Stacy Gehringer (00:06):

Hello. Welcome everyone. Thank you for tuning into the CASCW Podcast Channel. My name is Stacy Gehringer and I'm the Outreach Director at the Center for Advanced Studies in Child Welfare. We are excited to share our latest podcast series with you. This series is titled Early Development and Child Welfare and features interviews with a variety of professionals in the fields of early childhood and child welfare listeners will enjoy content related to attachment, culture, screening, brain development, infant mental health, and more. Please be sure to subscribe to our channel for future episodes. Thank you for listening and take care.

Christine Cole (00:51):

Hello, I'm Christine Cole from the Washington State Health Care Authority, and I'm here with Dr. Kathleen Thomas from the Institute of Child Development at the University of Minnesota. Today, we will be talking about early brain development and its reliance on adult interactions. We'll be covering topics such as serve and return and development as a cumulative process. I'd like to start out asking you Katie a little bit about the term brain architecture. So we often hear that term used when we're talking about infant infants, early brain development. And I'm wondering if you could provide us an overview of what's meant by that.

Dr. Kathleen Thomas (01:25):

Sure. Thanks, Christine. When we talk about brain architecture, we're really just talking about the structure and function of the brain together. So when we think about the structure of the brain, architecture is really about how it's sculpted, how it's put together the different pieces that make up the brain. So we have different types of cells or different regions of the brain. But we also have connections between all the different areas. This turns out to be really important in brain function and brain development, the connections or the networks that we create in the brain. And so when we talk about brain architecture, we're often talking about those networks and the connectivity between different parts of the brain so that we can have all of the complex functions that we need as humans.

Christine Cole (02:14):

So when we're thinking about brain architecture and the early brain development, another term that I've often heard is serve and return. And can you tell me a little bit about how serve and return is related to those brain structures that you were talking about?

Dr. Kathleen Thomas (02:30):

Absolutely. So serve and return is really the idea that we are active participants in our environment and that we're when we're engaged with, especially in social interactions with other people that one person is initiating a conversation and action and interaction and the other, and then gives the other a chance to respond and participate in that together. So it's really the back and forth between people. And when we think about brain development, it might not be so obvious how you get serve and return in the brain. But it's actually incredibly important that our brains can react to the environment.And so it's really about what stimulation we give the brain and how we have a chance for our brains to react to that and to change their structure or architecture in response to their experiences. So all of that is what we mean by this serve and return. It's the active process of infants and children participating in their own development. Um, and part of that is through the way that their brains are being shaped and molded by the kinds of interactions that they're having in their environment.

Christine Cole (03:40):

So Katie, I'm wondering if you can speak a little bit about, you know, I think sometimes we think the brain is fully baked when it comes out of the oven, but the structure is already built when we think about that architecture and as you're talking about serve and return, it sounds like maybe not. So can you share a little bit about you know, where our brain starts when we're born and then why that, that interaction is important over time?

Dr. Kathleen Thomas (04:04):

Absolutely. You know, when we think about brain development, we're often thinking about a newborn baby or a child, but there's actually a lot to what happened in the brain in utero before the baby's even in the outside world as we think of it. And all of those in utero interactions are really important too. Now that can sound scary. It sounds like, wait, everything that possibly happens, that could be negative. I need to avoid. It's not quite like that, right? It's more that the fact that there are sounds outside the womb, that there are physiological changes that are happening in the developing body. And all of those processes are influencing brain development in utero. 99% of the time that goes perfectly. It's quite an amazing aspect of brain development that without any intervention, this brain develops normally and the majority of the time, right.

Dr. Kathleen Thomas (04:56):

And it's very rare that we have errors in brain development. But when we think about brain development, it is easy to think about the brain is perfectly formed already. And if we look at it physically, we just look at a brain at the newborn baby. It will look a lot like a small version of the adult brain, but it's very different internally. So even though the external structure of the brain, what you would physically see, if you could see inside the head might look similar. Those networks that I was talking about that deep part of brain architecture, the, how would the connections are formed between different parts of the brain are really not developed at all. Early on, we definitely do have structures that we do have connections. It's not that there are no connections. In fact, very early in brain development, we have way too many connections.

Dr. Kathleen Thomas (05:47):

I used to think in terms of old fashioned landline phones right now with cell phones, we don't think it'd be quite the same way. But if you think about all the cell towers in your state and, you know, early in brain development, we could think about the connections in the brain from one your cell phone to one other person's cell phone. And that's the only connection you have. But over time, we're developing connections to other phones or other cell towers, right? And initially our brains don't quite know which ones are going to be important or which ones are going to be relevant. And so we have an over abundance of connections. We call this synaptogenesis, what does that fancy word just means that we're creating synapses or connections from one, one brain cell and neuron to another.

Dr. Kathleen Thomas (06:36):

And we have to do this thousands of times and get an overabundance of connections just in case we need them. And then we use our experiences over time to mold that brain, to keep the connections that are meaningful and helpful and useful to us and to let go of the connections that we're not using. We often talk about that, use it, or lose it phenomenon that the connections that are being used a lot and are helping make our behaviors efficient and fluent are the ones that are kept. And the other connections drop out. They regress and they're no longer there. And that's a normal important process

of brain development that takes a long time. Some parts of the brain, for example, areas that are involved with our senses, like vision or hearing, they develop their most efficient connections quite early in development in the first year, the first six to 12 months of life, we get very nice connections and all of those systems, perhaps because they're the ones we need right away. They're ones we're using right away to get new information. But, connections that have to do with our social interactions might take a little bit longer connections that have to do with our decision-making our planning skills, those higher order, cognitive domains are going to take much longer. And so those are refinements that are happening into childhood, into adolescence, even into young adulthood.

