Reimagining School Readiness

A literature review

Center for Childhood Creativity
at the Bay Area Discovery Museum

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A child's first day of school is one of the most memorable and important events in early childhood. The transition to formal school is one of the most significant changes for young children, and the first day of kindergarten can often be filled with a mix of emotions including some tears (from both the child and parent).

For kindergarten teachers, the first day of school is especially challenging because they are welcoming a group of children into their classrooms who are likely to have a wide range of needs based on their previous experience (or lack of) interacting with other children in a childcare or preschool setting, listening to an adult read a book, or regulating their emotions when another child takes the toy they are playing with. This scenario is unfortunately the norm in many American schools and most would agree this haphazard transition to kindergarten is one of the nation's most challenging and critical educational issues.

Many children—especially those from families living in low-income communities—enter school unprepared for both academic and social expectations. 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). As such, school readiness has emerged as an increasingly important issue at the forefront of research and policy. Research supports that school readiness is multifaceted and not limited to early reading and mathematics skills, but rather includes a wide range of components including executive function skills, curiosity, language, socioemotional well-being, motor skills, and health. Furthermore, school readiness has traditionally focused on the transition from preschool to kindergarten, but the challenges that children face in a formal school environment go beyond the kindergarten years. In this paper, we take a broader developmental perspective and advocate for examining the skills, concepts, and behaviors that children in preschool and early grade school need to be successful in school and in life. Although there is a rich and growing body of literature on school readiness, the best way to prepare children for success in school and exactly what readiness means are still a mystery.

Many definitions of school readiness can be found in the research literature. For many researchers, school readiness is related to children's cognitive abilities (Nobel, Tottenham, & Casey, 2005), often with a focus on early literacy and mathematics. Others have focused on social and emotional development (Ray & Smith, 2010) or approaches to learning that examine children's behaviors and dispositions related to engaging in and completing tasks effectively in a classroom setting (McClelland, Acock, & Morrison, 2006). More specifically, Head Start views school readiness as "children possessing the skills, knowledge, and attitudes necessary for success in school and for later learning and life" (Head Start Approach to School Readiness, n.d.). In their recent literature review of predictors of school readiness, Linder, Ramey, and Zambek (2013) define school readiness as "what children are expected

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to know and do in a variety of academic domains and processes of learning prior to entering a formal classroom setting."

Historically, readiness has been defined as the combination of two concepts: readiness to learn and readiness for school (Kagan, 1990; Lewit & Baker, 1995). The former refers to children's level of development and when they are able to learn specific material. Readiness for school is viewed as children's ability to be successful in a formal school setting. Both of these components assume that readiness is inherent in the child, and have been described by researchers and theorists as an idealist or nativist view (Meisels, 1998). In a seminal paper that discusses several theoretical perspectives of "readiness, " Meisels (1998) described four interpretations of the term: (1) the idealist or nativist view, (2) the empiricist or environmental view, (3) the social constructivist view, and (4) the interactionist view. The idealist or nativist perspective—the most dominant view in research and practice—holds that children's maturation is the driving factor for school readiness. That is, children's development can only be marginally influenced by external factors and they are ready to start school when they reach a level of maturity that allows them to follow directions, complete tasks, and interact with peers and teachers in socially acceptable ways.

In contrast to the idealist view, the empiricist perspective concentrates on how the child behaves and what they can do. That is, readiness is viewed in terms of a child's proficiency with a specific set of skills that can be acquired through teaching and holds that readiness is something "outside of the child." The social constructivist view shifts the focus to the community and sees readiness in terms of the values, expectations, and norms that are meaningful and important to a particular school community. Lastly, Meisels (1998) identified a fourth view—the interactionist—that views readiness as a *bi-directional* concept. More specifically,

> Readiness and early school achievement are bi-directional concepts that focus both on children's current skills, knowledge, and abilities and on the conditions of the environment in which children are reared and taught...Although it [readiness] can be applied to individual children, it is not something in the child, and it is not something in the curriculum. It is a product of the interaction between children's prior experiences, their genetic endowment, their maturational status, and the whole range of environmental and cultural experiences that they encounter. (Meisels, 1996, p. 409)

Beyond the four perspectives of readiness, Meisels (1998) highlighted that readiness should be conceptualized as a process that occurs over several years and through consistent interactions with caring and trustworthy adults. That is, the definition of school readiness needs to go beyond a few skills that are seen in the first weeks of kindergarten and limited to reciting the alphabet, identifying colors, and learning to count. To this end, we present a comprehensive view of school readiness by exploring a wide range of cognitive, social, emotional, and physical skills as well as approaches to learning that support children to succeed in the early years of school. Furthermore, we also recognize the vital importance of the role of creativity and other 21st century skills, including collaboration and communication, in supporting school readiness. We discuss several critical components of creativity (see

Center for Childhood Creativity, 2015) in relation to some of the school readiness skills and how these components support, motivate, and guide children's learning both in and outside of the classroom.

We conducted an extensive literature review to find the most recent and high-caliber developmental and education research on school readiness to provide an in-depth and accessible summary of the multitude of factors that impact school readiness. One theme that emerged in our research was a rich body of longitudinal data that reveals several powerful predictors of later learning and academic success. We start by synthesizing those studies and then discuss ten key topic areas organized by five developmental domains. These domains are parallel to those used in Head Start's Early Learning Outcomes Framework, a research-based framework that describes the skills and concepts that early childhood programs should foster in children ages birth to five (U.S. Department of Health and Human Services, Administration for Children and Families [ACF], 2015).

Approaches to learning

- Executive function
- Curiosity, interest, and motivation

Cognition

- Scientific reasoning
- Math knowledge and skills

Language and literacy

- Language development
- Literacy

Social and emotional development

- Prosocial behaviors
- Self-regulation

Motor development and health

- Gross and fine motor development
- Sleep, nutrition, and toxic stress

Longitudinal Research

Longitudinal data, although challenging to collect for a number of logistical and financial reasons, often provides the most meaningful and powerful evidence related to developmental change. In this section, we discuss several longitudinal studies conducted in the past 10 years that provide a helpful roadmap when considering the multitude of factors that play a role in preparing children for school.

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 (feeling sadness) or outward (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, socioemotional 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. More specifically, knowledge of numbers and *ordinality* were highly predictive of *both* reading and math achievement. Ordinality is the understanding that successive number words represent larger quantities and is often assessed in children by comparing two numerals and asking, "Which is bigger?" In addition, early language and reading skills (e.g., vocabulary, letters, and beginning

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and ending word sounds) were also consistent predictors of later learning. It is interesting to note that early math measures predicted both later math and reading scores, but early reading measures predicted only later reading scores. Furthermore, early math scores predicted later reading as strongly as early reading scores.

With respect to internalizing and externalizing problem behaviors and socioemotional skills, Duncan et al. found that these skills did not affect achievement and had average effect sizes close to zero. These findings are somewhat surprising given that, theoretically, children's socioemotional skills and responses to stress should affect achievement because they influence children's ability to participate in learning activities and successfully engage with peers and teachers. Relatedly, Duncan et al. found that attention skills were modestly and consistently associated with later achievement. This finding supports the rich body of literature that has supported a link between attention skills and school success (Alexander et al., 1993; Howse et al., 2003; McClelland et al., 2000; Yen et al., 2004).

More recently, Romano and colleagues (2010) replicated and extended findings from Duncan et al. (2007) by examining a nationwide Canadian data set that was not included in Duncan et al.'s research. Similar to Duncan et al., Romano and colleagues found that early mathematics, reading, and attention skills were significant predictors of third grade mathematics and reading achievement. In contrast to Duncan et al., the researchers found significant associations between kindergarten socioemotional behaviors and later achievement. More specifically, greater prosocial behaviors significantly predicted later reading and mathematics skills and less hyperactivity/impulsivity significantly predicted better reading achievement. In summary, a noteworthy conclusion to be drawn from this study is that socioemotional behaviors are important predictors of later reading and math achievement. This important finding supports the conventional wisdom that children's success in school is heavily influenced by their interpersonal skills and ways in which they interact with their teachers and peers.

A recent 20-year retrospective study by Jones, Greenberg, and Crowley (2015) provides further support for the argument that early socioemotional skills are a critical component of future wellness and success. The researchers examined whether teacher-rated prosocial 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 (i.e., graduated from high school on time, completed a college degree, obtained stable employment in young adulthood) and negative milestones (i.e., 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.

Using statistical models to control for background characteristics including family circumstances, gender, and academic ability, the researchers found statistically significant associations between teacher-assessed prosocial 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 prosocial skills are more likely to achieve success in young adulthood across a wide range of domains. Jones, Greenberg, and Crowly (2015) highlight the importance of focusing on *noncognitive* skills (e.g., social skills, self-regulation, attention, and behavioral characteristics) as critical for predicting later achievement and success, and more importantly, being mindful to consider how cognitive and noncognitive skills interact to enable success in school and beyond. That is, intellectual ability is only one component of achievement—social-emotional skills such as self-control, motivation, attention, and social interactions are important factors that influence readiness for learning (Duncan & Magnuson, 2011). It is important to note that historically there has been a division between cognitive and noncognitive skills, but researchers are starting to move away from this dichotomy, as most would agree that all skills relate to cognition.

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In addition, Jones, Greenberg, and Crowly advocate for policymakers and program developers to focus on efforts to improve early prosocial skills given a rich body of literature on effective interventions in preschool and the early grade school years to improve noncognitive skills with long-term effects (Bierman et al., 2008; Bierman et al., 2010; Campbell et al., 2014; Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011; Heckman & Kautz, 2012). Lastly, these findings provide important practical implications for identifying children in need of early intervention by utilizing teacher-assessed ratings of prosocial behaviors as an indicator of noncognitive ability at school entry.

Approaches to learning

Executive function

The development of executive function (EF) has recently received substantial attention from researchers and the popular press because of the important links between EF and school readiness and achievement (Alloway & Alloway, 2010; Blair, 2002; Duckworth & Seligman, 2005), cognitive skills including early math and literacy skills (Blair & Razza, 2007; McClelland et al., 2007; Welsh, Nix, Blair, Bierman, & Nelson, 2010), theory of mind (Carlson & Moses, 2001; Hughes, 1998), and social understanding (Sabbagh, Xu, Carlson, Moses, & Lee, 2006). Furthermore, an overwhelming amount of research supports the benefits of EF skills for childhood friendships (Rotenberg, Michalik, Eisenberg, & Betts, 2008), mental and physical health in adulthood (Baler & Volkow, 2006; Miller, Barnes, & Beaver, 2011), and in the workplace (Bailey, 2007). In a 32-year longitudinal study of 1000 children, those with better inhibitory control at ages 3 to 11 years grew up to have better physical and mental health, earn more, and be less likely to commit crimes 30 years later, controlling for several factors including IQ, gender, social class, and home and family environments during childhood (Moffitt et al., 2011).

What are executive functions? A standard definition is a set of higher-order processes including working memory, inhibitory control, and attentional (or

Links to creativity: Executive function, imagination, and pretend play

It makes sense to assume that because executive function (EF) involves controlling our thoughts, actions, and emotions that it would not be linked to creative thinking and imagination. However, just the opposite happens to be true. EF appears to be a critical component for the development of imagination. What is the relationship between EF and imagination? Pretend play—how young children express their imagination—promotes the development of EF, specifically self-regulation. Vygotsky (1967) was one of the first to propose and explore this connection and believed that pretend play promotes self-regulation because children learn to inhibit their impulses and follow socially based rules in pretense. When playing tea party, children have to ignore that a teacup is empty in reality and treat it as if it were full of liquid in the context of the pretend tea party. In addition, Vygotsky proposed that pretense is instrumental in the development of cognitive flexibility. That is, pretend play requires children to consider and selectively attend to more than one aspect of a situation. When children pretend to be someone else, they have to take the perspective of another and simulate the other's beliefs, desires, and emotional responses to situations.

Recent correlational and experimental studies provide further evidence for the relationship between EF and pretense (see Carlson & White (2013) for a summary). Carlson, White, and Davis-Unger (2014) found that EF scores were robustly correlated with measures of pretense in preschool children. Relatedly, White and Carlson (2011) investigated how pretense facilitates EF performance in young children and found that EF scores were significantly higher for children who were encouraged to pretend that the events of a story they just heard happened than for those who were not encouraged to pretend.

Given the ubiquitous presence of pretend play in early childhood and the importance of strong EF skills for school readiness, it is important for researchers to continue to explore the practical implications of the relationship between these two essential ingredients for healthy development. While pretend play might look like time spent doing nothing much, it actually helps build critical cognitive skills, including self-regulation and cognitive flexibility.

cognitive) flexibility (Hughes & Ensor, 2009). Children use components of EF including planning and inhibitory control when they make decisions in everyday settings. For example, when children interact with their peers, 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 choices—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 EF 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.

Big idea #1: Working memory and inhibitory control show strong links to early math skills, emergent literacy, and theory of mind.

Longitudinal studies illustrate that early developing EF 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 school context, but are in fact correlated with the cognitive capacities that underlie academic skills including early math skills and emergent literacy. More specifically, working memory and inhibitory control show strong links to early math skills, emergent literacy, and theory of mind (Blair & Razza, 2007; Carlson & Moses, 2001; Hughes, 1998; McClelland et al., 2007; Welsh, Nix, Blair, Bierman, & Nelson, 2010). Welsh et al. (2010) recently conducted 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. The researchers examined two hypotheses focusing on two core EF skills: (1) growth in working memory and attentional control will be associated concurrently with growth in emergent literacy and numeracy skills over the pre-kindergarten year; and (2) growth of domain-general (working memory and attentional control) and domain-specific (emergent literacy and numeracy) skills during the pre-kindergarten year will each make unique contributions to reading and math achievement in kindergarten. Child assessments were conducted at the beginning of the pre-kindergarten year (as soon as the children had acclimated to the classroom), at the end of the pre-kindergarten year, and at the end of kindergarten.

At each time point, children were given assessments to measure working memory and attentional control and domain-specific cognitive skills in the areas of emergent numeracy and literacy. For example, to assess working memory, children were asked to listen to a list of words read aloud and then repeat the words back in reverse order. To assess inhibitory attentional control, children were required to tap a wooden dowel twice after watching an experimenter tap once, and to tap once when the experimenter tapped twice. To be successful on the *Peg Tapping* task (Diamond & Taylor, 1996) children have to inhibit their natural tendency to imitate the action of the experimenter and keep in mind the rule for the correct response. Thirdly, children participated in the classic *Dimensional Change Card Sort task* (DCCS; Frye, Zelazo, & Palfai, 1995) to assess their inhibitory control and attention set-shifting capacity. In the DCCS, children are asked to first sort cards based on one dimension (e.g., color) and then after a number of trials asked to sort the cards based on another dimension (e.g., shape).

As predicted and supported by previous research (Duncan et al., 2007), Welsh and colleagues found that pre-kindergarten literacy and mathematics skills significantly predicted reading and math achievement in kindergarten, respectively. Furthermore, initial levels of EF skills predicted growth in emergent literacy and numeracy skills between the beginning and end of the pre-kindergarten year, with initial levels of those skills and language skills accounted for. Relatedly, growth in EF made unique contributions to both math and reading achievement in kindergarten. Taken together, these findings support the two hypotheses of the researchers and revealed that working memory and attention control, two of the core components of EF, predicted growth in emergent literacy and numeracy skills in the pre-kindergarten year, and that growth in both of these EF skills predicted kindergarten math and reading achievement. One additional, intriguing finding was the reciprocal relation between emergent math and EF skills—initial levels of EF skills predicted growth in emergent math skills *and* initial levels of emergent numeracy skills predicted growth in EF skills during the pre-kindergarten year. Welsh et al. speculate that this reciprocal relation might reflect the degree to which pre-kindergarten math activities, in comparison to pre-kindergarten literacy activities, may place demands on working memory and attention control that relate to growth in those domain-general skills. This finding is particularly noteworthy given evidence that early mathematical ability is a powerful predictor of both math and reading achievement (Duncan et al., 2007).

Relatedly, a number of researchers have investigated the relation between Theory of Mind (ToM), in particular false belief understanding, and EF to help determine how children's understanding of their own and others' mental states may contribute to developing competence in school settings (Blair & Razza, 2007; Carlson & Moses, 2001; Hughes, 1998). False belief understanding, typically emerging in the later preschool years, is an awareness that one may hold and act on beliefs that are false. In a classic false belief task,

children are told a story about Sally and Anne, in which Sally places some candy in a basket and then leaves the room. Anne then moves the candy from the basket to the cupboard. Children are asked where Sally will look for the candy when she returns. Most 3-year-olds tend to fail this task by responding that Sally will look in the cupboard (where the candy actually is), whereas 4-year-olds and older children tend to respond correctly that Sally will look in the basket (where she thinks the candy is). In other words, older preschoolers recognize that Sally will act on her belief, even if that belief is false.

There are several reasons to suspect that EF skills, specifically inhibitory control, and theory of mind abilities are closely related: important developmental changes occur in both in the preschool years, they share a common brain region (prefrontal cortex), and most interestingly, success on many ToM tasks seems to require well-developed inhibitory control skills (Carlson & Moses, 2001). For example, in the Sally Anne task, children have to resist the temptation to reference reality (and respond that Sally will look where the candy actually is) in order to respond correctly. A wealth of evidence indicates that EF skills are closely linked to children's developing theories of mind (Carlson & Moses, 2001; Carlson, Claxton, & Moses, 2015; Hughes & Ensor, 2007). In a study with preschool-age children, Carlson and Moses investigated the relation between inhibitory control and ToM by testing a large sample of 3- and 4-year-olds across two sessions with a battery of tasks measuring key components of inhibitory control and theory of mind, as well as verbal ability and mental state control tasks (i.e., tasks similar to the theory of mind tasks but with no reference to mental states). The researchers found that inhibitory control was strongly related to ToM even when controlling for a number of factors including age, gender, verbal ability, and family size. Similarly, Blair and Razza (2007) found that inhibitory control and false belief understanding were closely linked in their investigation of the interrelations among EF, effortful control, and false belief understanding in preschool children from low SES-backgrounds.

These findings confirm that EF and ToM are significantly related and in turn highlight ToM as a developmental pathway towards school readiness. That is, given the close relationship between developments in ToM and EF *and* the overwhelming evidence that EF skills play in school readiness, it makes sense to explore the possible role that children's ability to think about thinking plays in school readiness. ToM is not often included in discussions or research investigating school readiness, but recently Astington and Pelletier (2013) pointed out the important link between ToM and several factors that influence school readiness including social maturity, cognitive monitoring, narrative understanding, and the beginnings of scientific thinking. With respect to cognitive monitoring, Astington and Pelletier explain that, "theory of mind development also allows children to reflect on their own intentions and beliefs, which facilitates monitoring of their own cognitive activities. Such 'self-monitoring' is an important aspect of success in school settings" (Astington & Pelletier, 2013, p. 215). These valuable insights highlight the importance of providing opportunities for children to think and talk about their own and other people's thoughts. For example, young children learn about mental states from story books that are read to them (Dyer, Shatz, & Wellman, 2000) and often ask questions about the intentions, motives, and feelings of the characters (Donaldson, 1978). Furthermore, talking about different people's viewpoints may facilitate children's understanding that their beliefs may differ from another person's and that people have different beliefs about the world.

Big idea #2: Diverse activities and interventions can improve EF skills in children.

Given the critical role that EF skills play in many aspects of development and success in adulthood, it is important to examine the best methods for improving EF skills, especially in early childhood. The good news is that EF skills can be improved and the positive effects of a diverse range of activities and programs have been supported by empirical studies (see Diamond, 2012 for a review). The strongest evidence exists for a number of computer-based training methods that focus on improving working memory, reasoning, and task-switching. More specifically, a number of studies support the positive effects for Cogmed computer-based training for working memory and reasoning (Holmes, Gathercole, & Dunning, 2009; Klingberg et al., 2005; Thorell, Lindqvist, Bergman, Bohlin, & Klingberg, 2009). The Cogmed program is designed to improve working memory through a series of 30- to 45-minute

training sessions (five times a week for five weeks) that involve completing game-like tasks. 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 EF 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. It is important to note that research to date suggests that Cogmed and martial arts work best for children ages 8 years and older in relation to improving EF skills.

