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THE IMPACT OF EARLY EXPERIENCE ON
CHILDHOOD BRAIN DEVELOPMENT

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P R O C E E D I N G S

MR. HASKINS: So welcome to Brookings. My name is Ron Haskins. I'm the co-director of the Center on Children and Families along with Belle Sawhill. I'd like to welcome you to Brookings this morning.

One of the most dazzling chapters in a book of science in recent decades has been research on the developing brain. Perhaps the most provocative finding is that early exposure to situations that produce fear and chronic anxiety can have long-term consequences on learning, behavior, and health, by disrupting infant brain development. Equally important from the perspective of the Center on Children and Families is that understanding brain development opens the possibility that we can develop activities that enhance brain development, especially in children from poor and minority families who we know fall behind in intellectual development by at least age three.

Today we're fortunate to have three of the leading lights in the study of brain development. You have biographical material on all of our guests so I'm just going to say a few things by way of introduction.

First, Jack Shonkoff, who is the head of the Center of the Development Child at Harvard, I think, could be called the ambassador of brain development. He has a great talent for explaining things simply and he's used this talent to teach the basics of brain development to influential audiences all over the country. I've been at a couple of those audiences

and they are really great as you're about to find out.

Next is Gary Evans of Cornell. He's one of the foremost basic researchers in brain development. Among other things he's shown that childhood poverty is inversely related to working memory in young adults and that chronic stress is the mediator of the relationship. The word elegant was invented for research like that of Dr. Evans.

Nathan Fox, from the University of Maryland, has been one of the prime movers in the Bucharest Early Intervention Early Project, which may be the only study to use truly scientific designs to compare the effects of child rearing in institutions as compared with child rearing in families. In this case, foster families.

And then finally, Ruth Kagi. You probably can't see her up here because she's in the state of Washington. She's a representative from Washington State. In Washington State they have the quaint notion that budgets are supposed to be balanced. How primitive is that? So she is involved in a big fight over the budget and the Speaker told her she could not leave town. So the National Conference of State Legislators is meeting here and she plays a big role in that. She couldn't come to that -- couldn't come to Brookings, so she's real sad. Ah, but she did send a very nice video, which is probably the strongest endorsement I have ever seen from a policymaker on why science is so important to social policy. And you'll see that right at the end.

And then, of course, there'll be some very perceptive, wonderful questions. And we'll stump the audience -- stump the panel and then we'll open it up for some comments from the audience. So that's our plan of proceeding.

So now, Jack Shonkoff.

MR. SHONKOFF: Thanks very much, Ron. So when does the clock start?

I'm going to give you a whirlwind overview of neuroscience and developmental biology and simplifications for policy in 20 minutes. So let's get right into it.

So first, just to start, I think what science has really been telling us for a long time, and particularly in the last decade, is that literally the foundations of most of the things we care about for successful society are laid down in early childhood. So the healthy development of young children and the development of their brains is really a foundation of economic productivity and that a secure society and responsible communities and successful parenting of the next generation. And that's not really a slogan. There was actually a biological basis for that which I'd spend more time talking about, but I don't have time.

So what I'm going to do now is just kind of give you a whirlwind tour of what the basic concepts are from the study of the brain and neuroscience that really lend themselves to thinking about policy

implications. So four takeaway messages, four core concepts of brain development.

The first is that experience literally shapes brain architecture, brain circuitry, through a process where the brain early on -- it proliferates it. Over -- it overcreates connections in the brain and then it prunes them over time. The overcorrection is to prepare for a variety of environments and the pruning is really affected by the kind of experiences kids have. And these connections are literally developing at the rate of 700 new synapses every second in the first several years of life.

So this is what it looks like at birth. You see these brain cells with these connecting branches. By six years of age you have this much denser circuitry. And by 14 years of age it's thinned out. Now, that doesn't mean that 14-year-olds are losing their mind. But what it means is the brain after overproducing has to kind of refine and prune out and specialize so it can work more effectively.

Now, brains -- the circuitry in the brain and the skills that go along with those circuitries are built in a bottom-up sequence. Basic circuits for basic skills first, more complex circuits on top of more complex -- along with more complex skills. And that is shaped -- when we talk about experience affecting brain development, from a science point of view we have to measure that. We can't just talk about experience as some vague notion. And what we've learned from animal research, from human

research, from decades of not just neurobiology, but developmental behavioral research, it's that it's the serve and return nature -- the contingency between what children do and what adults do in response to them -- that literally shapes brain circuitry.

So just to look at something like the development of literacy, it starts in earliest infancy in the interactions between babies and the important adults in their lives. Babies make sounds. Adults make sounds back. Facial expressions, gestures. It's a highly interactive process. And this interaction is literally shaping the circuits that are being developed in the brain, those 700 synapses per second. They're being shaped by that experience. As kids get a little bit older we start to -- instead of just making sounds they start to be able to put those sounds together and produce words that have meaning. We help them assign labels to things through that interaction, not through an educational video for babies. Through the interaction kids develop a vocabulary. We introduce them to written language before their brain is capable of reading independently, but it helps to build that preliminary circuitry of understanding through this serve and return contingent interaction. At some point then children don't need adults to read to them anymore. They can do it by themselves, but they need adults to teach them how to write and then they can go off and write their own novels and sonnets and text each other and all those other things that kids do.

But the point of this is that it's an interactive process. This is basic biology. Birds -- songbirds can't learn to sing the songs of their species by listening to tapes. They have to learn it through interaction, actually, with their fathers, not their mothers. It's kind of interesting. So videotapes are not the way babies learn; it's human interaction. That's the way the brain develops.

Another important concept is that cognitive, emotional, and social capacities are inextricably intertwined within the architecture of the developing brain. We can separate these domains in chapters in a book. We can have laboratories that study one and not the other. But in the brain it's highly integrated. There is specialization, but there is integration. So, we have a part of the brain called the amygdala that's been very well studied. Nathan is going to talk more about that I'm sure a little bit later. The amygdala is where a lot of the basic circuitry for fear and response to threat develops. It develops very early.

Not that far away is a part called the hippocampus, which is where simple memory circuits and early simple learning processes are encoded into the circuitry of the brain as a result of experience. When these circuits come in is genetically determined, but how they get shaped is highly influenced by experience. They are not on automatic pilot by any means.

And then up toward the front of the brain -- I'm sure Gary will have a lot to say -- but this is the prefrontal cortex, which is where the higher

order functioning is: working memory, self regulation, various forms of attention. These are areas that mature well into early adolescence and early adult life. But the initial circuitry begins in childhood.

So there are areas of specialization, but all of these interact. The circuits interconnect. Reading is not just a cognitive process. If you're preoccupied with fears and anxieties you don't learn to read well. That's the way the brain works.

The last principle is that the ability of the brain to change decreases over time. And it's a pretty dramatic drop in the childhood, a huge drop in what we call its plasticity, it's flexibility in the early years. You can see this goes out only to age 70. And you can see that there's much less flexibility in the brain at age 70 than there was at age 7, not to mention 7 months. But it's not zero. Okay? The brain loses its capacity to adapt when you have a flat line and they pull the sheet up over you, but it's maximal. It's optimal in the early years. And so the physiological effort for the brain to kind of adapt or enhance its connects gets higher as time goes on. It costs the brain more in biological energy to adapt to earlier circuits that weren't formed correctly. And as you might guess, it costs society more for the interventions and the remediation in older individuals than it costs for the kinds of appropriate experiences early in life. So that's your crash course in normal brain development.

So now let me move on and talk about this basic concept

which is how we move from neuroscience into policy and programs, which is the fact that early life experiences literally are built into our bodies, for better or worse. This is a fundamental principle of biology. What happens early on creates biological memories, not only in our brain, but in our cardiovascular system, our immune system. Just think of the immune system. It remembers things it encountered early, which is why you're sick more when you're younger with colds and infections, and as you get older you don't get them as much because your immune system remembers the early experiences and produces antibodies. It's a basic biological principle.

Well, what's most relevant for the work we're talking about this morning is research on the biology of stress, which is again a fundamental property of all existing animal species. Every animal species, including our own, has a system that automatically responds in the face of threat. This is the -- everybody here knows what it feels like to be stressed. I'm not talking about what causes us stress; I'm talking about the physical feeling. Okay? And what you feel when you're stressed is a variety of physiological systems that are activated automatically in response to threat. Your heart rate goes up. Your blood pressure goes up. Your stress hormone levels go up -- cortisol being one that's been studied quite a bit. Your inflammatory system is activated. Your blood sugar goes up. All of these things are an automatic response. This is the fight or flight phenomenon. This is what leads an animal to recognize a predator is on their way and to run and jump up into a

tree or run away to save your life. This is what we do when we're threatened physically or emotionally. It's what you feel when you're threatened at work and everything else.