Christine Cole (08:03):

When you're talking about these early experiences, that kind of shape that pruning that happens that growth and that pruning, which you know, you really highlighted why we say there's so much happening in the brain and these early years, right. Cause there's just all this activity that you just described. I'm wondering what experiences you know, that serve and return that you were talking about. What are the things that parents or other caregivers can do, that's helping to build out those structures and helping to create all those connections that you're talking about.

Dr. Kathleen Thomas (08:33):

Yeah. I would say, you know, we're tempted to think, oh, more stimulation, more stimulation is good and on some level that's true. But if we think about things like baby Einstein and these ways that we try to make our kids smart, those aren't the kinds of stimulation that we're really thinking about what we're thinking about our daily and moment to moment interactions. Being a responsive caregiver when your child has a particular action or reaction and having an appropriate response back to that, you know, it's hard on parents. I think sometimes they're like, what's the appropriate response? Am I doing it right? Our natural tendency to have a back and forth with our child is one of those super important ways that we get serve and return another is simply being a stable, reliable source of support and security, right?

Dr. Kathleen Thomas (09:30):

So being the person that the child can go to for comfort, that they know you're going to be there, right. That you're going to be the stable person that's that's there regularly and is reacting to their needs. That sounds like something like, well, that seems obvious. That's just taking care of basic needs, right. But it's that kind of interaction around basic everyday needs. That really is building the foundation of this brain architecture to expect stable environments and to rely on and to be able to branch out and explore other aspects of the world that are unknown because we always know we have that stable, location to come back to. And it sounds like that's a behavior, but the brain is doing the same thing. The brain first wants to establish basic foundational connections and then to build on those and get more and more new experiences. So, the other piece might be to, you know, make sure your child is getting new experiences because those are allowing the brain to adapt a new way.

Christine Cole (10:31):

What you're describing Katie is so powerful that these little moments are actually making a huge difference in children's brains. And I'm wondering outside of parents, are there other folks in children's lives that you think can contribute to building children's brains in this way?

Dr. Kathleen Thomas (10:47):

Oh, absolutely. Every person that the child interacts with has a role in this. So whether it's a stranger on the street who stops to interact with your child for a moment or, you know, siblings, caregivers, childcare, providers, grandparents, friends of the family, whoever it might be. Even the pets. Even your pets, they may not be talking and using language that's helping to stimulate certain parts of the brain, but their interactions are also helping to develop the child's brain. That's one of the most powerful things about brain development is that all of the experiences and interactions that a child has with the world are helping to shape that brain. Of course, if there are certain ones that are repeated again and again and again, or are really similar over time, like I have a very positive interaction with my parent again and again and again, that will become a really solid foundation and a connection set of connections and network. That's very stable in the brain. If we have a fleeting interaction, we might establish some initial connections, but if that isn't maintained over time, it might become weaker, um, or even disappear in the brain. So we, we think about things that are repeated over time that are stable interactions, things that we can anticipate and rely on are going to become the most stable over time. But everyone that the child interacts with definitely is impacting brain development.

Christine Cole (12:15):

You led perfectly into the next question that I was going to ask you, which is around, you know, when we think about research, timing, quality, predictability of adult responses, for infants leads to growth in their brain architecture, which you just illustrated beautifully. How does this work as a protective factor for children as they grow? You know, not just thinking about this early experience, which is really important, but, you know, looking ahead playing the tape forward, how does that impact things?

Dr. Kathleen Thomas (12:43):

Yeah. You know, it's a little bit hard to talk about that in a specific research context. But I would say that the sense that there are, there's a solid foundation built early on that, for example, around positive relationship interactions, exposure to language, exposure, to different kinds of motor stimulation and activity opportunities to move and explore the environment, are all ways that we're building the basic foundation of our brain, right? If we think about it like a house and we need that solid foundation to make sure the house isn't shifting over time so that when we weather a storm, which we all do in our lives, as much as we would like to protect children from all negative things, right. There are storms in our lives, the same way that our houses are bombarded by storms. And as long as we have that solid foundation, even in the brain, yes, we'll have some residual experience of, of that storm.

Dr. Kathleen Thomas (13:44):

We'll remember it we'll be able to learn from it perhaps. We might even have challenges to overcome related to that storm, but we can work with that solid foundation to find a positive outcome on the other side. So, you know, really it's, it's just like in behavior, when we establish positive relationship, quality, stable caregiving environments, you know, meeting the child's basic needs that when we have all of those things, it's much easier to deal with a situation that comes up, a challenge that comes up. Yeah. And the same is true in the brain.

Christine Cole (14:22):

Yeah. It's that really creating stability early on and around what to expect and what to do and creating those functions. Katie, I'm wondering, you mentioned like linguistically and I'm thinking about emotions and social skills, I guess I'm curious. What if one of those areas doesn't get addressed, but those other

ones are, you know, what if one of those areas is lacking? How does that impact the brain development and those other functions?