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 EF. The two programs share a number of features that appear to play an important role in promoting various EF skills: (1) children are consistently pushed to exercise their EF 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.

In addition, two programs designed to complement school curriculum—Promoting Alternative Thinking Strategies (PATHS; Riggs, Greenberg, Kusche, & Pentz, 2006) and the Chicago School Readiness Project (CSRP; Raver et al., 2008; Raver et al., 2011; Jones, Bub, & Raver, 2013)—provide convincing evidence that EF skills can be improved. The CSRP targeted disadvantaged children's school readiness through an emotionally and behaviorally focused classroom-based intervention designed to improve self-regulation. The intervention was implemented in Chicago Head Start classrooms serving neighborhoods selected on the basis of a set of criteria including high poverty, exposure to high rates of crime, and lower rates of mobility (Raver et al., 2008; 2009). Teachers in CSRP classrooms were provided with intensive training classroom management strategies (e.g., implementing clearer rules and routines and redirecting negative behavior) and guidance on providing children with more effective regulatory support. Additional classroom support was provided by a mental health consultant, who supported teachers in applying strategies and also conducted stress-reduction workshops for teachers throughout the year to limit burnout.

Raver and colleagues (2011) conducted one of the first investigations of the CSRP intervention on school readiness outcomes in preschoolers. The researchers predicted that children in the CSRP classrooms would develop more effective self-regulation and gain greater academic competence as measured by increases in letter-naming, early math, and vocabulary than their control group counterparts. Head Start classrooms were selected for participation in the study with some of the classrooms randomly assigned to the CSRP treatment intervention and the others to the control group. The treatment classrooms received the multiple components of the intervention described previously across the school year, and the control classrooms were paired with teaching assistants to act as a control for the mental health consultant placed in each of the CSRP classrooms. The researchers collected data on children's behaviors, background, classroom, and site characteristics from several sources including parents, teachers, classroom observers, and the children themselves. Children's self-regulatory skills and pre-academic skills including vocabulary, letter naming, and math were collected individually from each child in the beginning and end of the school year. As predicted, Raver et al. found clear evidence of the benefits of the CSRP intervention for children's self-regulation. More specifically, children enrolled in treatment classrooms demonstrated significantly higher attention skills, better impulse control, and higher performance on EF tasks than children in the control group classrooms at the end of the preschool year. Furthermore, the treatment-enrolled children had significant improvements in vocabulary, letter-naming, and math skills relative to children in the control group.

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(Diamond, 2014, p. 220)

In a follow-up study, Jones, Bub, & Raver (2013) found supporting evidence for the positive influence of CSRP's intervention on children's behavioral and academic outcomes with an additional focus on the mediating role of teacher-child relationships. That is, children in the CSRP classrooms had better relationships with their teachers, which positively influenced their self-regulatory skills, and these skills in turn led to better behavioral and pre-academic outcomes. In summary, research on the CSRP classroom intervention provides compelling evidence that children's social-emotional competence and EF skills are key for learning in early childhood contexts. Furthermore, studies examining the positive impact of CSRP interventions such as training, coaching, and mental health consultation for teachers provide meaningful guidelines for steps that school readiness programs can take to substantially improve children's chances of succeeding in school. From a practical standpoint, these studies emphasize the importance of providing teachers and other significant adults in children's lives with knowledge and strategies to enhance children's self-regulation, which in turn can help to reduce behavior problems and increase opportunities for learning.

While environmental factors do play a role in the development of EF skills, such that children from low socioeconomic backgrounds often show early disparities, there is promise in existing and novel interventions to promote important lifelong learning skills. Successful interventions have taken the form of computerized trainings, mindful physical activity, school curricula, and extracurricular programs. Many of the features of these impactful programs can be integrated into a variety of contexts, and a range of activities, based on what motivates individual children. In a recent review of the research on the development of EF and the best ways to optimize EF in relation to academic outcomes, Diamond (2014) provides a convincing and persuasive argument for the vital role of EF, social, emotional and physical development in school readiness and academic achievement:

> We are not only intellects; we also have emotions, social needs, and bodies...Counterintuitively, the most efficient and effective strategy for improving academic achievement is probably not to focus only on academics but to nurture all aspects of the child. While it may seem logical that if you want to improve academic outcomes you should concentrate on academic outcomes alone, not everything that seems logical is correct. (Diamond, 2014, p. 220)

Curiosity, interest, and motivation

Children are naturally curious. They are born eager to discover, explore, and figure out how the world works. However, as children grow and mature, formal expectations, extrinsic motivators, and diverse social interactions challenge this inborn desire to learn. 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. For example, the National Education Goals Panel (NEGP) specified "openness and curiosity about new tasks and challenges" as an important indicator of school readiness (Kagan, Moore, & Bredekamp, 1995, p. 23; National Education Goals Panel, 1995) and have also argued that "children who start school with...a lack of curiosity are at greater risk of subsequent school failure than other children" (NEGP, 1995, p. 12). More recently, the American Association for the Advancement of Science has highlighted the importance of curiosity in science education and offers training workshops for elementary school teachers that focus on developmentally appropriate strategies for fostering scientific curiosity in children.

Big idea #1: Children explore more when they encounter conflicting evidence.

From a research perspective, curiosity is an elusive concept to study, especially in children (Jirout & Klahr, 2012). In a recent review, Jirout and Klahr (2012) discuss the challenge of formulating an operational definition of curiosity given that most research on curiosity has focused on adults using questionnaire-type measures that are not appropriate for children. With this challenge in mind, the researchers proposed an operational definition of curiosity that emphasizes the environment: curiosity is "the threshold of desired uncertainty in the environment that leads to exploratory behavior" (Jirout & Klahr, 2012, p. 25). In other words, curiosity is motivated by gaps in information and leads to exploration in order to satisfy curiosity or narrow that gap. Two 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 at 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.

Relatedly, van Schijndel, Visser, van Bers, & Raijmakers (2015) investigated children's pattern of exploration in a situation where they observe conflicting evidence in an ecologically valid domain (shadow formation). Similar to Bonawitz et al. (2012), the researchers hypothesized that children who are confronted with conflicting evidence will perform more informative experiments during free play than children who encounter confirming evidence. Children (ages 4-9) were introduced to a shadow machine that consisted of two light sources, a screen, and puppets that could be placed in pegs on a board in varying distances between the light sources and screen. The lights were activated when a button was pressed and the shadows of the puppets were displayed on the screen.

In the first phase of the study, van Schijndel et al. (2015) determined which children had "Rule 1" beliefs about shadows where children take into account size but not distance in determining shadow size. Children then watched as the experimenter placed different size puppets in varying distances from the light source in two different conditions. In the confirming condition, the experimenter placed a small puppet farther away from the light source and a large puppet closer the light source. In this scenario, the large puppet would have the bigger shadow, which follows Rule 1 beliefs. In the conflicting condition, the experimenter placed a small puppet close to the light source and a large puppet farther away from the light source. In this case, the small puppet makes a larger shadow, which conflicts with Rule 1 beliefs. After children watched either the confirming or conflicting event, they were encouraged to play with the shadow machine for five minutes. The researchers found that all of the children who were confronted with conflicting evidence performed an unconfounded informative experiment in the beginning of their free play session compared to only half of the children in the confirming condition. That is, children who were presented with conflicting evidence performed an experiment in which one dimension (size or distance) was varied while the other was kept constant.

Van Schijndel et al.'s (2015) findings support those of Bonawitz et al. (2012) by showing that children's curiosity is fueled by uncertainty and conflicting evidence. Relatedly, in an often-cited study with preschoolers, Bonawitz and colleagues found that children explored a novel toy more when they thought there was more to be discovered (Bonawitz et al., 2011). Moreover, recent research with infants less than a year old shows that babies selectively explore objects that violate their expectations (e.g., a car that passes 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, 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.

Big idea #2: Modeling different kinds of effective questions can help children learn how to engage in inquiry.

Children often seek information from others by asking questions—lots of questions. Although many of these questions may not seem to have a specific purpose, 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. Seeking information from others in order to solve a problem is a complex process that involves: (1) determining the appropriate informant to question, (2) deciding how to use questions as a tool to acquire information related to a problem, and (3) determining how to apply the information received to solve the problem. 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. The goal of the game was to determine which of two cards with pictures of common objects on them was placed inside a box by asking the puppets questions (e.g., "Does it fly?" or " Is it blue?"). In one condition, a knowledgeable informant (puppet) was contrasted with another that verbally expressed his own ignorance ("I don't know, I just don't know!"). In another condition, a knowledgeable puppet was contrasted with another who gave consistent inaccurate responses to questions. Children's questions were coded for two types of information: (1) whether it was directed to the knowledgeable, ignorant, or inaccurate informant, and (2) whether the question was *effective* (i.e., provided information to help solve the problem), *ineffective* (i.e., did not provide relevant information to solve the problem), or a *clarification* of the protocol (e.g., "Am I supposed to pick a puppet first?").

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. As predicted, the researchers found that older preschoolers are better than younger at directing questions to the most knowledgeable informant and also better at coming up with effective questions. Interestingly, children typically struggled more to discount an inaccurate informant than an ignorant one. One of the most notable (and unexpected) findings related to the number of effective questions required to solve the problem. That is, Mills et al. found that success at problem solving in the card selection task was not all about age and distinguishing between sources. 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 majority of 4-year-olds asked ineffective questions in Experiment 1, but the majority asked effective questions in Experiment 2. The researchers attribute this improvement to an important difference in the warm-up phases of the two experiments: modeling effective questions in the second experiment (but not in the first). Thus, modeling different kinds of effective questions can help children to learn how to ask effective questions themselves and engage in inquiry-based problem solving. Relatedly, research with preschoolers and early grade school children suggests that by age 4 children attend to factors that may influence the effectiveness of how information is gathered (e.g., a visible vs. invisible property) (Fitneva, Lam, & Dunfield, 2013) and can track the relative frequency of errors when deciding whether an informant is trustworthy or untrustworthy (Pasquini, Corriveau, Koenig, & Harris, 2007). Taken together, these findings highlight the importance of engaging children from an early age in the process of inquiry-based problem solving that involves integrating knowledge of who to question, what to ask, and how much information to ask for.

Big idea #3: Process praise promotes a growth mindset and intrinsic motivation in young children.

Student motivation has an important influence on a multitude of school readiness components. Researchers and practitioners agree that cognitive abilities alone are not enough to succeed in formal schooling; students must be motivated to engage in learning activities. Children are born with an innate desire to learn and are intrinsically motivated to explore and gain control over their environment—often referred to as *mastery motivation* (Reineke, Sonsteng, & Gartrell, 2008). However, as many children reach school age the intrinsic motivation that drives learning has faded or disappeared. Fortunately, developmental science has helped us to understand the beginnings of motivation and strategies to build strong motivational patterns that help to promote learning in the later years.

Lepper, Greene, and Nisbett (1973) carried out a seminal study on the benefits of intrinsic motivation in a preschool classroom using a simple and age-appropriate procedure. Children's baseline tendencies to use markers were measured, and later children were either given an award or not given an award for playing with markers. The results showed that several weeks later, children who did not receive the award were more likely to continue the activity. That is, children who received a reward believed that the activity was tied to the reward, and when there was no longer any reward, children lost interest in the activity. These findings strongly suggest that intrinsic motivation can sustain children's interest in an activity, while extrinsic motivation in the form of a reward may undermine children's budding creative tendencies.

When children are intrinsically motivated, they try harder in the face of difficulty, which leads them to understand that effort leads to achievement. This in turn leads them to adopt an incremental view of their own ability (Dweck & Leggett, 1988; Dweck, 2000). Over three decades of research by Carol Dweck and her colleagues demonstrates that the type of praise that children hear has an impact on the motivation framework that they adopt, and in turn can predict behavior outcomes including how children reorient themselves after failure (Dweck, 2006; Kamins & Dweck, 1999; Mueller & Dweck 1998).

In one line of research, Dweck and her colleagues looked at the effect of different types of praise on children, mostly early adolescents (Dweck, 2006; Mueller & Dweck, 1998). First they gave each child a set of ten fairly difficult problems from a nonverbal IQ test and then praised some of the children for their *ability* ("Wow, you got eight right. That's a really good score. You must be smart at this."). They praised other children for their *effort* ("Wow, you got eight right. That's a really good score. You must have worked really hard."). Dweck and her colleagues found that 90 percent of the children who were praised for effort were willing to take on a challenging new task (Mueller & Dweck, 1998). In

Over three decades of research by Carol Dweck and her colleagues demonstrates that the type of praise that children hear has an impact on their motivation framework that they adopt, and in turn can predict behavior outcomes including how children reorient themselves after failure.

contrast, the ability-praised children rejected a challenging new task that they could learn from. Why? Because they were averse to taking risks for fear of failure. When children inevitably fail, they must reorient themselves to try harder to overcome obstacles by taking risks, and they are much more likely to take risks when their self-efficacy increases through practice and hard work (e.g., a growth mindset).

More recently, researchers have demonstrated that the type of praise children hear in the toddler years in real-world parent-child interactions can impact their motivational framework in the long term (Gunderson et al., 2013). When young children (ages 1-3) hear process praise (e.g., "you worked hard") in a naturalistic environment they are more likely to adopt a growth mindset at later ages (ages 7-8). Interestingly, parents' use of person praise (similar to ability praise, e.g., "you're so smart") did not predict children's later orientation toward a fixed mindset. Gunderson et al.'s findings are noteworthy because they demonstrate the role of process vs. person praise in a naturalistic interaction (not in a lab), they show the long-term impact of the type of praise on children's motivational framework, and they suggest that interventions focusing on the type of praise parents give to their toddlers can have a long-term impact on children's beliefs about intelligence.

Together, the research by Dweck and colleagues demonstrates that children who hear praise for effort may have a very different belief system from children who hear praise for traits (Cimpian et al., 2007; Dweck, 2006; Gunderson et al., 2013; Kamins & Dweck, 1999; Mueller & Dweck, 1998). More specifically, guiding children to focus on the process that leads to learning and improvement can foster a growth mindset and play a positive role in motivation and achievement.

In a recent article, Dweck (2015) revisited her often-cited theory and emphasized that a growth mindset is more than just effort—equal emphasis should be placed on trying new strategies and learning from others to improve. For example, praising students for

Links to creativity: Intrinsic motivation fuels creativity

Motivation inspires children to explore and satisfy their curiosity. When individuals are intrinsically motivated, learning for the sake of learning and self-improvement, they are more likely to be creative. In a classic study demonstrating the benefits of intrinsic motivation in preschoolers, researchers first measured children's baseline tendencies to use markers and later children were either given an award or not given an award for playing with markers (Lepper, Greene, and Nisbett, 1973). Children who did not receive an award were more likely to continue using markers compared to children who received an award. These findings strongly suggest that intrinsic motivation can sustain children's interest in an activity, while extrinsic motivation in the form of a reward may undermine children's budding creative tendencies.

Further evidence for the positive role of intrinsic motivation in the creative process was found in a study with college students in which two groups of participants wrote poems after being primed with intrinsic or extrinsic motivation (Amabile, 1985). The participants in the intrinsic motivation condition wrote poems that were judged to be more creative by independent raters. Additional research suggests that extrinsic motivation is often associated with lower creativity in studies of the workplace (Amabile, 1983, 1988, 1993) and may lead students to study less regularly, show less excitement about schoolwork, and use less innovative strategies to tackle challenging material (Simons, Dewitte, & Lens, 2000).

A rich and growing body of research supports the conventional wisdom that creativity is best fostered by an internal drive to accomplish tasks for their own sake. It is the pure joy of discovering something new that fuels our creative potential.

effort ("Great effort! You tried your best!") is only part of the equation. It is just as important to emphasize that learning and improving happen over time ("Let's talk about what you've tried, and what you can try next."). Dweck also cautions banning fixed mindsets and the dangers of developing a "false growth mindset." That is, some teachers and parents claim to understand and foster growth mindsets in children, but do not follow through with their actions and responses to children's mistakes. What is the best way to adopt a true growth mindset? Dweck advises recognizing fixed-mindset reactions when facing challenges (e.g., feeling anxious, incompetent, defeated), acknowledging and accepting those thoughts and feelings, and being mindful that the path to a growth mindset is a journey filled with many twists and turns.

Big idea #4: Environments that focus on needs of relatedness, competence, and autonomy support the development of motivation.

Since early childhood is such a sensitive and important time for the development of motivation, much research has focused on creating environments that support beliefs and foster skills that contribute to intrinsic motivation (Carlton & Winsler, 1998; Stroet, Opdenakker, & Minnaert, 2013; Vartuli & Rohs, 2008). More specifically, environments that foster relatedness, competence, and autonomy provide ideal settings for intrinsic motivation to thrive. This approach is theoretically based on *Self Determination Theory* (SDT; Deci & Ryan, 1985; 1991), a broad motivational theory that links a greater sense of choice to better conceptual understanding and enhanced personal growth and adjustment. Carlton and Winsler (1998) provided a comprehensive list of research-based principles for strengthening intrinsic motivation in young children that highlight this trio of concepts. For example, fostering self-evaluation by giving children opportunities to evaluate their own activities provides a sense of control over their own environment and ties to both competence and autonomy. In addition, including activities that promote joint attention and joint

collaboration can increase feelings of relatedness by giving children the opportunity to interact with another child or adult in consistent and predictable ways.

More recently, Vartuli and Rohs (2008) highlighted the power of intrinsically motivated content and the importance of focusing on children's interests as the driving force in selecting the content for children's projects. In order to extend and enhance children's learning, they need to solve "real, relevant, authentic, and meaningful problems" (Vartuli & Rohs, 2008, p. 394). Vartuli and Rohs described the "panning for gold" method of finding the most relevant and meaningful topics from among all of the children's interests. That is, when you pan for gold, you start with nuggets of gold, dirt, and other debris all in the pan, but eventually only the nuggets of gold remain. In the process of selecting topics for projects and themes, it is important to start with surveying the varied interests of the group and then identifying the most valuable and meaningful topics by looking for content with emotional investment. Dewey (1913) eloquently described the importance of following children's interests:

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> If we can discover a child's urgent needs and powers, supply an environment of materials, appliances, and resources—physical, social and intellectual—to direct their adequate operation, we shall not have to think about interest. It will take care of itself. (Dewey, 1913, pp. 95-96)

Cognition

Scientific reasoning

Piaget (1930) believed that young children construct knowledge by actively exploring their environment. Decades of research support that children construct knowledge—particularly causal knowledge—through hands-on experiences, however, more recent research suggests that young children know much more about the causal structure of the world than Piaget believed (Flavell, Green, Flavell, Harris, & Astington, 1995; Gelman & Wellman, 1991; Spelke, Breinlniger, Macomber, & Jaconbson, 1992). In a recent article for the Smithsonian, developmental psychologist and author Alison Gopnik (2012) discussed scientific discoveries from the past three decades that strongly suggest that "children learn about the world much as scientists do—by conducting experiments, analyzing statistics and forming intuitive theories of the physical, biological and psychological realms."

With respect to early science skills, young children exhibit intuitions fundamental to formal scientific reasoning, and their early knowledge may bear structural resemblance to scientific theories (Gopnik & Schulz, 2007; Legare, 2014). A rich and growing body of literature on preschoolers' causal reasoning demonstrates that even young children can make causal inferences and predictions based on probabilistic data (Gopnik, Sobel, Schulz, & Glymour, 2001; Schulz & Gopnik, 2004). More specifically, preschoolers recognize confounded evidence, test hypotheses by performing—and even designing—interventions to isolate relevant variables within a causal system, and make predictions about the outcomes of such interventions (Legare & Lombrozo, 2014; Schultz, Gopnik, & Glymour, 2007). Relatedly, research with toddlers as young as 24 months suggests that young children have the capacity to infer a wide range of new causal relationships, especially when those events are outcomes of human actions (Meltzoff, Waismayer, & Gopnik, 2012). Impressively, additional experiments show that 24-month-olds can plan their own causal actions to bring about desired effects after observing other people's actions (Waismayer, Meltzoff, & Gopnik, 2015).

