Reimagining School Readiness

A position paper with key findings

Bay Area Discovery Museum

Introduction

Based on a comprehensive review of cognitive and developmental psychology literature (available at BayAreaDiscoveryMuseum.org/Research), this position paper aims to surface the skills and conditions that matter most for a child's success in school and life, and to guide educators and others (including families) in designing learning experiences and environments to support this development.

With recent advances in neuroscience, we now understand that a child's early experiences are critical for long-term learning and growth. In particular, during the first five years of life, interactions and environment shape a child's brain, as neurons weave together in pathways that direct our perception and processing. While brains maintain "plasticity" over the lifespan, early childhood experiences fundamentally shape our cognitive capacities. Thankfully, we are reaching a tipping point in the public's understanding of the importance of these early years. Pediatricians promote awareness of key developmental milestones with parent questionnaires at every well-child visit; public campaigns encourage parents to speak and read to their children from the earliest months; and politicians increasingly cite high-quality preschool programs, particularly for our community's most vulnerable children, as core solutions to educational inequity and poverty.

Our growing sense of urgency to prepare all children for school is, by and large, positive. After all, research tells us that children who start behind stay behind, and early gaps in understandings, especially those in literacy and math, tend to be sustained or widened over time (McLoyd & Purtell, 2008). With every passing year, remediation is more cognitively complex and demanding for the child and, as a result, more time-intensive and expensive for the education system.

At the same time, urgency can lead to misdirected efforts. Across the U.S., formal elementary education has become narrowly focused on literacy and mathematics. Pressure to address achievement gaps in these areas has led many preschools and early elementary grades to increase didactic, academic instruction and remove the child-directed exploration, hands-on learning, and imaginative play that are longitudinally correlated to higher order thinking.

Schools that serve large numbers of children from low-income communities and communities of color feel particular pressure to meet test score proficiency levels, and as a result have little time or flexibility to incorporate instruction that is open-ended, project-based, or not overtly linked to reading or mathematics proficiency. The intention may be to narrow the achievement gap, yet all too often the outcome is a narrowing of rich experience for young children. In the best circumstances, this may lead to an increase in test scores, but there is little evidence that it prepares children for longer-term success, and in fact, it might undermine the development of critical 21st century skills like creativity, collaboration, and complex problem-solving.

In more affluent communities, families may have the resources and knowledge to complement their children's in-school academic learning with out-of-school time programs and family activities that provide STEM (science, technology, engineering, and math) or arts education; with exposure to cultural organizations and nature; and with learning-rich toys and media. For children from lower-income communities, for whom developmentally appropriate out-of-school time learning is especially critical, these programs and activities are far less accessible.

Positive early learning experiences carry a predictive power that extends far beyond the first foray into elementary school, wiring children's brains for the deep conceptual thinking and sustained interest, curiosity, and persistence they will need throughout their lives.

Elizabeth Rood, Ed.D. – *Author*

Helen Hadani, PhD – *Co-author and Lead Researcher*

Babe Liberman – *Contributor*

Amber Whiteside – *Editor*

References can be found in *Reimagining School Readiness: A Literature Review*, available at BayAreaDiscoveryMuseum.org/Research

Key Findings

Overview

A recent review of the literature, including over 150 studies, indicates that we are missing the mark in preparing our children for learning and achievement by equating "school readiness" with a finite checklist of academic skills to be mastered by age five. Instead we should think about school readiness as a robust developmental process that spans the early childhood years through age eight.

By age eight, children need to have developed complex thinking skills, as best evidenced by their grasp of conceptual mathematics; they should be effective at self-regulation and control and should be able to independently make and carry out plans; and they should know how to get along with peers and adults.

All children are capable of developing these skills if the adults in their lives provide developmentally-appropriate and rich experiences to boost learning and cognitive development. The six key findings in this paper provide a research-backed roadmap.

#1 Quality adult-child interactions shape children's thinking skills. The conversations we have, the questions we ask, and the experiences we provide matter. Simple shifts in our approach and language boost children's learning and cognitive development.

While children are wired to learn, and while much learning appears to happen automatically, researchers now understand that the degree to which children learn and grow from their experiences depends significantly on how the adults interact with them. For babies and toddlers, communication with caregiving adults lies at the center of experience and has profound impact not only on language development but also on cognitive processing. As children grow older, interaction often takes the form of play and exploration with adults. Research shows that the most effective interactions strike a balance between child and adult directed learning.

In a seminal study on early learning, researchers demonstrated that affluent, college educated families talk more to their babies and preschoolers than families who are living in poverty (Hart & Risley, 1995). This widely-cited study has prompted campaigns and programs to address this "word gap" by teaching families the importance of talking to their children and by coaching them to talk more, often by having babies wear monitors that track the numbers of words spoken to them in a typical day.

Since then, developmental and cognitive scientists and linguists have dug deeper into the word gap phenomenon and surfaced two important findings. One, when very young children experience more language exchanges with caregiving adults, their brains learn to process language more efficiently. Rather than using their cognitive processing skills to simply make sense of the words they are hearing, their brains have greater capacity to process the ideas and thinking that the language represents. In essence, by talking frequently with our babies and toddlers, we are helping to wire their brains to have capacity for complex thinking. Additionally, researchers have discovered the importance of the *quality* of the child-directed speech children hear, as opposed to sheer quantity.