Dr. Kathleen Thomas (14:47):

Yeah, that's a complicated question because it's the area that we know the least about. Right. And it's hardest to test in the brain. Um, and when we're talking about functions and how different functions interact, that's the hardest thing to test in the brain, with any sense of security that we know what we're talking about, but I will say that because the brain has plasticity, this is what we've been talking about this whole time, the ability to adapt to new stimulation, new contexts, new environments, and to change its physical structure and its connections based on those experiences. That's what we mean by the term plasticity. Because our brains are plastic throughout our lifespan. We always have the ability to learn from new situations, right? So if we are missing one piece, we might set up a slightly different network in the first place, it might make it a little bit harder. It might make it a little bit harder to bring in that new domain. So for example, if we have a child who's raised in a context where amilies just really are, are not expressing any emotion or in the opposite case and or even preventing emotion within the family or in the opposite case where there's a lot of negative emotion, right. It can set up an expectation for the child and set up a network that will be a little bit harder to overcome later when the child is in a different environment where there is a lot of positive emotion, but it doesn't make it impossible at all. There's always the possibility. And always the likelihood that we will be able to establish new skills and to change that brain architecture after the fact, it makes it easier if we have that solid foundation.

Dr. Kathleen Thomas (16:32):

And as we talked about it before, it's more of a protective factor, right. We can think of it a little bit as a risk, right? If we're missing a major domain, another one might be language. If we have a child who's not exposed to language, right. It's pretty hard in our environment. There's so many different stimuli forms of language stimulation. But we know that human to human language, whether it's oral language spoken language, or it's a sign language, for example, um, that those are really important interactions. The person to person interaction with language, not just hearing passively language on TV or things like that can really set the foundation for how we can interact in the world later. But there's always that ability to learn new skills later and to change our brain architecture throughout our lives. I think it's quite a powerful idea that we have some control over our brains so that they don't drive us.

Dr. Kathleen Thomas (17:24):

Right. Um, yes, we have certain risk factors. I'm born with a certain genetic makeup that may put me at risk for, not developing a particular brain network as easily. But I have some control in my life and I'm able to go out and interact in the world in ways that will help to bolster that network over time. And I really think that plasticity piece is a powerful piece of hope for everyone when they're worried about the risk factors that their child is exposed to. And the things that we can't prevent. Right, right. We can't prevent certain kinds of risks. And we know that they're going to happen, unexpectedly often, and having a solid foundation and knowing that we have brain plasticity allows us to move forward with in a positive direction, thinking about interventions and ways that we can alter our brain development.

Christine Cole (18:20):

Yeah. I think, I always think about you know, Center for the Developing Child from Harvard, on all their podcasts. They talk about early as better, but it's never too late.When it's talking about that plasticity and I think I share with you that it's very powerful and it creates a lot of hope that when we're, I think

it's important for us to hold the, what all could happen. And as you're speaking to the risk factors and how that might alter things and that there's still opportunities to help with shaping the brain over time. I think that's a really important message for all of us to hold in mind as we keep thinking about children and how we're supporting them. For sure.

Dr. Kathleen Thomas (18:56):

Yes. I think it's easy to think about the brain as, oh, it's that biological thing, right? It's the biological side of this. But that sometimes leads us astray into thinking that it's unchangeable, right. And we think of biology as something that's set that, that just happens. We don't have control over it, but that's not true at all. And we think about the ways that we can impact our physical health. We can make choices in our lives that are better for our physical health. We have some vices that are not so great for our physical health, but the same is true for our brains, that there are many, many ways, that we can intervene to alter brain development in positive ways. There is the double-edged sword of plasticity. I always think of it that way, which is that because the brain is open and adaptable and sensitive to the environment, both positive environments and negative environments can have impacts.

Dr. Kathleen Thomas (19:50):

And so we do want to try to protect our children from as many of those negative environments as we can, but we know it's not possible. We do everything. We can, we do all the right things. And there's still something negative that happens. And really having that solid foundation in the brain is going to help children overcome those challenges. And, you know, the brain learns from challenges as well. They're not just piled up risk factors that, you know, are just bringing us down. We start at a hundred percent positive and it brings us down. That's not the case. There are many, many positive cases that can bring us up. And I think when we think about the challenges that our children are going to experience, sometimes that can actually lead to brain growth and development. Having a little bit of stress, a little bit of challenge is a learning opportunity when it's too much, of course it can overwhelm us. But when we have a little bit of stress, a little bit of challenge that encourages our brain to adapt in positive ways.

Christine Cole (20:53):

Yeah. Katie as you were describing, you know, it's not like it's at the top and then decreases or then, or you fill it up. And it makes me think about the brain architecture game. I'm not sure if you're familiar, but it's something that we utilized with early educators to teach about brain architecture. And you're given like these pipe cleaners and these straws and these weights, and you're told to build up the brain, you can use this many pipe cleaners and that the straws are protective factors. So you draw a card and it's, you know, a positive interaction with your parent or something that happens and you get to put on a protective factor, but then there's also like you're speaking to things happen, you know, there might've been a storm that impacted your living environment. And so you add these weights and that might like make them slump down a little bit. And it's such a beautiful, concrete example to simplify something that's super complex and hard to think about. But I found it super powerful in helping to see, you know, it's not just one or the other and it's not like we're building it up and then taking it down. They all continue to interact over time and grow together.