While the groundwork for scientific reasoning is laid before school, children's explicit knowledge of the strategies they implicitly employ develops during the school years and can benefit from direct instruction (Chen & Klahr, 1999). Studies show a reinforcing relationship between learning such investigative skills and strategies and conceptual domain knowledge. A similar, synergistic relationship may be evident between explanation and exploration. Explanation leads the child to selectively attend to information relevant to a functional or mechanical understanding of a causal system. Exploration, in turn, may enable the child to test the hypotheses generated via explanation (Legare, 2014). This early process of hypothesis generation and revision seems to benefit from peer collaboration, and can be scaffolded by an adult making causal relationships more salient in physical stimuli, by verbally framing activities, and by asking children to self-explain (Butler & Markman, 2012). *Scaffolding*, a common term used in early

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childhood development and education, refers to the process of an adult or more skilled individual supporting a child's learning by modeling a skill or providing clues and strategies to solve a problem. A critical aspect of scaffolding is adjusting the level of support to fit the child's current level of knowledge or performance. For example, when a child is first learning to count, parents can scaffold the child's learning by suggesting the strategy of tapping each object once as they count.

Big idea #1: Children generating explanations benefits causal learning.

Explanation and exploration are critical components of the scientific process and the synergistic relationship between the two is a current and growing focus for developmental researchers examining early science reasoning. In a recent review of the contributions of explanation and exploration to children's scientific reasoning, Legare (2014) shed light on the relation between explanation, exploration, and the development of scientific reasoning and proposed that explanation and exploration "operate in tandem as hypothesis-generating and hypothesis-testing mechanisms." That is, explanation serves as a tool for generating and evaluating hypotheses while exploration provides a mechanism for testing them.

One series of studies (Legare & Lombrozo, 2014) 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.

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 two learning tasks to assess the extent to which they understood the machine's functional-mechanical relations and memory for perceptual features of the machine. In the *causal choice* task, 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). For the *color choice* task, children were presented with five other parts that were all the correct size and shape, but only one was the same color as the original. Children were asked, "Can you point to the piece that will make my machine look like it did in the beginning?" This task was designed to assess children's memory of a perceptual feature of the machine, a property irrelevant to functional-mechanical understanding. 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 prompted to explain performed significantly better on measures of causal learning. Interestingly, the children in the explanation condition performed *worse* on non-causal learning (i.e., color choice task).

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, but not on measures of non-causal learning. 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

These findings suggest that when children engage in exploratory play and "get into everything," they may distinguish confounded and unconfounded evidence and explore more when there *is something to be learned*.

performed significantly better on this generalization task than non-explainers. The findings from both studies suggest that explanation has unique benefits over observation or other kinds of verbalization and selectively supports causal learning. Furthermore, the results demonstrate that explanation directs children's attention to causal patterns, but does not improve memory for functionally irrelevant, perceptual details. Legare and Lombrozo's findings also have practical implications for training methods to improve the quality of self-explanation in young children by highlighting the value of intentionally worded explanation prompts. 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."

Relatedly, Butler and Markman (2012) conducted a series of studies providing evidence that scaffolding from adults in the form of verbal prompts can facilitate children's causal reasoning. The researchers explored when and how preschoolers are able to apply their causal reasoning abilities to identify a causal problem and attend to meaningful evidence in a game-like scenario. Children were introduced to a lion puppet that interacted with different animals, some of which made the lion laugh and some that did not. Butler and Markman found that when children were given explicit framing of the causal problem—a simple question like "Which animals make Lion laugh?"—they were better able to make causal inferences. That is, when children are faced with the problem of identifying and extracting evidence from situations with many actions and events (picture a typical preschool classroom), verbal framing and prompts from adults can act as a type of scaffolding that enables children to focus their attention on the most meaningful evidence to solve a causal problem.

Big idea #2: Exploratory play provides a mechanism for children to learn cause and effect relationships.

Researchers and theorists have long believed that children learn about causal relationships through exploratory play. How does the type of evidence children observe affect their exploratory play? More specifically, will children engage in more exploratory play when they observe confounded evidence (i.e., evidence that fails to distinguish a clear cause) about the causal structure of an event? Schulz and Bonawitz (2007) examined this question by introducing preschoolers to a novel toy box with two levers that made a duck and a puppet pop up. One group of children was shown that the duck popped up when you pressed one lever and the puppet appeared when you pressed the other lever. The second group of preschoolers was instructed to press one lever at the same time as the experimenter pressed the other, and then saw that both the duck and puppet appeared. In this case, the causal structure of the toy was ambiguous and children never got to see which lever controlled the duck and which controlled the puppet.

The experimenter then let the children play with the familiar toy box, as well as a similar novel toy for 60 seconds. As predicted, children in the first group that were clearly shown how the toy worked played with the familiar toy much less compared to children in the second group that were faced with confounded evidence. They already knew how the toy worked (i.e., the specific function of each lever) so they were much less interested in exploring it, and were more likely to play with the novel box. In contrast, children faced with confounded evidence were more likely to first reach for the familiar box and exhibited a desire to figure out which lever did what. These findings suggest that when children engage in exploratory play and "get into everything," they may distinguish confounded and unconfounded evidence and explore more when there *is something to be learned*.

In a more recent series of studies, Cook, Goodman, and Schulz (2011), provide additional support for the claim that children's exploration helps generate evidence relevant for disambiguating causal information and can design informative interventions that follow the basic principles of experimental design. The researchers showed preschoolers a "special machine" that played music when some objects were placed on it and did not play music when other objects were placed on it. Children in the All Beads condition were shown that four out of four beads (each placed on the machine one at a time) made the machine go. In the Some Beads condition, children were shown that two out of four beads activated the toy. The experimenter then showed both groups of children two pairs of beads: one pair that could be pulled apart into two individual beads, while the other pair was glued together. Lastly, the children learned that both bead pairs make the machine go. So in the All Beads condition, the evidence about the bead pairs is unambiguous and children can safely assume that both beads in both pairs activate the toy. In contrast, in the Some Beads condition the evidence about the bead pairs is ambiguous and fails to distinguish which bead makes the machine go (or if they both do).

Cook et al. (2011) hypothesized that if children understand that causal variables need to be tested independently then they should be more likely to separate the beads in the bead pairs and place them individually on the toy in the Some Beads condition than in the All Beads condition because the potential for information gain in the Some Beads condition is much higher. Across two studies, the researchers found that children in the Some Beads condition, where only half of the beads activated the machine in the initial demonstration, were much more likely to perform the informative "experiment" than those in the All Beads condition. This was not the result of children simply exploring more broadly in the face of ambiguous evidence (they performed the same variety of actions during free play in all conditions), but rather children conducting informative interventions in the condition where the causal mechanism was ambiguous (i.e., pairs of beads activated the machine, but they had evidence that only some of the beads were responsible). That is, preschoolers in this study were not only able to distinguish ambiguous and unambiguous evidence, but they were also able to selectively perform actions that maximized the amount of information gained. Thus, despite the often unstructured appearance of children's exploratory play, research supports that children's exploration helps generate evidence to disambiguate different causal variables and facilitates early science reasoning.

From a methodological perspective, science and children's museums are ideal places to test the relationship between exploration and explanation

because engaging exhibits and parent-child interactions foster these early science skills and provide an opportunity for children to practice science reasoning in a social context (Legare, 2014). For example, Legare and colleagues have conducted several studies at the Thinkery, a children's museum in Austin, Texas, that explore the relationship between explanation, exploration and the development of scientific reasoning (see Legare, 2014; Legare &

Lombrozo, 2014). This work builds on previous research that demonstrates the value of children's museums in promoting exploration (Gaskins, 2008) and rich parent-child conversations (Callanan & Jipson, 2011) to examine the interaction between children's cognition and the social context of family interactions.

Math knowledge and skills

Young children's mathematical knowledge varies greatly when they enter school. More specifically, the mathematical knowledge of children from low-income households trails far behind their peers from more affluent households (Jordan, Kaplan, Olah, & Locuniak, 2006; Jordan, Levine, & Huttenlocher, 1994; Starkey, Klein, & Wakeley, 2004). Research tells us that these early deficits have large and long-term consequences—those who start behind generally stay behind. That is, 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). A growing body of literature supports that this gap can be reduced by providing children from low-income backgrounds with opportunities to engage in playful activities, such as number board games and building with blocks, that develop foundational math skills aligned with Common Core standards. Moreover, a series of studies by Sielger and Ramani (2008; Ramani & Siegler, 2008; Ramani & Siegler, 2011) demonstrates that young children's number skills—from both low-income and middle-income backgrounds—can be improved quickly and substantially through experience playing a linear number board game. Another related body of literature highlights the importance of guided play and joint block play activities as valuable ways to promote early math and spatial abilities (Ferrara, Hirsh-Pasek, Newcombe, Gonlinkoff, & Lam, 2011; Ramani, Zippert, Schweitzer, & Pan, 2014; Verdine, Golinkoff, Hirsh-Pasek, Filiopwicz, & Chang, 2014).

Big idea #1: Playing a linear number-based board game improves numerical knowledge in preschoolers.

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—similar to the popular children's game 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 ten and the color game had squares of different colors. On each turn, children spun a spinner and moved a token the indicated number of spaces. Children were asked to say the numbers or colors on the spaces as they moved their token. For example, if the child was on three and spun a two, he would say "four, five" as he moved his token. Children played one of the two games one-on-one with an experimenter for four 15- to 20-minute sessions over a two-week period. After approximately an hour of game playing time, children who played the number game showed significant improvements on a number line estimation task, whereas children who played the color version of the game did not show comparable improvements in numerical magnitude. The number line estimation task is frequently used to assess number sense and involves asking children to mark the location of a number on a line. Children are first asked to identify a number at the top of a page and then asked, "If this is where zero goes, and this is where ten goes, where does *N* go?"

In subsequent studies, Siegler and Ramani replicated and extended their findings by demonstrating the generality of the benefits of playing the number board game with regard to improvements in the range of

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numerical knowledge and stability of learning over time. More specifically, Ramani & Siegler (2008) compared the effects of playing the number and color board games on the understanding of numbers one through ten on four tasks: (1) number line estimation (same task used in Siegler & Ramani (2008)), (2) magnitude comparison ("Which number is bigger, N or M?"), (3) number identification ("What number is on the card?"), and (4) counting ("Can you count from one to ten?"). The researchers assessed performance on the four tasks on pretest, posttest and on a follow-up session nine weeks after the final game-playing session. Similar to the previous study (Siegler & Ramani, 2008), children's accuracy on the number line estimation task increased after approximately an hour of game playing time with the number board game, but no significant gains were found for the color game. In addition, the same pattern of improvements was found for the other three numerical tasks (e.g., magnitude comparison, numerical identification, and counting tasks), and these gains remained present nine weeks later in the follow-up session. Furthermore, the researchers had similar findings when the number game was played with younger preschool children from middle-income backgrounds (Ramani & Siegler, 2011) and in a classroom setting with teachers' assistants who facilitated the game with small groups of children (Ramani, Siegler, & Hitti, 2012). Together, these studies strongly suggest that playing a simple number board game one-on-one with an adult or small group of peers can promote the numerical knowledge of preschool children. These findings provide practical advice for parents, teachers, and out-of-school educators on how to improve a broad range of numerical skills in children with a simple and inexpensive activity that children can enjoy in a variety of learning environments.

Big idea #2: Guided play can help children learn early math (and other) skills.

During early childhood, children learn best through play and an emerging body of research highlights the importance of *guided play* as an age-appropriate and effective method to foster exploration and learning in young children. What is guided play? In a recent article, Weisberg and colleagues (2015) define guided play by comparing it to free play and direct instruction. They describe free play as both child-initiated and child-directed—children decide both what to play and how. In contrast, direct instruction is both adult-initiated and adult-directed. Guided play is a combination of adult initiation and child direction. More specifically, 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). A growing body of research suggests that the balance between structure and freedom in guided play makes it a successful tool for a range of educational outcomes and often more effective than free play or direct instruction (Alfieri, Brooks, Aldrich, & Tennebaum, 2011; Fisher, Hirsh-Pasek, Newcombe, & Golinkoff, 2013; Weisberg, Kittredge, Hirsh-Pasek, Golinkoff, & Klahr, 2015). 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 two typical and two atypical exemplars of a shape and explained that all of the shapes were "real" shapes even though they looked different. The experimenter encouraged the child to touch and trace the shapes and asked her questions to encourage "discovering" each shape's distinguishing features. In the didactic instruction condition, the experimenter used the same introduction to the activity as in the guided play condition, but during training the experimenter acted as the explorer while the child passively listened and watched. Lastly, in the free play condition, children were allowed to play with the shapes in any way that they wished. After participating in one of the three training conditions for approximately 15 minutes, children were given a shape sorting task in which they were asked to place all "real shapes" in a box and all "fake shapes" in a trashcan ("Is this a real triangle or a fake triangle?" Why do you think so?"). Fisher et al. found that children in both the guided play and direct instruction conditions learned the properties of the shapes; however, children taught shape properties through guided play were better at accepting less typical instances of shapes, like triangles with large internal angles. In contrast, children in the direct instruction condition tended to display relatively concrete knowledge of shapes and often rejected atypical exemplars as "real shapes." 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 young children can learn to identify shapes in a rule-based manner, earlier than they would learn this strategy in school. Moreover, these findings show that guided play is an effective tool for directing children's attention to defining features of shapes and prompts deeper learning and transfer of knowledge.

Fererra, Hirsh-Pasek, Newcombe, Golinkoff, and Lam (2011) provide additional evidence to support the benefits of guided play in the context of a block building activity. The researchers observed parents and their preschool children play with blocks in one of three different conditions: (1) free play with blocks, (2) guided play, and (3) play with assembled structures. In the free play condition, the parents and children played with blocks without any guidance. Children and parents in the guided play condition were given five numbered photographs (similar to instructions for IKEA furniture assembly) that depicted steps to build a garage or helipad. In the last condition—play with preassembled structures—children and parents were given a completed and glued-together model or a garage or helipad and extra play pieces including vehicles and figures. Ferrera et al. found that children in the guided play condition produced significantly more spatial talk than those in the free play condition and did not differ from those in the preassembled condition. Furthermore, the researchers found that parents in the guided play condition produced significantly higher proportions of spatial talk than the parents in the other two conditions. Taken together, these results suggest that the play context impacts the amount of spatial vocabulary that children are exposed to and produce, which in turn can benefit their spatial skills.

Big idea #3: Block building is an ideal play activity for promoting geometric and spatial sense.

Another line of research that focuses on guided play and building activities provides evidence that geometric and spatial reasoning can be fostered through playful block building activities (Ferrara, Hirsh-Pasek, Newcombe, Gonlinkoff, & Lam, 2011; Ramani, Zippert, Schweitzer, & Pan, 2014; Verdine, Golinkoff, Hirsh-Pasek, Filiopwicz, & Chang, 2014). In a recent study, Ramani, Zippert, Schweitzer, and Pan (2014) examined pairs of preschoolers from predominantly middle-class homes during a guided play block building activity in which the children were instructed to build a house with large colorful blocks. The children were asked to include specific features of a house (e.g., a door, walls, and rooms) in their structure, but were not given explicit instructions on how to complete it. Ramani and colleagues examined the children's communication, building behaviors during interactions, and coordinated actions with their peer partner during the building block activity. The researchers found that the peers often engaged in discussion about the design of the structure of their houses ("I'm going to put more blocks on top."), the symbolic meanings of the blocks ("I'm making a door."), and the spatial relations of the placement of the blocks ("Move this closer to here."). These findings suggest that encouraging guided, cooperative block play provides an opportunity for children to increase their spatial understanding through quantity-related and spatial talk with a same-age peer. Relatedly, Pruden, Levine, and Huttenlocher (2011) investigated

the relation between spatial talk in toddlers and preschoolers and found that more spatial language between ages 14 and 46 months links to better performance on spatial problem-solving tasks at 54 months.

How does spatial reasoning relate to math skills and achievement? A range of studies supports a link between activities that develop spatial thinking and math skills and achievement. For example, Grissmer et al. (2013) gave kindergarten and first graders Legos, Wikki Stiks, and pattern blocks and asked them to copy model designs. They found that this experience with visuospatial toys increased the children's math skills. In another study with older children, Cheng and Mix (2012) showed that 6- and 8-year-olds' performance on calculation problems and use of place value concepts increased after experience with a mental rotation task. From a neuroscience perspective, researchers have found that similar areas in the brain are active when individuals engage in space and math processing (Göbel, Walsh, & Rushworth, 2001).

In a recent study with Head Start preschoolers, Verdine, Golinkoff, Hirsh-Pasek, Filiopwicz, and Chang (2014) investigated the relation between spatial assembly and early math skills. Children's spatial skills were assessed by asking them to build a set of target constructions from models and were given identical pieces to the model structure. To assess early math skills, children were given the Number and Operations subtest of the Early Mathematics Assessment System (EMAS; Ginsburg, Pappas, & Lee, 2012), which included four tasks: (1) *Free counting task*: Ask child to count and note highest number; (2) *Give-N task*: Ask child to give specific number of objects (i.e., three) from a larger quantity (i.e., seven); (3) *Number order task*: Ask child "What number comes after X when we count?" and (4) *Nonverbal addition and subtraction task*: Experimenter shows one chip to child, puts it under a mat, and then shows another chip and puts it under the mat. The child is then asked how many chips are under the mat. As predicted, Verdine et al. found that scores on the spatial assembly task were correlated with scores on the EMAS subtest indicating that spatial skills are linked to early math skills. In addition, the researchers collected parent report data about the spatial terms that parents used with their children and found relations between spatial language (e.g., between, above, below, and near) and scores on the EMAS suggesting that parental spatial language input is an important foundation for early math learning.

Taken together, this rich and diverse body of research on linear numerical math games and building block activities using guided play supports the conventional wisdom that play and learning can and *should* go hand in hand, especially for young children. Moreover, most children enjoy these playful activities and are intrinsically or internally motivated to participate in these activities at home or in a preschool setting. Research tells us that intrinsic motivation has a wide range of benefits for learning and development (Stipek, 1996). That is, when children are intrinsically or self-motivated, they are more attentive, prefer challenging tasks, express pride in their achievements, show a desire to expend their knowledge, and make connections between content they learn in the classroom and out-of-class activities (Stipek, 2002).

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Language and literacy

Children's language and literacy skills in kindergarten are strongly related to their later academic success (Cunningham & Stanovich, 1997; Snow et al., 1991; Whitehurst & Lonigan, 1998). Yet young readers in the U.S. are more likely to read below average in their grade than at or above, and children enter kindergarten with language gaps that too often widen throughout their school years (Dickinson, McCabe, Anastasopoulos, Peisner-Feinberg, & Poe, 2003; Hart & Risley, 1995). In an effort to address these issues, the National Early Literacy Panel was convened in 2002 to examine strong, peer-reviewed research to determine "what can be done in U.S. homes, preschools, and kindergartens to better prepare children to succeed in learning to read and write" (NELP, 2008, p. v). The result was a review of approximately 500 studies, and a meta-analysis of the effect sizes of factors influencing short- and longer-term reading achievement. The report (which starts with a highly readable summary) represents an excellent synthesis of literacy research up until 2003 and is available online. It is accompanied by an equally accessible educator-oriented reference on practices that promote the 11 precursor abilities the panel identified (Goodson, Layzer, Simon, & Dwyer, 2009). For complementary overviews of longitudinal research before and after 2003, see the chapter by Paratore, Cassano, and Schickedanz (2011) in the Handbook of Reading Research, Vol. IV (and especially the sections on Skilled Reading and Predictors of Beginning and Later Reading Success, pp. 110-115), as well as Chapter 6 of the Handbook of Early Literacy, Vol. III (Development of Early Literacy: Evidence from Major U.S. Longitudinal Studies: Burchinal & Forestieri, 2011), which focuses especially on positive parenting and child care practices.