One study explored the effects of speech style and social context on the language development of 11- and 14-month-old infants. Rather than the total *number* of words the child heard, the authors found that the proportion of time children spent being addressed one-on-one in "parentese," the exaggerated speech adults often use with infants, was positively related to their word production both at the time of the recording, and around a year later when they were 2 years old (Ramírez-Esparza, Sierra, & Kuhl, 2014). While the overall *quantity* of speech the child hears is important for language development, rich, interactive discourse supports the child's understanding of shared communicative contexts.

Another key area of adult-child interaction that research shows can benefit children in dramatic and long-lasting ways is play. During early childhood, children learn best through play and a growing body of research suggests that guided play, in particular, with its balance of structure and freedom is a successful tool for a range of educational outcomes and often more effective than free play or direct instruction. Weisberg and colleagues (2015) describe guided play as a combination of adult initiation and child direction (as contrasted with free play, which is both child-initiated and child-directed, and direct instruction, which is both adult-initiated and adult-directed). In guided play "[children] are in control of what happens next and in what they wish to explore and how...they truly decide what to do next and how to respond" (Weisberg et al., 2015, p. 9).

For example, Fisher, Hirsh-Pasek, Newcombe, and Golinkoff (2013) found significantly better learning outcomes for children who were introduced to properties of shapes through guided play compared to those who learned about shapes through direct instruction. The researchers introduced 4- and 5-year-olds to four shape categories (triangles, rectangles, pentagons, and hexagons) by presenting them with two typical and two atypical examples of each shape. In the guided play condition, the experimenter introduced the properties for each shape in a playful and exploratory manner ("Did you know that all shapes have secrets? Today I need your help in discovering the secret of shapes."). The experimenter then presented the child with the shapes and encouraged them to touch and trace. In the didactic instruction, the experimenter acted as the explorer while the child passively listened and watched. Lastly, in the free play example, children were allowed to play with the shapes in any way that they wished. After participating in one of the three training conditions, children were given a shape sorting task. Fisher et al. found that children in both the guided play and direct instruction conditions learned the properties of the shapes; however, the children who were taught shape properties through guided play were better at accepting less typical instances of shapes. In contrast, children in the direct instruction condition tended to display relatively concrete knowledge of shapes and often rejected atypical exemplars. It is important to note that preschoolers do not typically define shapes based on rules (e.g., a triangle has three sides and three angles), but rather based on shape recognition. These findings suggest that, through guided play, young children can learn to identify shapes in a rule-based manner, earlier than they would learn this strategy in school, and with a deeper understanding.

#2 Science learning is critical for the development of higher-order thinking but is missing from most early school experiences.

Children develop higher-order cognition by practicing different kinds of thinking. Learning to observe, alter, and explain phenomena; learning to ask good questions and to imagine different possible solutions; learning how to connect or evaluate information are examples of different kinds of thinking processes. Exploratory, hands-on science learning—particularly with thoughtful adult scaffolding and modeling—are critical to turning children's innate desire to understand the world around them into experiences that wire the brain for complex, conceptual thinking.

Children are naturally curious. They are born eager to discover, explore, and figure out how the world works. Developmental scientists, educators, and policy makers all agree that maintaining and developing children's innate curiosity and desire to learn is a critical component of school readiness.

When we think of "science education," however, we tend to think about learning particular information or content. We might teach that *metamorphosis* is a change of an animal's form, or we might explain to children that gravity makes things fall to the ground. The best science education asks children to *do* science—to closely observe the world around them and create hypotheses, to design and conduct experiments, to build and to make models or tools.

Particularly in the early years, science education should ask children to use various thinking skills to actively explore and make sense of both the natural and human-made world. Research shows that children have an innate sense of scientific inquiry; our interactions with them and the experiences we design for them can help ensure that their exploration feeds their innate curiosity and that, as they grow from preschoolers to early elementary students, they build increasingly complex reasoning skills to assess and question their own understanding.

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Many researchers understand curiosity to be motivated by gaps in information that leads to exploration in order to satisfy curiosity or narrow that gap. Recent empirical studies with preschool and early grade school children provide support for the "information-gap theory" of curiosity. In a clever experiment that examined 6- and 7-year-olds' pre-existing "theories" about balance, Bonawitz, van Schijndel, Friel, & Schulz (2012) found that children tended to play longer when they witnessed a surprising event that violated their theory. The researchers first categorized children based on their pre-existing beliefs about what determines if blocks will balance on a scale. That is, some children believe that blocks will balance in their geometric centers ("Center Theorists") while others (correctly) believe that blocks will balance at their center of mass ("Mass Theorists"). Children were then presented with scenarios in which their theory was violated or supported by using magnets—one in the block and one on the scale—to secure the blocks to the scale (unbeknownst to the children). After observing a surprising or unsurprising balancing block, children were given the opportunity to play with the scale and blocks. Bonawitz and her colleagues found that children tended to play longer with blocks that violated their initial theory. That is, children's curiosity—a gap in their current knowledge—paved the way for learning and compelled them to explore an aspect of their environment that challenged their current theory.

