Review of the Science Behind the ***Seeding Success Zero-to-Three*** Initiative: Evidence for the *Fundamental Five* Early Childhood Parenting Behaviors

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1. Maximize loving responsiveness and minimize stress, beginning at birth and especially later when delivering discipline to toddlers. Discipline toddlers in ways that regulate behavior, but don't undermine a sense of emotional security and growing behavioral autonomy.

Warm and responsive parenting lays the foundation for healthy social, emotional and cognitive development in infancy and beyond. With a young infant, responsive parents follow cues (e.g., facial expressions, movements, verbalizations). They react promptly and effectively to the infant's needs (e.g., sooth them when they are upset). The Center on the Developing Child at Harvard University (2007) uses the phrase "serve and return" to describe this back-and-forth that takes place between the caregiver and child. Over time, "serve and return" parenting helps the infant develop self-regulatory skills. Children move from being totally dependent on adults to being more in control of their bodies, attention, and emotions (National Research Council and Institute of Medicine, 2000). Consistent warmth and responsiveness also help cultivate autonomy. As the infant develops trust in parents and other caregivers, they develop a general sense of security. This reduces their fear of unfamiliar situations and supports developmentally healthy tendencies to explore surroundings (Ainsworth & Bell, 1970).

In a longitudinal study of children from 6 months old through 8 years of age, Landry, Smith, and Swank (2003) found the consistency of mothers' warmth and responsiveness across early childhood to be a significant predictor of both cognitive and social development. Children with consistently warm and responsive mothers exhibited cognitive growth rates that averaged 10.2 months per year compared to only 8.3 months for those whose mothers ranked consistently low (Landry et al., 2003). Fortunately, research has shown that warmth and responsiveness can be enhanced through interventions. For example, when mothers participated in the Play and Learning Strategies (PALS) intervention across early childhood they exhibited half a standard deviation more contingent responsiveness compared to mothers in a control group (Landry, Smith, Swank, & Guttentag, 2008).

It is also important to protect children from excessive stress. Chronic exposure to stressful situations (e.g., a chaotic home or neglect) affects a child's biology. Specifically, "toxic stress" causes chronically elevated stress hormones and can alter the stress response system. It can also hamper brain development in domains associated with executive functioning skills such as memory and inhibitory control (Committee on Psychosocial Aspects of Child and Family Health, 2012). Secure relationships can serve as a stress buffer. Infants and toddlers who have secure relationships with their caregivers tend to

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be less emotionally and physiologically sensitive to stressful situations (Nachmas, Gunnar, Mangelsdorf, Parritz, & Buss, 1996).

The *Seeding Success Zero-to-Three* initiative aims to raise parental awareness of the forms that stress takes for infants and toddlers and build socio-economical supports focused on ways of mitigating it. Living by the mantra, "maximize love, minimize stress," can help parents raise healthy and resilient children. It is the foundation of the Fundamental Five.

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2. Talk, sing, and gesture a lot beginning at birth. *Real talk* more than baby talk, from the very beginning.

There are well-documented gaps between more and less advantaged children in the language skills that that they acquire in early childhood. Disadvantaged children develop smaller vocabularies and a more limited command of grammar by the time they enter preschool (Hart & Risley, 1995;

Vasilyeva, Waterfall, & Huttenlocher, 2008). This is problematic given that early gaps in language development tend to predict later gaps in literacy and school success (Snow, Burns, & Griffin, 1998; Vernon-Feagans, Hammer, Miccio, & Manlove, 2002). For example, longitudinal studies have demonstrated associations between oral language development in early childhood and later reading ability. Oral language skills—especially performance on semantic tasks involving word definitions and word retrieval—may be particularly important for later reading comprehension (Roth, Speece, & Cooper, 2002). Roth et al. (2002) found kindergarteners' semantic knowledge to be a significant predictor of their reading comprehension in second grade, with word definition and retrieval accounting for 23 percent of the variance in this measure.

Research has uncovered strong links between children's home language environments and their oral language. There are racial, ethnic, and socioeconomic differences on average in the quantity and quality of language input that children receive (Brooks-Gunn & Markman, 2005). Factors such as stress and depression have also been shown to affect parental language use (Lovejoy, Graczyk, O'Hare, & Newman, 2000). By age 3, middle and upper income children typically have heard more utterances and a greater diversity of words than low-income children (Hart & Risley, 2005; Pan, Row, Singer, & Snowe, 2005). Moreover, these differences in exposure are consistently correlated with differences in language comprehension, vocabulary, and syntax (Hart & Risley, 1995; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991; Hoff, 2006; Hurtado, Marchman, & Fernald, 2008; Pan, Row, Singer, & Snowe, 2005; Vasilyeva, Waterfall, & Huttenlocher, 2008).

