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Mr. Chairman and Members of the Committee, I am delighted to be here this morning to talk with you about *Investing in Early Education: Paths to Improving Children's Success*. I have had the opportunity to testify for you in the past and it's nice to be back. I also had the opportunity to help plan the Speaker's Summit on America's Children held last May, which addressed many of the issues that are likely to arise here today. I am especially encouraged that both the Summit and your discussion today start with scientific knowledge as your departure point for considering the next policy steps.

I am a developmental psychologist who has studied the effects of early environments on young children for the past 35 years. My central focus has been on early educational settings and their effects on children's well-being and development, including child care, Head Start, and pre-kindergarten programs. Before joining the faculty at Georgetown University in September 2000, I spent seven years at the National Academy of Sciences, the last three of which were devoted to writing the comprehensive report on early development titled, *From Neurons to Neighborhoods: The Science of Early Childhood Development*. I am now involved with the follow-on to this work under the banner of the National Scientific Council on the Developing Child, which is continuously updating the knowledge base and policy recommendations that we synthesized in *Neurons to Neighborhoods*. My remarks today will draw heavily upon the work of the Council, as well as upon my own NICHD-funded research on child care, longstanding work with Head Start, and recent multi-year evaluation of the Tulsa, Oklahoma Pre-K program.

There has been a virtual explosion of research in neurobiology and the behavioral and social sciences that bears directly on this hearing. What we now know about the conditions that start children along promising or worrisome pathways is leaps and bounds ahead of where we were even a decade ago. I will focus my remarks on what is new...what didn't we know or know firmly when I testified in 2001.

They are directed to three points: **(1) Brain Development:** Brains soak up the environments around them like a sponge and what they absorb makes the difference between a sturdy or fragile foundation for subsequent development. What is new is that we now understand, in great detail, how this works and what neurological systems and thus which aspects of development are most profoundly affected. **(2) Trajectories of Achievement:** Income-linked disparities in what children know and can do are clearly evident well before they enter kindergarten and are predictive of later school success and life achievements. The evidence linking a child's location on the early learning curve to his or her trajectory through school and beyond is firmer than ever before, and **(3) Investing in Early Education:** Children's experiences in early education settings display astonishing variation with significant implications for development. What is new is that we now have documented impacts on early brain development and we know more about the active ingredients of these experiences.

Early Brain Development

Brains are built over time, neural circuits are wired in a bottom-up sequence with simple circuits and skills providing the scaffolding for more advanced circuits and skills over time, and the capacity for change decreases with age.

In the first few years of life, our brains are creating 700 new synapses every *second*. Synapses are the life-line of our neural systems, supporting communication from one neuron to the next, just like phone lines used to connect one home to another. They determine which neurons are activated (thus, what our brain knows and can do) and how efficiently our brain processes information. From the moment we are conceived, our brains – guided by the instructions provided by our genes -- greedily recruit information from their surrounding environment in order to know which synapses to keep and which to discard. The synapses that get activated a lot, whether they are those that establish a well-working or compromised visual system or that tell us to speak English rather than Ukrainian or that prime us to be fearful or trusting of others, create the underlying architecture of the developing brain. Those that don't get used, whither away through a process called "pruning".

This is not a random process. Brain circuits that process basic information (like the visual and auditory and motor systems) are wired earlier than those that process more complex information (like reading emotions, or doing algebra, or running a marathon). Once a circuit is up and operating, it participates in the construction of later-developing circuits. The shaping of higher-level circuits thus depends on the successful, strong wiring of the lower-level circuits. A sturdy early foundation leads to a well-functioning, efficient brain; a weak early foundation leads to a fragile, over- or under-reactive neural system.