Dr. Kathleen Thomas (21:59):

They're all happening simultaneously. And, you know, I've talked broadly about connections, but I haven't said much about what kinds of connections those are. I mentioned the synapse earlier when we talked about the physical connection between a neuron and another neuron, we have seen thousands

and thousands of neurons in the brain, and they're all interconnected. Many of them are connected to multiple other neurons. And so we have this highly interconnected structure, but over time we are not really gaining a lot more neurons. So we're not over over development. Building more neurons, there are rare few places in the brain where we might do that. But instead what we're doing is we're strengthening those connections. And the way that we strengthen those connections is through activity when one neuron is talking to another as signaling another. So when we have activity in the brain that can strengthen a connection and the other is by another physical system called myelination and myelination is something that helps make our connections more efficient.

Dr. Kathleen Thomas (23:03):

It's like the rubber wrapper around your electrical cords, right? If you think about your computer power cord, right, it's got this rubber thing. So we don't, we're not holding an electrical wire. Right. But the other thing it does besides protecting outside people from getting zapped is that it's making the connection between your computer and the electrical outlet, very efficient, the energy that goes down that wire is not being lost into the air or into the hand of somebody who's holding it. Right. And so that's exactly what myelination does in the brain. It puts the sheath, this wrapper around those synapses and around those neuronal axons, the, the arms of the neurons that are going out to communicate, and it makes the signal that goes down that neuron to the next one, more efficient. And so when we think about what is actually going on in brain development, it's both the activity of neurons talking to one another and how they work together in communities of neurons.

Dr. Kathleen Thomas (24:05):

Neurons are just like we are, they're in communities. They talk to one another and they have interactions with one another and they change their behavior based on what their neighbors are doing and it's that myelination. And there are lots of things that we can do over time that can enhance myelination and things that we can do that hurt myelination. There are of course medical illnesses that can impact new myelination, neurological disorders like multiple sclerosis, that damage myelin over time can make it difficult. But there are foods that we eat. There are ways that we're interacting every day that can help to strengthen those connections. And to build that myelin,

Christine Cole (24:48):

Katie you've really highlighted that, you know, infants go through lots of different circumstances. They have lots of different environments and caregiving environments, and all of these things are shaping their developmental outcomes. And you've touched on a little bit several times about the risk factors as well. And I'm wondering if you can talk a little bit about what, what sorts of things do you mean when you talk about these things that might create more risk factors that might create poor outcomes for developmental outcomes?

Dr. Kathleen Thomas (25:17):

Right. Well, the first one that we tend to think of as developmental neuroscientists is a category called teratogens. Teratogens is just a general term that we use for anything that can have a negative impact on brain growth or health. Right. And so when we think about early teratogens, we think about things like prenatal, alcohol exposure, or smoking, right, maternal smoking during pregnancy. We know that those can be a risk factor for physical development and brain development, but there are other things that can work as function as a teratogen as well. So for example, if, we're in a context that has high lead

paint, right? And if we think about lead paint in the home, so there are many families who can't choose where they live. They have to live in the circumstances that they are in.

Dr. Kathleen Thomas (26:11):

They don't have control about whether the paint in their house has lead in it or not. And we know that lead can act as a teratogen in the brain for children. It can act as a teratogen and for all of us, but it has a major impact on the brain for children, but there are other contexts too. An infection, right? So, when children are exposed to different kinds of viruses and bacteria, right, those can act as teratogens over time. Thankfully, most of them are innocuous and their immune system will grow and develop in response to that the same, the brain is developing in response to the environment. The immune system gets stronger and develops in response to those minor challenges, but there are some contexts where that could be a risk factor. Of course, there are also social circumstances when we think about the lack of things that we need, right?

Dr. Kathleen Thomas (27:02):

So lack of basic needs would certainly be a risk factor, lack of medical care, lack of stable living environment and safe living environment, even things like air pollutants, are things that we can think about as risk factors. It can get really scary if we start to list all of these, that everything in life could be a risk factor. Um, and on some level it's true in the sense that our bodies are sensitive to our environments, but some things are much more impressionable than others, right? Some things have a bigger impact on development than others do. And that having that stable foundation, the caregiving environment, the responsive parenting, right? The presence of stimulation in the motor and cognitive and language, domain, social interactions, those are going to provide the solid foundation. And these other things are going to be challenges along the way. Some of which have a bigger impact than others.

Christine Cole (28:05):

Katie, could you maybe speak a little to those ones that have a bigger impact than others and the consequences associated with those?

Speaker 4 (28:14):

So we know that certain risks have a direct impact on the brain and on brain development. Also, you mentioned earlier, timing is so important. And so a lot of times we think about risk factors that happen. Like I mentioned, lead paint in the environment. Well, if that happens in an environment, if an adult, it usually isn't a problem with most adults are not finding lead paint chips and chewing on environments that have lead paint. And yet babies do that because they're exploring their environment. They're not trying to chew the paint, right. They're just trying to explore their environments. So that's an example of timing. A major example of timing is prenatal development. And so there are a lot of direct impact events that can occur in prenatal development. A big one is a lack of oxygen. Most parents have zero control over this, right?