Together, these reviews point to a recurring set of decoding abilities (e.g., alphabet knowledge, phonological awareness, writing, phonological memory, and rapid automatic naming of letters, digits, objects, or colors), as well as environmental factors that influence cognitive, behavioral, and emotional outcomes more generally, and reading among them. A critical message, supported by long-term longitudinal data and developmental behavioral studies, is that early oral language skills exert a pervasive and long-lasting influence on reading, but may be easily overlooked (Dickinson, Golinkoff, & Hirsh-Pasek, 2010; Lonigan, 2007; Metsala, 2011). This is exciting because from many perspectives, children are language-learning aficionados: in the years before kindergarten, they have figured out how to segment sounds and words from the speech stream (Kuhl, 2004); they say words in the correct order more often than not (Brown, 1973), and they understand subtle cues to the intentions of their conversational partners (Creel, 2012; Matthews, Lieven, Theakston & Tomasello, 2006). In the domain of word-learning, young children infer the meanings of new words from the surrounding discourse (Sullivan & Barner, 2015) and can even learn words through overhearing (Akhtar, 2005) and over Skype (Roseberry, Hirsh-Pasek, & Golinkoff, 2014). This remarkable, uninstructed talent, however, does not mean that caregivers and teachers should not encourage children's general language-learning just as they promote more measurable literacy skills. Language is hard to *teach* (Neuman, 2011). Yet by providing stimulating environments (Burgess, Hecht, & Lonigan, 2002; Leventhal, Martin, & Brooks-Gunn, 2004) and engaging children in rich, interactive discourse (Weisberg, Zosh, Hirsh-Pasek, & Golinkoff, 2013), adults can benefit children's language development in dramatic and long-lasting ways. Doing so ensures the task of learning to read—and read for *understanding*—will go much more smoothly.

Big idea #1: Oral language skills underlie long-term literacy.

Oral language forms a platform for the precursor skills that are highly predictive of reading achievement. *Phonological awareness* (the ability to identify and manipulate units of sound in speech) is an example of a decoding skill that seems to be founded on oral language. Evidence for this comes from a yearlong longitudinal study during which two groups of preschoolers received either explicit phonological awareness training, or an oral language and vocabulary intervention. Remarkably, the preschoolers in the latter group showed improvement in phonological awareness along with greater oral language skills, despite not receiving direct training. The first group showed improvement exclusively on specific measures of phonological awareness (Lonigan, 2007), further confirming the value of oral language skills like vocabulary as instructional targets.

> **...by providing stimulating environments and engaging children in rich, interactive discourse, adults can benefit children's language development in dramatic and long-lasting ways. Doing so ensures the task of learning to read—and read for understanding—will go much more smoothly.**

Vocabulary is also important because the words children know represent the ideas they can read about and understand. While early-developing decoding abilities enable a child to sound out a word on a page, language skills enable her to map that word to a concept, and make sense of the sentence around it. A concept familiar to teachers across grades is that of "context clues," or cues in the text surrounding an unknown word that give clues to its meaning (Fukkink & de Glopper, 1998). Using context clues—critical to reading comprehension—requires a reader stumped by a new word to make inferences about its meaning based on its relation to the content surrounding it. As it turns out, it also describes what preschoolers are doing when they hear a new word.

In a series of word-learning experiments, Sullivan and Barner (2015) explored whether 2- to 5-year-old children could use the relations between words in the speech surrounding a new word to infer its meaning. In the critical trials of their experiments, children heard a stuffed animal say something like, "I'm very hungry, but sweet things make me sick. Look what I want! There's a *blick* on the table!" Children were then asked to "find the *blick*" from among pictures of a cookie, pretzel, and shoe. The experimenters reasoned that if children were merely attending to the individual words in the discourse preceding the novel word, they would select the cookie (based on hearing "hungry" and "sweet"). If, however, children were attending to the relations *between* the words in the discourse, they would select the pretzel by inferring that the novel word referred to a) a food ("I'm hungry"), but b) not a sweet food ("...but sweet foods make me sick"). The authors found that 3- and 4-year-old children successfully chose the correct referent for the novel word. Moreover, they found that the two-year-olds who selected one of the inappropriate objects also failed a post-test assessing whether they knew, for example, that a cookie was an example of a "sweet food." This suggests that 2-year-olds' limitations were in real-world knowledge, rather than inferential capacity. Sullivan and Barner's (2015) results are especially promising for later instruction in reading comprehension, suggesting that strategies like "using context clues" are in fact explicit formulations of skills that have been in place since children were toddlers.

Big idea #2: Socially engaging children from a young age strengthens speech processing and word learning.

Children exhibit wide variability in their language skills from a young age. One study, for example, reported 24-month-old vocabularies ranging from 56 to 520 words (Fenson et al., 1994). These individual differences have a well-established association with environmental factors (themselves widely variable) like the amount and quality of child-directed language and gesture (Fernald, Marchman, & Weisleder, 2013; Rowe & Goldin-Meadow, 2009). In one sample of Spanish-speaking families, researchers estimated infants heard anywhere from under 2,000 to 29,000 adult words each day, depending on their household (Weisleder & Fernald, 2013). Another study that followed a cohort of preschoolers throughout their schooling found effects of the richness of their home and classroom environments through at least fourth grade (Roach & Snow, 2000). These and other studies point to the importance of engaging adult-child interactions for language-learning from infancy through kindergarten.

Roseberry, Hirsh-Pasek, and Golinkoff (2014) discovered the importance of a particular aspect of adult-child interaction on language development. In a study that was innovative for its use of video chatting technology, the authors tested the effect of social contingency on children's word-learning. They found that 30-month-olds, but not 24-month-olds, learned a novel word taught to them over Skype as well as they did in a live interaction. This held as long as the video call was *socially contingent*—that is, the experimenter was timely and appropriate in her responses to the child. Children whose Skype instruction lacked social contingency (they saw the pre-recorded video of another child's call) failed to learn the new word. This finding has implications for learning from media like television. For very young children, language-learning seems to be dramatically enhanced by live interaction.

Looking at even younger children, Weisleder and Fernald (2013) conducted a study examining potential mechanistic relations between child-directed speech and children's own speech processing and vocabulary. In the study, 19-month-old children from Spanish-speaking households were equipped with audio recorders secured to their chests in the pockets of specialized clothing. In this way, the researchers were able to estimate the number of words directed to each child in a typical day. Children's efficiency processing incoming speech was also assessed two times, five months apart, in an experiment measuring how long it took them to look at a matching picture when they heard a familiar word (e.g., look at the apple when they heard "la manzana"). The authors found that not only could differences in the amount of child-directed speech explain the gains in speech processing efficiency children made over the course of the study, but that those gains could explain later differences in children's vocabulary sizes at 24 months. Thus, talking to children from a young age is of critical importance for increasing the speed at which they can recognize familiar words, and thereby add new ones to their vocabulary.

Other studies emphasize the importance of the *quality* of the child-directed speech children hear, as opposed to sheer quantity. One study using the same recording technology as the previous study explored the effects of speech style and social context in interaction on the language development of 11- and 14-month-old infants. Analyzing the infants' first-person recordings, they were able to estimate how much of each infant's time was spent one-on-one or with multiple adults, and being addressed in standard speech, or "parentese," the exaggerated speech adults often use with 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 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).

Another study took a different approach to examine the importance of parent-child communication quality over quantity. From an existing longitudinal dataset, the researchers selected videos of parent-child play sessions of families from low-income communities featuring two-year-olds of a diverse range of backgrounds and language outcomes the following year. They analyzed the videos for measures of the quality of *communication foundation* parents and children were co-constructing, assessing aspects of their interaction like its overall fluidity or cohesion, the child's attention to objects, events, words and gestures shared with the parent, and the dyad's engagement in familiar routines or rituals. The researchers found this measure of the quality of communication foundation assessed when the child was 24 months predicted their expressive language scores at 36 months, even when controlling for other factors, like speech quantity or general parental sensitivity (Hirsh-Pasek et al., 2015).

These results thus complement the findings of earlier studies investigating the effects of *quantity* of speech. High-quality speech is child-focused and supports the child's understanding of shared communicative contexts. While the overall *quantity* of speech the child hears is important for language development, these studies urge us to appreciate the *quality* of that speech, as well.

Big idea #3: Intentionally selecting and reading storybooks boosts children's linguistic and conceptual vocabulary.

Experts in child development, from parents, to early educators, and even pediatricians (High et al., 2014), recognize the value of shared storybook reading. In its meta-analysis of nineteen shared reading interventions, the NELP found significant evidence across studies for the positive impact of shared reading on children's print knowledge and oral language skills (NELP, 2008). In a recent neuroscientific study, preschoolers from households that read more even showed greater brain activity in a region associated with meaning extraction and mental imagery as they listened to new narratives (Hutton et al., 2015). So while it is not news that reading to children is positive, recent research illuminates *how* it is that the storybook reading context can bolster children's early cognitive and linguistic skills.

One potential function of storybook reading may be to increase children's print knowledge. *Print knowledge* refers to a constellation of skills reflecting children's understanding of the forms and functions of print. Developing print knowledge is evident in children's pretend play: when a child scrawls a receipt in the checkout line at her preschool "grocery store," for example, she is demonstrating knowledge of print organization and meaning. However, despite the importance of print knowledge, adults rarely overtly direct children's attention to print during activities that would seem to provide natural opportunities, like shared book reading (Ezell & Justice, 2000). Across multiple longitudinal studies, print knowledge is implicated as a contributor to elementary reading success (NELP, 2008), making the discovery of home and classroom practices that support it critically important.

Justice and colleagues demonstrated that intentional shared reading can be just such a practice. In one of their intervention studies, parents of 4-year-olds were sent home with picture books, and instructed to embed print referencing in their shared reading for four weeks. Print referencing includes questions, comments, or requests about print (e.g., "Show me where the O is" or "What do you think this says?"), as well as non-verbal gestures like tracking print on the page while reading (Justice & Ezell, 2004). Compared to children whose parents had read the same books aloud without explicit print referencing, children in the intervention condition of their study exhibited significantly greater improvement in recognizing words in print, segmenting and counting words, and demonstrating knowledge of basic print concepts (Justice & Ezell, 2000).

In addition to explicit print referencing, there are features of children's books themselves that naturally cause more engagement with print. Acknowledging children's tendency to attend more to storybooks' pictures than their text, researchers have identified four key features of storybooks that naturally encourage children's print

Links to creativity: Imagination and word learning

Children love to read and listen to stories. Some stories contain realistic themes of farmers and firemen and some contain fantastical themes of wizards and fairies. Does children's learning vary depending on the content of the stories that they hear? A recent study by Weisberg and colleagues (2015) examined this question as part of a large-scale study of vocabulary learning in schools in low-income communities. Preschoolers were taught words using either realistic or fantastic storybooks and toys over a two-week intervention. Children's comprehension knowledge did not differ across conditions. In contrast, children who learned the words presented through books and reinforced through play sessions with a fantastic theme showed significantly greater gains in their production knowledge of the new words.

These findings support previous work showing that encouraging imagination-based thinking enhances children's reasoning abilities, including their understanding of improbable events and how to conceptualize pretend actions (Lillard & Sobel, 1999; Weisberg & Sobel, 2012). Researchers speculate that fantastical contexts may encourage flexible thinking in children and as a result be more successful on a range of problem solving and reasoning tasks. In the case of word learning, the fantastical themes including elements not present in children's everyday lives may encourage children to pay greater attention to the stories and new words within the stories.

With good reason, the preschool years are often referred to as the "high season of imaginative play" (Singer & Singer, 1990). Children naturally engage in pretend play with fantastical themes and a rich and growing body of work supports that imagination-based play and thinking has a wide range of benefits for language, reasoning, and problem-solving skills.

awareness (Evans & Saint-Aubin, 2005). Those 'print-salient' features are 1) visible sounds (e.g., when an animal like a snake has a printed sound (*hiss*) accompanying its picture), 2) visible speech (e.g., speech bubbles), 3) environmental print (e.g., labels of objects in illustrations), and 4) changes in font size, color, or style for accenting purposes (Justice et al., 2008).

Simultaneously capitalizing on these print-salient features and following up on evidence of at least the short-term effectiveness of print referencing on children's emergent literacy skills (see Justice & Piasta, 2011 for a review), Justice and colleagues conducted a 30-week-long intervention, this time implemented by teachers in preschools serving predominantly families from low-income communities. Teachers embedded print referencing in their classroom reading of storybooks selected by the researchers for their print-salient features. A year after the intervention, children who had received its most intensive version scored significantly higher on literacy and vocabulary assessments than children whose teachers had just read the books aloud. Another year later, those children also had better spelling, language comprehension, and word-reading. These results are promising and provide practical guidance for preschool teachers and parents for how they read to children. First, the literacy advantage conferred by intentional shared reading took place early in children's academic trajectory, before disparities correlated to socioeconomic disadvantage begin to widen (Chatterji, 2006). Second, this program required minimal materials, training, and only subtle adjustments to teachers' typical reading practices. The simplicity of the strategies teachers employed mean that any adult in a child's life can make a similar impact, especially since they took place during an activity that is already a part of many families' daily (or nightly) routines.

Ultimately, the strength of shared reading may be its power to spark adult-child conversations—about print, about new ideas, and about people.

Evidence from interventions, then, indicates that shared reading relates to positive literacy outcomes at least in part because it offers an opportunity for caregivers to intentionally promote children's metalinguistic awareness. In addition, the content of parent-child discussions during shared reading goes well beyond talking about print. Children's books themselves provide a source of rich and varied language that may in turn improve cognitive and linguistic outcomes. In one study, researchers compared the quality of language in children's books to that of child-directed speech outside of shared reading contexts. Not only did storybooks prove to be more *dense* with unique words, but those words were more varied than the unique words in equivalent samples of child-directed speech (Montag, Jones, & Smith, 2015). This implies that in hearing storybooks read aloud, young children are being exposed to words that they would never get in speech alone. As an example of the sort of conceptual impact that might make, several studies link shared reading to children's developing theory of mind (Adrian, Clemente, Villanueva, & Rieffe, 2005). Storybooks themselves are rich sources of mental state vocabulary (Dyer, Shatz, & Wellman, 2000), and even without text, they seem to inspire parents to engage in discussion further from the "here and now" than they do with their young children in everyday life (Sabbagh & Callanan, 1998). Reading storybooks promotes school readiness at least in part by infusing the adult speech available to pre-readers with qualitatively different and conceptually advanced vocabulary children might otherwise not encounter. However, that's not to say the child who requests her favorite book over and over again is missing out for the lack of novel words. Ultimately, the strength of shared reading may be its power to spark adult-child conversations—about print, about new ideas, and about people.

Social and emotional development

Prosocial behaviors

An age-old question that has been the focus of a rich body of literature is "Why do people help each other?" A current debate in developmental psychology has attempted to reveal if our early social experiences play a critical role in shaping our capacity to help. Recent studies strongly suggest that altruism has environmental triggers and can be elicited by a very simple (and short) reciprocal activity (Barragan & Dweck, 2014). Altruism is the act of promoting the welfare of another person—this welfare could range from a simple act (e.g., giving back something a person dropped) to elaborate (e.g., alleviating pain during a difficult situation). Researchers have also found that short synchronous interactions (e.g., tapping a drum at the same time as a partner) fostered perceived similarity and closeness with an interacting partner in grade school children (Rabinowitch & Knafo-Noam, 2015). Relatedly, infants were more likely to engage in altruistic behavior after having been bounced to music in synchrony with an experimenter, compared to infants who were bounced asynchronously (Cirelli, Einarson, & Trainor, 2014). With a similar focus on music, Kirschner and Tomasello (2010) found that 4-year-olds who engaged in joint music making were more helpful and cooperative relative to children who participated in a non-musical activity. Together, these studies provide convincing evidence for the positive effects of simple, short, and easy-to-facilitate interactions between children and an adult or between two children that have powerful and meaningful influences on children's prosocial behaviors.

Big idea #1: Reciprocal and synchronous interactions promote helping and perceived similarity and closeness in young children.

Helping, giving, and cooperation are fundamental aspects of human nature, and the study of altruism is one of the most popular and fruitful areas of research in developmental and social psychology. Are children inherently helpful and what role, if any, does social experience play in promoting early prosocial behaviors? A seminal study by Warneken and Tomasello (2006) found that most toddlers spontaneously helped an adult that "accidentally" dropped an object on the floor. These results were taken as evidence that young children are innately altruistic and until recently were the predominant view of the field. As with most developmental studies with young children, the participants in Warneken and Tomasello's experiments engaged in a brief "warm-up" activity with an experimenter that is aimed at making the child comfortable with a new adult and the testing environment. These warm-up activities often involve activities such as rolling a ball back and forth and having the child and experimenter play with the same set of toys in a back-and-forth manner. Could these brief interactions prime young children to help and affect the results of Warneken and Tomasello's (2006) findings?

Barragan and Dweck (2014) recently investigated this question in a groundbreaking series of studies that demonstrate that simple reciprocal activities can elicit altruistic behaviors in young children. 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. These findings provide convincing evidence that altruistic behavior is strongly influenced by social interactions rather than innate tendencies. 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.

What other types of social interactions promote prosocial attitudes and behaviors? An emerging body of research has investigated synchronous interactions as a mechanism for influencing social attitudes and prosocial behaviors in infants and grade school children (Cirelli, Einarson, & Trainor, 2014; Rabinowitch & Knafo-Noam, 2015). A recent study by Rabinowitch and Knafo-Noam (2015) investigated the influence of synchronous interaction between pairs of 8- to 9-year-old children on perceived similarity and closeness. Some of the pairs of children (same-sex pairs and previously unacquainted) engaged in a tapping task in which they tapped a drum-like device in synchrony with their partner, and other pairs engaged in a similar tapping task but tapped out of sync with each other. Following the rhythmic interaction, each child completed a similarity questionnaire and closeness measure. For the similarity questionnaire, children were asked to give a rating ranging from 1 (not similar at all) to 4 (extremely similar) to questions including "Does he/she remind you of yourself in any way?" and "Do you think he/she likes the same musical styles that you do?" To examine how close the tapping partners felt toward each other, children were presented with a series of pairs of circles (one labeled "me" and one labeled "he/she") with an increasing degree of overlap between them and asked to select the pair that matched their experience of tapping together. Rabinowitch and Knafo-Noam found that the similarity and closeness scores of children who engaged in synchronous interaction were significantly higher than those of children who engaged in asynchronous tapping.

Optimizing children's early interactive and cooperative experiences with other children and adults to create a community characterized by care and helping appears to be an effective way to promote other-oriented prosocial responding in very young children.

Similarly, Cirelli, Einarson, and Trainor (2014) found that when infants were gently bounced to music in-synchrony with an adult facing them, they were more likely to engage in altruistic behavior compared to infants that were bounced out-of-synchrony. Interestingly, the measure of altruistic behavior in Cirecelli et al.'s study was very similar to those used by Barragan and Dweck (2014) and Warneken and Tomasello (2006) where an experimenter "accidentally" drops an object and waits for the child to come to the rescue. In a study with older 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 of both genders 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.

Taken together, studies examining the role of reciprocity, synchrony, and joint music making strongly suggest that these simple and highly engaging forms of interaction can promote altruistic behaviors starting in the early years. These findings have important and practical implications for parents, educators and other adults who have opportunities to structure activities where children can engage in one or more of these types of interactions. Optimizing children's early interactive and cooperative experiences with other children and adults to create a community characterized by care and helping appears to be an effective way to promote other-oriented prosocial responding in very young children.

Big idea #2: Parental scaffolding and talk about emotions and mental states promotes sharing and helping behaviors in young children.

Young children love to help their parents with tasks and chores around the house. Toddlers and preschoolers are often eager to "help" fold laundry, bake cookies, or wash dishes. 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 and scaffolding of their children's emotion understanding in a picture book reading context. Mothers and toddlers ages 18- to 24-months participated in a picture book reading activity at the beginning of the study session and at the end played "tea party" and cleaned up the toys together. Parents' emphasis on emotional and anticipatory aspects of the storybook were examined in the book reading and used as a measure of emotion understanding scaffolding. In the clean up task, mothers' scaffolding of their child's involvement in cleaning up after the tea party (e.g., how much they involved their child and the age appropriateness of their comments and efforts) was used as a measure of chore scaffolding. In between the two 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. Consistent with everyday observations and previous research, young children had a high rate of helping the experimenter (Svetlova, Nichols, & Brownell, 2010; Warneken & Tomasello, 2006). Moreover, Hammond and Carpendale's findings revealed some intriguing insights into individual differences in toddlers' helping. That is, 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. Contrary to expectations, mothers' scaffolding of children's emotion understanding in the picture book reading task was not associated with children's propensity to help the experimenter. Interestingly, the best predictor of children's helping behavior was how readily children approached the experimenter at the beginning of the session (a measure of sociability) before the children participated in the helping tasks.