The developing chemistry of the brain also matters greatly. Notably, during the infancy, toddler, and preschool years, the brain's stress response system gets calibrated, just like you would calibrate the thermostat for your home heating system. In the first five years of life, these systems learn to ramp up rapidly in the face of stress, and to ramp

back down and return to baseline when they have done their job. But, under conditions of what we have come to call *toxic stress*, such as child abuse or neglect, severe maternal depression, parental substance abuse, or family violence, persistent elevations of stress hormones and altered levels of key brain chemical produce an internal physiological state that disrupts the architecture and chemistry of the developing brain. Not only does the stress system get activated at a lower threshold of stress (e.g., a kitten becomes a tiger), but it has a much harder time calming down to baseline levels of functioning.

Over time, associated disruptions of the immune system and metabolic regulatory functions lead to a lifetime of greater susceptibility to physical illnesses and mental health problems. What we see in the short term are children who are highly reactive to stressful events (that would not bother other children), who have trouble reading social cues and interpret social interactions in “suspicious” ways (e.g., an innocent bump in the hallway becomes a taunt), and who have learning and memory difficulties. This is all quite recent work. What is very new and relevant to today’s hearing is that child care experiences, especially during the toddler years, appear to affect this developing system.

Today, we also have a much more nuanced understanding of why early experiences hold a special place in the equation of brain and skills development:

1) When neural circuits are first forming, the molecular and cellular mechanisms that guide neural plasticity are highly active, enabling circuits to undergo substantial changes in architecture, chemistry, and gene expression in response to experience. The information-processing circuits of our young brains are eager to be customized...to react to the lessons – both positive and negative -- that early life experiences have to teach.

2) It is far easier to form a pattern of connections in a neural circuit that does not already have an established configuration. When a circuit first develops, our genes dictate the blueprint of what goes where, but in a relatively imprecise and weak way. It is the brain activity set in motion by experience that sharpens and strengthens these innate patterns of connection. Once these connections stabilize, it is more difficult for subsequent experience to change the initial formation. Early experience trumps later experience.

By the same token, skills beget skills. All capabilities are built on a foundation of capacities that are developed earlier. It follows that:

- Early learning confers value on acquired skills, which lead to self-reinforcing motivation to learn more.
- Early mastery of a range of cognitive, social, and emotional competencies makes learning at later ages more efficient and, therefore, easier and more likely to continue.
- Early intervention, in effect, lowers the cost of later investment.

This is true for the brain and it is true for society. This explains both smart rats and the cost-benefit ratios that are linked to strong early childhood programs. This is why

both neuroscientists and economists (and business leaders) have singled out high-quality early education as their best bet for an early investment of public dollars.

Trajectories of Achievement

One of the most significant insights about educational attainment in recent years is that educational outcomes in adolescence and young adulthood can be traced back to capabilities seen during the preschool years and the experiences in and out of the home that foster their development. For example, reading scores in 10th grade can be predicted with surprising accuracy from knowledge of the alphabet at kindergarten entry. Differences in high school completion can be traced back to preschool achievement test scores. Children thus embark on successful or unsuccessful pathways through school during the preschool years. Moving a child who has embarked on a pathway towards failure onto one that guides him or her toward success becomes increasingly difficult and costly over time.

By the preschool years, however, the gap in what children living in impoverished environments and those who escape these environments know and can do has already emerged. Low- and higher-income children are already moving along different trajectories well before school entry, not because their brains are different or because they have different capabilities, but because their early environments in and out of home do not constitute a level playing field. This is not news. More recently, we not only have more evidence documenting this troubling fact, we have documented specific deficits not only for early literacy development, but also for early numeracy development, and there is longitudinal evidence suggesting that math concepts, such as knowledge of numbers and ordinality, at school entry are the strongest predictors of later achievement...perhaps even stronger than early literacy skills. There are also exciting new efforts to develop curricula that address these specific deficits in early learning.