Dr. Kathleen Thomas (29:07):

So this is not something that we can prevent. But it is a major impact. So oftentimes in cases of children who are slow growing in utero or children who are born prematurely, they may have, they may experience a lack of oxygen, especially right around the transition of birth. Snd we know that lack of oxygen can have a direct impact on brain development. Um, that can be rather large. Um, so that can, um, present with children who have motor or cognitive disabilities. It can even lead to death in the most

serious cases. Of course, others, you know, things like prenatal, alcohol exposure. We know that there's a lot of evidence now that prenatal alcohol exposure because of the timing of where the brain is and its development can have a direct impact on brain development, the same exposure for a child. Like if your three-year-old accidentally drank alcohol would not be the same. Right. As it is in utero. And that's because it matters when that impact hits during brain development. And there's such rapid brain development in utero, about the really basic structures of how neurons are born, how they connect with one another and how we set up those basic first networks that if we disrupt that with any kind of teratogen like alcohol it can have longterm impacts.

Christine Cole (30:36):

Katie I really appreciate you talking about the timing piece. I know that there's another podcast around developmental lens and we talked about, you know, infancy, toddlerhood, preschoolers, I'm wondering, are there like large impactful risks during those different phases during those different times that folks should also be mindful of?

Dr. Kathleen Thomas (30:54):

Yeah. You know I think that as we think about the behaviors that our children are developing at particular points in time, we have to be really thinking about what are the risk factors at that time. So for example, if we're in a period of time when children are really starting to learn language, it starts earlier than you think, right in the earliest infancy periods, nfants are already sensitive to speech sounds and words, and are paying attention to the differences among speech sounds. They are actually much more sensitive than we are as adults. And so there are times in development like that when we really want to make sure both that children are getting exposure to language and that we're preventing any kinds of tragedies that might interfere with that. Whether there's one that's specific to language development and infancy, I don't want to say that there's a particular case like that, but language would be more sensitive during the infant and early toddler years, as children are really starting to develop those skills, then they will, then it will be later in life, even if we're, you know, putting a child into a second language environment or something like that, that might be a challenge, but not necessarily a risk to the development of language skills and social interaction.

Dr. Kathleen Thomas (32:08):

I do want to say that just from a brain perspective, there are a couple of periods in time that the brain seems to be more flexible, more plastic, and adaptive or sensitive to the environment. We've talked about the prenatal period as being really important. The first couple of years of life are of course well within that range as well. But the other period that might surprise some people is in adolescents, we're learning more and more. Now that adolescents may act as another period of enhanced plasticity. What do we mean by that? Well, we think about all of the biological changes that are occurring in the body as we transition through puberty and the social changes that are occurring as we're entering, you know, middle school, junior high school, high school, and the developmental milestones that we need to achieve in those times, gaining a little bit of independence, right?

Dr. Kathleen Thomas (33:04):

Seeking out things on our own, separating a bit from our parents. That's a period of time that's rife with all these changes. And so maybe it's not surprising that some of those biological physiological changes might also trigger the brain to be more open to adaptation to the environment. So that could be another period of risk. As we think about adolescence as a period, when there are a lot of things that children

could be exposed to during adolescents that are, we would consider risky. On the other hand, it's a huge period of opportunity for revamping, you know, the brain structure that we had before. So it opens up another window for us to intervene and have very positive outcomes. Even if, even if say in the middle childhood, things were not so great. So adolescence is this really great example of a period of both risk and opportunity. And so that's another period of time that I think we really want to be paying attention to how to support our kids during that period.

Christine Cole (34:05):

Yeah, Katie, I so appreciate how you have this balanced perspective. It's not one or the other, it's, you know, we're holding the both and. And I think that that's something that as a therapist, you know, an infant mental health therapist, we talk about, I think the both and a lot, and I really appreciate how you're highlighting that.

Dr. Kathleen Thomas (34:22):

Yeah, it's been hard in the research literature. I will admit that my training is as a basic scientist, I study basic human behavior and cognition. And I also study basic brain development. And I do less about how these are applied in real world context, but of course, everything that we're doing has an implication for real-world contexts in the laboratory. It's easier to study the risk. And so I think that, you know, in, in part, the research literature has contributed to the sense that it's all about risk, and that we didn't prevent risks, but really we haven't done as much to focus on what's the impact of the everyday interventions that every family and is doing every school is doing. You think about school as an intervention at school is a major opportunity context for many children, and yet it's required, it's mandatory in this country.

Dr. Kathleen Thomas (35:18):

So we think of it as just it's part of the everyday fabric of life, but it really is an opportunity to intervene and expose children to new things that they haven't been exposed to before, new opportunities to expand brain development. There are many, many studies that are looking at specific interventions. So when there has been a risk when there's been a challenge or, um, atypical development, um, looking at a particular intervention and what impact that intervention itself might have on brain development, I think that's a really exciting direction that we're going, it's a little bit harder to study the everyday protective factors that we think of in every child's life. And yet, I know, I know in my heart that those have exactly the same kind of impact in the brain. It's just a little bit harder to study because they're quite ubiquitous or it's a little bit harder to manipulate in the library.

Christine Cole (36:14):

You make me think about, you know, early educators and how important they are at offering these different interactions and experiences, and thinking about all the different places in children's lives, where they're getting these opportunities to actually build resilience and buffer against these risk factors that we were talking about. Katie, when you were talking about your experience as a researcher, I know previously you said, you know, you look at MRIs and you look at the actual brain, when we're thinking about these risk factors and when we're thinking about these developmental outcomes, do you see any differences in terms of the brain and looking at it from these MRI scans?