Hammond and Carpendale's (2015) finding that mothers' use of emotion and mental state words and efforts to scaffold their children's understanding of these terms in a book reading context did not predict children's helping is surprising given other research supporting a link between parental talk about emotions and early altruistic behaviors (Brownell, Svetlova, Anderson, Nichols, & Drummond, 2013; Drummond, Paul, Waugh, Hammond, & Brownell, 2014). For example, Brownell et al. (2013) conducted two studies with 18- to 30-month-olds using a procedure similar to Hammond and Carpendale's (2015) in which parents read wordless picture books to their children and the content and structure of the parents' emotion-related language was coded. In contrast to Hammond and Carpendale (2015), Brownell et al. (2013) found that children who helped and shared more quickly and more often had parents who more often *elicited* children's talk about emotions while reading picture books. It is important to note that the degree to which parents elicited talk about emotions and mental states (e.g., think or know) by asking open-ended questions like "How does she feel?" over and above the amount of parent talk about the same concepts, predicted children's prosocial behaviors. That is, an important component of these shared experiences is actively engaging children in conversations about emotions and mental states that prompt children to attend to and respond to questions about these concepts.

Building on Brownell et al.'s (2103) findings, Drummond et al. (2014) examined two everyday contexts that afford parental talk about emotions and mental states—book reading and joint play with toys. Children also participated in two tasks with an experimenter designed to measure different types of helping. The instrumental helping task, designed to measure helping behavior with respect to goal-directed actions, involved picking up sticks "accidentally" dropped on the floor by the experimenter. The empathic helping task, which required an understanding of another person's internal state to understand the need to help, involved the child bringing a blanket to the experimenter when he shivered. The researchers found that the nature of parents' talk about mental states and emotions differed by context: parents labeled emotions (e.g., happy or sad) and mental states more often during book reading than during joint play; whereas they used more terms to describe desire and mental state words (e.g., think, or know) in the joint play activity. Drummond et al. (2014) largely replicated findings from Brownell et al. (2013) and found that children who helped more quickly in the empathic helping task (e.g., bringing a blanket to an experimenter when he was cold) had parents who elicited talk about emotions and mental states more often from children in the book reading context. Contrary to expectations, parents' emotion and mental state talk was mostly unrelated to instrumental helping in children (e.g., picking up sticks accidentally dropped on the floor). Thus, talk about emotions and mental states appears to play a significant role in the early socialization of prosocial behavior, but that role varies by context.

Overall, empirical studies suggest that providing opportunities for children to help—even if that help does not speed up the task—and eliciting talk about emotions and mental states in everyday contexts can develop young children's natural tendencies to help others. Furthermore, this body of research provides practical guidelines for parents and educators for how to structure interactions at home and in the classroom around helping and cooperative tasks and contexts that promote eliciting talk about emotions and mental states in young children. For example, seeking opportunities for children to help with chores at home or tasks in the classroom with age-appropriate scaffolding may help children learn to work with others in a cooperative way and give them an opportunity to step in to solve a problem. This in turn may promote helping others when they see that another person faces an obstacle.

Self-regulation

Self-regulation is a critical skill for maximizing one's own learning potential and for establishing positive social relationships with others. Researchers often talk about self-regulation as closely related to executive function and emphasize the critical importance of both for learning and development. Prior work has documented associations between social contexts, such as parenting styles and reliability of others, on developing self-control capabilities (Bernier, Carlson, & Whipple, 2010; Grolnick & Ryan, 1989; Kidd, Palmeri, & Aslin, 2013). Additional work has documented meaningful differences in when children are able to self-regulate. For instance, Karniol et al. (2011) impressively showed that simple manipulations can lead children to demonstrate improved self-control skills in an experimental setting. Finally, a variety of work on longitudinal delay of gratification task findings have shown that preschoolers who are better able to resist temptation grow up to demonstrate a plethora of positive outcomes in physical, mental, and social domains (Mischel, Shoda, & Peake, 1988; Mischel, Shoda, & Rodriguez, 1989; Schlam, Wilson, Shoda, Mischel, & Ayduk, 2013). A greater understanding of the development of and individual differences in self-regulation may help pinpoint ideal windows for intervention designed to improve self-control and increase the likelihood of expected positive outcomes associated with this social-cognitive skill set.

Big idea #1: Self-regulation can be improved through social contexts and transformational thinking.

Children's ability to regulate their emotions, behaviors, and thoughts is critical for thriving in a school environment. Teachers often struggle to create a positive learning environment for their students when they have children that are constantly squirming in their seats, not paying attention, and talking over their classmates. In contrast, children with good self-regulation skills can pay attention to directions, focus on activities long enough to complete them, and ignore the many distractions in a busy classroom. What influences children's self-regulation skills and how can they be improved? In a study with toddlers, Bernier, Carlson, and Whipple (2010) observed mothers interacting with their toddlers when they worked together on puzzles and other cognitive tasks at age 12 to 15 months. The same children were tested again at age 16 to 26 months and the researchers found that the children of mothers who had encouraged their toddlers' autonomy in the earlier study subsequently had better cognitive and self-regulation skills. These findings send the important message that parents who overcontrol their toddlers can undermine the development of young children's self-control skills, while those who encourage autonomy are more likely to maximize their children's chances of developing strong self-regulation skills.

Additional research supports that parenting styles shape children's school performance through self-regulation in the classroom. In a study with elementary school children in grades 3-6, Grolnick and Ryan (1989) examined how parent practices are associated with children's self-regulation and competence in addition to academic achievement. Children were assessed using a variety of measures including self-report, teacher report, and school scores. The child outcomes included academic self-regulation, which examined why children engage in school-related behaviors such as doing homework and answering challenging questions in class. Additional child outcomes were school competence (self and teacher ratings of how well a child interacts effectively in the school environment) and behavioral adjustment (teacher ratings of acting out and learning problems).

In addition, parents participated in a structured interview that included questions with regard to how their child acts at home and at school, as well as how the parent motivates and responds to their child across a variety of situations. For example, the parent was asked to describe typical conflicts that occur related to doing homework and how those conflicts usually get resolved. The parent interviews were rated by the interviewer and another experimenter who had observed the interview on a variety of dimensions, namely, *autonomy support* (encouraging independent problem solving and choice), *involvement* (extent to which the parent is interested in and takes an active part in the child's life), and *structure* (providing clear and consistent guidelines and expectations).

Grolnick and Ryan found that parents who engaged in more autonomy support had children who were higher in autonomous self-regulation. Furthermore, autonomy support was also positively associated with better classroom competence, achievement, and less acting out. These findings support the researchers' hypothesis that parental autonomy support provides a foundation for self-regulation and independence required for success in school and thus is predictive of both self-regulation and academic achievement. Moreover, these findings provide evidence that parents meaningfully affect how children internalize rules and perceive of their potential impact on their environment. This ultimately leads to differences in the developing ability to self-regulate while at home and in school.

In a more recent investigation of how the social context can affect children's self-regulation, in particular delay of gratification, Kidd et al. (2013), investigated how preschoolers' performance on the famous marshmallow task was affected by their beliefs about environmental reliability. In Mischel's classic delay of gratification task (Mischel, Ebbesen, & Zeiss, 1972; Mischel & Moore, 1973), often called the *marshmallow* test, preschoolers are given a choice between one reward (like a marshmallow or pretzel) they can eat immediately, or a larger reward (two marshmallows) that they can eat after a delay interval of up to 20 minutes. During this delay, the children are left alone, sometimes in the presence of the treats and sometimes with the rewards hidden from their view. Children can indicate that they no longer want to wait for the larger reward by ringing a bell. By doing so, the child forfeits the larger reward and is given a single treat. Children who successfully wait the full delay interval are given two marshmallows.

Since the original marshmallow study was conducted in the 1960s, an impressive and rich body of literature has documented that children with longer wait times are more successful later in life (Mischel et al., 1988; Mischel et al., 1989; Schlam et al., 2013; Shoda, Mischel, & Peake, 1990). Given the powerful predictive nature of delaying gratification as measured by the marshmallow task, it is important to investigate why some children are able to wait and others are not. Until recently, individual differences in the ability to wait have been attributed to self-control, however, a clever and influential study has recently shed light on an additional factor that may influence wait-times on the marshmallow task—children's beliefs about the stability of the world.

Kidd et al. (2013) examined how both self-control capacity and established beliefs regarding environmental reliability influence children's wait times in the marshmallow task. That is, could children be engaging in rational decision-making about whether to wait for the second marshmallow based on their belief that the second marshmallow is likely to appear after the delay? In Kidd et al.'s study, children ages 3 to 5 years of age were presented with evidence that the experimenter was reliable or unreliable with regard to giving children a promised better alternative to complete an art project. In one of the art tasks, children were given a small set of well-used crayons in a tightly sealed jar and told that they could use the crayons now or wait until the experimenter returned with a new set of exciting art supplies to use instead. The experimenter then placed the jar of crayons on the table and left the child alone for a few minutes. In the *unreliable* condition, the experimenter returned without the promised set of art supplies and explained, "I'm sorry, but I made a mistake. We don't have any other art supplies after all." In the *reliable* condition, the experimenter returned with the promised set of fancy art supplies. After the art task, children were given the marshmallow task with the choice to eat one marshmallow immediately or wait for 15 minutes to receive two marshmallows.

As predicted, Kidd and colleagues found that children in the reliable condition waited significantly longer than children in the unreliable condition. Furthermore, children in the reliable condition were significantly more likely to wait the full 15 minutes than the children in the unreliable condition. The researchers highlight that these findings have meaningful implications for work on the influences of socioeconomic status and parents on the development of self-regulation. That is, children growing up in a crowded shelter may be accustomed to stolen possessions and broken promises and could be less likely to wait for two marshmallows if they don't believe the second one will actually appear. In this case, children may have good self-control skills, but their response on the marshmallow task may be influenced more by their belief that waiting is a rational choice. There may be more than self-control at play in the delay of gratification task. Children's waiting capabilities may be explained in part by the way they think about other social beings and the expectations they have formed about how others are likely to act toward them in the future. Furthermore, these findings provide compelling evidence that young children are capable of waiting in the face of temptation when given evidence that waiting will pay off in the end.

Additional research on shifting the mindset of children through self-transformation provides promising evidence that children's ability to delay gratification can be improved. An interesting finding from the original marshmallow study (Mischel & Moore, 1973) was that children employed different strategies to pass the time during the delay interval. Some children talked to themselves, some sang, and a handful tried to take a short nap. Given that preschoolers used a range of effective self-regulation strategies, is it possible to facilitate children's ability to delay gratification by providing them with instruction to transform themselves by pretending to have special waiting "powers?"

Karniol et al. (2011) investigated this research question with a clever and age-appropriate procedure in which children were asked to transform themselves into Superman—a superhero with special powers that can wait really well. First, the experimenter showed each child a basket of pretzels and cookies and the child was asked to indicate whether he preferred the pretzels or cookies. The experimenter then explained that she was going to leave for a bit, but if the child stayed seated and waited to eat anything until she returned, the child could eat the preferred treat. However, if the child rang the bell, the experimenter would come back early and the child would get the less desired treat. After it was clear that the child understood the experimenter's instructions, children in the *cape-only* condition were given a Superman cape to wear and told, "Before I go, there is a Superman cape here. You can put it on while you wait for me to come back." Other children in the *cape and instruction* condition were given the same cape and in addition were told that Superman has special powers, has lots of patience, and knows how to wait really well. Children in the control condition were not given the cape or any instructions. Karniol and colleagues found significant differences between all three conditions. That is, children who were given the Superman cape delayed longer, especially when given instructions about Superman's special waiting powers.

...these findings provide compelling evidence that young children are capable of waiting in the face of temptation when given evidence that waiting will pay off in the end.

In a second study, all children were given a cape, but some were given instructions to be Superman (with the same instructions as Study 1) and others were asked to be another superhero named Dash who is very impulsive and never waits for anything. Children in the Superman condition were more likely to wait the full 20 minutes than those in the Dash condition. Lastly, in a third study Karniol et al. investigated whether children can imaginatively self-transform without props (e.g., a cape). In this study, some children were asked to imagine themselves as Superman with the same characteristics as the first two studies and others were asked to imagine themselves as another child named Danny with the same patient qualities. Two additional groups of children watched a short video of Superman and some were asked to imagine themselves as Superman and some were not. As predicted, Karniol and colleagues found that children who imagined themselves as Superman waited longer than those who imagined themselves as another child with the same delay-relevant characteristics. Furthermore, children who watched the video of Superman and those asked to pretend to be Superman waited equally often, often close to the 20-minute mark. Taken together, these findings strongly suggest that self-transformation can help improve young children's ability to successfully engage in delay of gratification. That is, self-control is not a static property, but instead can be modified via simple and creative means. Most impressively, Karniol and colleagues demonstrated that children do not need a prop to adopt the positive traits described as characteristics of Superman and that the self-transformational processes relevant for improving self-regulation seem to be effective for both boys and girls. As such, this work provides reason to believe that interventions designed to improve self-regulation may be effective with young children and via rather simple mindset manipulations.

Big idea #2: Delay of gratification and self-control predicts a wide range of positive outcomes in social, mental, and physical domains.

Over the last 50 years, the findings and real-world implications from Mischel's marshmallow studies have been the focus of dozens of academic and popular press articles. Researchers have followed the cohort of preschoolers that participated in the original studies conducted at Stanford University's Bing Nursery School and revealed a range of fascinating predictive patterns between individual differences in delay behavior and cognitive, social, and physical outcomes in adolescence and adulthood (Mischel et al., 1988; Mischel et al., 1989; Schlam et al., 2013; Shoda et al., 1990). In one of these investigations, Mischel et al. (1988) examined the possible links between delay behavior in preschoolers and cognitive and social competence a decade later. Parents of 4-year-olds who had participated in a series of experiments measuring delay of gratification using the marshmallow test were contacted 10 years later and asked to fill out two questionnaires designed to measure cognitive and social competencies, coping, and adaptation. The researchers found that children, both boys and girls, who had waited longer in the marshmallow task at 4 years of age were rated by their parents as more socially and academically competent than their peers and better able to cope with frustration and resist temptation as adolescents. More specifically, parents described children who had longer wait times as better able to express their ideas, plan and think ahead, handle stress, exhibit self-control in frustrating situations, and concentrate without becoming distracted. Other research has found correlations between longer wait times and higher SAT scores in adolescence (Shoda et al., 1990) and less likelihood of substance abuse in adulthood (Ayduk et al., 2000).

More recently, Schlam et al., (2013) investigated the relationship between preschoolers' performance on a delay of gratification task and the physical measure of body mass index (BMI) in adulthood. Given the substantial rise in the prevalence of obesity in childhood over the past several decades, it is important to investigate a range of protective factors including self-control and the ability to delay gratification. Schlam and colleagues contacted adults who had participated in a standard delay of gratification task at age 4 approximately 30 years later and asked for their current height and weight to calculate BMI. As predicted, children who were able to wait a longer time to get the reward in the delay of gratification task at age 4 had lower BMIs in adulthood. Impressively, these findings show that a simple task in early childhood can predict a physical outcome 30 years later. Moreover, children's wait-time times in a delay of gratification task may indicate a practical way to identify children who are more likely to struggle with weight issues later in life and provide an opportunity for cognitive-control intervention work with some individuals.

Another recent study with Marshmallow Test alumni examined possible differences in brain scans of people who, over their lifetime, had scored consistently high or low on self-control measures (Casey et al., 2011). Casey and colleagues found that brain images of these alumni revealed that the prefrontal cortex area—associated

with problem solving and control of impulsive behavior—was more active in those who had better self-regulation skills as preschoolers and remained consistently high in self-control through adulthood. In contrast, in low delayers the ventral striatum, linked to desire and addictive behavior, was more active. This latter finding was especially true when participants were trying to control their reactions to very attractive temptations. That is, those with lifelong low self-control did not have difficulty controlling their impulses under most conditions that they would face in everyday life. Rather, the impulse control problems surfaced only when faced with alluring and tempting stimuli.

Taken collectively, a rich and meaningful body of work on the long-term implications of the ability to delay gratification supports the claim that self-control is critical for success in life. On an everyday basis we see this in action when we forego indulging in a decadent dessert to follow a diet or resist the temptation to watch television until after all of our homework is done. The

The good news is that self-control and our ability to delay gratification is not fixed and can be enhanced and nurtured through supportive parenting practices, simple mindset manipulations, and creating a stable and safe environment where children trust and rely on others.

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Motor development and health

Gross and fine motor development

The relationship between motor and cognitive skills is well documented in the field of developmental psychology, starting with Piaget's developmental theory of the critical role that motor skills play in how infants and young children explore and learn about their environment. More recently, researchers have documented an important link between motor skills, especially fine motor skills, early school adjustment, and early academic achievement. Grissmer, Grimm, Aiyer, Murrah, and Steele (2010) extended Duncan et al.'s (2007) seminal work by incorporating motor skills measures and found that fine motor skills measured at kindergarten entrance strongly predicted later achievement in mathematics and reading. Using another nationally representative large sample, Son and Meisels (2006) also found evidence that early motor skills, especially visual motor skills, significantly predict later achievement. Similarly, Cameron et al. (2012) found that higher levels of both fine motor skills and executive function, specifically design copy, predicted higher achievement at kindergarten entry. Extending the link to social and emotional adjustment, Bart, Hajami, and Bar-Haim (2007) found that motor functions were a significant predictor of children's social and emotional adjustment, in addition to scholastic adaptation, to school. Together, this body of work provides strong support for increasing children's opportunities for fine motor learning experiences in the preschool years to give them a strong foundation for the challenges of transitioning to a formal school environment.

Big idea #1: Fine motor skills are a strong predictor of later academic achievement.

Early grade school students spend a significant portion of the school day engaged in activities that involve fine motor skills—art projects that involve cutting, coloring, and tracing, and practice with writing. Research estimates that 30-60% of the school day is devoted to fine motor activities (McHale & Cermak, 1992), however, despite this prevalence of motor skills in schooling, scant research has examined the associations between fine motor skills and academic skills including early reading and mathematics. One recent study extended the seminal work by Duncan et al. (2007; see earlier section on longitudinal research in this paper) by incorporating motor skills measures from three of the longitudinal data sets to examine whether fine motor skills were predictive of later achievement, and if so, compare the strength of this relationship to the role of attention (Grissmer et al., 2010). Examples of fine motor skills measures in the data sets included participants using building blocks to replicate a model, copying designs on paper, and drawing a person. For assessing gross motor skills, children were asked to skip, hop on one foot, walk backward, and stand on one foot. Grissmer et al. (2010) found that measures of fine motor skills had strong associations with both mathematics and reading in all three data sets. Furthermore, in comparison to attention measures, fine motor skills were almost always as significant or more statistically significant in predicting later achievement than attention. In contrast, the results indicated gross motor skills were not a significant predictor of later achievement.

In the discussion of their findings, Grissmer et al. (2010) highlighted evidence from the fields of neuroscience and developmental psychology that provides clues for a motor-cognitive link. From a practical standpoint, most activities that involve cognitive skills also involve the use of fine motor skills: writing requires fine motor hand movements and hand-eye coordination; and reading requires controlling eye movements for word tracking. Relatedly, Diamond (2000) summarized links between motor and cognitive skills using evidence from neuroimaging and neuroanatomy. That is, neuroimaging studies consistently indicate that the prefrontal cortex (associated with attention and executive function) and cerebellum (associated with motor processing) are co-activated when doing certain cognitive tasks alone. Furthermore, children diagnosed with cognitive disorders such as ADHD or dyslexia often experience motor impairments, and children with motor impairments often experience learning difficulties.

Importantly, Grissmer et al. (2010) make a similar point to Diamond (2014), highlighted earlier in this paper, that "paradoxically, higher longer-term achievement in math and reading may require reduced direct emphasis on math and reading and more time and stronger curriculum outside math and reading" (Grissmer et al., 2010, p. 1016). That is, a growing body of evidence suggests interventions to increase children's chances of a successful start to school should focus on domain-general, foundational skills including fine motor and executive function skills. Unfortunately, subjects and curriculum including music, art, physical education, and free play that foster attention and fine motor skills have been set aside to make more time for reading and mathematics instruction in many schools.