Moreover, recent research with infants less than a year old shows that babies selectively explore objects that violate their expectations (e.g., a visual illusion of a car passing through a solid wall) and test relevant hypotheses for that object's behavior (Stahl & Feigenson, 2015). Together, these findings provide convincing evidence that starting in infancy, children explore more when they encounter conflicting evidence: theory-violating evidence can evoke children's curiosity, motivate them to explore, and engage in hypothesis-testing behaviors that help them learn about the world around them.

Adults can help children engage in inquiry by modeling different kinds of effective questions. Children often seek information from others by asking questions and developmental researchers have started to reveal some interesting patterns in children's ability to determine who to ask, what to ask, and how much information to ask for. In a series of two studies, Mills, Legare, Grant, and Landrum (2011) examined these three components of information seeking in preschoolers by playing a game with pairs of informants (puppets) with contrasting levels of knowledge. Across the two studies, Mills et al. found that the ability to recognize that some informants are more knowledgeable is essential to guide inquiry-based problem solving, and the ability to direct enough effective questions to the appropriate informant related most strongly to problem solving success. Another notable finding relates to ways to encourage younger preschoolers to ask more effective questions. The researchers found that the majority of 4-year-olds asked ineffective questions, unless they participated in a warm-up exercise in which the experimenter modeled effective questions. Thus, modeling different kinds of effective questions can help children learn how to ask effective questions themselves and engage in inquiry-based problem solving.

Research also shows a significant correlation between explanation and exploration in the development of children's scientific reasoning. (Legare, 2014) One series of studies looked at how explanation influences learning in preschoolers by observing how children interact with a novel mechanical toy and examining their patterns of learning about the toy's functional

and nonfunctional properties (Legare & Lombrozo, 2014). In the first study, the researchers gave children a novel gear toy with a crank and five interlocking gears that made a fan turn. Children were trained on the pieces of the toy to familiarize them with the different parts and how they fit together and then observed an experimenter turn the crank to demonstrate that it made the fan turn. Some of the children were told, “Let’s look at this!” (*observation* condition) and then had 40 seconds to observe the machine. Other children were asked, “Can you tell me how this works?” and were given 40 seconds to give a verbal response (*explanation* condition). One of the gears was then secretly removed and the toy was presented to the participants again—this time with the experimenter indicating that this was the same machine as before but that one of the parts was missing. Children then participated in a *causal choice* task to assess the extent to which children understood the machine’s functional-mechanical relations. Children were presented with five parts (none of which were identical to the missing part) and asked, “Can you point to which one of these parts you think will make it work?” This task was intended to measure an aspect of functional-mechanical understanding (i.e., the causal contributions of the gears in how the machine works). Finally, the machine was disassembled except for the crank and fan, and children were given 10 minutes to reassemble the machine. As predicted, Legare and Lombrozo found that children who were in the *explanation* condition (prompted to explain) performed significantly better on measures of causal learning.

In a second study, learning was assessed as a function of the type of verbal response by asking children to either describe (“Describe the machine to me. Can you tell me anything else?”) or explain (“Explain the machine to me. Can you tell me anything else?”) the machine. Similar to Study 1, children who explained outperformed children who did not explain on measures of causal understanding. Study 2 also included a generalization task in which children were asked to put together a novel device given 18 new parts. The researchers found that children who were asked to explain the machine performed significantly better on this generalization task than non-explainers. The findings from both studies suggest that explanation has unique benefits in support of causal learning.

Legare and Lombrozo’s findings also show that adults’ intentionally worded explanation prompts significantly improve the quality of self-explanation in young children. That is, almost 80 percent of children produced an explanatory response when directed to explain, “how the machine worked” compared to approximately 40 percent when asked to “explain the machine.”

When children have a strongly internalized understanding of numbers before beginning kindergarten, they are far more likely to demonstrate long-term proficiency not only in mathematics but also in literacy over their academic lives.

#3 Demonstrating strong math skills at an early age is a strong indicator of developing conceptual thinking skills and predicts long-term success in school, not just in later math learning but also in later reading proficiency.

Longitudinal research demonstrates that foundational mathematical understanding—more than any other content area—predicts long-term success on school achievement measures. When children have a strongly internalized understanding of numbers before beginning kindergarten, they are far more likely to demonstrate long-term proficiency not only in mathematics but also in literacy over their academic lives. (Interestingly, the inverse is not true: children's foundational literacy predicts long-term proficiency with reading but is not correlated to long-term achievement in mathematics.)

So what constitutes foundational mathematical understanding? Research points to two specific skills, known as ordinality and subitization. Children who have foundational understanding of "ordinality" grasp that the words for numbers represent quantity and that quantity is fixed (e.g. four is always more than three). These children do not simply recite numbers in order; they understand quantity at a conceptual level and can use word representations of numbers to describe and compare. Children who are adept at "subitization" are able to see small quantities and know what the number is without counting. That is, when a four year old conceptually grasps that the word "five" represents a quantity that is more than four and less than six; when she understands that you may have four apples or four pencils and these represent the same quantity; and when she can quickly see a grouping of three children or roll a die and know, without counting, that she gets to move forward three in the game, then this child has a strong foundational mathematical understanding. She is more likely to thrive academically, read fluently by third grade, and master key algebraic concepts before high school, putting her on the predictive pathway to college.