It's a good system to have. Without it we would die. We wouldn't -- our bodies would not be prepared to deal with threat. The problem is it wasn't set up to be activated all this time. The biological property of this is it deals with an acute threat and it goes back to baseline. Heart rate comes down. Blood pressure comes down. Stress hormone levels come down. Why is that important? Because excessive or prolonged activation of the stress response system where the cortisol level stays up and doesn't come down or it's up more than it usually should be. When your heart rate doesn't come down, when your blood pressure is up all the time, it turns -- it literally turns on our bodies. So what protects us in an acute situation now is a biological threat.

So if your heart rate and blood pressure is up all the time, you're more likely to develop hypertension and heart disease. If your blood sugar is up all the time, you're more likely to develop metabolic syndrome and diabetes. If your cortisol levels and inflammatory cytokines are up all the time, it poisons brain circuits. And in fact, the hippocampus where early learning and memory circuits are is the most sensitive to elevated cortisol, helping us to begin to maybe have some ideas about why children who are experiencing significant adversity have problems learning, and it may not

just be kind of preoccupations. They may be real physiological disruptions.

Now when we talk about stress in this society it's a problem because our society thinks that stress is character building. It has no sympathy for stress. It doesn't get you anywhere. So what we have to do is recognize the differentiation between what we would call positive stress, which is character building. This is the stress of having to share your toys. It's the stress of the first day in a child care center. It's the stress of kind of coming to grips with the fact you're not the only person in the world. This is a natural, necessary means to which children develop the ability to adapt to threat. Stress system gets activated, kids with adult supervision and help learn to cope, and the stress comes back down.

The second category is what we would call -- what we call tolerable stress. This is more than just you can't have five cookies right now. This is the stress of being a survivor of an earthquake in Haiti or an earthquake in Chile or a tsunami in the Indian Ocean, or Hurricane Katrina or an act of terrorism or a death in the family, or all of these kinds of things that are more than just everyday stresses. Why do some children get through okay and other kids end up with post-traumatic stress disorders and other complications? Well, the best working model for that right now is the extent to which adults help kids get through, bring their stress systems back to baseline so damage isn't done to organ systems, including the brain.

Which leads us to the third category of what we call toxic

stress, which is the excessive activation of the stress response system in the absence of the buffering protection of adult relationships. This is the stress associated with chronic abuse, chronic neglect, chronic exposure to violence, the kinds of things where the stress response system is just activated all the time and it does damage to body organs. There's no question about that.

So here's -- this is taken from Nathan's work so I won't say much about it. But just to illustrate the dramatic point. These are representations of EEG recordings in children who were raised in families who had positive relationships with their parents as opposed to children who grew up in a very deprived, neglectful environment: an orphanage in Romania. I'll just very simply say the deeper the red, the higher the voltage in the EEG. What's the translation here? Extreme neglect in this extreme situation resulted in something like having a 10-watt bulb running your brain instead of a 100-watt bulb running your brain. This is real. This is not something we make up. It's a real phenomenon.

So this is another good one. I could take an hour to walk you through this framework. I'm going to do it in less than a minute, but just to show you how we can put this science together and begin to think about how it could inform policies and programs.

So this is thinking about how we can develop a biodevelopmental framework. How could we bring biology into our

developmental models to help us understand how experience gets into the body. So it starts with the voluminous knowledge we have about how -- what the foundations are of healthy development and what are the sources of early adversity. And all of that could, for practical purposes thinking about policy, be summarized in three basic categories.

The first is the environment of relationships that children grow up in ranging from secure, stable, nurturing, growth-promoting, and health-promoting, and learning-promoting relationships to various levels of abuse, neglect, or other adversities.

The second is the physical, chemical, and built environments in which children live. The brain is not just affected by human interaction. It's affected by chemicals. It's affected by other things in the environment. There are poisons in the environment that are not good for the brain. We know about lead; we've done something about that. We know about mercury; we haven't done very much about that. We know about organophosphate insecticides that poison brains; we haven't done a lot about that. There's also the built environment that children live in an environment where there are safe places to play, where their parents can buy healthful foods. Or do they live in an environment where it's just fast food operations? So the built environment also affects children's development, particularly related to even things like accident prevention.

And the third is nutrition, which we used to worry about mostly

in terms of undernutrition and now we worry about in terms of inappropriate and excessive nutrition so that this growing epidemic of obesity that we have has early roots in early childhood, and, in fact, in prenatal circumstances, which we can talk about in the Q&A if people have questions about it. This is not just about getting adults to start exercising more and eating better; this is about beginning in the prenatal period with metabolic systems that are primed to either store fat or use it more efficiently.

So in these three areas what we now know in this exciting revolution in molecular biology is the extent to which everything is a gene environment interaction issue. This nature versus nurture argument is by -- scientifically gone. It's dead. It's a historical -- it's of historical interest. There is no genetics without experiential impact, and there's no experience on a blank slate. Okay? So everything is about gene environment interaction. And what happens is -- and this is the other very exciting area of science -- is that what happens as a result of these experiences and environmental inputs and basic genetic predispositions through this interaction between nature and nurture, is that physiological systems develop in the body -- the brain in how it works, the immune system, the cardiovascular system -- and they either form adaptive responses or they're disruptive. And this begins very early in life. And if they're adaptive you're building on a strong foundation as you get older. If they're disruptive, the brain has to figure out how to readapt. The cardiovascular system has to

deal with early adversity. The immune system has been disrupted. These are real phenomenon that we are beginning to learn a lot more about.

And they all -- they happen through two mechanisms. One is the cumulative effect over time, the wear and tear of chronic adversity from chronic abuse, chronic neglect, chronic exposure to violence. And then there's the biological embedding during sensitive periods where it's not the cumulative burden, it's a particularly sensitive period where if something bad happens you're going to have an imprint forever. This is prenatal rubella, some period in pregnancy where exposure to that infection gives you cataracts and heart disease and mental retardation and deafness. And you can get rubella anytime after birth and it won't hurt any of those organs. This is prenatal alcohol. The number one known cause of mental retardation still in this country is prenatal alcohol exposure. It's not great for three-year-olds to drink, but for a fetus to be bathed in alcohol is a whole different story. This is a biological sensitivity issue.

In the end, the nice thing about this from a policy point of view is we get a three-for for this. All of these issues around early experiences and their effects on organ systems and the brain make -- provide a foundation for educational achievement and ultimate economic productivity. This is about how the brain works. It forms a foundation for health-related behaviors. It's awfully late to try to get 30-, or 40-, or 50-year-olds to start eating differently or exercising more. There are patterns that are established

early on that make you more or less likely to be addicted to drugs, to be addicted to alcohol. They start very early. They don't start in adolescence. And all of these things are shown to be predictive in ways that we still need to kind of understand more explicitly, but we do know that early adversity leads to greater likelihood of a whole host of chronic diseases. The most expensive ones we treat in our society, and it's independent of health insurance. This is true in every country in the world where there's universal health care. Poor people get sick more than more economically secure people. They don't live as long. And individuals who have significant adversity early in life have more health problems later, even if they have access to good health care. This is not about equal treatment in the health care system; it's about the biological origins, the early childhood roots of disease, physical and mental illness.

So I'm going to end with kind of a summary and a take-home message. So everything I've said could be summarized in three simple messages about what the keys are to healthy brain development. The first are supportive relationships and positive learning experiences. That starts in the family for most people, but the family can be helped and others could help to provide those positive relationships and those positive learning experiences, and the family could be strengthened by outside assistance. It could be voluntary in a community, and sometimes it could even be a publicly supported program. My goodness.

Second, a balanced approach to emotional, social, cognitive, and language development is essential to early childhood development and eventual kind of successful educational achievement. We suck up a lot of oxygen in the policy arena arguing about which is more important: cognitive or social-emotional development. They're intertwined and they're both biologically-based. And there's nothing more scientific about cognition than there is about what we know about emotion and fear as you'll hear from Nathan Fox later. It's all in the brain and there's a science there.

And the third is that we need highly specialized interventions as early as possible for children and families who experience significant adversity. The clock is always ticking when it comes to early brain development and the adverse impacts of significant risk factors they get embedded in the brain.

So what are the implications for policy? I'll give you three to take away. One is we clearly need to build an appropriately trained early childhood workforce whose skills match the needs of the children and families it serves. Okay? One simple example. There's a lot of interest in home visiting programs right now and putting more money into them. When appropriately matched it's a fantastic and wise investment of resources. But a well-meaning, poorly trained home visitor with a bag of toys and a warm heart is not an effective treatment for maternal depression, for substance abuse, for family violence, these sources of early adversity that need more

specialized intervention than just advice on how to take care of the needs of young children.

Secondly, we need to expand evidence-based programs. It's not just a matter of serving more children who would benefit from programs, but it's a matter of the programs being ecologically appropriate. By that I mean not only understanding differences in what's culturally appropriate for families, but, you know, if people are working and the program is available during the day and wants to make home visits that's not going to work.