Similarly, Son and Meisels (2006) explored the relationship between motor skills measured at the beginning of kindergarten and reading and mathematics achievement at the end of first grade using another nationally representative large sample. The researchers examined data from the Early Childhood Longitudinal Study–Kindergarten Class of 1998-1999 (ECLS-K), which provides background information about children's early home, preschool, and

kindergarten environments, and development through the school year with measurements in the fall and spring of kindergarten and first grade. For Son and Meisels's (2006) study, motor skills were assessed in the fall of kindergarten using visual motor and gross motor scales, and reading and math achievement were assessed in the fall of kindergarten and spring of first grade. The visual motor scale used fine motor and eye-hand coordination measures with seven tasks: building a gate, drawing a person, and copying five simple figures including a circle, cross, square, triangle, and open square and circle. Cognitive achievement was assessed in the domains of reading (i.e., identifying letters, letter-sound association at the beginning of words, letter-sound association at the end of words, recognizing words, and reading words in context) and mathematics (i.e., number and shape, relative size, ordinality and sequence, addition/subtraction, and multiplication/division) in the fall of kindergarten and spring of first grade. The analyses demonstrated a strong and significant relationship between motor skills and cognitive achievement, with visual motor skills having significantly higher correlations with cognitive achievement than gross motor skills. Furthermore, correlations with math scores were significantly higher than those with reading. In summary, Son and Meisels's (2006) findings provide additional support for the hypothesis that motor skills, specifically visual motor skills, are a valid predictor of later cognitive achievement and can successfully identify children at risk for academic underachievement at a critical period in school entry.

Cameron et al. (2012) provide additional evidence that both fine motor skills and executive function (EF) are predictive of kindergarten achievement. The researchers examined the contribution of EF and a range of fine motor skills to school achievement on six standardized assessments in a sample of kindergarteners from middle-income backgrounds. Fine and gross motor skills were assessed in a home visit before kindergarten, EF was measured in the beginning of the kindergarten year, and tests of academic achievement were administered in both the fall and spring of kindergarten. As predicted, Cameron et al. found that children entering kindergarten with higher fine motor and EF scores had higher academic achievement at kindergarten entry and significant improvement from fall to spring. In particular, design copy performance (i.e., using a pencil to copy shapes such as a square or circle) was strongly associated with gains in literacy-related skills such as phonological awareness, decoding, and reading comprehension. What could explain this link? Cameron et al. proposed that their findings could be interpreted in the context of the competing motor and cognitive demands of a particular task. That is, children who enter kindergarten

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with the ability to copy shapes and write letters are able to focus their attention on other cognitive tasks involved in reading such as decoding words and connecting letters with sounds. This interesting link also provides practical guidance for increasing opportunities for fine motor activities with elements of design copy as one promising direction for achieving automaticity in writing-related tasks, thereby allowing children to deploy more attention to learning more complex literacy skills.

Big idea #2: Fine and gross motor abilities predict social and emotional adjustment to school.

The transition to school requires children to adjust both academically and socioemotionally. Adjusting to a new and demanding learning environment requires an ability to pay attention, participate in class activities, and become increasingly independent. In addition, a successful transition to school involves social and emotional adjustments, including an ability to develop positive relationships with teachers and peers and feeling confident and secure. As highlighted in the previous section, research supports a positive association between visual motor ability and academic performance (Cameron et al., 2012; Son & Meisels, 2006), however, it is surprising that other basic motor functions such as motor planning and muscle tone have been neglected in relation to school readiness.

To address this gap in the literature, Bart, Hajami, and Bar-Haim (2007) examined relations between basic motor abilities—including visual-motor integration, fine motor accuracy, visual-spatial perception, kinesthesia, imitation of postures, and muscle tone—in kindergarten and scholastic adaptation and social and emotional adjustment to first grade. Kindergarten participants were administered a battery of standard assessments of basic motor functions, and then one year later adjustment to school was assessed with a series of questionnaires completed by children and teachers. As predicted and in agreement with other research, the results supported a strong link between visual motor integration in kindergarten and scholastic adaptation in first grade.

Furthermore, Bart and colleagues found that other motor functions including kinesthesia, muscle tone, and imitation of postures demonstrated significant predictive value of both scholastic adaptation and social and emotional adjustment. That is, better performance on *all* of the assessed motor functions in kindergarten was significantly associated with better scholastic adaptation in first grade. The findings also revealed several interesting patterns in relation to social and emotional adjustment to school. Specifically, low muscle tone and poor kinesthesia in kindergarten were correlated with more anxious-withdrawn behavior in first grade as reported by teachers. On the positive side, better visual-spatial perception and muscle tone were significantly associated with more teacher-reported prosocial behavior.

Overall, Bart et al.'s (2007) findings suggest that strong motor abilities—both fine and gross—are associated with better scholastic adaptation and social and emotional adjustment in the transition to formal schooling. Furthermore, the results highlight the fundamental role of various motor functions in successful interactions at school and previous research suggests that children with poor motor functions might shy away from participating in social activities in a school setting (Bar-Haim & Bart, 2006). In summary, the predictive value of a wide range of motor skills for school readiness provides a strong argument for considering both fine and gross motor abilities as important precursors to academic success.

Nutrition, sleep, and toxic stress

Children's healthy habits can be guided by building on their early scientific reasoning skills, giving them a causal theory to motivate their decisions. One study showed this in the domain of nutrition, where preschoolers elected to eat more vegetables at snack time after learning a mechanistic yet accessible theory of nutrients and digestion (Gripshover & Markman, 2013). Researchers have previously used a similar approach to convey a theory of germs to young children that conceptually motivates their prevention of infection (Au et al., 2008). Another area of research with important implications for healthy development focuses on sleep's cognitive benefits in children and adults (Maquet, 2001; Prehn-Kristensen et al., 2009; Stickgold, 2005; Wilhelm, Diekelmann, & Born, 2008). 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). Finally, as more and more studies reveal the ways in which prolonged and chronic stress alters the architecture of the developing brain, scientists and educators are taking a wide range of approaches to decrease toxic stress in young children and improve supportive parent-child relationships (Fisher et al., 2000; Middlebrooks & Audage, 2008; National Scientific Council on the Developing Child, 2004/2009; Shonkoff, 2011).

Big idea #1: Teaching children a causal system for nutrition can lead to healthier eating choices.

Preschoolers are notorious for their picky eating habits and many healthy foods are often pushed aside on their plates. A recent study by Gripshover and Markman (2013) in which the researchers discovered a novel way to get picky preschoolers to eat more vegetables gives hope to parents who often battle with their young children during mealtime. The researchers used a novel approach to teach young children (ages 4-5 years) about nutrition by providing a rich conceptual framework that emphasized the importance of eating healthy foods and why their bodies need a variety of foods and nutrients.

Gripshover and Markman created five storybooks that emphasized key concepts about food and nutrition: (1) dietary variety—the importance of a variety of foods; (2) digestion—how nutrients are extracted from food and blood carries the nutrients to different parts of the body; (3) food categories—foods in the same category (e.g., protein) may look different but share the same nutrients; (4) microscopic nutrients—you cannot see nutrients but they are there; (5) nutrients and biological functions—a variety of nutrients are needed to support different biological functions. In two preschool classrooms, children heard a different book read to them over a period of three months, while in another two preschool classrooms children had snack time as usual. After children in the intervention classrooms heard each of the books at least once, they were asked questions about food, nutrition, and bodily functions to assess their knowledge of each component of the intervention. In addition, children were observed at snack time before and after the intervention and the number of pieces of food (fruits, vegetables, crackers, and cheese) was recorded.

Gripshover and Markman found that children who had heard the nutrition books acquired the key concepts from the intervention and generalized them beyond the specific foods and processes taught in the books. More specifically, over half of the children in the intervention understood that blood carries nutrients throughout the body, and nearly 90% named nutrients when asked what is inside food. Furthermore, when asked to explain why eating only one kind of food is insufficient, nearly half of the children that heard the nutrition books referred to the need for different nutrients. With respect to snack time food preferences, the researchers found that the children who had heard the nutrition books more than doubled their intake of vegetables during snack time after the intervention, whereas the amount of vegetables eaten by children who did not hear the nutrition books stayed about the same.

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In a second study, Gripshover and Markman compared their conceptual framework to an educational program based on U.S. Department of Agriculture materials that focuses on the enjoyment of healthy eating and trying new foods. The researchers found that both methods increased children's voluntary intake of vegetables at snack time, but Gripshover and Markman's intervention proved to be the more effective method. In sum, Gripshover and Markman's findings strongly suggest that preschoolers can benefit from a conceptually based approach to learning about nutrition. From a developmental perspective, the researchers capitalized on young children's natural curiosity and desire to learn how things work—highlighting preschoolers' capacity to understand and reason about abstract concepts. People often assume that abstract and complex concepts will be too difficult to explain to young children, however, the findings from this study provide a meaningful and practical message for parents and educators that capitalizing on children's natural curiosity by creating a framework to scaffold their knowledge of a particular concept is an effective strategy for deepening their understanding and changing their behavior.

Big idea #2: Napping helps preschoolers learn and regulate their emotion expression.

Parents often go to great lengths to schedule activities around their child's naptime. A missed nap can lead to challenging behavioral and emotional responses and a very long rest of the day with an overtired and grumpy child. While a great deal of research supports that sleep benefits cognitive function in adults, in particular enhanced memory (Mednick, Cai, Shuman, Anagnostaras, & Wixted, 2011), the literature on the cognitive benefits of sleep for young children is surprisingly sparse. A few recent studies provide evidence that napping can boost children's memory and language learning skills and support the conventional wisdom that napping is an essential part of young children's sleep diets.

Kurdziel, Duclos, and Spencer (2013) recently investigated the benefits of daytime napping in preschoolers on children's 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 (remembering the locations of 9-12 items on a grid) 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.

People often assume that abstract and complex concepts will be too difficult to explain to young children, however, these findings provide a meaningful and practical message for parents and educators that capitalizing on children's natural curiosity by creating a framework to scaffold their knowledge of a particular concept is an effective strategy for deepening their understanding and changing their behavior.

Research on the effects of napping on word learning provide additional support for the critical role of sleep in early childhood. Horváth et al. (2015) recently examined how daytime napping enhances word learning in 16-month-old infants to provide insight on the underlying mechanisms of language acquisition during a period in which most children experience a dramatic increase in the rate of their vocabulary growth. First, the infants were introduced to two new objects, one at a time, in a play session with an experimenter. The infants played with and observed the toys while the experimenter labeled each object several times with phrases like, "Do you want to play with X?" After this play phase, the researchers tested the infants' initial performance on a preferential looking task in which infants see pictures of objects on two screens (e.g., dog and cup) while hearing the label for one (e.g., dog) and are expected to look at the target object (e.g., dog) more than the distractor. Some of the trials included familiar words and objects while other trials tested infants' word-object associations of the novel words they were introduced to in the play session. A second test session followed after approximately a 2-hour delay in which some of the infants napped and others did not. The initial performance of both the nap and wake groups did not differ for the novel or familiar word trials. As predicted, Horváth and colleagues found that infants in the nap group showed significantly increased target looking time to the novel objects that they were introduced to in the play session after a daytime nap in the lab, while there was no change in the looking behavior of the wake group for the novel object trials. These findings emphasize the importance of sleep and napping on language development in infancy and highlight the benefits of promoting healthy sleeping habits during a period of intensive vocabulary growth.

Another benefit of napping in young children is supported by a study that investigated the emotional benefits of daytime sleep in toddlers (Berger, Miller, Seifer, Cares, & Lebourgeois, 2012). From a developmental perspective, investigating the relationship between sleep patterns and emotion regulation and expression makes sense given that both undergo pronounced changes in early childhood. Berger and her colleagues assessed the emotional responses of ten 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, which is the developmentally appropriate response indicating children are engaged in solving a task. It is important to note the relatively small sample size (n=10) when interpreting these findings, however, the pattern of 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).

To conclude, a growing body of empirical evidence supports the parental wisdom that healthy sleep-nap patterns are a critical component of young children's cognitive and emotional development. This literature can provide important evidence to make informed recommendations for nap and bedtimes for parents and educators at a time when many school administrators may consider eliminating naps from preschool in favor of increased active learning time. Research on the cognitive and emotional benefits of sleep clearly argues against depriving children of daytime sleep and supports the importance of napping on memory skills, language development, and emotion expression.

Big idea #3: Prolonged and chronic stress can alter the architecture of the developing brain.

A certain amount of stress is inevitable, as well as necessary for healthy development. However, too much 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. For a succinct review of the findings of the ACE study, as well as existing prevention and intervention strategies, read "The Effects of Childhood Stress on Health Across the Lifespan," a publication by the U.S. Department of Health and the Centers for Disease Control and Prevention (Middlebrooks & Audage, 2008). For a description of the major findings of the developmental risks associated with maltreatment, see the Executive Summary of the report on the "Developmental Status and Early Intervention Service Needs of Maltreated Children," prepared by the Institute for Social and Economic Development, also available online.

The Center on the Developing Child, a research group of neuroscientists and developmental psychologists housed at Harvard University, has compiled excellent materials covering the mechanisms of how childhood adversity impacts brain development, as well as reviews of successful interventions and responses from the medical community to what they now recognize as a public health crisis. These resources are available on their website (http://developingchild.harvard.edu/science/key-concepts/toxic-stress/). In addition, compelling and informative lectures on the impact of early childhood adversity by key scientists in the field like Nadine Burke Harris and Megan Gunnar are viewable online.

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. Early evaluations of current interventions show some 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).

Though all children will experience some forms of stress throughout childhood, 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, for example, 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).

Though all children will experience some forms of stress throughout childhood, research on the impact of stress on development emphasizes the importance of relationships with parents, teachers, and friends for mediating long-term negative effects. 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.

references

Adrian, J. E., Clemente, R. A., Villanueva, L., & Rieffe, C. (2005). Parent–child picture-book reading, mothers' mental state language and children's theory of mind. *Journal of Child Language, 32*, 673-686.

Akhtar, N. (2005). The robustness of learning through overhearing. *Developmental Science, 8*(2), 199-209.

Alexander, K. L., Entwisle, D. R., & Dauber, S. L. (1993). First-grade classroom behavior: Its short-and long-term consequences for school performance. *Child Development*, *64*(3), 801-814.

Alfieri, L., Brooks, P. J., Aldrich, N. J., & Tenenbaum, H. R. (2011). Does discovery-based instruction enhance learning? *Journal of Educational Psychology*, *103*(1), 1-18.

Alloway, T. P., & Alloway, R. G. (2010). Investigating the predictive roles of working memory and IQ in academic attainment. *Journal of Experimental Child Psychology*, *106*(1), 20-29.

Amabile, T. M. (1983). *The social psychology of creativity*. New York: Springer-Verlag.

Amabile, T. M. (1985). Motivation and creativity: Effects of motivational orientation on creative writers. *Journal of Personality and Social Psychology*, *48*(2), 393-399.

Amabile, T. M. (1988). A model of creativity and innovation in organizations. In B. M. Slaw & L. L. Cummings (Eds.), *Research in organizational behavior* (Vol. 10, pp. 123-167). Greenwich, CT: JAI Press.

Amabile, T. M. (1993). Motivational synergy: Toward new conceptualizations of intrinsic and extrinsic motivation in the workplace. *Human Resource Management Review*, *3*(3), 185-201.

Astington, J. W., & Pelletier, J. (2013). Theory of mind, language, and learning in the early years: Developmental origins of school readiness. In B. D. Homer & C. S. Tamis-LeMonda (Eds.), *The development of social cognition and communication* (pp. 205-230). New York: Psychology Press.

Au, T. K. F., Chan, C. K., Chan, T. K., Cheung, M. W., Ho, J. Y., & Ip, G. W. (2008). Folkbiology meets microbiology: A study of conceptual and behavioral change. *Cognitive Psychology*, *57*(1), 1-19.

Ayduk, O., Mendoza-Denton, R., Mischel, W., Downey, G., Peake, P. K., & Rodriguez, M. (2000). Regulating the interpersonal self: strategic self-regulation for coping with rejection sensitivity. *Journal of Personality and Social Psychology*, *79*(5), 776-792.

Bailey, C. E. (2007). Cognitive accuracy and intelligent executive function in the brain and in business. *Annals of the New York Academy of Sciences*, *1118*(1), 122-141.

Baler, R. D., & Volkow, N. D. (2006). Drug addiction: The neurobiology of disrupted self-control. *Trends in Molecular Medicine*, *12*(12), 559-566

Bar-Haim, Y., & Bart, O. (2006). Motor function and social participation in kindergarten children. *Social Development*, *15*(2), 296-310.

Barth, R. P., Scarborough, A., Lloyd, E. C., Losby, J., Casanueva, C., & Mann, T. (2007). Developmental Status and Early Intervention Service Needs of Maltreated Children. Washington, DC: U.S. Department of Health and Human Services, Office of the Assistant Secretary for Planning and Evaluation.

Barragan, R. C., & Dweck, C. S. (2014). Rethinking natural altruism: Simple reciprocal interactions trigger children's benevolence. *Proceedings of the National Academy of Sciences*, *111*(48), 17071-17074.

Bart, O., Hajami, D., & Bar-Haim, Y. (2007). Predicting school adjustment from motor abilities in kindergarten. *Infant and Child Development, 16*(6), 587-615.

Berger, R. H., Miller, A. L., Seifer, R., Cares, S. R., & Lebourgeois, M. K. (2012). Acute sleep restriction effects on emotion responses in 30-to 36-month-old children. *Journal of Sleep Research*, *21*(3), 235-246.

Bernier, A., Carlson, S. M., & Whipple, N. (2010). From external regulation to self-regulation: Early parenting precursors of young children's executive functioning. *Child Development*, *81*(1), 326-339.

Bierman, K. L., Coie, J. D., Dodge, K. A., Greenberg, M. T., Lochman, J. E., McMahon, R. J., & Pinderhughes, E. (2010). The effects of a multiyear universal social–emotional learning program: The role of student and school characteristics. *Journal of Consulting and Clinical Psychology*, *78*(2), 156-168.

Bierman, K. L., Domitrovich, C. E., Nix, R. L., Gest, S. D., Welsh, J. A., Greenberg, M. T., . . . & Gill, S. (2008). Promoting academic and social-emotional school readiness: The Head Start REDI program. *Child Development*, *79*(6), 1802-1817.

Blair, C. (2002). School readiness: Integrating cognition and emotion in a neurobiological conceptualization of children's functioning at school entry. *American Psychologist, 57*(2), 111-127.

Blair, C., & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child Development*, *78*(2), 647-663.

Bonawitz, E. B., van Schijndel, T. J., Friel, D., & Schulz, L. (2012). Children balance theories and evidence in exploration, explanation, and learning. *Cognitive Psychology*, *64*(4), 215-234.

Bonawitz, E., Shafto, P., Gweon, H., Goodman, N. D., Spelke, E., & Schulz, L. (2011). The double-edged sword of pedagogy: Instruction limits spontaneous exploration and discovery. *Cognition, 120*(3), 322-330.

Brown, R. (1973). *A first language: The early stages.* Cambridge, Mass: Harvard University Press.

Brownell, C. A., Svetlova, M., Anderson, R., Nichols, S. R., & Drummond, J. (2013). Socialization of early prosocial behavior: Parents' talk about emotions is associated with sharing and helping in toddlers. *Infancy*, *18*(1), 91-119.

Burchinal, M., & Forestieri, N. (2010). Development of early literacy: Evidence from major U.S. longitudinal studies. In S. B. Neuman, & D. K. Dickinson (Eds.) *Handbook of Early Literacy Research*, Volume III. New York: Guilford Press.

Burgess, S. R., Hecht, S. A., & Lonigan, C. J. (2002). Relations of the home literacy environment (HLE) to development of reading-related abilities: A one-year longitudinal study. *Reading Research Quarterly, 37*, 408-426.