In a widely-cited and seminal study, Duncan et al. (2007) presented a new methodology for identifying school readiness factors by utilizing six international longitudinal data sets to determine the skills measured around school entry that predict later reading and mathematics achievement. The school readiness factors in the analyses included measures of early math, attention, internalizing and externalizing behavior (e.g., negative responses to stress that are focused inward, such as feeling sadness, or outward, such as physical aggression), and social skills.

Duncan et al.'s research was unprecedented for several reasons. First, the researchers used data from six large-scale longitudinal studies: two that are nationally-representative of U.S. children, two drawn from multi-site studies of U.S. children, one from Great Britain, and one from Canada. The researchers also examined academic achievement outcomes using a range of measures, including math and reading achievement assessed by teacher rating, test scores, and grade retention. Lastly, Duncan et al. tested a number of hypotheses related to how school-entry academic, social-emotional skills, and attention are associated with later achievement. Both early math and reading skills rose to the top of the most powerful predictors of later learning. But where math measures predicted *both* later math and reading scores, early reading measures predicted only later reading scores. Furthermore, early math scores predicted later reading as strongly as early reading scores.

Given the significant long-term impact of early math development, it is all the more concerning that the mathematical knowledge of children entering school from low-income households trails far behind their peers from more affluent households. Research tells us that these early deficits have large and long-term consequences—those who start behind generally stay behind. Longitudinal studies have shown that children's mathematical knowledge in kindergarten predicts their math achievement scores in elementary school, middle school, and high school (Duncan et al., 2007; Stevenson & Newman, 1986).

Thankfully, something as simple as a board game can have a big impact, and, again, the adult-child interaction plays a significant role. In a series of studies focusing on preschoolers from low-income communities, Siegler, Ramani, and colleagues (Siegler & Ramani, 2008; Ramani & Siegler, 2008; Ramani & Siegler, 2011; Ramani, Siegler, & Hitti, 2012) have found strong and convincing evidence that playing a number-based board game—such as Chutes and Ladders—can improve children's numerical knowledge and skills. In the initial study, Siegler & Ramani (2008) randomly assigned Head Start preschoolers to play either a number board game or color board game. The games were identical and included ten horizontally arranged squares of equal size, except that the number game had

squares numbered from one to 10 and the color game had squares of different colors. After approximately an hour of game playing time (broken up over two weeks), children who played the number game showed significant improvements on a number line estimation task, which asks children to mark the location of a number on a line, whereas children who played the color version of the game did not show comparable improvements in numerical magnitude.

Research finds success in mathematics to be deeply correlated to mindset, and, unfortunately, too many children (and adults) lack confidence in their math abilities, and math anxiety begins at an early age. In *Mathematical Mindsets*, Jo Boaler shares neuroscience research showing that with the right mindset and learning opportunities, anyone and everyone can be good at math. Research points to two strategies for building a strong foundation for math skills in early childhood: (1) providing a "spatial education" for preschoolers; and (2) encouraging children to count on their fingers.

Research on the relation between *spatial skills*, or the ability to mentally manipulate shapes and objects in the environment, and math skills emphasizes the importance of spatial thinking for school readiness and success in STEM fields—science, technology, engineering, and math (Verdine, Golinkoff, Hirsh-Pasek, & Newcombe, 2014). A number of training studies with kindergarteners and first graders indicate that tasks such as block building can improve children's spatial skills. In these studies, children are given the opportunity to build with blocks or other construction toys (e.g., Wikki Stix) and asked to copy model designs. Researchers have found that these spatial assembly tasks improved children's spatial and math skills (Casey et al., 2008; Grissmer, et al., 2013). In line with this, work in neuroscience has shown that similar areas of the brain are active when individuals engage in spatial and math processing (Göbel, Walsh, & Rushworth, 2001).

A related area of research highlights the critical role of gesture, or using the body, in helping children grasp the meaning of spatial terms (Goldin-Meadow & Wagner, 2005). For example, we frequently spread our arms out wide when describing something as "big." Gesture also plays an important role in children's early number and math skills. Children often learn to count on their fingers and point to objects when counting a set. Many children, however, abandon using their fingers to count in early grade school, or before, because finger use is portrayed in a negative light. In a recent article in *The Atlantic*, Jo Boaler and Lang Chen (2016) present evidence from psychology and neuroscience that suggests teachers and parents should be encouraging children to use their fingers to count. For example, first graders with better finger representation tended to score higher on number comparison and estimation tasks in the second grade. Children's finger representation, or *finger gnosia*, is assessed by having one of their fingers touched by another person (while their fingers are under a table or covered) and asking them which finger was touched. The good news is that finger representation can be improved with training and this often leads to increases in math achievement (Gracia-Bafalluy & Noël, 2008). Surprisingly, researchers found that first graders' finger representation was a better predictor of future math achievement than their scores on measures of cognitive processing. This interesting link could explain why musicians, pianists in particular, often have strong math skills compared to people who do not play a musical instrument.

#4 Planning, self-awareness, and self-control—what psychologists refer to as "executive functions"—predict positive school and life outcomes. Studies show that children develop executive functions through experience.