In a longitudinal study, Rowe and Goldin-Meadow (2009a) found that a one standard deviation difference in vocabulary at 18 months of age was associated with a .41 standard deviation gap in vocabulary at 42 months as measured by the Peabody Picture Vocabulary Test (PPVT). Moreover, certain types of language input may be more strongly associated with children's language development than others. Pan et al. (2005) found that the *diversity* of mothers' words predicted the size of low-income children's vocabulary more than the mothers' level of talkativeness in general. At 24 months of age, low-income children whose mothers communicated using diverse vocabularies produced, on average, 33.5 unique words in a 10-minute interaction period compared to only 24.5 unique words for children whose mothers used less diverse vocabularies (Pan et al., 2005).

Non-verbal communication, including the use of gesturing, is also related to children's language development. Children begin to gesture during infancy. Even as they begin learning words, gesture remains an important supplement to their verbal expression (Capone, 2007; Goldin-Meadow, 2009). As such, gestures can guide adults in scaffolding interactions around an infant's current developmental level (Goldin-Meadow, Alibali, & Church, 1993). Gestures such as pointing may also be used by the parent to label objects, increasing the child's knowledge of object names (Pan, Rowe, Singer, & Snowe, 2005). And the more parents gesture, the more likely their children are to gesture (Rowe & Goldin-Meadow, 2009b; Tamis-LeMonda, Song, Levell, Kahana-Kalman, & Yoshikawa, 2012). Supporting the strong relationship between gesture and early language development, Rowe and Goldin-Meadow (2009a) found that 18-month-olds' gestures predicted their vocabulary size and sentence complexity at 42 months. Specifically, a standard deviation change in the number of meanings a child could convey in gesture at 18 months of age was associated with a .40 standard deviation in their score at 42 months of age on the PPVT (Rowe & Goldin Meadow, 2009a). Helping to establish a causal role for gesture in learning, recent experimental research has shown that infants who are encouraged to gesture during a word learning task (e.g., "That's a pig. Can you point to the pig?") learn more than children who are not made to gesture (Goldin-Meadow, 2011). Goldin-Meadow and her colleagues suggest that gesture increases the efficiency of learning by decreasing the load on our working memory (memory for information over a very brief interval that helps us keep our mind on a task; Cook, Yip, & Goldin-Meadow, 2011; Goldin-Meadow, 2011). Gesture may also facilitate learning by tapping into children's

implicit knowledge and connecting it to new concepts (Broaders, Cook, Mitchell, & Goldin-Meadow, 2007).

As with verbal input, the type and frequency of parental gesturing has been shown to differ across racial, ethnic, and income groups. Differences have been found in the amount that parents gesture to their children, as well as the types and diversity of gestures used (Rowe & Goldin-Meadow, 2009; Tamis-LeMonda et al., 2012). Moreover, these patterns of communication are associated with differential use of gesture and later language outcomes in children. Rowe and Goldin-Meadow (2009b) found that early parent gesture mediated the relationship between socioeconomic status and children's vocabularies at 54 months. Similarly, in a sample of Mexican, Dominican, and African American mothers, Tamis-LeMonda et al. (2012) observed an association between race/ethnicity and mothers' gestures at 14 months, with differences in gesturing predicting children's receptive language skills at two years.

As the above demonstrates, language learning is an inherently social process—mere exposure to language such as listening to the television or to adults talking among themselves provides little benefit for children's language development. Rather, infants need to interact directly with other human beings, to hear people talking about what they are seeing and experiencing, to develop optimal language skills. Kuhl (2010) explains that babies learn language by "taking statistics" on the sounds being spoken around them. Importantly, statistical learning appears to require interaction with another person: in one experiment, babies exposed to a new language via either videotaped or audio-only sessions showed no learning at all, whereas babies exposed to sessions with human interaction developed new language skills (Kuhl, Tsao, & Liu, 2003; Kuhl, 2007). Overall, the extant literature highlights the importance of supporting parents in being intentional about the ways in which they use language, exposing children to rich social interactions that will promote their language development.

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3. Use number games and rhythm to lay the foundations for numeracy.