We know, for example, that children living in poverty hear, on average, 300 fewer words per hour than do children in professional families, and these differences predict 3rd grade vocabulary and reading comprehension scores. Children whose mothers have less than a high school degree test, on average, at the 38th percentile in kindergarten-level letter recognition, while those with college-educated mothers test at the 69th percentile. Differences in vocabulary growth between children in low socio-economic households and high socio-economic households begin to appear as early as 18 months, the age at which the “word-learning explosion” (when children learn, on average, 9 words a day) begins.

Low-income children are also not exposed to the board games and other math-related experiences (e.g., Which is bigger? Which pairs of socks go together?) that foster early understanding of numerical concepts. We see the impact in the fact that low-income 5-6 year olds show the same knowledge of numbers as do middle-income 3-4 year olds.

Exacerbating these trends is the fact that children living in poverty who cannot avail themselves of programs such as Head Start are in some of the nation’s poorest

quality child care settings in which ample and rich language, let alone counting games, are rare to non-existent. Children growing up in working poor and modest income families, who fall between the cracks of eligibility for programs like Head Start and affordability of high-quality child care also experience developmentally stunting early childhood settings.

By age 4 or 5, children all over the world have mastered the fundamental grammatical system of their native language, including verb declensions, gender agreement, embedded clauses, and the like. They can understand other people's points of view, experience emotions that are important to the development of conscience (e.g., shame and guilt), and can sit quietly with a group of children and pay attention for at least brief periods of time. Many preschoolers have also learned amazingly sophisticated numerical and scientific concepts, and love the sense of discovery that comes from acquiring this knowledge. Having entered the crucible of peer groups, on average, by 1 ½ to 2 years of age, they have also acquired a large repertoire of early social skills...or deficits. This fact has led experts in the development of aggressive behavior and delinquency to refer to early childhood experiences as the headwaters of susceptibility to health and mental health problems, aggression, and enduring victimization. There is a great deal at stake here.

Investing in Early Education

The question of whether we can intervene successfully to foster early learning of both cognitive and social skills has been answered in the affirmative and should be put to rest. Evidence from the small, tightly-controlled Abecedarian and Perry Preschool programs has been widely cited. It tells us, importantly, what is possible. But, this evidence begs the question of whether and how more typical early childhood environments affect important developmental outcomes. Can the levers that can reasonably be pulled by public policy make a meaningful difference in the life chances of young children across the nation? Absolutely. This goes to what is feasible and effective.

Significant variations in the quality of more typical early care and education programs have the potential to produce lasting repercussions for both children and society as a whole. Evidence points to beneficial impacts at the highest end of the quality spectrum and to detrimental impacts at the lowest end.

We do, however, have firmer evidence than ever that, for children whose life circumstances lead to greater vulnerability, the nature of their out-of-home experiences is particularly important and the impacts of variation in quality are greater. Combined with children's extensive exposure to child care in the U.S. (starting around 4 months of age on average) and our growing knowledge of environmental influences on early brain development, it is critical to approach child care as a massive, sustained intervention in the lives of young children. From the child's point of view, child care is no less an early intervention program than is the Abecedarian or Perry Preschool program or Head Start program, although most child care settings are not designed or funded with this in mind.

For example, from the NICHD Study of Early Child Care, we have learned that:

- Children in center-based classrooms that were in compliance with American Academy of Pediatrics and American Public Health Association guidelines for ratios, group size, and caregiver training, and whose teachers had a college education performed at age level on a school readiness test, while children from classrooms that did not meet these guidelines performed 14 percentiles below this norm – not an inconsequential gap. This translates into children who know substantially more words, who can correctly identify the letters of the alphabet, can count and can understand instructions on a par with their age group versus children who cannot.
- Not only did higher quality child care –defined by the more proximal indicator of sensitive and stimulating adult-child interaction -- predict higher levels of pre-academic skills and language performance during the infant, toddler, and preschool years, but in third grade, higher quality early childhood care continued to be linked to higher scores on standardized tests of math, memory, and vocabulary skills and, the effects on vocabulary endured through sixth grade.