Over the last decade, psychologists have increasingly focused research on what are known as the executive functions, a suite of higher order cognitive processes responsible for directing the brain's power and attention. Executive functions include working memory, inhibitory control, and attentional (or cognitive) flexibility (Hughes & Ensor, 2009). Some researchers liken executive functions to a flight controller on a busy airfield; others describe them as the conductor of the symphony. Like an executive of a company, these functions oversee work flow, help us plan and prioritize, and balance short and long-term objectives. Regardless of the metaphor of choice, the implication remains the same: strongly developed executive functions provide a discipline and structure to our thinking that allows us to be our best.

Children use components of executive functions when they make decisions and interact with peers in everyday settings. For example, they use planning to generate ideas for what to play, working memory to remember rules of games, and inhibitory control to follow the rules of games (e.g., *not* touching your toes unless you hear "Simon says"). Children need an efficient working memory to process all of the information that they encounter in school and beyond. Working memory allows us to hold and mentally manipulate information in our mind and make connections between seemingly unrelated things. For example, computing any math facts in your mind requires working memory, as does making sense of written or spoken language. Inhibition or self-control allows us to make decisions—hopefully smart ones—by resisting the temptation to repeat incorrect responses and the impulse to do something that we would later regret. Young children (and adults) often act impulsively to satisfy their immediate needs, and developing self-control allows them to concentrate and persist in learning environments and have successful relationships with peers. The third core executive function skill, cognitive or attentional flexibility, is closely linked to creativity and problem solving and allows us to consider different perspectives and strategies—often called "thinking outside the box." Children often find themselves in noisy and complex learning environments (e.g., a typical preschool classroom) and shifting their attention to the most relevant and important stimuli is critical for successful learning.

Executive function development is correlated to the development of the prefrontal cortex, the area of the brain that matures most slowly (not reaching full development until one's twenties). This helps to explain why children are more inclined to act on impulse than adults and have more difficulty directing focus and attention. At the same time research is clear that children's early executive function development is highly correlated not only to success in school but also to success with a whole range of life outcomes. Longitudinal studies illustrate that early developing executive function skills are fundamental to school readiness not only in that they promote children's ability to appropriately regulate their emotions and behavior in a new or highly structured environment, as school often is, but are in fact correlated with the cognitive capacities that underlie academic skills including early math skills and emergent literacy. In a longitudinal study with 164 Head Start children starting at the beginning of their pre-kindergarten year and extending into the end of the kindergarten year, researchers found that initial levels of executive function skills predicted growth in emergent literacy and numeracy skills between the beginning and end of the pre-kindergarten year (Welsh et al., 2010). Furthermore, growth in executive function made unique contributions to both math and reading achievement in kindergarten. Executive function skills are also critical to creativity and problem-solving.

The good news is that executive function skills can be improved through a diverse range of activities and programs. We can build children's executive function skills by giving them opportunities to make decisions and plans themselves, rather than having their experiences directed by the adults around them. Additionally, we can build in opportunities for "metacognition," or awareness of one's thoughts and actions. Activities that ask children to be intentional about what they will do and then to reflect on the outcomes are particularly beneficial. Additionally and importantly, children develop their capacity for autonomous decision-making and self-control through child-directed play. Educators should create space and time for this open-ended play to ensure children's brains are being wired for self-direction and self-regulation.

Another promising intervention is a combination of exercise, character development, and mindfulness found in activities such as traditional martial arts and yoga. Interestingly, Lakes and Hoyt (2004) examined the possible benefits of traditional tae kwon do on executive function skills in school-age children. The researchers assigned 5- to 11-year-olds to participate in either traditional tae kwon do or standard physical education in their school classrooms and found that the students in the tae kwon do group improved more in working memory and inhibitory control than those in the physical education group.

Two forms of school curricula—Tools of the Mind (Diamond, Barnett, Thomas, & Munro, 2007) and Montessori (Lillard & Else-Quest, 2006)—both designed to be used with children ages 3 to 6 years, have also been found to improve children's executive functions. The two programs share a number of features that appear to play an important role in promoting various executive function skills: (1) children are consistently pushed to exercise their executive function skills at higher levels; (2) strategies are implemented to reduce stress in the classroom and avoid embarrassing children; (3) the classroom environment fosters joy, pride, and self-confidence in children; (4) children are given the opportunity to teach each other; and (5) lessons are designed to accommodate children progressing at different rates (Diamond, 2014; Diamond & Lee, 2011). The Tools of the Mind curriculum includes 40 executive function-promoting activities, including telling oneself out loud what one should do ("self-regulatory private speech"), dramatic play, and memory and attention aids (e.g., a picture of an ear to remind a child to listen). Play plans are another activity used in Tools of the Mind classrooms to promote self-regulation. Children create their play plan by writing and drawing the activities they envision for that day and those plans are often modified throughout the day. These plans help children to think and act purposefully and also provide a meaningful way to promote early literacy skills through drawing and writing.

#5 Children with stronger social skills do better in school, in the workplace, and in life. Child-directed play and modeling of helping behaviors are key to the development of social skills and need be prioritized in early education.

Increasingly, research indicates that social skill development should be an intentional outcome of all educational experiences for children from preschool through elementary school. Getting along with others, being helpful and cooperative, and demonstrating empathy certainly make for better community. Additionally, a child's early skills with building positive relationships with peers and with adults are correlated with positive life outcomes overall. Fortunately, like many other skills, social-emotional skills are malleable; adult support and intervention support children to develop these essential skills.