Mathematical knowledge and skills begin to emerge very early in life—infants have even been shown to come into the world already possessing a rudimentary number sense (Starkey, Spelke, & Gelman, 1990). Yet gaps in mathematical knowledge open up during early childhood, with disadvantaged children often falling behind their more advantaged peers by the time they enter preschool (Levine, Suriyakham, Rowe, Huttenlocher, & Gunderson, 2010). Unfortunately, these early disparities in mathematical knowledge predict later achievement gaps during the school-age years (Jordan & Levine, 2009). It is thus important to examine the role that parents can play in fostering their children's early math abilities.

While less attention has been paid to children's mathematical development than their language development, there is a growing body of literature on the sociocultural factors that shape the emergence of children's math skills (see Levine, Gunderson, & Huttenlocher, 2011 for a review). Examples of early mathematics concepts include: matching, sorting, cardinality, comparing, and ordering. Children's understanding of the cardinal meanings of number words (e.g., not just knowing that "five" comes after "four" in a counting sequence, but understanding that "five" actually refers to a set of five objects) is often a focus of research on early math development as it is an important insight that sets the stage for more complicated mathematical reasoning (Levine et al., 2010). In a longitudinal study, Levine et al. (2010) observed a large degree of variation in the amount of "number talk" that occurred between parents and their children ages 14 to 30 months. Furthermore, the amount of parent number talk at 14 to 30 months was a significant predictor of children's understanding of cardinal numbers at preschool entry even when controlling for SES (β=.35, $p<.01$). Over and above SES, observed number talk at 14 to 30 months accounted for 11.4% of the variation in children's cardinal number knowledge at 46 months (together, SES and number talk accounted for 36.2%; Levine et al., 2010). In a follow-up study, Gunderson and Levine (2011) looked more closely at the *types* of number talk that facilitate children's understanding of cardinal numbers. For example, they report that "parents' number talk involving counting or labeling sets of present, visible objects is related to children's later cardinal-number knowledge, whereas other types of parent number talk are not. In addition, number talk that refers to large sets of present objects (i.e. sets of size 4 to 10 that fall outside children's ability to track individual objects) is more robustly predictive of children's later cardinal-number knowledge than talk about smaller sets," (p. 1021). Talking about large sets of present objects predicted children's cardinal number knowledge, explaining 15.7% of the variance beyond what was accounted for by SES (Gunderson & Levine, 2011). The results from these observational studies also mirror those of survey studies that have found associations between parental reports of math-related activities in the home and children's math knowledge (Levine et al., 2011).

Taken together, these findings suggest that games and activities that increase certain types of parental number talk—particularly counting and manipulating present objects—could improve children's emerging math abilities. Research has shown that parents of young children tend to prioritize language-related activities over math activities (Barbarin, Early, Clifford, Bryant, Frome, Burchinal, Howes, & Pianta, 2008), so encouraging a focus on math may be all the more important.

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4. Enable and encourage three-dimensional competencies (e.g., skills at maneuvering (crawling and walking) in cluttered spaces and manipulating three-dimensional objects).

Children's physical movement abilities often get overlooked in discussions of issues like school readiness and achievement gaps. Yet research has begun to show the importance of "mind-body" connections—or *embodiment*—in the development of young children (Needham & Libertus, 2011). Movements such as reaching, crawling, and walking are important physical breakthroughs that affect children's bodily coordination as well as their relationships with their environments and the ways in which they can interact with their surroundings and the people in them (Newcombe, 2002).

Several studies have reported relationships between motor development in the early years and children's exploration of objects and spaces. With very young infants, the ability to explore objects manually appears to be associated with certain cognitive leaps. For example, Needham (2000) observed that infants with more advanced manual exploration skills performed better at an object identification task than infants with less developed object exploration abilities. In a related experimental study, Needham, Barret, and Peterman (2002) found that having infants play while wearing Velcro mittens (which allowed them to pick up objects before they had acquired the skills to grasp them on their own) resulted in more diverse and "sophisticated" approaches to object exploration than were observed in a control group. A follow-up experiment with the Velcro mittens demonstrated that reaching can also

promote social behavior. In this study, infants with experience using Velcro mittens showed significantly stronger preference for faces and tendency to orient to faces than infants in the control group (Libertus & Needham, 2011). Furthermore, regression analyses demonstrated that across both the experimental and control groups, increased manual exploration in general was significantly associated with an increased tendency to orient to faces (Libertus & Needham, 2011).