Dr. Kathleen Thomas (36:53):

Yeah, so there is a lot of work in this area now, when I first started in research that tells you how old I am. There were very few studies using MRI with children. We, we still didn't understand if the young brain reacted in the same way, if we could measure it in the same way and also whether or not children could handle the MRI environment. It turns out they're very good at it. There's still some challenges in that sort of one to four year age range. It's hard to get them to lie still in the MRI scanner, so we can take the pictures. But, we look both at the structure of the brain, what it physically looks like, how large different regions are or small different regions are, or for example, when we think about the outer surface of our brain, the cortex of our brain, it has a certain thickness of cell depth.

Dr. Kathleen Thomas (37:44):

And then underneath that small ribbon, there, all the connections, all the wiring that goes between the different regions. And so we can look at the density of the wiring. We can look at aware that wiring goes, we now have, MRI techniques that look at diffusion of water through the brain. And those help us identify where these physical connections and pathways sort of those myelinated fibers that are moving through and where they're going and what direction they're going. And that can help us see the differences between different groups of people. Every brain is different. Even though when we look at an MRI that we see a general structure, that seems very familiar, every brain is unique. So nobody's development is exactly like someone else's even in identical twins, which we've studied before. There's a lot of similarity in some ways.

Dr. Kathleen Thomas (38:36):

So we do understand that shared genetics and shared environments can lead to a lot of similarity in brain development of the structure of the brain, but there are also unique differences between even identical twins. Each one of us has a unique set of experiences that are going to drive that brain development. We do see contexts where there are differences in structure. So for example, I've studied children who are born extremely premature. So they're born, you know, two months early and their brain is now developing in a very unexpected environment out of the uterine environment. That's quite different. And so the brain does react to that and it's going to be different. Another is a context of, you know, extreme deprivation. We've studied children who spent the first part of their lives in institutional care and orphanages, right. In this country we don't use orphanage care. but, many other countries around the world, that's the system that works for them. And orphanage care can be very high quality. It can be very low quality. But in general, it's harder for those children to have the same stable social interactions, that solid foundation that we were talking about. And so that can put them at risk even after they're adopted into a very positive, highly resourced well-intentioned family. And so we've looked at that and we can see that there are size differences. The overall brain is smaller. Certain parts of the brain might be preferentially smaller, like the prefrontal cortex, and that may follow the functional differences. It doesn't always, I want to be cautious in saying that structure does not always follow function. So just because one part of the brain is smaller, doesn't always mean that it's a less able and sometimes bigger is not better.

Dr. Kathleen Thomas (40:32):

Right. So we also have to look at function. We do use functional imaging to try to look at the activity in the brain as well. That's sort of where my research interests lie and trying to look at the function it's a bit harder, and we have to be really specific about the functions that we look at. So it's a little bit harder to make general statements, but things like planning, problem solving, working memory, inhibitory control, behavior regulation, those are behavioral areas that are often correlated with some of these early

insults that might put the brain at risk. And so for example, the children who were raised in these deprived orphanage settings show even years later some deficits in their inhibitory control, but not in every domain.

Christine Cole (41:22):

Katie, I was just gonna ask you and I can't believe I didn't ask this earlier on when we're talking about like the prefrontal cortex and you're talking about inhibitory control. Can you tell us a little bit about the parts of the brain that we're talking about and where the different functions are? Cause I think that that's a piece that I think is really important, but I didn't even think to ask until now

Dr. Kathleen Thomas (41:43):

It can be a little bit difficult when somebody is throwing out these terms like prefrontal cortex. Our brain develops in two hemispheres, so they're sort of symmetrical hemisphere. So they are actually not connected very much down the mid line. So if we think about the left side of our brain and the right side of our brain, they are only connected to each other in a few places where there's wiring that goes back and forth, but otherwise they develop almost fully separately, which is a very unusual way for the body to develop things. I guess we have ears and things like that that are developing separately and in symmetry. But our brain has a very complicated symmetrical system that has two parts. So it's really important that we have strong connections between the two hemispheres, because there is some tendency for the brain to specialize some things in different hemispheres.

Dr. Kathleen Thomas (42:30):

We call that lateralization many people study lateralization. And what are some of the important functions that are lateralized language tends to be one that is highly lateralized. Many of us have a strong preference for language in our left hemisphere, but that's not true of everyone. You may know that you are right-handed or left-handed. There is some correlation between handedness and where language is lateralized, but it's not perfect, but we noticed that there are some lateralized functions like that, that we prefer. We develop a preference to write with one hand over the other. Some people are ambidextrous and can write with either hand. But many of us are lateralized beyond that lateralization within the brain. We have regions toward the front, toward our face that are predominantly involved in our emotions and our cognitive functions. And it regulating are all kinds of behaviors.

Dr. Kathleen Thomas (43:24):

So while we think of the frontal cortex and we talk about prefrontal just means the most frontal portion that's in front of our motor regions. So when we talk about frontal, that includes some motor regions of our brain. And when we say prefrontal, we're talking about all of the areas that are in front of that. And those are predominantly involved in cognition, emotion, and regulatory functions, but our prefrontal cortex regulates things that we think of as very low level, but you know, even things like our breathing and things like that, we have lower level systems that are deep in the brain. Deep structures in the brain are often termed basal ganglia or deep gray matter. And they're right along the midline of the brain. And they go from sort of the center of the brain down to the brainstem or to our spinal cord.

