask you a question about something you didn't talk about (**Uh-huh**) in this talk, and feel free to say we can talk about it offline.

JANA IVERSON: Okay.

Q: Um, let's see, let me read what I wrote here.

JANA IVERSON: Okay.

Q: Um, okay, so, you've talked in some of your papers about the idea that hand banging can present an opportunity for practicing rhythmically organized, tightly timed actions, and that this can be correlated with, or is related to the onset of reduplicated babbling. What I'm wondering though is, um... it kinda raises the question of why the repetitive behaviors characteristic of autism, don't help in that regard. (**Mm**) Instead they seem to really . . .

JANA IVERSON: Right, right . . .

Q: Hurt.

JANA IVERSON: Right, right. That is a fantastic question. Thank you for asking it. We can definitely talk about it now. Um... (Several people laugh) Um, so, I think this is one of the... one of the interesting, um, kind of paradoxes of rhythmic behaviors, is that they're developmentally normative in infancy, right. So, the first year of life is a time when infants shake and bang and do you now these wildly crazy things with their limbs, and it's a way of gaining control over these effectors. Um, and then they go away. So, you know, Esther Thelan used to talk about them as behaviors that having served their developmental task, you know kind of die off a natural death. Um... and so, one of the questions that has always fascinated me and I don't know how you could answer it, is, whether the repetitive behaviors we see in kids with autism are those behaviors, but just carried out over a longer trajectory, or whether they're

something qualitatively different. And, I don't know that we really have a good answer to that. And so, um, so I think that's, that's kind of one possibility. Another possibility is that, um, you know, in at least in autobiographical accounts of ASD, you know, people talk about engaging in repetitive behaviors as being something that kind of, um, draws them inward, right, and, and you know kind of helps them, um, recalibrate, and they're very focused inwardly during these moments. And so I wonder if, maybe another, uh, and, you know, probably not mutually exclusive explanation might be that, these behaviors kind of take away attention from other things, and so therefore, they're not out there, right, kind of to help pull in, um, activity in other systems, in the way that they might be early in infancy. Um, I think it's a great question, and, and I, if, if we could figure out what these behaviors are that happen later on, I, I think, you know I mean that, that for me is like a million dollar question, yeah.

Q: So, so I agree. And I think going back to Thelan's work, there's, she's talks about, um, sort of stable attractors in the chaotic sense. **(Yeah, yeah)** And so maybe those repetitive behaviors that we think are abnormal are too stable . . .

JANA IVERSON: Yes, yes, that's right, that's right. ..

Q: And you can't get out of them, and they, so they persist for a long time . . .

JANA IVERSON: That's right . . .

Q: And they also distract you from other things.

JANA IVERSON: That's exactly right, yeah. And she talks; she has a wonderful chapter, um, where she talks about, you know kids with developmental disorders having the tendency to get stuck, **(Yeah)** right. And, and the attractor wellbeing especially deep. **(Yeah)** And so, you know, very difficult to get out of yeah.

Q: Yeah, so I'm, I'm seeing some kids like that in the minimally verbal kids that I'm working with now to try to teach them to talk. And we can talk about that later.

JANA IVERSON: Uh-huh. Uh-huh. Okay, yeah, great.

Q: Hi, I'm **(Hi)** Ali Fitch from Boston University. And, um, so I think you presented some really compelling evidence about the contributions of motor development to language development. And it had me thinking about directionality. **(Um-hm)** And so I was wondering what, if anything, we know about children who have motor delays and difficulties that we don't typically think of as having language delays . . .

JANA IVERSON: Ah yes. **(Laughs)** . . .

Q: Like children with muscular dystrophy for example.

JANA IVERSON: Right. It's funny, you're about the third person who's mentioned that to me today. **(She and several audience members laugh)** Seems to be on everyone's minds, yeah . . .

Q: Tele visual all day . . .