Programs have to be implemented well. We have effective programs and ineffective programs, all drawing off the same model, but some are not implemented very well. We can no longer afford to put money into programs that are poorly implemented. And every one of them has to be continuously improved because we haven't reached the Promised Land yet. We make differences; we improve outcomes; but we haven't kind of nailed this completely. We have to get better.

Which leads me to my last implication. We need to design and test new interventions. This is not just a matter of fully funding the programs we have and training the staff well. We have to -- none of these programs have the capacity, nor were they set up to mitigate the impacts of sources of toxic stress in the lives of young children. And unless we think of how to mitigate these sources of toxic stress, all the positive learning experiences and all the parenting education will be necessary but insufficient

to address the needs of the most disadvantaged children because bad things are happening to their brains that just a good learning environment is not enough to counteract.

Here's our website. If you want more information, we've got a lot of stuff on this. And I think I'm at my 20 minutes. So thank you very much.

MR. EVANS: Good morning. My name is Gary Evans and I'm going to present a study that has been supported by the Stanford Center for Inequalities and Poverty, as well as give you a little bit of context about poverty, chronic stress, and human development.

Basically, I'm going to make three points. The first one is I'm going to remind you of something that many of you are already quite familiar with, which is the income achievement gap. Then we're going to talk about the relationship between poverty or lower socioeconomic status and chronic stress. And then I'm going to try to show you that part of the pathway of how we get from income to achievement deficits may be, in fact, related to chronic stress, which in turn is influencing brain development.

So here is a dataset which is all too familiar for many people. This is national data. It's from Jim Heckman, a Nobel-laureate in economics, showing that even when children start school, those who are poor are already behind. In this case, in standardized math scores. And as you can see, over time things do not get better; they may actually get slightly worse.

But certainly there's voluminous data verifying what are called income achievement gaps, that children who are poor are farther behind in various kinds of indicators of achievement and intellectual development.

Of course, the important question about this is not only that that happens, but why and how. How does that happen? Why does that happen? I'm going to tell you about a recent study that's been supported, as I said, by the Stanford Center for Inequalities and Poverty. And in this study what we are looking at is an unusual dataset. It's unusual in a couple respects.

First of all, it's a national dataset. As you can see from this overhead, this is looking at children born at eight different medical centers across the United States. And we're looking at these children at a very young age. And as you can see, they're children who are at-risk. These are children who are premature and/or have low birth weights. And it's a very diverse sample racially, as well as economically.

One of the things that's kind of interesting about this study is because of this diversity of income, we have the ability to look at a sample that's pretty large, but it's been followed over time. And another thing that's particularly interesting about this sample is we have physiological stress data on these children at a very young age and then we can follow them over time.

So I'm going to show you some of the data analysis that we've

been conducting. We're looking at in this example body mass index, which is an indicator of metabolic syndrome, being overweight. This is a strong predictor long-term of diabetes, for example, among other negative outcomes. What you can see here is at 24 months of age in this sample, children with all those controls -- lots of statistical controls for various kinds of background factors -- at 24 months there's not much difference. But over time, children who are from low-income neighborhoods, as you can see, their BMI continues to increase faster and faster, relative to children who are from middle class or from near poor. So the bottom line essentially is middle class kids or babies, and the upper two lines are either near poverty or at or above the poverty line -- below the poverty line, excuse me. So we're looking at affluent, near poor, and poor.

We also see a very similar kind of trajectory with blood pressure. The children who are poor, their blood pressure, and children who are near poor versus children who are affluent. And you'll notice that children who are affluent, their blood pressure actually is going slightly down as they age, which is a normal maturation process during this age period. But children who are poor, this does not occur. So these babies, this large sample of babies, as they are getting older and older, their body mass index is increasing and their blood pressure is increasing, whereas affluent children, their body mass index goes up, but only slightly and their blood pressure actually drops off a little bit.

Here's another study looking now -- instead of looking at babies, let's look at nine-year-olds. So this is a study of nine-year-olds. This is a rural sample. This sample is predominantly white, so it's less heterogeneous than the other sample. And here again you see this same kind of finding. At nine years old -- these are children from rural areas -- children who are at or below the poverty line have resting blood pressure. I forgot to mention these are resting blood pressures. We're not looking at their blood pressure when they're under some kind of a challenge or any kind of a demand. We're looking at at-rest, sort of what's considered a baseline indicator of their physiological stress. In this example, blood pressure. Same in this study. So nine-year-olds at rest. They're relaxed. They're resting. Baseline blood pressure is elevated at nine years old in relationship to poverty.

Professor Shonkoff mentioned that one of the indicators of stress, looking at particularly chronic stresses of interest to us, are not only these cardiovascular changes, but earlier on in the cascade looking at what are called stress hormones. These are -- again, these are part of this emergency response system which in the short term when there is an acute demand, it's critical for survival. We have to mobilize our energy in order to deal with a threat that's immediate. Part of the way that our body does that is we secrete what are called stress hormones and neuroendocrine hormones. For example, cortisol is a hormone that's secreted by part of

your adrenal gland. And as you can see, again at nine years old, at rest -- these actually are overnight, so these are while the children are sleeping, at rest -- they have elevated cortisol, elevated epinephrine, and elevated norepinephrine. So these stress hormones are elevated in nine-year-old children as a function of their poverty status.

Now, if we move to a little bit older, same study, now they're 13 years old. And here I'm going to show you something that's perhaps a little counterintuitive at first, but I think when I explain it it'll make some sense. Here what we are doing is we're now actually going to, if you will, test out that emergency response system. We're going to look at the way this stress response is supposed to work. So what we're going to do is we're going to present the child with a short-term acute threat or a challenge. In this particular case it's asking them to do some mental arithmetic. They're not expecting this so it's sort of a surprise. They're 13 years old and they have to do some calculations in their head, and we call it a test.

What's interesting here is that the children who are poor actually do not mobilize this system as well as children who are middle class. So in other words, there's some suggestion here that perhaps what's happening is because of this chronic stress, which is marked by these elevated hormones, marked by resting blood pressure elevations, that when the system is necessary, when it's put in a situation where it has to deal with a demand, there may be some damage from this chronic challenge and

adversity related to childhood poverty.

We also know that these hormones are elevated. This is another dataset just to show you the generalizability of this. This is a study looking, as it says, at urban 13-year-olds, looking at them over time in terms of their elevations of cortisol, again at rest. And what you see here again is a similar kind of a pattern that I've been showing you so that early deprivation, childhood deprivation -- poverty, low socioeconomic status -- seems to be associated with elevated stress hormones and various indicators of chronic stress.

Now, how might this get into the brain? How might this link to the brain and how might we get from poverty, low socioeconomic status, to the income achievement gap? This is a fascinating dataset from Martha Farah at Penn. And what Martha Farah and her colleagues have been looking at is neurocognitive indicators of brain function. So these are tasks which are well characterized in terms of when the task is being used. We have very good evidence, primarily from neuroimaging and other techniques, of what parts of the brain are being recruited. And what she's showing in this particular slide is the relationship between children who are lower socioeconomic status compared to children who are middle income or middle socioeconomic status. And as you can see, various kinds of parts of cognitive activity that are very essential, they're very large. So this graph is showing you differences in standard deviations. So the Y-axis here, the

differences in the standard deviation between the low SES and the middle SES sample. And as you can see, rather large, very dramatic effect sizes in several cases, the largest one being language.

So one possibility might be the following kind of pathway that early chronicity of stress, early deprivation. For example, as operationalized in my work and my colleagues' work looking at poverty, childhood poverty, one of the things that might happen is childhood poverty is a chronic stressor. It leads to what Professor Shonkoff called toxic stress. There's these unremitant demands. Many of them are difficult, if not impossible, to deal with. They're uncontrollable. Families often who are poor unfortunately have a double jeopardy. They not only have more demands; they also often will have less resources in order to deal with those demands. So, unfortunately, it's a crucible for this toxic stress to develop.

One way that we can mark toxic stress is with a concept called allostatic load. Allostatic load, as it says on the overhead on the slide, is an attempt to try to look at this regulation across multiple systems. So you heard about cardiovascular; you heard about immune system; you heard about the metabolic system. This is an attempt to sort of create a metric, which I would say is still evolving. The theory is evolving; the metric is evolving. But it's an interesting, intriguing idea. One reason why allostatic load is of interest to people is it predicts long-term outcomes, including mortality better than the individual markers of particular systems not working

well. So this predicts better than blood pressure by itself, for example. It predicts better than a hormonal measure throughout life, as well as concurrently. So it's sort of like a catch-all indicator of dysregulation of problems with these stress-related systems, chronic toxic stress not working.