Dr. Kathleen Thomas (44:15):

And those regions are also involved in regulation of basic things like our heart rate and our breathing, understanding time, our sleep patterns, all of those things that we take for granted, right? These higher order areas in the are tend to be more associated with our sensations and perceptions of the world and

the way that we use our cognitive skills and our social skills at the back of the brain is really our primary visual cortex. And we are very visual beings, even in folks who are no longer or were never able to use vision, they were blind at birth. The visual cortex takes on a different function. We never have empty real estate in the brain and is always doing something. So as long as it's healthy tissue, it will be taken over for a new function.

Dr. Kathleen Thomas (45:10):

That's one of those areas of plasticity and adaptation that we don't talk about a lot that, you know, if there's something unique about our situation, for example, if I'm someone who does not have vision, and so I'm not getting light into my eyes, then my visual cortex will develop in a totally different way. It will still be at the back of the brain, that's where it lives, but it won't be visual cortex. It will be something else and it will have a different function, but in general, if we have all of our five senses, then the back of the brain is used primarily for vision. And because we are such visual creatures, um, that visual information then travels forward, um, toward the top or dorsal part of the brain to help us understand things in space where we are, where we're located, what's around us, how we see in three dimensions, things like that.

Dr. Kathleen Thomas (46:03):

And then it also travels at the same time that visual information travels down on the lower part of the brain, the ventral or belly part of the brain in the temporal lobe, if we think about the brain, kind of, when you look at it from a side view, it looks kind of like a boxing glove. It has a thumb hanging down. That's our temporal lobe and the temporal lobe is the house of our auditory cortex, our primary hearing ability. So we're integrating our vision and our hearing. We have speech areas and language areas in that region that help us to connect up all of the things that we're seeing in the world with our vocabulary and our understanding of how they all fit together in categories. And then as we think about the connections further down into the temporal lobe, we have some deep structures that are in the temporal lobe.

Dr. Kathleen Thomas (46:53):

So they're not along the midline of the brain, like those basal ganglia, but they're out in the temporal lobes that are really involved in memory and emotion. Those are the hippocampus, which is most known for memory functions. And the amygdala, which is most known for emotion are really basic emotions. Like, should I run, or should I fight, right? Should I, should I freeze? Should I run? Should I fight those that reaction happens in our amygdala and then that communicates with these other cortical areas that tell us, where is the threat in the environment? What is it if we use our language system to know what is it, and with the prefrontal cortex to regulate, what do I do now, right. How do I make a decision moving forward? So all of these areas are interconnected. And yet over time we have kind of come to view some of them as having a particular function.

Dr. Kathleen Thomas (47:45):

That's a little bit of a simplification. It helps us, and we can only handle so much information at a time conceptually. Right. And so it helps us to understand that or to think about brain regions as having a primary function, but most brain areas have a lot of different functions, some quite complex that we really do not understand yet. And then of course, beyond just the cognitive and brain structure, we have all the other body systems working together. We have hormones coursing through our body that are signaling our brain to react in certain ways. We have immune functions that are happening. And we don't really think about our immune system influencing our cognition, but we know now that there's a

pretty strong connection between our, what we call our microbiome, the immune functions and the bacteria that we have naturally in our gut and how those interact with the brain. And so our physical health actually has a big impact on our brain as well.

Christine Cole (48:48):

Thank you for going into all of that, Katie. I think that, that there's a lot. And I'm thinking back at the beginning to when you were talking about, you know, there's all these different neurons and there's a lot of activity and then we're pruning, that's a lot of work going on in that little brain from the start.

Dr. Kathleen Thomas (49:05):

And when you look at it, if you were able to see it right, if we look at, an MRI classic MRI that most of us would get, if we were going to a medical facility to get an MRI of our brain, it would look like a picture, right? There's a picture of a brain. It looks very static that it's not doing anything, but it's so dynamic all the time. When we look at functional MRI, in all of the publications and pictures that we show, of our research results, we show this beautiful colored spot that shows activation, right? That's not at all what it looks like, what it looks like is oxygen being used all throughout the brain, which is really good, right? Every cell in our body needs oxygen. Our neurons definitely need oxygen and energy. And so we have oxygen throughout the whole brain, and we are looking at very, very subtle differences in how much oxygen is being used in a particular region and inferring that, that means there are more neurons active and more neurons are using that, that energy. It's a, it's a pretty long stretch. And yet when we look at it, it looks, it looks like a picture of the truth like that. That's what happens. And that's what it, that's what it looks like when we're actually activating the brain.

Christine Cole (50:20):

Very cool. Very cool. I'm thinking Katie about our listeners. I know that a lot of our listeners are in the child welfare field and we've covered a lot today. I'm wondering what should child welfare workers be aware of or what can they be doing to mitigate some of these risks that you've talked about today, or even building up those protective factors?

Dr. Kathleen Thomas (50:41):

Yeah, I mean, I think that one of the primary things that we know about brain development is that our early relationships, our ongoing social connections are critically important for a healthy brain, right. That having a positive social interaction with anyone is really important. Of course, we'd love it. If every person in the child's environment was developing a positive relationship that that child could count on. But having a foundation, even with your social worker you know, that that is a person who's trusted and who you know, is going to be there for you as a context and helping families to understand the importance of those healthy relationships. When circumstances are rough, when families are experiencing a lot of adversity and it's happening to a lot of people, and we have seen over the past year, how many people have been suffering that those relationships can buffer children from so much, even when there's a lot of bad stuff going on.