A recent 20-year retrospective study by Jones, Greenberg, and Crowley (2015) provides further support for the argument that early social-emotional skills are a critical component of future wellness and success. The researchers examined whether teacher-rated positive social skills in kindergarten predict key adolescent and early adult outcomes across a wide range of domains including education, employment, criminal activity, substance use, and mental health. Overall, Jones, Greenberg, and Crowley found statistically significant associations between early childhood social competence and outcomes measured up to two decades later across all five domains.

In the early 1990s, kindergarten teachers participating in the Fast Track Project, an intervention program that targeted children identified as high risk for behavioral problems, rated their students' social competence skills in a classroom setting using an eight-point scale. The teachers rated children on capabilities such as "listens to others," "shares materials," "cooperates with peers without prompting," and "resolves problems on his/her own." Jones, Greenberg, and Damon then followed the participants over the next 19 years and recorded both positive milestones (e.g., graduated from high school on time, completed a college degree, obtained stable employment in young adulthood) and negative milestones (e.g., developed a criminal record or substance abuse problem) for the study participants until they turned 25 using a wide range of data sources, including reports from parents, self-reporting, and official records.

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Using statistical models to control for background characteristics including family circumstances, gender, and academic ability, the researchers found statistically significant associations between teacher-assessed social-emotional skills and outcomes in all five domains investigated: education, employment, criminal activity, substance use, and mental health. More specifically, in the domain of education, kindergarten social competence was significantly predictive of whether participants graduated from high school on time and completed a college degree. With respect to employment in young adulthood, obtaining stable employment and being employed full time as a young adult were both significantly linked to early social competence. For the domain of criminal activity, a number of inverse associations were revealed in the data: children with lower social competence scores had a higher chance of being arrested by young adulthood, spending time in a detention facility, and having any involvement with police before adulthood. Results were mixed for both substance abuse and mental health, although the researchers found that lower social competence scores were associated with higher rates of marijuana usage and number of years on medication for emotional and behavioral issues through high school.

Taken together, these research findings provide strong evidence that young children with more developed social-emotional skills are more likely to achieve success in young adulthood across a wide range of domains. Like executive function skills, social-emotional skills can be developed through experience and need be seen as core and foundational for children to thrive in school and beyond. Through self-directed play, children learn key social skills and develop awareness of their own emotions and how best to regulate these. As a community, as we have become increasingly concerned with academic outcomes, many schools have eliminated or dramatically decreased time for children to play. Educators need to embrace and help families understand what developmental psychology research makes clear: play is not frivolous, lost time; play provides children an unparalleled opportunity for building the social-emotional skills that predict long-term academic and life success.

Additionally, a recent series of studies provide convincing evidence that helping behavior is strongly influenced by social interactions, and simple reciprocal activities can elicit altruistic behaviors in young children (Barragan and Dweck, 2014). In one of the studies, one- and two-year-olds either played reciprocally with an experimenter (e.g., rolled a ball back and forth) or engaged in parallel play (e.g., the experimenter and child each rolled a ball on their own while next to each other). After a few minutes, the experimenter "accidentally" knocked an object to the ground and clearly needed and desired help from the child to retrieve the object. As predicted, toddlers who engaged in reciprocal play with the experimenter were three times more likely to help pick up the objects as children who engaged in parallel play. In another study with preschoolers, children who engaged in reciprocal play were significantly more generous (i.e., more likely to share stickers with the experimenter) than children who engaged in parallel play. In the discussion of their findings, Barragan and Dweck (2014) proposed that in reciprocal play, children may have learned that people interact with each other by being responsive to each other's needs and this prompts them to follow the "cultural norm" to help. This interpretation provides an important message to teachers, parents, and others who regularly interact with children that actions can speak louder than words—simple reciprocal interactions can implicitly communicate to children that this is a context in which people help each other.

An emerging body of research has investigated synchronous interactions as a mechanism for influencing social attitudes and helping behaviors in children. Kirschner & Tomasello (2010) examined the influence of joint music making on prosocial behavior in pairs of 4-year-olds. The researchers designed a fun and age-appropriate task in which children heard a story about a garden pond and colored frogs sitting in groups on lily pads. Some of the children played the "game" by interacting with one another (and an adult) in a musical context by dancing, singing, and playing percussion instruments, while other children interacted with one another and the adult in a similar joint activity but with no dancing, singing, or playing instruments. Immediately after playing the game, children participated with their partner in two social interactions that were designed to test their

willingness to help their partner and cooperate in a problem-solving task. As predicted, children helped one another more and chose the cooperative solution to the problem-solving task more often after joint music making compared to the non-musical interaction.

Research also shows that adult scaffolding promotes sharing and helping behaviors in young children. Toddlers and preschoolers are often eager to "help" their parents with tasks and chores around the house. Although these genuine efforts to help are not always helpful to adults, recent research suggests that this parent-child interaction may contribute to the development of early helping. Hammond and Carpendale (2015) examined young children's tendency to help an experimenter when they encountered a problem (e.g., dropping an object) in relation to parents' scaffolding of their children's helping behaviors during an everyday chore. In the clean-up task, mothers' scaffolding of their child's involvement in cleaning up (i.e., how much they involved their child and the age appropriateness of their comments and efforts) was used as a measure of chore scaffolding. Alternating with the parent-child tasks, children participated in five helping tasks including the laundry task in which the experimenter "accidentally" drops a clothespin while hanging dishcloths on a clothesline and the blanket task in which the experimenter pretends to shiver from being cold. Hammond and Carpendale found that children whose mothers scaffolded their helping behavior more in the clean up task helped the experimenter with more tasks and had quicker responses to help.