So this is some recent data with that same dataset I showed you earlier. These are back to the white, rural children who you saw data on. Blood pressure and hormones at age nine. You saw some blood pressure data in terms of responding to an acute stressor at age 13. Now I'm showing you data at age 17. And what I'm looking at here is as you can see on the Y-axis is an indicator of allostatic load. That's this overall marker of multiple dysregulation across various systems -- metabolic, cardiovascular, neuroendocrine -- looking across these different systems. So the higher the allostatic load the more multiple dysregulation. In relationship to at age 17 the proportion of your life that you spent in poverty for this rural sample.

So you could spend all of your life in poverty, which obviously the proportion would be one, versus zero which meant none of your life was spent in poverty. And as you can see there is a relationship between how long -- what proportion of your childhood was in poverty and this elevation of allostatic load.

There's also a relationship for this exact same sample between how long you spent your life; what proportion of your childhood was

in poverty from birth up to age 13; proportion from 0 if you will to 13; predicting 17-year-old working memory; and allostatic load. There's also a decrease in working memory. Working memory is part of this brain system that Professor Shonkoff mentioned -- the prefrontal cortex. Working memory is a fundamental cognitive process. It's a building block. We need it for logic. We need it for making decisions. We probably need it for inhibiting our behaviors. Behaving appropriately in different circumstances. And it's also critical building block of learning how to read, mathematical achievement, et cetera. So this is a fundamental, cognitive system that's a building block of healthy cognitive development.

Whoops. Now what I'm showing you is the same slide looking at the proportion of life in childhood poverty on the X-axis within the same sample and working memory. Only now what I've done is I've statistically modeled allostatic load. So what I'm showing you is that chronic childhood poverty appears to be linked to elevated allostatic load, which in turn appears to help explain or is one -- not the only -- but one underlying mechanism linking the proportion of life and childhood poverty and your working memory. So these deficits in working memory, which are significant and substantive, may be explained because of the child's longer history of chronic stress.

Let me end up with one slide. This is -- there are only two studies that I'm aware of looking directly at brain function and poverty in

terms of neuroimaging. So actually looking at structure and functioning of the brain using neuroimaging techniques. This is a study from a group at Pittsburgh at the Medical School at the University of Pittsburgh. Here we're looking at adults. In this particular study they do not have an objective measure of income; they have a subjective measure of social standing. So where do you stand relative to other people in your community in terms of how well off you are or how not well off you are. So using -- literally it is a ladder. It's a MacArthur Foundation ladder. And they are looking at an area of the brain that is part of the prefrontal cortex. And what you can see here in adults who perceive themselves as having lower social standing, their brains are different. They have less gray matter volume in the part of the brain related to decision-making, related to inhibition. It's probably a critical part of this process. Again, this is not a study of children, because there is very little data right now on this topic of what actually is happening in the brain. But as you can see, there is reason to believe that we have something to be concerned about.

Thank you very much.

MR. FOX: Good morning. My name is Nathan Fox and I'm going to be talking to you about a study that I've been involved in for the last 11 years called Bucharest Early Intervention Project. My collaborators on that project are Charles Nelson from Children's Hospital of Boston and Charlie Zeanah, who is at Tulane Medical School. And together we have

studied the effects of early psychosocial deprivation on the developing brain and cognitive and social development in children in Romania.

So I want to make three points in my talk -- in my 15-minute talk this morning. The first is that psychosocial neglect, which I'm going to be telling you about, is both a worldwide problem in terms of institutionalization of children, and it's also a national problem here in the United States. And I'm going to show you some statistics to validate that point.

The second is that institutionalization is bad for children. And I'll hope that you'll agree with me after you see the data from our study. And the third is that early intervention actually facilitates remediation from early psychosocial neglect.

So, these are the questions that I'm going to be addressing. The effects of early experience in brain and behavior and are there sensitive or critical periods during which the effects of experience have their greatest impact.

So, some context for the talk. Children in institutions represent what you can consider to be a natural experiment, one in which you can examine the effects of early experience. And as I mentioned, they represent a worldwide problem, but there's also relevance to here in the U.S. So, for example, this is from a survey that was done by the World Health Organization in 2003. And you can see those red lines. Those are different

countries in Eastern and Western Europe. And you can see the incidence of percentage of children who are actually in institutions in those different countries. Another way of looking at it is you can see -- I'm going to try and use the cursor here -- here are the reasons for institutionalization for children in European Union states. And you can see here that the majority of those children are actually in these institutions not because they're orphaned, but because they've been abandoned or have had a history of abuse and neglect.

We know from studies of post-institutionalized children -- that is children who have been adopted by families in both the United Kingdom and in the United States -- that children from institutions demonstrate a number of emotional and behavioral problems. And I've listed some of them here for you, including inattention and hyperactivity. And behaviors that actually appear to mimic autism.

These are some data that a colleague of mine, Phil Fisher, who is at the University of Oregon, was nice enough to send me. And what Phil and his group did is they surveyed 300 children in the state of Oregon -- the case records of 300 children in terms of their histories through the Child Welfare System. The slide is a little bit hard to read, but what you can see here is they have four different reasons that a child could be -- have a maltreated profile: emotional maltreatment, which is that they witnessed; domestic violence; supervisory or physical neglect; or physical and sexual

abuse. And they came up with four different profiles or groups of children.

The first are children who have undergone emotional maltreatment or neglect. And you can see there that those children do not generally -- have not undergone physical or sexual abuse. The second are children who have undergone neglect, but also sexual abuse. The third are children who have undergone physical abuse, but not sexual abuse and neglect. And the fourth are children that have had all of these different adverse experiences. But when you look at the percentage of children -- and this is now in the state of Oregon -- who are in the foster care system, it's rather remarkable to find that fully 62 percent of the children in foster care are those children that have undergone neglect, but not physical or sexual abuse. And there you can see the percentages of children in the other profiles.

So the point of the slide here really is that the majority of children in the foster care system in Oregon, but probably elsewhere in this country as well, are there because of psychosocial neglect and not necessarily because of physical or sexual abuse.

Okay. So the Bucharest Early Intervention Project that I've been involved in is examining institutionalization. We are -- we attempted to determine whether or not through a foster care intervention we could remediate the effects of early psychosocial neglect and obviously improve the welfare of the children in Romania.

Very briefly, Nicolae Ceausescu began a program of increasing the population of infants and young children in his country. And he did this in a number of ways, including setting up what he called "menstrual police" and having a celibacy tact. He outlawed contraception and abortion. And the result was a large increase in infants and young children who were abandoned, mostly because of poverty. And what Ceausescu did is he set up a network across the country of institutions where these children and infants could be placed.

So there are hundreds of thousands of these infants and young children who were warehoused into these institutions. And some of you may remember that back after Ceausescu was deposed in 1989, 1990, when the Western media went in there. There was an exposé of the kinds of situations in which these infants and very young children were being housed.

Our study, which started in -- soon after that -- is the first randomized clinical trial of foster care intervention for infants and very young children who were in these institutions. And what basically we did is in the city of Bucharest we randomized -- we screened a large number of infants and very young children, identified 136 institutionalized children, and randomized them to either be in one of two arms. Either they remained in their institutions -- there were six institutions in Bucharest that we worked with -- or they were taken out of the institutions and they were placed into

foster care family homes that we had identified, the parents of whom we had trained and who we had supervised. We also had a group of community children who were matched on age and gender who we followed as well.

So we've assessed many different domains, but the three domains that I'm going to be talking to you about this morning are cognitive development or IQ, brain function, and mental health problems. And our general hypotheses are pretty straightforward. We believe that institutional rearing would have profound effects upon children's development. We believe that removing the children would benefit them in placing them into family environments. And we also believe that the timing in which the children were taken out -- that is the age at which the child laws taken out -- would affect the efficacy of our intervention.

So first in terms of cognitive development or IQ. When we assessed their IQ at baseline, that is prior to randomization, what we found is that the infants and very young children who were in the institutions were significantly delayed in terms of their IQ. You can see there that they had an average IQ of 64. And this is on a measure, the Bayley Scales of Infant Development, which is mean for 100 with a plus or minus standard deviation of 15. So these children were significantly delayed in terms of -- or impaired in terms of their IQ. Now, if we follow these children up after we've removed half of them and put them into these families, what you can see here is when we compared those children who remained in the institution to the children

that were placed into our foster care setting, you could see that at each of the follow-up ages when the children were 30, 42, and 54 months, that there was a significant effect of the intervention. That those infants who had been removed from the institution, placed into foster care, had higher IQs compared to those children who remained in the institution.

When we then break up the age at which the child was taken out of the institution and you can read down in terms of the 42-month Bayley or the 54-month WPPSI, which is another measure of IQ, what you can see there is that the earlier that the child was removed from the institution, the higher the child's IQ. And I have here a graph here. You can just really look at these purple bars here. Those are the foster care children that were removed before the age of two and these light brown bars here are the foster care children who were removed after the age of two. And what you can see is that those children through 54 months that were removed before the age of two, their IQs are normal compared to the children who were removed after the age of two, whose IQs are very similar to the children who remained in the institution.