From other child care research, we have recently documented that:

- Quality of child care affects the developing stress response system. Specifically, during the toddler and young preschool years, when the anterior cortical regions of the young brain are undergoing rapid development, exposure to long days in child care with peers can disrupt normal patterns of cortisol (e.g., a stress hormone) metabolism for some children, notably those with more immature social skills and those who experience peer rejection. Importantly, these effects were reduced for children who received high levels of attention and stimulation from their child care providers and who were in programs with smaller peer groups and child-adult ratios. We do not yet know if these findings have long-term consequences or whether they are a blip on the long path to maturity.

Thus, variation in the quality of typical early child care has important and enduring effects on child development. The military has figured this out and has supported extensive, on-going training and accreditation of all of its child care programs as pivotal to military preparedness and ensuring a next generation of effective soldiers.

Pre-Kindergarten programs represent another form of increasingly typical early childhood education programming. I have been involved in a 5-year long evaluation of the universal, school-based pre-kindergarten program in Tulsa, Oklahoma with several colleagues from the Georgetown Public Policy Institute (Professors William Gormley, Ted Gayer, and Carolyn Hill). Oklahoma has the largest pre-kindergarten program in the country, with the highest penetration rates among 4-year olds (currently hovering around 70%), and Tulsa is the largest school district in Oklahoma. Here are some of our latest findings:

- Students who participated in the Tulsa Public Schools (TPS) pre-K program in 2005-06 experienced an 8-month gain in their letter-word identification scores, an 8-month gain in their spelling scores, and a 5-month gain in their applied problems (pre-math) scores, relative to students who had not attended the program. This is the third time we have found significant gains for pre-K students.
- These substantial positive effects characterize Hispanic, African American, White, and Native American children. Similarly, we are documenting sizeable gains for disadvantaged, near-poor, and middle-class children. We have further discovered bigger effects on Spanish-speaking Hispanic students (and children who have a Mexican-born parent) than on English-speaking Hispanic students (and children who have a U.S.-born parent).
- The Tulsa Head Start program, which contracts with the Tulsa Public Schools and must comply with all of their pre-K standards (including a BA-level, credentialed classroom teacher whose wage matches the TPS wage), is also producing substantial learning gains for four-year-olds, though effects are less dramatic than for TPS students. For Head Start, pre-reading skills are boosted by 5 months, pre-writing skills by 3 months and pre-math skills by 5 months. (Note that our research was not designed to make a direct comparison across these two programs (e.g., children were not randomly assigned to TPS and Head Start classrooms) and it is likely that the populations of children served by these two programs differ in meaningful ways.)
- Our data also speak to the issue of universal versus targeted preschool. Specifically, the presence of middle-class peers has positive effects on the cognitive development of disadvantaged children. Effects are much more noticeable in half-day classrooms, where students are more heterogeneous socio-economically.

Why do we get these powerful effects, which are surprisingly comparable to those found for the Abecedarian and Perry Preschool programs? We have begun to address this question and can point to a few clues:

First, the Tulsa pre-K program's classroom quality is superior to other school-based pre-kindergarten programs on multiple measures and the Tulsa Head Start program's classroom quality is superior to other Head Start programs on multiple measures. It is probably not coincidental that every pre-K program – whether TPS or Head Start -- must employ a BA-level teacher with an early childhood credential, sustain a classroom size of no more than 20 students, and employ an assistant teacher to establish a 1:10 teacher:student ratio. It is a mixed delivery system (although the vast share of pre-K classrooms are in the public schools), but *not* with mixed quality standards. Every child is guaranteed a floor of quality below which his or her classroom will not fall, and it is a relatively high floor.

Second, Tulsa pre-K teachers (in TPS and Head Start classrooms) are paid at the same level, with the same benefits, as elementary school teachers in Tulsa, so there is no incentive for the best teachers to migrate to elementary classrooms if they don't want to. As in elementary education, wages and working conditions affect our ability to attract and retain the very best teachers. I strongly suggest that these incentives be a centerpiece of your policy discussions.