Butler, L. P., & Markman, E. M. (2012). Finding the cause: Verbal framing helps children extract causal evidence embedded in a complex scene. *Journal of Cognition and Development*, *13*(1), 38-66.

Callanan, M. A., & Jipson, J. L., (2001). Exploratory conversations and young children's developing scientific literacy. In K. Crowley, C. D., Schunn, & T. Okada (Eds.), *Designing for science: Implications from everyday, classroom, and professional settings* (pp. 21-49). Mahwah, NJ: Erlbaum.

Cameron, C. E., Brock, L. L., Murrah, W. M., Bell, L. H., Worzalla, S. L., Grissmer, D., & Morrison, F. J. (2012). Fine motor skills and executive function both contribute to kindergarten achievement. *Child Development*, *83*(4), 1229-1244.

Campbell, F., Conti, G., Heckman, J. J., Moon, S. H., Pinto, R., Pungello, E., & Pan, Y. (2014). Early childhood investments substantially boost adult health. *Science*, *343*(6178), 1478-1485.

Carlson, S. M., Claxton, L. J., & Moses, L. J. (2015). The relation between executive function and theory of mind is more than skin deep. *Journal of Cognition and Development*, *16*(1), 186-197.

Carlson, S. M., & Moses, L. J. (2001). Individual differences in inhibitory control and children's theory of mind. *Child Development*, *72*(4), 1032-1053.

Carlson, S. M., & White, R. E. (2013). Executive function, pretend play, and imagination. In M. Taylor (Ed.) *The Oxford Handbook of the Imagination* (161-174). New York: Oxford University Press.

Carlson, S. M., White, R. E., & Davis-Unger, A. C. (2014). Evidence for a relation between executive function and pretense representation in preschool children. *Cognitive Development*, *29*, 1-16.

Carlton, M. P., & Winsler, A. (1998). Fostering intrinsic motivation in early childhood classrooms. *Early Childhood Education Journal*, *25*(3), 159-166.

Casey, B. J., Somerville, L. H., Gotlib, I. H., Ayduk, O., Franklin, N. T., Askren, M. K., . . . & Glover, G. (2011). Behavioral and neural correlates of delay of gratification 40 years later. *Proceedings of the National Academy of Sciences*, *108*(36), 14998-15003.

Center for Childhood Creativity. (2015). *Inspiring a generation to create: Critical components of creativity in children* [White Paper]. Retrieved from http://www.centerforchildhoodcreativity.org/research-initiatives/.

Centers for Disease Control and Prevention. (2006). Adverse Childhood Experiences Study. Retrieved from http://www.cdc.gov/nccdphp/ace/index.htm.

Chatterji, M. (2006). Reading achievement gaps, correlates, and moderators of early reading achievement: Evidence from the Early Childhood Longitudinal Study (ECLS) kindergarten to first grade sample. *Journal of Education Psychology, 98*(3), 489-507.

Chen, Z., & Klahr, D. (1999). All other things being equal: Acquisition and transfer of the control of variables strategy. *Child Development*, *70*(5), 1098-1120.

Cheng, Y. L., & Mix, K. S. (2014). Spatial training improves children's mathematics ability. *Journal of Cognition and Development*, *15*(1), 2-11.

Cimpian, A., Arce, H. M. C., Markman, E. M., & Dweck, C. S. (2007). Subtle linguistic cues affect children's motivation. *Psychological Science*, *18*(4), 314-316.

Cirelli, L. K., Einarson, K. M., & Trainor, L. J. (2014). Interpersonal synchrony increases prosocial behavior in infants. *Developmental Science*, *17*(6), 1003-1011.

Cook, C., Goodman, N. D., & Schulz, L. E. (2011). Where science starts: Spontaneous experiments in preschoolers' exploratory play. *Cognition*, *120*(3), 341-349.

Creel, S. C. (2012). Preschoolers' use of talker information in on-line comprehension. *Child Development, 83*(6), 2042-2056.

Cunningham, A. E., & Stanovich, K. E. (1997). Early reading acquisition and its relation to reading experience and ability 10 years later. *Developmental Psychology, 33*(6), 934–945.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum.

Deci, E. L., & Ryan, R. M. (1991). A motivational approach to self: Integration in personality. In R. Dienstbier (Ed.), *Nebraska Symposium on Motivation: Vol. 38, Perspectives on Motivation* (pp. 237-288). Lincoln: University of Nebraska Press.

Dewey, J. (1913). *Interest and effort in education.* Cambridge, MA: The Riverside Press.

Diamond, A. (2000). Close interrelation of motor development and cognitive development and of the cerebellum and prefrontal cortex. *Child Development*, *71*(1), 44-56.

Diamond, A. (2012). Activities and programs that improve children's executive functions. *Current Directions in Psychological Science, 21*, 335-341.

Diamond, A. (2014). Want to optimize executive functions and academic outcomes?: Simple, just nourish the human spirit. In *Minnesota Symposia on Child Psychology* (Vol. 37, p. 205). NIH Public Access.

Diamond, A., Barnett, W. S., Thomas, J., & Munro, S. (2007). Preschool program improves cognitive control. *Science, 318*, 1387-1388.

Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science*, *333*, 959-964.

Diamond, A., & Taylor, C. (1996). Development of an aspect of executive control: Development of the abilities to remember what I said and to "Do as I say, not as I do". *Developmental Psychobiology*, (29), 315-334.

Dickinson, D. K., Golinkoff, R. M., & Hirsh-Pasek, K. (2010). Speaking out for language: Why language is central to reading development. *Educational Researcher, 39*(4), 305-310.

Dickinson, D. K., McCabe, A., Anastasopoulos, L., Peisner-Feinberg, E. S., & Poe, M. D. (2003). The comprehensive language approach to early literacy: The interrelationships among vocabulary, phonological sensitivity, and print knowledge among preschool-aged children. *Journal of Educational Psychology, 95*(3), 465.

Donaldson, M. (1978). *Children's minds*. New York: W. W. Norton & Company.

Duckworth, A. L., & Seligman, M. E. (2005). Self-discipline outdoes IQ in predicting academic performance of adolescents. *Psychological Science*, *16*(12), 939-944.

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., . . . & Japel, C. (2007). School readiness and later achievement. *Developmental Psychology*, *43*(6), 1428.

Duncan, G. J., & Magnuson, K. (2011). The nature and impact of early achievement skills, attention skills, and behavior problems. *Whither Opportunity*, 47-70.

Durlak, J. A., Weissberg, R. P., Dymnicki, A. B., Taylor, R. D., & Schellinger, K. B. (2011). The impact of enhancing students' social and emotional learning: A meta-analysis of school-based universal interventions. *Child Development*, *82*(1), 405-432.

Drummond, J., Paul, E. F., Waugh, W. E., Hammond, S. I., & Brownell, C. A. (2014). Here, there and everywhere: Emotion and mental state talk in different social contexts predicts empathic helping in toddlers. *Frontiers in Psychology*, *5*, 1-11.

Dweck, C. S. (2015, September 22). Carol Dweck revisits the 'Growth Mindset'. *Education Week*. Retrieved from http://www.edweek.org/ew/articles/2015/09/23/carol-dweck-revisits-the-growth-mindset.html.

Dweck, C. S. (2006). *Mindset: The new psychology of success*. New York: Random House Digital, Inc.

Dweck, C. S. (2000). *Self-theories: Their role in motivation, personality, and development*. New York: Psychology Press.

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*, *95*(2), 256-273.

Dyer, J. R., Shatz, M., & Wellman, H. M. (2000). Young children's storybooks as a source of mental state information. *Cognitive Development*, *15*(1), 17-37.

Evans, M. A., & Saint-Aubin, J. (2005). What children are looking at during shared storybook reading: Evidence from eye movement monitoring. *Psychological Science, 16*, 913-920.

Ezell, H. K., & Justice, L. M. (2000). Increasing the print focus of adult-child shared book reading through observational learning. *American Journal of Speech-Language Pathology, 9*, 36-47.

Felitti, V. J., Anda, R. F., Nordenberg, D., Williamson, D. F., Spitz, A. M., Edwards, V., . . . & Marks, J. S. (1998). Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults: The Adverse Childhood Experiences (ACE) Study. *American Journal of Preventive Medicine*, *14*(4), 245-258.

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D. J., & Pethick, S. J. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development, 59*(5, Serial No. 242).

Fernald, A., Marchman, V., & Weisleder, A. (2012). SES differences in language processing skill and vocabulary are evident at 18 months. *Developmental Science, 16*(2), 234-48.

Ferrara, K., Hirsh-Pasek, K., Newcombe, N. S., Golinkoff, R. M., & Lam, W. S. (2011). Block talk: Spatial language during block play. *Mind, Brain, and Education*, *5*(3), 143-151.

Fisher, K. R., Hirsh-Pasek, K., Newcombe, N., & Golinkoff, R. M. (2013). Taking shape: Supporting preschoolers' acquisition of geometric knowledge through guided play. *Child Development, 84*(6), 1872-1878.

Fisher, P. A., Gunnar, M. R., Chamberlain, P., & Reid, J. B. (2000). Preventive intervention for maltreated preschool children: Impact on children's behavior, neuroendocrine activity, and foster parent functioning. *Journal of the American Academy of Child & Adolescent Psychiatry*, *39*(11), 1356-1364.

Fitneva, S. A., Lam, N. H., & Dunfield, K. A. (2013). The development of children's information gathering: To look or to ask? *Developmental Psychology*, *49*(3), 533.

Flavell, J. H., Green, F. L., Flavell, E. R., Harris, P. L., & Astington, J. W. (1995). Young children's knowledge about thinking. *Monographs of the Society for Research in Child Development*, i-113.

Franzen, P. L., Buysse, D. J., Dahl, R. E., Thompson, W., & Siegle, G. J. (2009). Sleep deprivation alters pupillary reactivity to emotional stimuli in healthy young adults. *Biological Psychology*, *80*(3), 300-305.

Frye, D., Zelazo, P. D., & Palfai, T. (1995). Theory of mind and rule-based reasoning. *Cognitive Development*, *10*(4), 483-527.

Fukkink, R., & de Glopper, K. (1998). Effects of instruction in deriving word meaning from context: A meta-analysis. *Review of Educational Research, 68*, 450-469.

Gaskins, S. (2008). The cultural meaning of play and learning in children's museums. *Hand to Hand*, *22*(4), 8-11.

Gelman, S. A., & Wellman, H. M. (1991). Insides and essences: Early understandings of the non-obvious. *Cognition*, *38*(3), 213-244.

Ginsburg, H. P., Pappas, S., & Lee, Y.-S. (2012). *Early mathematics assessment system (EMAS)*. In preparation.

Göbel, S., Walsh, V., & Rushworth, M. F. (2001). The mental number line and the human angular gyrus. *Neuroimage*, *14*(6), 1278-1289.

Gómez, R. L., Bootzin, R. R., & Nadel, L. (2006). Naps promote abstraction in language-learning infants. *Psychological Science*, *17*(8), 670-674.

Goodson, B., Layzer, C., Simon, P., & Dwyer, C. (2009). *Early beginnings: Early literacy knowledge and instruction.* Washington, DC: National Institute for Literacy.

Gopnik, A. (2012, July/August). Let the children play, it's good for them! Smithsonian.com. Retrieved October 23, 2013, from http://www.smithsonianmag.com/science-nature/Let-the-Children-Play-Its-Good-for-Them.html.

Gopnik, A., & Schulz, L. (Eds.). (2007). *Causal learning: Psychology, philosophy, and computation*. Oxford, UK: Oxford University Press.

Gopnik, A., Sobel, D. M., Schulz, L. E., & Glymour, C. (2001). Causal learning mechanisms in very young children: two-, three-, and four-year-olds infer causal relations from patterns of variation and covariation. *Developmental Psychology*, *37*(5), 620-629.

Gripshover, S. J., & Markman, E. M. (2013). Teaching young children a theory of nutrition conceptual change and the potential for increased vegetable consumption. *Psychological Science*, *24*(8), 1541-1553.

Grissmer, D. W., Grimm, K. J., Aiyer, S. M., Murrah, W. M., & Steele, J. S. (2010). Fine motor skills and early comprehension of the world. *Developmental Psychology, 46*(5), 1008-1017.

Grissmer, D. W., Mashburn, A. J., Cottone, E., Chen, W. B., Brock, L. L., Murrah, W. M., . . . & Cameron, C. (2013, April). *Play-Based After-School Curriculum Improves Measures of Executive Function, Visuospatial and Math Skills and Classroom Behavior for High Risk K–1 Children.* Paper presented at the biennial meeting of the Society for Research in Child Development, Seattle, WA.

Grolnick, W. S., & Ryan, R. M. (1989). Parent styles associated with children's self-regulation and competence in school. *Journal of Educational Psychology*, *81*(2), 143-154.

Gujar, N., McDonald, S. A., Nishida, M., & Walker, M. P. (2010). A role for REM sleep in recalibrating the sensitivity of the human brain to specific emotions. *Cerebral Cortex*, 21: 115-123.

Gunderson, E. A., Gripshover, S. J., Romero, C., Dweck, C. S., Goldin-Meadow, S., & Levine, S. C. (2013). Parent praise to 1-to 3-year-olds predicts children's motivational frameworks 5 years later. *Child Development*, *84*(5), 1526-1541.

Hammond, S. I., & Carpendale, J. I. (2015). Helping children help: the relation between maternal scaffolding and children's early help. *Social Development*, *24*(2), 367-383.

Hart, B., & Risley, T. R. (1995). *Meaningful experiences in the everyday experiences of young American children.* Baltimore: Brookes.

Head Start Approach to School Readiness (n.d.). In Head Start: An office of the administration for children and families. Retrieved from http://eclkc.ohs.acf.hhs.gov/hslc/hs/sr/approach/pfcef.

Heckman, J. J., & Kautz, T. (2012). Hard evidence on soft skills. *Labour Economics*, *19*(4), 451-464.

High, P. C., Klass, P., Donoghue, E., Glassy, D., DelConte, B., Earls, M., ... & Schulte, E. E. (2014). Literacy promotion: An essential component of primary care pediatric practice. *Pediatrics, 134*(2), 404-409.

Hirsh-Pasek, K., Adamson, L. B., Bakeman, R., Owen, M. T., Golinkoff, R. M., Pace, A., . . . & Suma, K. (2015). The contribution of early communication quality to low-income children's language success. *Psychological Science*, *26*(7), 1071-1083 .

Holmes, J., Gathercole, S. E., & Dunning, D. L. (2009). Adaptive training leads to sustained enhancement of poor working memory in children. *Developmental Science*, *12*(4), F9-F15.

Horváth, K., Myers, K., Foster, R., & Plunkett, K. (2015). Napping facilitates word learning in early lexical development. *Journal of Sleep Research*, *24*, 503-509.

Howse, R. B., Lange, G., Farran, D. C., & Boyles, C. D. (2003). Motivation and self-regulation as predictors of achievement in economically disadvantaged young children. *The Journal of Experimental Education*, *71*(2), 151-174.

Hughes, C. (1998). Executive function in preschoolers: Links with theory of mind and verbal ability. *The British Journal of Developmental Psychology*, *16*, 233-253.

Hughes, C. H., & Ensor, R. A. (2009). How do families help or hinder the emergence of early executive function? In C. Lewis & J. I. M. Carpendale (Eds.), Social interaction and the development of executive function. *New Directions for Child and Adolescent Development*, (123), 35-50.

Hutton, J. S., Horowitz-Kraus, T., Mendelsohn, A. L., DeWitt, T., & Hutton, S. K. (2015). Listening to stories home reading environment and brain activation in preschool children. *Pediatrics, 136*(3), 466-478.

Jirout, J., & Klahr, D. (2012). Children's scientific curiosity: In search of an operational definition of an elusive concept. *Developmental Review*, *32*(2), 125-160.

Jones, S. M., Bub, K. L., & Raver, C. C. (2013). Unpacking the black box of the Chicago School Readiness Project intervention: The mediating roles of teacher–child relationship quality and self-regulation. *Early Education & Development*, *24*(7), 1043-1064.

Jones, D. E., Greenberg, M., & Crowley, M. (2015). Early social-emotional functioning and public health: The relationship between kindergarten social competence and future wellness. *American Journal of Public Health*, *105*(11), 2283-2290.

Jordan, N. C., Kaplan, D., Nabors Oláh, L., & Locuniak, M. N. (2006). Number sense growth in kindergarten: A longitudinal investigation of children at risk for mathematics difficulties. *Child Development*, *77*(1), 153-175.

Jordan, N. C., Levine, S. C., & Huttenlocher, J. (1994). Development of calculation abilities in middle-and low-income children after formal instruction in school. *Journal of Applied Developmental Psychology*, *15*(2), 223-240.

Justice, L.M., & Ezell, H.K. (2000). Enhancing children's print and word awareness through home-based parent intervention. *American Journal of Speech-Language Pathology, 9*, 257-269.

Justice, L. M., & Ezell, H. K. (2004). Print referencing: An emergent literacy enhancement strategy and its clinical applications. *Language Speech and Hearing Services in Schools, 35*(2), 185-193.

Justice, L. M., & Piasta, S. (2011). Developing children's print knowledge though adult-child storybook reading interactions: Print referencing as an instructional practice. In S. B. Neuman, & D. K. Dickinson (Eds.) *Handbook of Early Literacy Research, Volume III*. New York: Guilford Press.

Justice, L. M., Pullen, P. C., Pence, K. (2008). Influence of verbal and non-verbal references to print on preschoolers' visual attention to print during storybook reading. *Developmental Psychology, 44*, 855-866.

Kagan, S. L. (1990). Readiness 2000. Rethinking rhetoric and responsibility. *Phi Delta Kappan, 72*, 272-279.

Kagan, S. L., Moore, E., & Bredekamp, S. (1995). Reconsidering children's early development and learning: Toward shared beliefs and vocabulary. Washington, DC: National Educational Goals Panel.

Kamins, M. L., & Dweck, C. S. (1999). Person versus process praise and criticism: Implications for contingent self-worth and coping. *Developmental Psychology*, *35*(3), 835-847.

Karniol, R., Galili, L., Shtilerman, D., Naim, R., Stern, K., Manjoch, H., & Silverman, R. (2011). Why superman can wait: Cognitive self-transformation in the delay of gratification paradigm. *Journal of Clinical Child & Adolescent Psychology*, *40*(2), 307-317.

Kidd, C., Palmeri, H., & Aslin, R. N. (2013). Rational snacking: Young children's decision-making on the marshmallow task is moderated by beliefs about environmental reliability. *Cognition*, *126*(1), 109-114.

Kirschner, S., & Tomasello, M. (2010). Joint music making promotes prosocial behavior in 4-year-old children. *Evolution and Human Behavior*, *31*(5), 354-364.

Klingberg, T., Fernell, E., Olesen, P. J., Johnson, M., Gustafsson, P., Dahlström, K., . . . & Westerberg, H. (2005). Computerized training of working memory in children with ADHD-a randomized, controlled trial. *Journal of the American Academy of Child & Adolescent Psychiatry*, *44*(2), 177-186.

Kuhl, P. K. (2004). Early language acquisition: cracking the speech code. *Nature Reviews Neuroscience*, *5*(11), 831-843.

Kurdziel, L., Duclos, K., & Spencer, R. M. (2013). Sleep spindles in midday naps enhance learning in preschool children. *Proceedings of the National Academy of Sciences*, *110*(43), 17267-17272.

Lakes, K. D., & Hoyt, W. T. (2004). Promoting self-regulation through school-based martial arts training. *Journal of Applied Developmental Psychology*, *25*(3), 283-302.

Legare, C. H. (2014). The contributions of explanation and exploration to children's scientific reasoning. *Child Development Perspectives*, *8*(2), 101-106.

Legare, C. H., & Lombrozo, T. (2014). Selective effects of explanation on learning during early childhood. *Journal of Experimental Child Psychology*, *126*, 198-212.

Lepper, M. R., Greene, D., & Nisbett, R. E. (1973). Undermining children's intrinsic interest with extrinsic reward: A test of the" overjustification" hypothesis. *Journal of Personality and Social Psychology*, *28*(1), 129-137.

Leventhal, T., Martin, A., Brooks-Gunn, J. (2004). The EC-HOME across five national data sets in the third to fifth year of life. *Parenting: Science and Practice, 4*, 161-188.