We've actually followed these children up through age eight. And the findings remain. So here you can see that in terms of verbal IQ -- the green are the foster care children -- is that they remain elevated compared to the children who were randomized to be in the institution. That's CAUG, care as usual.

And just to say one word, the analyses that I'm representing are what are called intention to treat, which means that even though some of the children may no longer be in the institution, they are being analyzed as if they remain in the institution.

In this slide -- this is only to show you that those children that remained in our foster care intervention -- we call it the MacArthur Foster Care Intervention because our study was funded by the MacArthur Foundation. Those children are actually doing best of all the children at age eight in terms of their IQ.

So the summary of the IQ findings are that young children raised in institution display severe, intellectual impairment compared to age match controls. If you remove children before age of two, it appears to remediate those effects. And the timing of that intervention, at least through 54 months of age, is critical. So those children that were removed before age two, their IQs are normalized compared to those children that were removed after age two.

We actually set up a laboratory in Bucharest and measured brain electrical activity in the infants and young children across the different ages of assessment of the study. EEG is a general measure of the activity of the brain -- electrical activity that is generated from the neurons in the brain, in the cortex. And we were looking to see what the different frequencies or the level of activity was.

So this is actually a slide. I think Jack already showed you. And it compares the community to the institutional group. And there are two things to note. One is that you want fast EEG activity because it's as if your light bulb is -- Jack gave you the metaphor -- it's as if your light bulb is turned up or turned down. And slow wave activity means that you're light bulb is turned down or the generating -- the neurons that are generating electricity are turned down versus fast wave activity. And you can see there that for the slow-wave activity the institutional children compared to the community controls are showing greater slow wave activity. But if you look at the fast wave activity, which is the more mature response, it's the community children that have that red -- deep red mark, which is the fast wave activity compared to the institutional children.

In fact, that pattern of brain activity is ameliorated by our foster care intervention. So here is the data from age eight. And what you could see here is that those children that were removed before the age of two, they actually have normalized fast wave brain activity compared to the children who were either removed after the age of two or were left randomized to remain into the institution.

So I want to just present one small other aspect of data. We also assessed mental health problems in the children. And you can think about it in terms of both emotional disorders and behavior disorders, like ADHD. And what we found is that our intervention actually remediated

emotional disorders, like anxiety, in the children that were removed from the institution. But it did not ameliorate things like ADHD, which are more of the behavioral problems that these people had.

And here you can see a graph which shows you the incidence of ADHD and the institutional from left to right -- the institutional, the foster care, compared to the community controls. But what's important in a recent analysis in a paper that's just been accepted for publication in Biological Psychiatry, what we've done is a mediation analysis. And what we can show is that, in fact, brain activity that was measured at baseline -- that's the low and high activity that I showed you earlier -- actually mediates the mediation between institutionalization and these ADHD symptoms so that it's the brain activity. It's the effects of that early psychosocial neglect on the brain, which is actually mediating the relationship between that early institutionalization and the symptoms of ADHD. And that's shown in these two mediation models.

So to summarize our findings, children exposed to early life due to severe social deprivation, displayed deficits in IQ and brain activity, removing children from institutions and the accompanying deprivation enhances these children's lives across multiple domains. Early placement -- that is early intervention -- is better than later. For mental health problems, such as ADHD, actually the timing of intervention did not affect outcome. In fact, intervention was not facilitating of behavioral problems. But early

affected brain activity mediated the emergence of impulsivity and hyperactivity in the institutionalized children. And so removing children from institutions and removing children in this country from conditions of psychosocial neglect, we'll advance the welfare of children and prove brain activity for those children.

Thank you.

MS. KAGI: (Via video) Thank you very much for the opportunity to talk with you today. I'm very sorry that I was unable to join you in person, especially since I wanted to hear the panel presentations about developments in science that affect early learning. Science has been a tremendous driver of policy in Washington State and continues to be. And I think it has great promise for changing our policies around parents and their children.

Science really started our engagement with early learning about five years ago when Dr. Pat Kuhl, who is the co-director of the Institute for Learning and Brain Sciences came to the appropriations committee and gave a presentation on our research on the development of infants and their understanding of brain waves and healthy development (inaudible). It was a spellbinding presentation that really demonstrated to legislators the link between those first few years and the learning that takes place in a successful school later in life. And has sparked our drive to really address the needs of your children because we know that is the best thing we can do

for academic achievement.

That seed that was planted by Dr. Kuhl really sprouted when Dr. Shonkoff came to Washington and to Olympia to work with us on getting a bill passed to create an Early Learning Council. And Jack met with legislators, presented to a Senate hearing, met with the governor, and all of that resulted in the passage of legislation. But as important, he also met with the policy directors in Washington: the Secretary of the Department of Social and Health Services and staff from the Department of Health and from our Child Welfare and TANF agencies. As a result of that we really focused on the needs of very at-risk young children and changed our policy so that public health nurses and our TANF caseworkers could refer children to therapy to child care, not just our child welfare care workers. It's an example of how we can holistically look at the needs of children if we pay attention to the science.

We have steadily built on that base over the past few years. And I have built a very strong policy foundation for early learning. We created a Department of Early Learning and funded a Quality Reading and Improvement System -- the development of a system. Unfortunately, in one of the first rounds of the many budget cuts we've had, funding for QRIS was eliminated. So we have established the foundation and the framework for a system to improve the quality of child care, but we don't have the funding to build the house.

Two years ago we passed a bill to create an evidence-based and research-based holistic program across the state. And that, again, has been very successful and is producing good results. It focuses on the highest risk families and is voluntary, but it only reaches two percent of the eligible families. With private funding through our public-private partnership, (inaudible) By Five, we are going to expand that program a very small amount this year. But we're very excited about the funding in the Health Care Reform Bill which will enable us to reach many more families in the years ahead, and we look forward to receiving guidance about how we can build that program.

I'm very proud of one bill we passed this session, which I think best reflects the priority that this legislature has established for young children. We passed an entitlement for our state-funded Early Childhood Education Program for three- and four-year-olds. The entitlement won't be fully implemented for eight years, but it clearly establishes that we want to serve all eligible three- and four-year-olds who are low-income, and we will build to that as we are able to do so. It's one of the best reflections of how much we have learned about the importance of preschool for the success of children when they get to kindergarten.

We're also working very hard to redirect existing programs so that they better serve the needs of young children. One of the issues we addressed this session was the stability of child care for children enrolled in

TANF. Currently, eligibility for TANF child care is only three to six months. So when a parent loses their job or leaves school, their child is pulled out of child care. And when the parent gets a job, the child is put back generally into a different child care. We know from the research how important stability is for children and those relationships that they develop with their caretakers, so we created a year eligibility for children who are receiving TANF child care or also in Head Start or ECAP. We are unable to adopt this policy for all children receiving TANF child care because of the cost, but I'm very hopeful that we will be able to demonstrate with this small pilot that providing stability and longer term eligibility will really benefit children and families.

Probably the area of greatest promise and greatest frustration is child welfare. We, and many other states, have been working to reduce foster care caseloads by investing in evidence-based and innovative strategies to work with families with young children to keep them out of foster care, to help parents learn the skills of responding and reading their babies' cues, and really developing a bond that will help them parent that child successfully. Unfortunately, when children don't go into foster care, we lose our federal funding. So as we are successful in reducing our caseloads, we lose the federal funding to reinvest in the front-end and in strategies that really help families.

States and jurisdictions used to be able to apply for 4D

waivers which gave them the flexibility as they obtain savings from these caseloads to reinvest in the front-end. It gave the flexibility to the states and that has produced tremendous results in many (inaudible). Unfortunately, the 4D waiver authority expired in 2006, so now states like Washington, who are very anxious to invest in effective targeted strategies for supporting these high at-risk families, we can't do it without losing our federal funding. So it's a huge disincentive. It's a policy that needs to be changed, and I'm very hopeful that Congress will look at reauthorizing the 4D waiver.

Finally, I couldn't end this conversation without talking about TANF. TANF is the safety net for families with children. And our TANF resources are stretched way too thin. We currently face over \$100 million shortfall that we're struggling with in the budget. We're trying to finish now. I'm aware of it in the House a bill was passed a few weeks ago that would provide \$2.5 billion in emergency TANF funds to help states that are struggling to serve these families in this tremendous economic crisis. I just encourage the Senate to address this spell and to provide the resources for states so we do not have to make drastic cuts in our services for these very vulnerable families.

Science can and should guide our policymaking in the states and at the federal level. In Washington, we have refocused on targeted, effective strategies for addressing the needs of children who are birth to five. We think that this investment will provide the best payoff of any investment

of our state resources and really encourage Congress and other states to invest in young children so that they have the best opportunity to succeed.