Dr. Kathleen Thomas (51:44):

So that's one thing that I would say, we do know that in the long run, we want to avoid as much adversity as we can. Right? I think all of us intuitively know this. We want to protect children from adversity. Sometimes we can't, there are things that happen that no one can predict the death of a family member, for example can be very traumatic and adverse and we couldn't have prevented it. But,

any adversities that we can prevent, will really help to scaffold positive, early development in learning and brain development. And then of course finding those protective factors. What are some of those other early protective factors, meeting basic needs. That's certainly one of them having opportunities for new experiences, having small, manageable challenges, not overwhelming adversity, right? Those are the ways that we build resilience.

Christine Cole (52:43):

Katie, what I love about what you just shared is I think often when we, at least for myself, when we think about child welfare workers, even though it's impacting the child, a lot of times they're thinking about interactions with the adult, but you just highlighted how a child welfare worker can interact with the child and be helping with that brain development and even things like getting resources to the family and connecting them to these other things can actually be helping the child, even though it feels sometimes so distant from the kiddo. For sure.

Dr. Kathleen Thomas (53:09):

Absolutely. I know that's a really hard piece of the work that many folks are doing, that they really care about the context of these families, the wellbeing of these families and the children and these families. And yet they may not have those direct one-to-one interactions. And what you said was absolutely true every time that we're providing resources to a family and building their capacity to provide a stable, safe home. We're doing lots for the child. We're doing so much to protect those children and to help promote healthy brain development.

Christine Cole (53:40):

Katie, the other thing that I'm wondering, and I know we've been focused a lot on kiddos, but you just highlighted the context and the caregivers are so important. Is there anything in terms of child welfare workers roles with adults that, that we should be thinking about the adults, brain architecture and, and our interactions with them?

Dr. Kathleen Thomas (53:57):

Yeah. One thing I think is that many adults have not heard this notion about lifelong plasticity. You know, we go to school, we sometimes say that, well, I'm going to go on and get an advanced degree. I'm going to go to college. Or I'm going to get trained in a new area. And we don't realize that those are exactly what we're talking about as changing our brains, right. That we can still change as adults. We can develop new skills. We can take charge of some of the context in our life. I think it's really hard for many adults, especially those who are going through the child welfare system and are experiencing a lot of adversity are feeling like they aren't doing the best with their parenting are worried about that, that having that sense, that there is hope for them as well, that they are developing new skills. They can become better parents, that they can make the environment better for their children, that they have the power to protect their children, can be a really powerful context. Powerful context.

Christine Cole (54:58):

Yeah. Thank you. You know, we've covered a lot today. We've covered risk and protective factors. I think you've really done a nice job balancing all of that. Are there like two to three, main takeaways that you would want anyone listening, whether in the child welfare or not to really hold in mind when they think about brain development and that architecture piece.

Dr. Kathleen Thomas (55:18):

Yeah, I would say the first one is that the brain is a biological organism, but that doesn't mean that it's fixed. That it's something we have no control over. It is constantly changing. It's dynamic and it's always in action. And so that everything that we experience in life is going to impact how our brain responds to the next time or how our structure has changed over time. And that can be a very powerful, motivation in our future development. The second is that timing matters. Like timing is so important when we think about brain development of course that word suggests that there's timing involved, but the impacts of different experiences can be different at different points in the lifespan. I don't want to rule out, we focus on zero to three, a lot. It's such an important time of plasticity and many, many skills are coming online during that time.

Dr. Kathleen Thomas (56:12):

So it is a critically important period of a child's life, but all of the ages are important. We don't want to ignore four to 12, but we don't want to ignore adolescence. Don't even want to ignore old age. Right. And we understand that the brain is changing again in older age and it's going the other direction. And there are many ways that we can work on brain development to help protect against the ravages of late-life dementia, for example. So timing matters. And really, we often think about things like direct teratogens, like alcohol exposure or something like that impacting the brain. And we forget that social interactions and every day little activities that we're doing with children, even if they're not our children have an impact that we all have an impact on everyone around us. And that those social interactions, those cognitive opportunities are critically important in shaping the brain.

Christine Cole (57:14):

Katie, this has all been super helpful and I feel like you've done such a great job capturing a very complex topic, a very complex topic. I love your use of analogies and metaphors because I think that that's really helpful to make it concrete. Are there any resources or, you know, places that people can look to to get more information about brain architecture, as they're trying to build their knowledge base around this topic?

Dr. Kathleen Thomas (57:40):

Well, you talked about the Harvard site and the Developing child. So there are often a lot of videos and podcasts and other things there that people can find as well as readings. The Institute of Child Development has resources about all aspects of child development. So we welcome you to come to our site at the University of Minnesota. But also within our communities, most states have resources for families and children and, and learning about, the kinds of developmental milestones that are critical for both behavioral outcomes, as well as brain health. So I'd really encourage people to just go to their early childhood and family services sites and their states to the child welfare system. And there are going to be a lot of resources in all of those areas.

Christine Cole (58:27):

Perfect. Thank you so much, Katie. I've really enjoyed talking with you today about brain development and I'm sure that our listeners are going to really appreciate this too. It was super helpful.

Dr. Kathleen Thomas (58:38):

Thanks Christine.

Stacy Gehringer (58:43):

Thank you for listening to the Early Development and Child Welfare podcast series. This podcast was supported in part by the Minnesota Department of Human Service Children and Family Services Division.