JANA IVERSON: So I think this is also an extremely important question. And, um, I mean one thing that we really don't know, is much if anything about the language of children with severe motor impairments. It's just not studied at all. And, you know, I, I think this is a, this is a significant gap in the literature. Um... from, you know, from just a, an empirical knowledge base point of view, and also for, you know, for clinical reasons, from a theoretical point of view, it's, you know, a really critical absence. Um, I think one thing that is helpful to me in thinking about this is, um, you know, I, I would never, I, I hope that no one has taken me as saying that motor development is necessary for language development, because, I, you know, there are many cases, like you pointed out, of children who, you know, are paralyzed, and yet somehow they learn to talk, or they, you know, they get language. Um, and so, you know what's great about development is that there are so many alternative routes to... the same outcome, right. So we're all super different, and yet we all learn to walk, and yet we all learn to talk, right. And so in typical development, you know, you have the, these, all of these alternative possibilities, right. So, if you're, you know, if you experience an obstacle at one point in time, oh look; let's go off on this other pathway, and we can, we can go, we can grow that way for a while. Um, one of the things about, um, disorder, and atypical development is that development might be less flexible. So that when you hit an obstacle, so, if you're already... vulnerable, right, if you have ASD risk, which confers on you vulnerabilities, in the area of language development for example, and you encounter these obstacles along the way, that might not be favorable for you. Now it's not to say that you know this is go, you know, that you're going to end up with, um, developmental concerns, but it might mean that you either have to come up with alternative strategies, right, so take advantage of other kinds of skills to get to that common, um, outcome, or, it takes you much longer to get there, right. Or some combination of the two. Um, and so, you know, just the sort of narrowing of the possibilities, right. If you're already vulnerable, and you have fewer possibilities, there are these constraints that kind of then, um, happen. And so that if you have difficulties, or, or you know the experiences that you get through motor exploration are not the kinds of normative experiences that would be generated. That that might not be beneficial either. And so you're vulnerable, and then you're not getting great learning opportunities. And so that's kind of, um, then perpetuating the, the difficulty. Does that, does that make sense?

Q: Yes, thank you, yeah.

JANA IVERSON: Okay.

Q: Hi, I'm Dana Battaglia from Adelphi University. **(Hi)** Um, I wanted to thank you for this presentation because I feel like it's qualified things I anecdotally have been talking about for a while. (Laughs)

JANA IVERSON: Oh that's always, uh, I, I love hearing that from clinicians, because . . .

Q: I, I'm feeling so validated right now . . .

JANA IVERSON: It feels like it's like real. (Both laugh)

Q: No it's very real . . .

JANA IVERSON: Thank you, thank you.

Q: Um, I had a technical question about your data earlier, uh, like one of your first slides when you talked about lying behaviors.

JANA IVERSON: Yes, uh-huh.

Q: Um, and when you talked about how children diagnosed with ASD have longer durations of lying.

JANA IVERSON: Yes.

Q: My question to you is do you have any data about during those lying periods, I don't know how else to describe it.

JANA IVERSON: Yes.

Q: Were there tantrums going on at that time . . . ?

JANA IVERSON: Oh yeah, that's a good question, yeah.

Q: Um . . .

JANA IVERSON: Um, yeah.

Q: Because I'm envisioning, like the rolling and the noncompliance, and, you know, all of that. . . .

JANA IVERSON: Right, right; right, right, right. Right, yeah. No, that's a great question. And so that, this is like a natural follow-up. I just have to find the lucky winner for this project.

Q: Excellent, Right (Laugh) . . .

JANA IVERSON: Um, because, no, we need to, what we need to do is we need to code what infants are doing in these postures . . .

Q: During those postures, yeah . . .

JANA IVERSON: Yeah, exactly, because, yes. And, and the same thing like with the, the sitting, right, (Right) at the later ages. Like what are they doing when they're sitting, when you know, most other kids are like up and walking, and, and . . .

Q: Yeah, like are they sitting in a noncompliance episode . . .

JANA IVERSON: Wreaking havoc in the neighborhood. Yeah, exactly. (Right) Exactly right. No I think, I think that's an excellent question, and hopefully we'll have an answer,

Q: Or watching TV, yeah, yeah. **(Laughs)** That's what we said. Okay. (Laughs) Uh, thank you very much, I appreciate it.

JANA IVERSON: Yeah, yeah, thanks.

Q: Good luck.

JANA IVERSON: thank you.

MARGARET: We have time for 2 questions.

Q: Thank you. She gets the other one, right? Um, uh, I'm Nan Ratner from the University of Maryland. And it was a beautiful talk, and it got me thinking in multiple ways as both a parent and a clinician. And I may have the goofiest comment or question you've heard in a long time. But, um, I was tryin' to imagine when you were showing these beautiful interactions, because I believe in reciprocal relationships, of what I would do if I knew for sure that more time sitting up and more time locomoting would really help language development. And my solution was something that's now off the market, which is basically those rolling walkers . . .