Thank you very much.

MR. HASKINS: Okay, now I'm going to ask a couple of questions to the panel. Before I do I can't help but observe Ruth's comment that they started a Department of Early Education and when the budget cuts came it wound up cut and on the floor. And this I think is a model for what is likely to happen in the future at some -- this year, next year, the year after -- at the federal year. And all programs -- all state programs, probably less so entitlements, but will be on the cutting block. And Belle and I have been concerned for many years now that children's programs are going to be first to be cut. So we're saying let's do it early. Let's make our adjustments. Raise taxes, cut programs, especially make transfers between programs for the elderly and programs for kids, and do it in an orderly fashion. Because if we wait until the crisis comes, then a lot of things that shouldn't be cut are going to be cut and I think that's a perfect example of the problem that we could very well face here at the federal level in the near future.

All right. So let me ask the first and obvious question here. And that is we have known for a long time that early intervention is crucial and that early development sets the pattern for the rest of life in many cases. In fact, just think of Head Start. We started Head Start a half a century ago almost. And we still have it. And it's expanded and expanded. And now we

have many more programs.

So what are you all adding to this? We already know that early development is important, so now you're coming around with all these elegant, beautiful methods. I love it. I like knowledge. I'd be willing for my taxes to pay for this kind of research. But what are you really telling us that's going to help us with intervention studies and policy?

Jack Shonkoff. I never guessed you would answer that.

MR. SHONKOFF: Do you guys want to go?

SPEAKER: Go ahead.

MR. HASKINS: You're going to give them time to think up something.

MR. SHONKOFF: Well, I'll put two things on the table for starters. One is that I think what the neuroscience and the molecular biology and the genomics and this whole burgeoning field of epigenetics which we haven't talked about this morning that's getting at the molecular level of how experience gets into our bodies. So two things I would say that this is doing. One is it's helping us to rethink the health dimension of early childhood policy. We have -- from the beginning we've thought about this almost entirely through an education lens in terms of readiness to succeed in school and the implications for economic productivity which are real and true. But the science is screaming at us right now that this is not just about learning. This is about physical and mental health. This is not only -- has implications

for how well kids will read, but how healthy the population is going to be. So I think this is something that's new.

It's actually even new to the medical world. I'm a pediatrician. Right? Even the American Academy of Pediatrics has not yet, I think, gotten in touch as it should with the fact that all of the health promotion and disease prevention stuff that we do in primary care is as much about long-term adult health as it is about short-term child health. So not to mention the extent to which the adult medical community hasn't caught on. This is a disconnect between basic science and I think public health. So that's kind of one issue that I think has to be developed more.

And the second, which I alluded to in my last slide, is that our theory of change for early childhood in the education framework has been provide good learning opportunities for kids, rich learning opportunities, and support and education about parenting and child development for their parents, both of which I think are absolutely real and necessary, but not sufficient and at least from my perspective a reason of hypothesis that the reason why the best we've ever achieved -- someone is sitting here right now, Craig, the Adversarial Project, the Perry Preschool Project, Chicago Parent and Child Centers, you know, the studies we continue to squeeze every drop of blood we can squeeze out of these studies as they get further and further apart. What they do is they underscore the value of rich learning opportunities, but they don't address the issue of what the negative impact is

of toxic stress on children. And the programs haven't really been addressing that. So I think these are two very important new messages from the science. This is about health learning and behavior, not just learning. And this is not only about enriching children's experiences, but it's doing something about adversity in their lives that's undermining their biological development and therefore, limiting what we can expect to achieve on the learning side and on the health side. I think those are new.

MR. HASKINS: Do you want to add anything?

MR. EVANS: I would just echo the comment that we tend to have expertise in particular areas, we tend to have policy that reflects particular areas, and we don't treat it as an integrated holistic problem. I mean, the data that I showed you is suggesting that chronic stress is leading to deficits in working memory. Those are two areas that are very rarely put together, and we've seen other evidence of that before you today. So I would just underscore this notion that, you know, stress and adversity, resources, mental health -- when you talk to a preschool teacher about learning and educational development, what he or she -- and it's typically a "she" -- talks about is the child's ability to sit still. They don't talk about letters and language. I mean, those are important, of course, but what's very salient is the child's ability to sit still. And then as he or she develops ability to follow directions and to understand the notion of sequences. So these things are intimately integrated, but we tend to both as researchers

traditionally, the way departments are organized, the way policy is organized, to treat these as separate issues.

MR. FOX: Yeah, so I would say that although you started out your comment by saying that well, we all know that early intervention works, that's true on one level. But it's also not true on a very significant level. When we started our study of institutionalized children, our scientific colleagues said to us, duh, don't you know that institutionalization is bad? Bu the policy people around the world, even in this country who have talked about setting up institutions and congregate care for children, taking them out of families, they have not seen the evidence that institutional care for young children is bad for you. And witness the large number of institutions that still exist in Eastern and Western Europe, and the large problem that we have with young children who are without families. So think about the AIDS epidemic in African and the need to figure out how to care for a large number of very young children.

And one of the reflexive responses is we'll build an institution and we'll put all the kids in there and at least they'll be okay. Well, but the problem is that they may be okay in the very short term, but what the research tells us is that the experiences of institutional care have long-term consequences. And we couldn't have done that -- we couldn't have had that without what you -- I remember Ron came to a meeting of the International Site of Infant Studies and said that now policymakers understand random

assignment. So without -- without studies that have random assignment, policymakers aren't going to accept or generally accept those findings. And so we need that research in order to nail down the policy.

MR. HASKINS: So for a specific application of this question now, can you imagine a time when daycare centers and parents are doing things that we discovered as a result of this kind of brain research, specific activities, curriculum materials and so forth that would be consistent and suggested by brain research that they should be doing? Or is that not likely to happen?

MR. SHONKOFF: Yeah, no, I'd like to pick up on this because I think there's an implication some people think about that is not what we're saying. I think anybody is saying, well, what's great about this brain is now we're going to have all these kind of brain-based kind of formulates for what we do in curriculum. Although I think there is certainly important information that can be contributed, that's not the power of the brain research. It's because basic interactions and learning experiences are, you know, we know what they are. We don't need a refined molecular analysis to tell us what good interactions look like between adults and kids.

But I think what's powerful about this is it's opening up the black box about why certain kinds of risk factors result in problems later. We can go on -- we can produce data. We can drown people in data at the most elegant levels of analysis about so many things early on it can produce with

greater likelihood for problems later. If you don't buy into that or you're pressed for money, a more elegant analysis is not going to change your mind. But helping people understand causal mechanisms, this is I think what's very powerful here. And it's what I learned in working with people in Washington state, is that once the causal mechanisms become more clear and we say, well, what is it about all this stuff that gets into your body and how does it affect your learning and why are kids ill more? Then policymakers and other people who have to make decisions about allocation of resources can have an understanding that can lead to a lot more creative thinking about what to do.

You know, we have this fragmentation -- we've all talked for decades about the problem of the silos and the fragmentation. And our answers has always been, you know, interagency agreements, better communication, sharing information. What the science is allowing us to do is to have everybody now feed off a common understanding about what's going on. What are the mechanisms of development? That's the beauty. And what was great about working in Washington State is we just presented the science and they figured out this isn't just child care. This is TANF. This the child welfare system. This is all these other things. So that's the beauty of it. It really ought to change the way we think about problem solving and the way we think about kind of how different systems ought to come together on the same knowledge base. And that's something we haven't been able

to do before.

MR. HASKINS: You don't have to make a comment, but if you want to say something, please do.

SPEAKER: The only --

MR. HASKINS: Go ahead.

MR. EVANS: The only thing I would add to what Jack just said is -- and this is relevant to this comment about training, about training earlyhood child interveners and educators -- I think we've probably not appreciated sufficiently yet the role of stress and strain. And just the kind -- I have some work -- I use the word "chaos" -- that many of the environments that young children who are placed at risk are in are very, very chaotic. And they're chaotic not only for the child, but I would also point out for the parent.

So, for example, to say to a parent, well, okay, I'm going to teach you to be more responsive and to do better, higher quality parenting, that's certainly a reasonable goal. But if we forget about the fact that one of the things that's stress and strain and pressure does to the parent, think about yourself. You've had a bad day at the office. You go home. You're not exactly high on your responsiveness. So if you're living under those circumstances, it's important to have this, if you will, an ecological kind of model that the caregivers, they themselves, may also be under a lot of stress and strain. And one of the outcomes of that is less responsiveness, less attention, less ability to interact in a socially supportive and in a positive

way when you're under a lot of pressure yourself. So I think adding that perspective is important.