In addition to providing opportunities to help, research suggests that eliciting talk about emotions and mental states in everyday contexts can develop young children's empathetic helping tendencies. Drummond et al. (2014) conducted a study which measured children's empathetic response (bringing a blanket to the experimenter when he shivered) in relation to parents' elicitation of talk about emotions and mental states while reading a book together.

The empathetic response requires an understanding of another person's internal state to understand the need to help, and Drummond et al. found that children who helped more quickly to bring a blanket to the experimenter had parents who elicited talk about emotions and mental states more often in the book reading context.

Research makes clear that social-emotional skills and helping behaviors are important for children's success in school, and adult scaffolding of interactions plays an important role in the development of these skills.

#6 Higher-order thinking, retention of information, and creativity flourish when children experience minimized stress and when their basic needs are met. While persistent stress can impede brain development, caring relationships with adults as well as programs that teach emotion regulation provide protection from risk.

Through our senses, we take in information about the world around us. This information flows through the amygdala, at the center of the brain, a region responsible for routing information and for flagging information for long-term memory. The direction information is routed—whether to the lower parts of the brain where impulse and instinct drive reaction or to the pre-frontal cortex for higher order processing—depends on whether we sense threat or safety. Because of this, when children experience positive and safe environments, they will learn more and retain more information. Similarly, proper sleep and healthy food support the brain to route information to the prefrontal cortex for processing.

Unfortunately, our nation has a sizable number of children living with regular stress. A small amount of stress is normal and healthy for children, but persistent stress in a child's life can have long-term deleterious effects on brain development. Research shows that caring relationships with adults provide a protective factor to help children manage adversity. Programs and approaches that support children to learn emotion regulation can help build learning environments where all children—even those coping with persistent stress—can thrive.

Naptime is shown to improve learning in preschoolers, and studies of memory and language learning in particular demonstrate its importance from infancy to late childhood (Gómez, Bootzin, & Nadel, 2006; Horváth, Myers, Foster, & Plunkett, 2015). Kurdziel, Duclos, and Spencer (2013) recently investigated the benefits of daytime napping on preschoolers' memory skills. Preschoolers learned a visuospatial task similar to the game Memory in which pairs of covered pictures were shown in a grid and children had to uncover and remember the location of the pictures in order to find matches. The children played the game at the beginning of the day and then were immediately tested to get a measure of their baseline performance. Later, during nap time, children were either sleep- or wake-promoted, after which their performance on the task was tested. It was tested a final time 24 hours later, following a night's sleep. Children in the napping group remembered significantly more locations (and forgot significantly fewer compared to their own baseline) than children in the wake group when tested both later that same day, and following a full night's sleep. Interestingly, the benefit of napping was greatest for children who napped habitually. That is, the children who napped regularly did consistently better than those who did not nap as part of their daily routine.

Research also shows daytime sleeping to have emotional benefits, and this relationship makes sense given that sleep patterns and emotion regulation and expression undergo pronounced changes in early childhood (Berger, Miller, Seifer, Cares, & Lebourgeois, 2012). Berger and her colleagues assessed the emotional responses of 10 toddlers between the ages of 2 ½ and 3 years while completing a picture puzzle both after a missed nap and after a regular nap. One puzzle the child worked on had all of the correct pieces while another puzzle included a "wrong" piece and was frustrating to the toddlers because it was unsolvable. The researchers videotaped the children's faces while they worked on the puzzles and coded the participants' facial expressions for a range of emotions including joy, excitement, anger, anxiety, and confusion.

Berger and colleagues found that nap-deprived toddlers completing the solvable puzzles had a 34% decrease in their positive emotional responses compared to the same children completing similar puzzles after their regular nap. The findings also revealed a 31% increase in negative emotional responses for nap-deprived toddlers when trying to complete an unsolvable puzzle compared to the same children after they napped. Interestingly, the researchers found that nap-deprived toddlers were much less likely to express confusion when trying to complete an unsolvable puzzle. Berger and colleagues interpret this finding as a non-adaptive response since confusion often leads to seeking help from others, the developmentally appropriate response indicating children are engaged in solving a task. The results suggests that depriving children of just one nap can produce substantial changes in their emotion expression and make positive events less exciting and negative events more frustrating. These results support and extend previous research with adults on the links between sleep-deprivation and increased negative mood and anxiety (Franzen, Buysse, Dahl, Thompson, & Siegle, 2009; Gujar, McDonald, Nishida, & Walker, 2011).