Lewit, E. M., & Baker, L. S. (1995). School readiness. *The Future of Children*, 128-139.

Lillard, A., & Else-Quest, N. (2006). The early years: Evaluating Montessori education. *Science*, *313*, 1893-1894.

Lillard, A. S., & Sobel, D. (1999). Lion kings or puppies: The influence of fantasy on children's understanding of pretense. *Developmental Science*, *2*(1), 75-80.

Linder, S. M., Ramey, M., & Zambak, J. (2013). Predictors of school readiness in literacy and mathematics: A selective review of the literature. *Early Childhood Research and Practice*, *15*(1).

Lonigan, C. J. (2007). Vocabulary development and the development of phonological awareness skills in preschool children. R. K. Wagner, A. E. Muse, & K. R. Tannenbaum (Eds.) *Vocabulary Acquisition: Implications for Reading Comprehension*. Guilford Press, 2007.

Lupien, S. J., McEwen, B. S., Gunnar, M. R., & Heim, C. (2009). Effects of stress throughout the lifespan on the brain, behaviour, and cognition. *Nature Reviews Neuroscience, 10*, 434-445.

Maquet, P. (2001). The role of sleep in learning and memory. *Science*, *294*(5544), 1048-1052.

Matthews, D., Lieven, E., Theakston, A. & Tomasello, M. (2006). The effect of perceptual availability and prior discourse on young children's use of referring expressions. *Applied Psycholinguistics, 27*(3), 403-422.

McClelland, M. M., Acock, A. C., & Morrison, F. J. (2006). The impact of kindergarten learning-related skills on academic trajectories at the end of elementary school. *Early Childhood Research Quarterly*, *21*(4), 471-490.

McClelland, M. M., Cameron, C. E., Connor, C. M., Farris, C. L., Jewkes, A. M., & Morrison, F. J. (2007). Links between behavioral regulation and preschoolers' literacy, vocabulary, and math skills. *Developmental Psychology*, *43*(4), 947.

McClelland, M. M., Morrison, F. J., & Holmes, D. L. (2000). Children at risk for early academic problems: The role of learning-related social skills. *Early Childhood Research Quarterly*, *15*(3), 307-329.

McHale, K., & Cermak, S. A. (1992). Fine motor activities in elementary school: Preliminary findings and provisional implications for children with fine motor problems. *American Journal of Occupational Therapy*, *46*(10), 898-903.

McLoyd, V. C., & Purtell, K. (2008). How childhood poverty and income affect children's cognitive functioning and school achievement. In S. Neuman (Ed.), *Educating the other America: Top experts tackle poverty, literacy, and achievement in our schools*. (pp. 53-72). Baltimore: Paul H. Brookes.

Mednick, S. C., Cai, D. J., Shuman, T., Anagnostaras, S., & Wixted, J. T. (2011). An opportunistic theory of cellular and systems consolidation. *Trends in Neurosciences*, *34*(10), 504-514.

Meisels, S. J. (1996). Performance in context: Assessing children's achievement at the outset of school. In A. J. Sameroff & M. M. Hairth (Eds.), *The five to seven year shift: The age of reason and responsibility* (pp. 410-431). Chicago: University of Chicago Press.

Meisels, S. J. (1998). Assessing Readiness. (Report No. 3-002). Ann Arbor, MI: Center for the Improvement of Early Reading Achievement. Retrieved from: http://files.eric.ed.gov/fulltext/ED429272.pdf.

Meltzoff, A. N., Waismeyer, A., & Gopnik, A. (2012). Learning about causes from people: Observational causal learning in 24-month-old infants. *Developmental Psychology*, *48*(5), 1215.

Metsala, J. L. (2010). Lexical reorganization and the emergence of phonological awareness. In S. B. Neuman, & D. K. Dickinson (Eds.) *Handbook of Early Literacy Research, Volume III.* New York: Guilford Press.

Middlebrooks, J. S. & Audage, N. C. (2008). *The Effects of Childhood Stress on Health Across the Lifespan.* Atlanta, GA: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control.

Miller, H. V., Barnes, J. C., & Beaver, K. M. (2011). Self-control and health outcomes in a nationally representative sample. *American Journal of Health Behavior*, *35*(1), 15-27.

Mills, C. M., Legare, C. H., Grant, M. G., & Landrum, A. R. (2011). Determining who to question, what to ask, and how much information to ask for: The development of inquiry in young children. *Journal of Experimental Child Psychology*, *110*(4), 539-560.

Mischel, W., Ebbesen, E. B., & Raskoff Zeiss, A. (1972). Cognitive and attentional mechanisms in delay of gratification. *Journal of personality and social psychology*, *21*(2), 204-218.

Mischel, W., & Moore, B. (1973). Effects of attention to symbolically presented rewards on self-control. *Journal of Personality and Social Psychology*, *28*(2), 172-179.

Mischel, W., Shoda, Y., & Peake, P. K. (1988). The nature of adolescent competencies predicted by preschool delay of gratification. *Journal of Personality and Social Psychology*, *54*(4), 687-696.

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Mischel, W., Shoda, Y., & Rodriguez, M. I. (1989). Delay of gratification in children. *Science*, *244*(4907), 933-938.

Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., . . . & Caspi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences*, *108*(7), 2693-2698.

Montag, J. L., Jones, M. N., Smith, L. B. (2015). The words children hear: Picture books and the statistics for language learning. *Psychological Science*, 1-8.

Mueller, C. M., & Dweck, C. S. (1998). Praise for intelligence can undermine children's motivation and performance. *Journal of Personality and Social Psychology*, *75*(1), 33-52.

National Early Literacy Panel. (2008). *Developing early literacy: Report of the National Early Literacy Panel.* Washington, DC: National Institute for Literacy. Retrieved from http://www.nifl.gov/earlychildhood/NELP/NELPreport.html.

National Educational Goals Panel. (1995). National education goals report: Building a Nation of Learners. Washington, DC: U. S. Government Printing Office.

National Scientific Council on the Developing Child (2004/2009). *Young Children Develop in an Environment of Relationships: Working Paper No. 1*. Updated Edition. Retrieved from www.developingchild.harvard.edu.

National Scientific Council on the Developing Child (2005/2014). *Excessive Stress Disrupts the Architecture of the Developing Brain: Working Paper No. 3*. Updated Edition. Retrieved from www.developingchild.harvard.edu.

Neuman, S. B. (2010). The challenge of teaching vocabulary in early education. In S. B. Neuman, & D. K. Dickinson (Eds.) *Handbook of Early Literacy Research, Volume III.* New York: Guilford Press.

Noble, K. G., Tottenham, N., & Casey, B. J. (2005). Neuroscience perspectives on disparities in school readiness and cognitive achievement. *The Future of Children*, *15*(1), 71-89.

Paratore, J.M., Cassano, C.M. & Schickedanz, J.A. (2011). Supporting early (and later) literacy development at home and at school: The long view. In M. Kamil, P.D. Pearson, E. Moje, & P. Afflerbach (Eds.) *Handbook of Reading Research, Volume IV*. New York: Routledge.

Pasquini, E. S., Corriveau, K. H., Koenig, M., & Harris, P. L. (2007). Preschoolers monitor the relative accuracy of informants. *Developmental Psychology*, *43*(5), 1216.

Piaget, J. (1930). *The child's conception of physical causality*. New York: Harcourt, Brace.

Prehn-Kristensen, A., Göder, R., Chirobeja, S., Breßmann, I., Ferstl, R., & Baving, L. (2009). Sleep in children enhances preferentially emotional declarative but not procedural memories. *Journal of Experimental Child Psychology*, *104*(1), 132-139.

Pruden, S. M., Levine, S. C., & Huttenlocher, J. (2011). Children's spatial thinking: Does talk about the spatial world matter? *Developmental Science, 14*(6), 1417-1430.

Rabinowitch, T. C., & Knafo-Noam, A. (2015). Synchronous Rhythmic Interaction Enhances Children's Perceived Similarity and Closeness towards Each Other. *PloS one*, *10*(4).

Ramani, G. B., & Siegler, R. S., (2008). Promoting broad and stable improvements in low-income children's numerical knowledge through playing number board games. *Child Development*, *79*(2), 375-394.

Ramani, G. B., & Siegler, R.S. (2011). Reducing the gap in numerical knowledge between low- and middle-income preschoolers. *Journal of Applied Developmental Psychology, 32*(3), 146-159.

Ramani, G. B., Siegler, R. S., & Hitti, A. (2012). Taking it to the classroom: Number board games as a small group learning activity. *Journal of Educational Psychology*, *104*(3), 661-672.

Ramani, G. B., Zipper, E., Schweitzer, S., & Pan, S. (2014). Preschool children's joint block building during a guided play activity. *Journal of Applied Developmental Psychology, 35*, 326-336.

Ramírez-Esparza, N., García-Sierra, A., & Kuhl, P. K. (2014). Look who's talking: Speech style and social context in language input to infants are linked to concurrent and future speech development. *Developmental Science*, *17*(6), 880-891.

Raver, C. C., Jones, S. M., Li-Grining, C. P., Metzger, M., Champion, K. M., & Sardin, L. (2008). Improving preschool classroom processes: Preliminary findings from a randomized trial implemented in Head Start settings. *Early Childhood Research Quarterly*, *23*(1), 10-26.

Raver, C. C., Jones, S. M., Li-Grining, C., Zhai, F., Metzger, M. W., & Solomon, B. (2009). Targeting children's behavior problems in preschool classrooms: A cluster-randomized controlled trial. *Journal of Consulting and Clinical Psychology*, *77*(2), 302-316.

Raver, C. C., Jones, S. M., Li-Grining, C., Zhai, F., Bub, K., & Pressler, E. (2011). CSRP's impact on low-income preschoolers' preacademic skills: Self-regulation as a mediating mechanism. *Child Development*, *82*(1), 362-378.

Ray, K. & Smith, M. C. (2010). The kindergarten child: What teachers and administrators need to know to promote academic success in all children. *Early Childhood Education Journal, 28*, 5-18.

Reineke, J., Sonsteng, K., & Gartrell, D. (2008). Nurturing mastery motivation: No need for rewards. *YC: Young Children*, 89-97.

Riggs, N. R., Greenberg, M. T., Kusché, C. A., & Pentz, M. A. (2006). The mediational role of neurocognition in the behavioral outcomes of a social-emotional prevention program in elementary school students: Effects of the PATHS curriculum. *Prevention Science*, *7*(1), 91-102.

Roach, K.A., & C.E. Snow. (2000, April). *What predicts fourth grade reading comprehension?* Paper presented at the annual conference of the American Education Research Association, New Orleans, LA.

Romano, E., Babchishin, L., Pagani, L. S., & Kohen, D. (2010). School readiness and later achievement: Replication and extension using a nationwide Canadian survey. *Developmental Psychology, 46*(5), 995-1007.

Roseberry, S., Hirsh-Pasek, K. & Golinkoff, R.M. (2014). Skype me! Socially contingent interactions help toddlers learn language. *Child Development, 85*, 956-970.

Rotenberg, K. J., Michalik, N., Eisenberg, N., & Betts, L. R. (2008). The relations among young children's peer-reported trustworthiness, inhibitory control, and preschool adjustment. *Early Childhood Research Quarterly*, *23*(2), 288-298.

Rowe, M. L., & Goldin-Meadow, S. (2009). Differences in early gesture explain SES disparities in child vocabulary size at school entry. *Science, 323*, 951–953.

Sabbagh, M. A., & Callanan, M., A. (1998). Meta-representation in action: 3-, 4-, and 5-year-olds' developing theories of mind in parent-child conversations. *Developmental Psychology, 34*, 491–502.

Sabbagh, M. A., Xu, F., Carlson, S. M., Moses, L. J., & Lee, K. (2006). The development of executive functioning and theory of mind a comparison of Chinese and US preschoolers. *Psychological Science*, *17*(1), 74-81.

Schlam, T. R., Wilson, N. L., Shoda, Y., Mischel, W., & Ayduk, **O. (2013).** Preschoolers' delay of gratification predicts their body mass 30 years later. *The Journal of Pediatrics*, *162*(1), 90-93.

Schulz, L. E., & Bonawitz, E. B. (2007). Serious fun: Preschoolers engage in more exploratory play when evidence is confounded. *Developmental Psychology*, *43*(4), 1045-1050.

Schulz, L. E., & Gopnik, A. (2004). Causal learning across domains. *Developmental Psychology*, *40*(2), 162-176.

Schulz, L. E., Gopnik, A., & Glymour, C. (2007). Preschool children learn about causal structure from conditional interventions. *Developmental Science*, *10*(3), 322-332.

Shoda, Y., Mischel, W., & Peake, P. K. (1990). Predicting adolescent cognitive and self-regulatory competencies from preschool delay of gratification: Identifying diagnostic conditions. *Developmental Psychology*, *26*(6), 978-986.

Shonkoff, J. P. (2011). Protecting brains, not simply stimulating minds. *Science*, *333*(6045), 982-983.

Shonkoff, J. P., Garner, A. S., Siegel, B. S., Dobbins, M. I., Earls, M. F., McGuinn, L., . . . & Wood, D. L. (2012). The lifelong effects of early childhood adversity and toxic stress. *Pediatrics*, *129*(1), e232-e246.

Siegler, R. S., & Ramani, G. B. (2008). Playing board games promotes low-Income children's numerical development. *Developmental Science, Special Issue on Mathematical Cognition, 11*, 655-661.

Simons, J., Dewitte, S., & Lens, W. (2000). Wanting to have vs. wanting to be: The effect of perceived instrumentality on goal orientation. *British Journal of Psychology*, *91*(3), 335-352.

Singer, D. G., & Singer, J. L. (1990). *The house of make-believe: Play and the development of imagination.* Cambridge, MA: Harvard University.

Snow, C. E., Barnes, W. S., Chandler, J., Goodman, L., & Hemphill, L. (1991). *Unfulfilled expectations: Home and school influences on literacy.* Cambridge, MA: Harvard University Press.

Son, S. H. & Meisels, S. J. (2006). The relationship of young children's motor skills to later school achievement. *Merrill-Palmer Quarterly. 52*(4), 755-778.

Spelke, E. S., Breinlinger, K., Macomber, J., & Jacobson, K. (1992). Origins of knowledge. *Psychological Review*, *99*(4), 605-632.

Stahl, A. E., & Feigenson, L. (2015). Observing the unexpected enhances infants' learning and exploration. *Science*, *348*(6230), 91-94.

Starkey, P., Klein, A., & Wakeley, A. (2004). Enhancing young children's mathematical knowledge through a pre-kindergarten mathematics intervention. *Early Childhood Research Quarterly*, *19*(1), 99-120.

Stevenson, H. W., & Newman, R. S. (1986). Long-term prediction of achievement and attitudes in mathematics and reading. *Child Development*, *57*(3), 646-659.

Stickgold, R. (2005). Sleep-dependent memory consolidation. *Nature*, *437*(7063), 1272-1278.

Stipek, D. J. (1996). Motivation and instruction. In. D. C. Berliner & R. C. Calfee (Eds.), *Handbook of Educational Psychology* (pp. 85-113). New York: Macmillan.

Stipek, D. J. (2002). *Motivation to learn: Integrating theory and practice.* Boston: Allyn & Bacon.

Stroet, K., Opdenakker, M. C., & Minnaert, A. (2013). Effects of need supportive teaching on early adolescents' motivation and engagement: A review of the literature. *Educational Research Review*, *9*, 65-87.

Sullivan, J., & Barner, D. (2015). Discourse bootstrapping: Preschoolers use linguistic discourse to learn new words. *Developmental Science, 16*(2), 234-248.

Svetlova, M., Nichols, S. R., & Brownell, C. A. (2010). Toddlers' prosocial behavior: From instrumental to empathic to altruistic helping. *Child Development*, *81*(6), 1814-1827.

Thorell, L. B., Lindqvist, S., Bergman Nutley, S., Bohlin, G., & Klingberg, T. (2009). Training and transfer effects of executive functions in preschool children. *Developmental Science*, *12*(1), 106-113.

U.S. Department of Health and Human Services, Administration for Children and Families. (2015). *Head Start Early Learning Outcomes Framework: Ages Birth to Five*. Retrieved from http://eclkc.ohs.acf.hhs.gov/hslc/hs/sr/approach/pdf/ohs-framework.pdf

van Schijndel, T. J., Visser, I., van Bers, B. M., & Raijmakers, M. E. (2015). Preschoolers perform more informative experiments after observing theory-violating evidence. *Journal of Experimental Child Psychology*, *131*, 104-119.

Vartuli, S. A., & Rohs, J. (2008). Selecting curriculum content that stimulates thought. *Early Childhood Education Journal*, *35*(5), 393-396.

Verdine, B. N., Golinkoff, R. M., Hirsh-Pasek, K., Filiopwicz, A. T., & Chang, A. (2014). Deconstructing building blocks: Preschoolers' spatial assembly performance relates to early mathematical skills. *Child Development, 85*(3), 1062-1076.

Vygotsky, L. S. (1967). Play and its role in the mental development of the child. *Soviet Psychology*, *5*(3), 6-18.

Waismeyer, A., Meltzoff, A. N., & Gopnik, A. (2015). Causal learning from probabilistic events in 24-month-olds: an action measure. *Developmental Science*, *18*(1), 175-182.

Warneken, F., & Tomasello, M. (2006). Altruistic helping in human infants and young chimpanzees. *Science*, *311*(5765), 1301-1303.

Weisberg, D. S., Kittredge, A. K., Hirsh-Pasek, K., Golinkoff, R. M., & Klahr, D. (2015). Making play work for education. *Phi Delta Kappan*, *96*(8), 8-13.

Weisberg, D. S., Ilgaz, H., Hirsh-Pasek, K., Golinkoff, R., Nicolopoulou, A., & Dickinson, D. K. (2015). Shovels and swords: How realistic and fantastical themes affect children's word learning. *Cognitive Development*, *35*, 1-14.

Weisberg, D. S., & Sobel, D. M. (2012). Young children discriminate improbable from impossible events in fiction. *Cognitive Development*, *27*(1), 90-98.

Weisberg, D. S., Zosh, J. M., Hirsh-Pasek, K., & Golinkoff, R. M. (2013). Talking it up: Play, language development, and the role of adult support. *American Journal of Play, 6*(1), 39-54.

Weisleder, A., & Fernald, A. (2013). Talking to children matters: Early language experience strengthens processing and builds vocabulary. *Psychological Science, 24*(11), 2143-2152.

Welsh, J. A., Nix, R. L., Blair, C., Bierman, K. L., & Nelson, K. E. (2010). The development of cognitive skills and gains in academic school readiness for children from low-income families. *Journal of Educational Psychology*, *102*(1), 43.

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White, R. E., & Carlson, S. M. (2011). *Priming in pretense boosts 3-year-olds' executive function performance in "Less is More" task*. Poster presented at the biennial meeting of the Society for Research in Child Development, Montreal, QC.

Whitehurst, G. J., & Lonigan, C. J. (1998). Child development and emergent literacy. *Child Development, 69*(3), 848-872.

Wilhelm, I., Diekelmann, S., & Born, J. (2008). Sleep in children improves memory performance on declarative but not procedural tasks. *Learning & Memory*, *15*(5), 373-377.

Yen, C. J., Konold, T. R., & McDermott, P. A. (2004). Does learning behavior augment cognitive ability as an indicator of academic achievement? *Journal of School Psychology*, *42*(2), 157-169.

About the Center for Childhood Creativity

Creativity is the foundation of all other milestones in educational development. Harnessing creativity at a young age, when brain development and plasticity is at its peak, not only optimizes academic success, but is critical for social-emotional development, critical thinking, and problem solving.

Launched in 2011 as the research and advisory division of the Bay Area Discovery Museum, the Center for Childhood Creativity (CCC) works at a national scale to advocate for the critical importance of creativity development in childhood and to inspire the next generation of innovators, thought leaders, and problem-solvers.

The CCC is committed to advancing the research that informs our understanding of childhood creativity and its cultivation. High-quality, empirical research provides the foundation for all of the CCC's work, including advising to schools, museums, and other non-profits, as well as companies that directly influence children's development.

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