Third, as we've begun to look at what predicts higher quality interactions and more time on instruction in the pre-K classrooms, cutting across TPS and Head Start programs, the important elements that are emerging are: (a) the teacher's classroom experience, (b) the teacher's Grade Point Average in college, (c) and reliance on a relatively structured, clearly paced curriculum (perhaps especially for children who have not been exposed to early learning opportunities at home). As a next step, we will be examining which elements of classroom experience and teacher qualifications predict the students' test scores.

Conclusions and Implications

What can we conclude from this work on typical early childhood programs about the wisest investments in early education? Neuroscience and economic evidence point to investments in high-quality early childhood programs as a promising avenue for fostering healthy development, a strong start in school, and, ultimately a productive citizenry. Developmental and education science point to specific avenues for ensuring that these investments fulfill their promise.

First, what happens inside the classroom door, whether it is called child care or Head Start or pre-K, is where the action is. Mixed delivery systems are fine, they are the norm, and they offer working parents the range of options they need. The challenge is one of **ensuring equity of access to developmentally-supportive educational and social experiences for all children** across these systems. This is an especially compelling message having just celebrated Martin Luther King's birthday. Today, poor children, who are disproportionately children of color, are not treated equitably in our early childhood system. This involves looking across child care, early education, and Head Start legislation to begin the task of ensuring that each strand of funding supports the healthy development and early education of young children – not in a cookie-cutter way, but to the same extent. In this context, the disparity between the 4% set-aside for quality improvements in the Child Care and Development Block Grant and the 40% set-aside in Head Start is impossible to justify. Young children and notably young children's brains are blind to these distinctions. They have the same needs whether they walk through a door labeled Head Start, Pre-Kindergarten, or Sally's Super child care center or Hannah's Happy child care home.

Second, classrooms that work depend on well-designed curricula based on the latest knowledge about how children learn and develop, and on a qualified and stable workforce of early childhood teachers who know how to bring these curricula to life to foster early learning and development. Programs that show promising

evidence of success with low-income preschoolers, in particular, blend age-appropriate content tied to what children are ready to learn with forms of instruction that transmit this content in ways that excite and motivate young children. A curriculum is only worth the paper it is printed on unless it penetrates the classroom and affects the quality of teaching that children receive every day. National concern has galvanized around teacher shortages, large class sizes, and poor teaching quality at the elementary level. Comparable concerns need to be directed at the preschool level.

Third, teaching quality depends on the teacher and his or her working conditions. This is precisely why we require elementary school teachers to have Bachelor's degrees, specialized training, and a teaching credential. Yet, the vast majority of preschool children are in programs and settings with adults who have little more than a high school education and a fingerprint that clears them of a criminal record. You have addressed this in the Head Start program and I applaud your efforts. While there is no magic in a B.A. or a credential, they do increase the odds that children in Head Start will be exposed to the kinds of early learning environments that will get them ready for both the cognitive and behavioral demands of school. But, there is large variation among teachers with all of these qualification and so the next step is to ensure that the best teachers who want to teach young children are drawn into and retained in early child classrooms. As Oklahoma discovered, this involves minimizing the separation between preschool and elementary education policies, perhaps especially with regard to wages, benefits, and working conditions. I hope you will keep this in mind as you embark on re-authorizing No Child Left Behind. You have a rare opportunity, in this legislation, to support state efforts and research aimed at building effective early childhood programs and to ensure that these mostly-fledgling programs, like the brain, are built on a sturdy -- rather than a fragile -- foundation of effective and committed teachers, age-appropriate instruction that instills knowledge and excitement in young children, and equity of access to these opportunities.

Thank you very much for this opportunity to testify. I'd be happy to answer any questions today and in the crucial months that lie ahead.