Article

Supporting Healthy Brain and Behavioral Development During Infancy

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Abstract

Much of infant development occurs in the home and in the context of caregiving support. Babies learn through their everyday interactions with parents—from watching, listening, communicating, cuddling, and playing with them. Foundations for cognitive skills such as attention, perception, learning, and language are all built in the brain during the first year of life. Socioemotional development, including the ability to self-regulate behaviors and emotions, also begins during infancy. Recent advances have allowed researchers to answer questions about the developing brain and how it is impacted by experience and environmental systems, including parental sensitivity and consistency, the home environment, socio-cultural factors, community support systems, and public policies. Giving parents the opportunity to support healthy infant development through paid parental leave programs that are accessible, flexible, and equitable, will positively impact early trajectories of brain and behavioral development.

Keywords

brain development, infant development, paid parental leave

Tweet

Give parents the opportunity to provide their infants with a supportive and healthy developmental environment, through paid parental leave programs that are accessible, flexible, and equitable. This will benefit early trajectories of brain and behavioral development.

Key Points

- Parental interactions and the home environment are critical for brain development in the first year of life.
- Neurocognitive development—nested within everyday activities and interactions with parents—forms the foundation for subsequent developmental outcomes.
- Socioemotional competencies develop within the context of parent–infant relationships and parental stress, anxiety, and depression affect infants.
- The developing brain is impacted by environmental systems including the home environment, socio-cultural factors, community support systems, and public policies.
- Ensuring that the basic needs of families are met during the first year of life will provide parents with the tools needed to support brain and behavioral development.
- Paid parental leave programs that are accessible, flexible, and equitable will benefit early trajectories of brain and behavioral development.

Brain Development in the First Year of Life

Brain development begins prenatally, and the brain continues to adapt to environmental experiences throughout life (see Stiles & Jernigan, 2010). During the first months of life, the brain is changing at a rate never again seen across the lifespan. The process of forming connections between neurons in the brain supports learning and is very different early in development than when new connections form during adulthood. The speed and efficiency of neural communication develop at different rates for different brain regions. The sensory regions of the brain, including visual and auditory cortices, appear to begin this process earlier than other areas that integrate information across regions, including language, memory, and attention. Human cognitive and socioemotional capacities emerge from patterns of neural activity that work in concert with both development and experience, and recent work has examined how experience shapes patterns of cortical activity across the first years of life.

The brain is very flexible or "plastic" throughout life, but especially during early development. Increased plasticity during infancy facilitates functional brain specialization in

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response to relevant experiences. Early plasticity also allows the brain to recover more quickly from an acute injury or developmental impairment and adapt to changing environments (Greenough et al., 1987; Kolb et al., 2017). However, this plasticity may also result in the brain being susceptible to negative experiences, including exposures to toxins, parental stress, parental mental health impairments, neglect, deprivation, and abuse. Negative developmental experiences have differential impacts on the developing brain depending on the type, dose, duration, and timing of the impact (Belsky & Pluess, 2009; Nelson & Gabard-Durnam, 2020).

Much of early infant development occurs within the home and in the presence of caregivers. As such, the early caregiving environment matters substantially, and infants immediately begin learning from the surrounding world. Learning is nested within everyday activities and interactions with caregivers, and these early experiences are the foundation for subsequent neurocognitive and socioemotional development.

Neurocognitive Development: Attention, Perception, and Learning

During the first year of life, infants build perceptual representations of the surrounding world. Infants pay attention to the relevant features of their environment, including the sounds and words of the languages they hear and the people, animals, and objects they see. What was once obligatory orienting toward salient images and sounds, becomes more controlled and purposeful selective and sustained attention (Colombo, 2001). Throughout this process, parents highlight the relevant features in their environment with their gestures, verbal labels, and use of emotion in language. Between approximately 3 and 9 months of age, infants go through a process during which time processing of the sights and sounds of the world shift from being somewhat universal to being specific to their experienced environment (e.g., Hadley et al., 2014; Markant & Scott, 2018; Scott et al., 2007). This process builds biases in the brain for attending to and accurately perceiving the most relevant parts of their world, like the sounds of the languages they hear and the faces of the people they see. As a result, some of the perceptual differences infants were previously able to notice between unfamiliar language sounds or faces from an unfamiliar group have become more difficult to distinguish, an experience called perceptual narrowing (Scott et al., 2007).