JANA IVERSON: Oh yes, the walker, yeah.

Q: And, um, you know I just; I'm wondering what your personal impression would be, (Both laugh) uh, of suggesting that high risk families actually make some judicious use of when they bought from another country. (Laughs)

JANA IVERSON: Right. (Laughs)

Q: Uh, becau—and watch the stares and all the other stuff. **(Laughs)** Um, because it seems to bode sort of, you know, do the things that you're suspecting are not happening. And I know that I'm sure Kim Maller, I won't speak to him, but I'm sure he's very happy about this issue with the babbling and the posture, right. And, I, what do you think?

JANA IVERSON: So yeah, I think that's a really great question. So, um, so, with regard to sitting, it's a little easier to think about that, because you know you can just say alright, well you know, if your infant's 6 months old and is, is not looking like they're, uh, ultra-stable, upright, then you can, you know, you can get them upright in a variety of propped ways, there's, you know, all sorts of things that you could do. With the uprights, you know, with the standing, it's, it's diffi—I would never wanna recommend the walker for, you know, legal reasons. (She and several people laugh) I think, I think legal counsel at the University of Pittsburgh would be very concerned about that. Um, but I mean I think it's the right idea. Because, you know it's not, uh, you, it's, it's the, what walking buys you in terms of being able to get out there, being able to select what you're interested in, bring it to a parent, you know, kind of engineer these

interactions in a way that's really tailored to you. Um, and so... you know, and there, so I have, I have colleagues in physical therapy who design, um, power mobile sol—power mobility solutions for toddlers and actually infants, so they, you know, they build these cars, ride on cars that infants can ride around on, and also harness systems where infants are, you know, and these are kids with really severe CP. But you know, the idea might not be a horrible one where they have, if they have a mobility limitation, you rig a system where, you know, they can... actually get out there, you know, using what they have available, and explore the environment. I mean that I think empirically that would be something that would be extremely interesting to do. Um, no one's done it before, but I think it's, it's exactly the right idea and the way we should go. (Someone makes a comment and she says right and laughs) Yeah, that's right. Yup, yeah, yeah.

Q: Hi, I'm Victoria Henbest from the University of South Carolina. And my question is related to this notion that you mentioned in your paper about this unverified, um, notion that when, when we're having a motor development spurt, **(Yes, um, hm, yeah)** that language, um, stops. And I think that's an important question for clinicians, because that's definitely something that was, that was told to parents when I was working in the early childhood center, and we just kinda went with it, because, **(Um-hm)** that's what the boss and the director of Special education was saying. **(Laughs)** And, and, everybody seemed to go oh that makes sense. And so, um, I'm curious on your thoughts on that, **(Right)** and, and where the evidence is, **(Right)** on that.

JANA IVERSON: So, um, we actually have some new evidence. Um, and this is from typically developing infants. So, um, this is a collaboration with Sarah Burger at College of Staten Island where we looked at, um... we had data available for, uh, every 2 weeks from the first 17 months of life. And what, what we did was look at, um, production of, this was production of vocalization. Um... around the onset of crawling. So this is not walking, this is crawling. And so, the... you know, the, the big finding was that, uh, when infants begin to crawl, they're much less likely to crawl and vocalize at the same time. But with crawling experience, you start to see co-occurrence of these behaviors more and more. Um, and, but so it was a transitory effect, right. It, right, it lasted for like 4 weeks, right, and then you started to see crawling and vocalization happening over and over again. We were able to also look a little bit at the onset of standing, and found something quite similar. So when infants were first beginning to stand, they stopped vocalizing while they were standing. Um, so it's not exactly what you're asking, but I think it's, it's sort of close. So I think you know the, the point there is that these are temporary effects, right. So they should not last for 3 months, right. That, that's, that doesn't seem to be what the typical developmental pattern is. Um, but I do think that I mean that, that sort of made me happy because there's this, you know, this longstanding, oh yeah, they start to walk and then they stop talking. And people have kinda taken that to the extreme, right. And especially if they think oh well he's a motor kid, you know. He's, he's just so busy being a motor kid, of course he's not talking. And so, I don't, I think that that's like kind of gotten blown out of proportion. So there does seem to be some evidence for kind of temporary disruptions, but they are temporary.

MARGARET: Please join me in thanking Dr. Iverson. (Applause)

JANA IVERSON: Thank you.