MR. HASKINS: Okay. I want to point out something that I think is really clear, and that is we've undersold this a little bit because when you show policymakers those brains and the red one is a big light bulb, they really -- it's persuasive. So you all are adding a real political dimension here that for those in positions like Belle and I are in where we're trying to get policymakers to say this stuff is important; you ought to spend more money on it. When they see that brain color, that is really -- that's a big impact event. So I think you're really doing important work.

Let me ask one more thing before I turn it over to the audience. We talked a lot about child protection here, especially Professor Fox. And we have elaborate programs, of course, and we have all kinds of rules and procedures. And the federal government preempts some of these rules. They say to the states you have to have certain rules if you want our money. And we're talking about something like 5- or \$6 billion here. So they go to court --

MR. FOX: That used to be a lot of money.

MR. HASKINS: It still is. You must be a Democrat.

In the context of Health Reform, nothing is big money. But so you go to court and imagine that you're in court and you present all this stuff and showing how bad it is when kids are exposed to abuse and neglect and

so forth. But the courts have all these laws that really in most situations say stick with the parents unless it's completely, totally, unbelievably outrageous. Can you imagine that there will be a time when your work will change the views of the courts and the policy world and really make a fundamental change here? And if so, isn't -- aren't we -- couldn't we err on the side of taking kids away from their parents and put them in what we consider to be, you know, produce that red spot in the brain?

MR. SHONKOFF: Do you want to start?

MR. FOX: No, go ahead. It's too hot a potato for me.

MR. SHONKOFF: Well, a couple of things. One is the approach we've taken in bringing science into the policy world is to be extraordinarily conservative about what we say. So we have an internal --

MR. HASKINS: That must be hard for you, Jack.

MR. SHONKOFF: Not at all. Not at all. No, because it's more effective. We have -- we actually have an internal vetting process in our council where for us the litmus test is --

MR. HASKINS: Wait, tell him what Council is.

MR. SHONKOFF: National Scientific Council, Nathan, is the part of it. It's a collection of 12 scientists around the country who work on translating science for policymakers and business executives. Not for the advocacy of the service community, but for nonscientists to kind of help inform the process. And we don't sponsor any bills and we don't take nay

positions on anything. We like to think of ourselves as knowledge brokers rather than advocates in the traditional sense.

But so in order to do that we subject ourselves to an internal review process that in some ways is more unforgiving than the most onerous and ornery journals, you know, in terms of what they'll accept. So the litmus test for us is, you know, is there any part -- is any part of what we are about to say that any credible scientist would disagree with or would say, you know, well, you're being a little bit creative or stretching the boundaries. And if that's the case, we cut it out. And what we do is we put forward things where we can say if you go to the meeting of the Neuroscience Society and there are thousands of scientists there, every one of them will say, well, that's absolutely right. We all agree with that. There are other things we disagree with. So, you know, kind of in that sense we're very careful about the science.

Now, when it comes to applying it to things like, well, what should be the threshold for taking a child away from a family. We make the distinction between questions that science can answer and questions that science can't answer. Whether to take a child away from a family is not a scientific question. That's a values, that's a judgment, it's a politically motivated -- whatever. You can't do a study to answer that. So that's not for scientists to say.

But what scientists can say and what the courts can

understand is how critically important the stability of relationships and the continuity of relationships is. This is an example of where in the old days, you know, it was common sense. People would say -- when they would take a child away -- say, well, let's move the kid around a lot to make sure the kid doesn't get attached to anybody because it's going to be hard, you know, to take the child away. So in the best interest of the child people moved kids, you know, wouldn't let them stay in one place more than a couple of months.

SPEAKER: And still do in some places.

MR. SHONKOFF: And still do in some places. So what science has to say is that is so wrong. That is the opposite of what we know children need. So for the courts to then decide about, I mean, this critical issue of whether to take a child away from a family, the issue should be in part whether you make that decision or not, how can we maximize the quality of the relationships and the environment in which a child lives, which means you start with doing everything you can to be able to have the family provide what the child needs because taking the child away from the most abusive or neglectful family is another punishment for the child because it's another separation, you know. And if it's going to be a move, as quickly as possible figure out, you know, with all due process, what's going to happen as opposed to take years to kind of make a decision, have a child be going through that period that's so important.

So I don't think -- I think we have to be careful about having science step over the boundary and tell people what to do on a basis which science really has no greater need than anybody else to have an opinion.

MR. HASKINS: Do you want to add anything?

MR. FOX: No, very quickly I would agree. I mean, I think that the question about whether or not a child should be removed from a home is also a question of what the alternatives are. So if policy and society do not support reasonable alternatives for a child, you're stuck between bad alternatives in terms of whether to leave a child in an abusive household or to put a child into a situation where they're going to be shuttled from place to place. And neither of those alternatives is a good one.

And so what society needs to do is they need to decide that they're going to provide the resources so that if, in fact, you do need to make those kinds of decisions, that there are reasonable and thoughtful alternatives for a child.

MR. HASKINS: So turn to the audience now. Let me caution you that we're interested in questions and not long comments.

Belle Sawhill.

MS. SAWHILL: I think this was just a fascinating presentation so thank you all for your research and for what you're telling -- oh, sorry. Thank you for what you're telling us today. I find it just fascinating.

I think my -- I have lots of questions, but I think the one I'll stick

with right now is this question about what's inside the black box. And my question about that is -- I guess to you, Jack -- you talked about toxic, tolerable, and positive levels of stress. And my question is can we quantify those with allostatic load or whatever? And can we say then more about what proportion of children are experiencing each level roughly. And can we then further talk more about what's the correlation of those levels of -- different levels of stress, not just with poverty, but with other markers that might underlie what it means to be poor. You know, is it material resources? Is it the stress of the parent being translated to the child as you said? Is it a sense of feeling that your relative status in society isn't very high? I wouldn't think that would affect very young children, but anyway, what is it?

MR. SHONKOFF: Yeah. Thanks for the question because I should be really clear. The concept of toxic stress and the differentiation from positive and tolerable is, you know, that concept was developed half a dozen years ago at the most. It's a concept. Okay? What you just --

MS. SAWHILL: (inaudible)

MR. SHONKOFF: The questions you asked and the issues you raised are the scientific agenda for the next decade. Right? It is not -- we don't -- we haven't quantified that. And in fact, the one thing -- but it doesn't mean that it isn't real. But it means that like a lot of science -- so now we have a working model and we have to study it. And so what I would say is we don't need any -- what we don't need are more studies, you know,

kind of documenting and more refined where the correlation between adversity and poor outcomes when you're doing studies to answer the questions you just put out.

And the other thing about this, as we've watched, as the term has been out there, that it's been overgeneralized a lot. And I think Gary put his finger on something that's really important. I don't think we want to necessarily say that every child living in poverty is experiencing toxic stress. That would be a really erroneous statement to make. It's the things that are associated with poverty -- the chaos, the kind of freedom, the absence of -- well, I'm not going to repeat what he said.

So the other thing, every time we present this in front of an audience, half the audience walks out panicked that there's toxic stress in their own homes. You know. You give the example of coming home after a bad day or having a very stressful life. That's life for everybody. You know, there are a lot of very well-to-do people in this country. And so we have to understand the element that toxic stress is essential is not the level of stress. It's whether there are adults to help the child adapt and cope on a day-to-day basis. So toxic stress has really caught on, but it's also misunderstood. And it's a concept that now needs to be quantified more carefully. A lot of kids in poverty do fine, and a lot of kids in wealthy families have a lot of problems. And some of it is related to how well they're buffered in their daily lives.

MR. HASKINS: In the back on your right. Raise your hands again. Right there.

FEMALE SPEAKER: I think it was very interesting. Thank you. And I was hoping to hear a little more about mothers and the power of really reaching out and helping mothers. Like David Olds has done with the Nurse-Mother Partnership. And -- I'm sorry. And I would think that that would be an important step in between the idea of looking at the problem and removing the child from the home. And I know some of you mentioned that, but I think there are a number of things -- there was a CDC study that came out about a year ago about the importance of looking at postpartum depression in women, and there's an awful lot that can be done in communities to help mothers that we haven't been doing. We've been really downplaying the role of nurturer and the role of mother for decades in our culture.

MR. HASKINS: Okay. Thank you.

FEMALE SPEAKER: I wonder how you see that, excuse me, how you see that coming in policy and whether you see that coming as a policy option.

MR. HASKINS: Thank you.

MR. EVANS: I have two perspectives on that. One is clearly one of the major pathways that we get from chronic low-income poverty to some of these adverse outcomes is via parenting. So it's clearly empirically

supported that parenting is an essential part of this process. And as I alluded to, parents are often part of some of these situations which are chaotic and adverse, and they themselves may need support in order to be a better parent.

So, for example, one of the things that we've done with this same dataset that I was describing of the rural children is we've looked at the reason -- we document, like many studies do, that low-income parents, particularly mother who have been studied the most are less responsive, which means they're less sensitive. There's less of this give and take with the interaction, which as Professor Shonkoff demonstrated is a critical component of healthy development. That poverty is linked to that.