Shared book reading between infants and parents provides an ideal context for examining perceptual narrowing and early learning in the home. During shared book reading, parents point, name, ask questions, and express emotions all while they cuddle with their babies—leading to engaging and high-quality learning experiences. In infants between 9 and 18 months of age, including this experience within daily routines increased parent and child talking compared to other daily activities including toy play, personal care, or mealtime (Clemens & Kegel, 2021).

Infants exhibit increased attention and perceptual learning and show more specialized brain responses after parents read them books with specifically labeled names for faces or objects (Pickron et al., 2018; Scott, 2011; Scott & Monesson, 2009, 2010). For example, when infants learned to associate individual level labels (e.g., "Fiona" and "Boris") with individual objects over the course of three months, they attended to the images longer and their attention-related electroencephalography neural responses differentiated the objects at the individual level. These effects were not present before book reading, for a comparison group with no book reading, or for infants who were read books with the same generic label for all images (Pickron et al., 2018). This increased attention when parents use different names during book reading, highlights the parents' role in shaping the developing brain with their words, actions, faces, and time.

Neurocognitive Development: Language

Infants attune to the properties of the language or languages heard within their home environment during the first year of life—facilitating language learning and laying the foundation for later language skills. Parents play a role in the development of language abilities; both the quality and quantity of parent language positively correlate with subsequent language outcomes (Hirsh-Pasek et al., 2015; Smith et al., 2000). Even in the first half-year of life, infants begin to understand that words refer to objects or people in their environment, and they show knowledge of common nouns (Bergelson & Aslin, 2017; Bergelson & Swingley, 2012). Parent–child interactions provide a context for language exposure and shape early language development. Characteristics of the caregiver, including levels of warmth, responsiveness, and sensitivity predict children's developing language skills (Tamis-LeMonda et al., 1996). Language learning also increases through repeated exposure to words and phrases, as this increases the child's chances to learn and remember (McGregor et al., 2007).

Early language ability is one of the best predictors of school readiness and later academic achievement (Pace et al., 2019). Consequently, previous research has focused on what elements of the home environment may significantly impact language learning trajectories, with many studies focusing on the role family socioeconomic status (SES) may play in influencing developing skills. By the time children enter kindergarten, children from higher SES homes outperform their peers from lower SES homes on standardized measures of receptive and expressive language skills (Ginsborg, 2006). Associations between SES and language skills reportedly emerge during the second year of life, with characteristics of the home environment, including

literacy resources and parent–child interactions, partially accounting for SES differences in language skills (Noble et al., 2015).

Although SES may be highly correlated with early developmental outcomes, examining the home environment may be more informative in revealing underlying mechanisms. The quality of the home environment, but not SES, predicts the ability to tell apart sounds at 9 months (Melvin et al., 2017). Similarly, factors such as the number of people in the home and consistent routines link to infant language skills, independent of SES (Johnson et al., 2008; Martin et al., 2012). Chaotic or disorganized home environments are associated with reductions in language abilities during infancy (Wachs & Chan, 1986) and toddlerhood (Vernon-Feagans et al., 2020). An unpredictable or inconsistent home environment may contribute to reduced parental responsiveness during infancy (Corapci & Wachs, 2002; Matheny et al., 1995) and differences in infant brain activity (Brito et al., 2020).

Language input within the home is related to both brain structure and function. Conversational turns, or the back-and-forth verbal interaction between caregiver and child, is significantly associated with neural activation in language areas of the brain during story-listening, with differences in brain activation mediating links between language input and preschool language scores (Romeo et al., 2018). Likewise, language input is also related to a greater cortical surface area in a region of the brain linked to language comprehension and production (Merz et al., 2019). Notably, interventions designed to increase parental language input and turn-taking during infancy increased children's language skills during toddlerhood (Ferjan Ramírez et al., 2020) and may be explained by neuroplasticity (Romeo et al., 2021).