Like reaching, crawling provides new ways for infants to acquire information about their surroundings. For example, self-locomotion promotes the transition from an egocentric frame of reference to an allocentric one (Needham & Libertus, 2011). In a review of the literature on the impact of self-locomotion on psychological development, Campos, Anderson, Barbu-Roth, Hubbard, Hertenstein, and Witherington (2000) argue that crawling promotes the development of spatial cognition, citing observational studies where infants with more advanced locomotor skills performed better than children of the same age with less advanced locomotor skills on tasks requiring spatial searching (Horobin & Acredolo, 1986; Kermoian & Campos, 1988) and spatial coding (Bai & Bertenthal, 1992; Bertenthal, Campos, & Barrett, 1984).

Finally, there is some longitudinal evidence linking motor development with later cognitive outcomes, although the research base with typically developing children is fairly small. As an example, Piek, Dawson, Smith, and Gasson (2008) found that gross motor skills measured in children between birth and age 4 were associated with cognitive processes such as working memory and processing speed by school age. So while the developmental pathways linking motor and cognitive skills are not fully clear, they do appear to have important associations throughout early childhood.

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5. Cultivate a love of learning through conversations during book reading and travel; interact with your child to remember, explain, and anticipate together.

Shared book reading provides an important context for young children's language and literacy development. It introduces them to words, concepts, and forms of discussion and reasoning that they might not encounter in other activities. Empirical research has repeatedly shown the amount of time spent reading and the nature of interactions during reading to be associated with children's later cognitive and language development (e.g., Bus, van IJzendoorn, Pellegrini, 1995; Sénéchal, LeFevre, Hudson, & Lawson, 1996). These effects have been noted across demographic groups, and highlight the importance of early reading for children at risk of academic difficulties (e.g., Britto, Brooks-Gunn, 2001; Raikes, Pan, Luze, Tamis-MeLonda, Brooks-Gunn, Constantine, Tarullo, Raikes, & Rodriguez, 2006; Van Kleeck, Gillam, Hamilton, & McGrath, 1997). However, Raikes et al. (2006) point out, much of the research findings on book reading and children's development are correlational, and research has tended to focus on preschool aged children with less attention to reading that occurs before the age of three.

The frequency of early book reading matters for children, with daily reading providing a "strong and direct" influence on young children's development (Raikes et al., 2006, p. 944). In a longitudinal study of a large, ethnically diverse sample of low-income families with infants and toddlers, Raikes et al. (2006) reported an association between the frequency of reading and children's language and cognitive development at 14 and 24 months. Furthermore, daily reading during the first two years continued to predict children's language and cognitive development at 36 months as measured by the PPVT (SB=.14, $p<.05$) and Bayley Mental Scales of Infant Development (MDI; SB=.13, $p<.05$) respectively (Raikes et al., 2006). The authors suggest that the findings "underscore the value of emphasizing book reading experiences for low-income infants and toddlers" (p. 947).

The quality of interactions that occur during book reading also matter for children. Specifically, the richness of discussions during shared book reading tends to predict children's later literacy skills. In a longitudinal study of shared book reading, Haden, Reese, and Fivush (1996) observed that 40-month-old children of mothers who expanded on the text (e.g., made connections to general knowledge, encouraged their children to make inferences and predictions, and confirmed their children's comments) performed better on literacy tasks at 58 and 70 months of age than children whose mothers simply read and described the text. Similarly, in an observational study with 3- and 4-year-old children, Van Kleeck, Gillam, and Hamilton (1997) found that particular combinations of higher and lower order questions from parents were associated with children's abstract language development a year later. The authors suggest that conversations at different levels of abstraction serve different purposes, with low abstraction helping to encourage and reinforce concepts to children and higher levels of abstraction

advancing children's abstract reasoning abilities. Finally, intervention studies suggest that training parents in more interactive approaches to reading with young children (e.g., dialogic reading) can improve literacy outcomes across demographic groups (Valdez-Menchaca & Whitehurst, 1992; Whitehurst, Falco, Lonigan, Fischel, DeBaryshe, Valdes-Menchaca, & Caulfield, 1988).

There is a lot of variation in families' reading behaviors. Many families do report reading to young children with some regularity. Of the 2,581 low-income mothers in Raikes et al.'s (2006) study, 48% reported reading daily to their children at 14 months, with 55% reading daily by 24 months—figures that are similar to national averages. They did find differential reading patterns by race and ethnicity, with Hispanic and African American parents reading less frequently to their children than white parents (Raikes et al., 2006). In a national survey, Yarosz and Barnett (2001) noted similar racial and ethnic patterns in reading habits. There is also significant variability in the types of conversations that occur during reading. Even within demographic groups, some mothers constantly elaborate on the text and interact with their children while others rarely do (Haden et al., 1996). Such findings highlight the importance of supporting all families in using effective reading strategies with their children.

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