However, when we then look at the questions why and how we found two things that were interesting. Those low-income mothers -- and not all low-income mothers are less responsive, just on average -- one of the things that explains the variability in the responsiveness of mothers in low-income families is how much stress they're under. So moms who are under a lot more stress -- and this is also interesting because I think it helps rebut a myth -- moms who are low-income are also much more likely to be socially isolated, at least in terms of rural poverty. I'm not -- I think it's probably true for urban as well. So this is not a good combination. You have a lot of stress and you're socially isolated. We found that those two things together link to the less responsiveness on average in low-income families. So I think

one of the points that you're raising there is quite valid, that mothers are an essential part of this.

Also, one of the outcomes of maternal depression is less responsiveness, less sensitivity to children. So there, of course, are interactions here that are related to poverty. But some of them are also related as alluded to earlier to genetics so that you may have someone who already may be predisposed to depression who then in this combination of this genetic predisposition, high stress, low social support, that's a toxic miss.

MR. HASKINS: Jack Shonkoff.

MR. SHONKOFF: I had a quick thing and it's something I didn't know until several months ago when we actually looked at this and there's a paper on our website on maternal depression on just this issue.

So we made a lot of progress in treating depression in this country. It's a very high prevalence problem, across social classes, and particularly among low-income families. And we know it has negative effects on kids, including on their brain development. And what we found in looking at the data is with a pitiful small exception of one or two promising looking programs, none of the treatments that we have for material depression in this country that improve maternal symptoms have had any impact on the children because the programs don't address the interaction between the mothers and the kids. They just treat the mothers.

So there's a policy issue for you. We don't reimburse for kind of joint parent-child treatment. The people who do adult mental health don't think about the kids when they treat depression. And so we're all talking about screening for maternal depression. Let's get women help with their depression and with rare exceptions, none of the help we give them affects the kids because it doesn't address their interactions with their children. There's where science is just sitting out there and saying I've got a different way for you to think about that. All we have to do is listen.

MR. HASKINS: Sharon Ring.

MS. RING: Yes. Wonderful session. And I think you pointed out that compartmentalizing the child -- health and education or social emotional cognitive language -- isn't really how children develop. I would like to hear your perspectives on a theory of the environment because we compartmentalize it. Craig and I did research and two randomized control trials 1990 to 1993 in Romania. And when we were called to Romania, I couldn't live with my conscience if we didn't do parallel work where we were living in Birmingham. And I can tell you children in Birmingham living with biological parents in federally subsidized child care environments, Early Head Start and Head Start, often were treated and neglected as horribly as children in Romanian orphanages.

So an orphanage or an institution isn't just a place; it's a functional experience. How can science help our policymakers get it that we

are paying for some public programs that are probably unacceptably horrible institutions. And some of them are phenomenally wonderful. But how can we raise that elevation not to look for a structural cure -- Is it foster care? Is it Early Head Start? -- but to see holistically the environment.

MR. FOX: It appears the answer is we can't.

MR. SHONKOFF: That's not true. That's not true.

MR. FOX: Sharon, you raised a really important issue and I don't know that we have an answer.

Let me just say that when we first got to Romania we were struck by the institutional support for these institutions. So this is not -- it's not simply -- and at the same time with a professed statement about how much we care for our children. And I think it's the same sort of cultural or social context here. We profess to care about children, but yet we don't understand how that translates into creating the environments for them that are necessary and to nurture their adaptive growth. How that will change in this country as well as elsewhere is a difficult question. I think that trying to impress upon policymakers now about the importance of environment -- reciprocal sensitive care giving, for example, whether it be in the family or extra family, would be -- and I mean, that message has been out there before, but it now can be linked to physical and mental development, as well as brain growth and development. And maybe that ultimately will change the culture. But there is a disconnect between a profession of how much we

care for our kids and how important they are and what we do to them.

MR. HASKINS: Jack.

MR. SHONKOFF: No, go ahead, Gary. I'll go next.

MR. EVANS: I think another part of the challenge of trying to address your question has to do with some fundamental paradigmatic aspects of cost benefit analysis. And what I mean by that is oftentimes it's pretty easy to cost out what something will cost right now. You know. What this will do; how much it will cost. And it's more difficult I think in many cases to try to put a cost on long-term outcomes that might be related to that short-term cost. So I think there's just some fundamental challenges in the way that we do business so to speak. And that we have difficulty -- we already know about the short-term, long-term. But I think another part of that also is we aren't always looking in the right place. You know, we're a little bit like looking for the key where the light is.

Let me give you a concrete example of that. If you were to go around the United States and you were to look at most schools and you were to look at the noise levels of those schools, what you would find is that hardly any, perhaps none at all, of the noise levels are loud enough to do any damage to hearing. End of story because there's no cost of hearing because of the noise exposure.

However, if you also know the chronic exposure to noise at levels lower than the levels that create hearing produce reading deficits.

Lots of evidence of this, including extremely good evidence of this. All of a sudden, because you're looking in a different place, the analysis changes. But if you define the problem as noise hearing you don't see it. But if you define it as, oh, by the way there was this other potential or documented in this case, outcome, you start to change the way that the analysis is done. And then unfortunately, hundreds and hundreds of schools in the United States who are in areas where the noise levels are more than enough to produce reading deficits. And it wouldn't surprise you to learn that that's highly -- many of these schools are highly associated with income status as well.

MR. HASKINS: Jack. Quickly.

MR. SHONKOFF: So I would just answer that and say that, you know, everyone understands now the value of randomized control trials. And everyone understands the value of cost benefit analysis. But what we haven't done is understand the value of scientific concepts that could lead us to some new ideas that need to be tried. And if we just set the bar and say we don't do anything until we have a randomized control trial and cost benefit analysis, we lose the opportunity to come up with some new ideas. And we desperately need new ideas.

You know, we were just talking the other day. In October it will be 10 years from the publication of From Neurons to Neighborhoods. And in 10 years we've learned a lot about the neurons and not as much about the

neighborhoods. And, you know, and I think -- and we're not going to learn enough about the neighborhoods unless we create an environment where we allow some new ideas to be tried and developed. And it's not safe nor is it possible to try new things in an environment that is kind of so demanding of short-term results.

And the last thing I'd say about that is the neurons are easier to figure out than neighborhoods. You know, molecular biology and genomics is a cakewalk compared to understanding how neighborhoods and culture affect outcomes. But the science says that they're interacting. So we have to somehow figure out how to make it environmentally safe to think of some new things and try some new things outside of the molecular biology laboratory.

MR. HASKINS: One more brief question. Right there on the aisle.

SPEAKER: To Dr. Shonkoff's point about looking at new models, I'm just curious to what extent the sort of mainstream child development community is looking at the 2 million children in the military who are facing extraordinary similar stresses, and a lot of the ongoing experimentation is really pretty interesting with how they're trying to have concretize and shore up those families. I mean, these are basically low-income working families, young mothers without support, you know, with a lot of experience of grief and loss.

MR. HASKINS: Not to mention that many of them are coming home with serious injuries, including traumatic brain injury.

MR. SHONKOFF: So what's great about that example is the military has already shown us that they know how to provide the best child care in the country by far. So they've shown it's possible to do it.

I think the benefit of what you're putting on the table is because it's such a compelling issue. But we should make sure everybody understands that it's the same science, whether you're a military family or a poor unemployed family. It's the same principles; it's the same interactions; it's the same dynamics. And this is where -- although I'm a big believer in the need for new ideas, if we learn nothing new, we've got a lot we could be doing of what we know right now a lot better for the kids in the military and everybody else.

MR. HASKINS: Do you have anything to add?

MR. FOX: Yeah, I would just say that your point is very well taken. The child development community is late in responding, but is now doing so. The Society for Research and Child Development has organized task forces to respond to the need, which has been articulated by the military. And -- but it's -- unfortunately, it was reactive as opposed to being proactive.

On the other hand, to echo Jack's point, I think we know the science is the same and we know a lot. And so to be able to provide

information to families who either are -- have military personnel who are overseas or who are returning with various conditions. I think is something that obviously is a challenge that the child development community could meet.

SPEAKER: (inaudible)

MR. FOX: Yeah, absolutely. And it doesn't help that the First Lady has also made it an aspect of her program.

MR. HASKINS: This event is not over. I have two quick announcements. The first is I want to acknowledge the contributions of the Stanford Center for Inequality and Poverty that Gary mentioned, and in particular Dave Gerske.

And secondly, the next event from Center on Children and Families will be April 27th in this very room. We're going to release a new volume of The Future of Children, this one dedicated completely to transition to adulthood. And then what we're going to focus on is school dropout and programs addressed to kids how have school dropout.

So thank you very much for coming. Good day.

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