Prolonged and chronic stress can fundamentally alter the architecture of the brain, changing how growing children respond to stress for the rest of their lives (Lupien et al., 2009; National Scientific Council on the Developing Child, 2005/2014). Experts categorize stress into three main types. Positive stress is a normal part of a child's daily life, and might occur in response to an experience like getting dropped off at preschool, or receiving a shot. It can be overcome with the support of caring adults in the child's life, and learning how to adapt to it is considered an important part of development. Tolerable stress occurs in response to adverse experiences that are more severe, like the death of a loved one, and is considered tolerable only with the protective buffering of supportive relationships that help the child to cope. Toxic stress, in contrast, results from intense and long-lasting adverse experiences, like maltreatment, poverty, or exposure to violence, and can disrupt or compromise early brain development (National Scientific Council on the Developing Child, 2005/2014).

Toxic stress in childhood can have long-term negative effects on individuals' functioning via a variety of mechanisms. Early toxic stress can disrupt the development of brain circuits, causing an individual to become excessively reactive to later stressors. High levels of stress hormones like cortisol can depress the immune system, potentially leading to greater risk for infections and disease (National Scientific Council on the Developing Child, 2005/2014). Persistent stress can additionally lead to structural changes in the brain that are associated with cognitive differences in learning, memory, executive function, and mood control (Shonkoff et al., 2012).

Strong evidence for the impact of early stress on adult outcomes comes from the Adverse Childhood Experiences (ACE) Study, a large-scale retrospective study linking past histories of abuse, neglect, and family dysfunction with poor adult health (Felitti et al., 1998). The study showed that as the number of adverse childhood experiences an individual experiences increases, so does his or her risk for mental, physical, and behavioral problems as an adolescent and adult. The study also revealed how prevalent early stress is in the U.S. Almost two-thirds of the over 17,000 participants reported at least one adverse childhood experience, and more than one-fifth had experienced three or more. Evidence for the more immediate impact of childhood adversity of outcomes comes from an examination of children under 3 in the Child Protective Services system (Barth et al., 2007). This study found that maltreated children were at substantial risk for developmental problems, and delays in domains we know to be important for holistic school readiness. This and the rates found in the ACE study further highlight how important it is that early childhood educators be aware of research on toxic stress and its impacts.

While experts in the field often look to populations like international adoptees and foster children to examine the effects of early childhood adversity, the ACE study, among others, emphasizes that this is an issue that affects *many* of our children. Given this, understanding how we can curb or even reverse the impacts of toxic stress is critical. Research points to effective interventions that teach children coping and self-regulation, including mindfulness activities such as meditation, traditional martial arts, and yoga (more on this in Key Finding #4). Additionally, early evaluations of current interventions focused on positive adult-child relationships show promise. In one pilot study, facilitating the development of a therapeutic relationship between foster parents and maltreated preschoolers improved children's problem behavior and parents' stress (especially compared to controls, whose functioning decreased during the same period in foster care). There was also some indication that the intervention decreased the preschoolers' levels of cortisol, a stress hormone, over time (Fisher et al., 2000).

Research on the impact of stress on development emphasizes the importance of relationships with parents, teachers, and friends for mediating long-term negative effects (National Scientific Council on the Developing Child, 2004/2009). Without quality adult relationships, tolerable stress can become toxic stress. With this knowledge, experts in the field encourage us to consider fostering the stress-buffering capacities of adults in children's lives as equally critical to school readiness as practicing executive function skills, or learning shapes, numbers, and letters (Shonkoff, 2011).

Changing the Checklist

Across the nation, there is growing demand for standardized early kindergarten readiness assessments, often in the form of checklists. As the saying goes, we treasure what we measure, and, all too often in education, what we measure is what is simple, cost-efficient, and highly reliable. The trouble is that children's development is complex, and as this paper shows, much research points to the fact that depth of thinking and quality of interaction matter more than rote learning and knowledge. Rather than chucking the checklist all together, educators should change their lens on the checklist and help families do the same to ensure children are set up for long-term success.

Generally, children's ability to name upper and lower case letters and to recognize the sounds of some of the letters are included in school readiness checklists. It's certainly important for early literacy that children learn their letters and learn that the letters together form words, and research shows we can build this knowledge by pointing out the letters while reading. However, the more important skill to be built through reading is language, as shown by children's vocabulary and capacity to articulate their thoughts. The depth of a preschooler's language skills—like early conceptual mathematics—is more predictive of long-term reading than simple measures of early literacy like letter recognition.

Within a single kindergarten class, the fine motor skills of the children in the class may range considerably. Some children can draw pictures that are recognizable to others and can easily form the letters of their name. Others struggle to use scissors, hold a pencil with a pincer grip, or form intelligible letters. This range makes early writing instruction difficult for teachers, while new standards expect all kindergarteners to be writing by the end of the year. All too often, we see early education environments expect children to do "desk work" earlier and earlier. Yet hands-on experiences in art, science, and making – such as ripping tape, handling Legos, painting, and building with clay –are terrific, and developmentally appropriate, ways for young children to build their fine motor coordination and the musculature for later writing.

To assess children's early numeracy, checklists generally ask if children are able to count from one to 10 or one to 20. Yet research shows that this performance task may indicate children's memory more than it represents their foundational understanding of quantity. As discussed at length in this paper, the more predictive and powerful indicators of long-term success with mathematics—and with other academic domains—is early conceptual mathematics. We can help children see mathematics in the world around them, use rich mathematical language in our work with children, and build growth mindset in mathematics by modeling our own use and learning of mathematics.

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