Socioemotional Development

During the first year, infants learn that parents are a consistent and reliable source of support and love, building the foundation for their future relationships with parents, teachers, peers, and even adult romantic partnerships. Attachments to caregivers start to form from birth and are established within the first year of life (Cassidy et al., 2013). Once attachments are formed, they remain stable throughout childhood (Gloger-Tippelt et al., 2002). These caring and consistent parent–child relationships mitigate the impact of stress and help develop learning foundations, positive relationships, and self-regulation of behavior and emotions.

The quality of parent–child interactions is directly related to the socioemotional development of the child (Bigelow et al., 2010; Gregory & Rimm-Kaufman, 2008). Parent–child interaction quality is often measured by maternal sensitivity and mother–infant reciprocity. Maternal sensitivity is the ability to notice, interpret, and appropriately respond to infant cues (Beebe & Steele, 2013), whereas reciprocity refers to the coordinated, back-and-forth exchanges of affective and behavioral cues (Feldman, 2007). An absence of these behaviors potentially contributes to negative outcomes for physiological and emotional development (Shonkoff & Phillips, 2000). Both maternal sensitivity and mother–infant reciprocity are linked to better emotion regulation and attachment security in children (Feldman et al., 2014; Raikes et al., 2007). Parent–infant interactions are a time for infants to receive needed physical contact, including holding, which reduces distress (Karasik et al., 2015; Yao et al., 2019). Finally, the quality of parent–child interactions is predictive of infant brain function across development (Bernier et al., 2016).

Maternal stress, anxiety, and depression are associated with negative impacts on brain development. For example, one investigation reported decreased connectivity between two brain regions involved in cognitive and socioemotional development as maternal anxiety increased (Dufford et al., 2021). In addition, mothers who experienced increased stress during pregnancy were more likely to have infants who showed atypical connections across brain regions (Humphreys et al., 2020). Correlations between infant neural development and maternal mental health may predict later infant abilities to self-regulate their behaviors and emotions. According to a recent systematic review, the quality of infant attachment and differences in maternal sensitivity was related to structural changes in brain regions involved in social–emotional processing, memory, and sensorimotor control (Ilyka et al., 2021).

A Systems Approach to Supporting Healthy Brain Development

Several frameworks and models have identified the importance of examining and interpreting developmental trajectories from a systems perspective (Bronfenbrenner & Morris, 2006; Cantor et al., 2021; Gottlieb, 2007; Thelen & Smith, 1994). Systems perspectives vary in their features, but all require development to be examined within the multilevel and interacting contexts. The developing child self-organizes and builds off previous experiences, while multilevel contextual influences both facilitate and constrain developmental outcomes. Within systems perspectives, context includes maturational and genetic factors, nutrition, parental sensitivity and consistency, the home environment, socio-cultural factors, community support systems, and public policies (see Figure 1). Experiences and development at one point in time may impact later outcomes through developmental cascades (Masten & Cicchetti, 2010; Oakes & Rakison, 2020). A developmental cascades perspective suggests that developmental outcomes do not occur in isolation but instead emerge and accumulate over time, such that a skill or experience at one point in development contributes to the foundation for later developmental outcomes.

A systems framework for infant development suggests that what babies hear, see, feel, touch, taste, smell, and experience

Figure 1. A systems approach to supporting healthy infant brain development. Family, community, workplace, health, sociocultural, and public policies impact parenting and their ability to support infant brain and behavioral development.

all set up the foundations for later healthy development and learning. As described above, the first years of life are sensitive periods for socioemotional and cognitive development (Knudsen, 2004; Sheridan & Nelson, 2009). Key neural connections within the brain are emerging in the context of warm, predictable, and responsive social interactions between the infant and caregiver (Shonkoff & Phillips, 2000). The first months of life set the stage for later development and problems encountered during this time may cascade into continued difficulties later in development.

Child development within this empirically supported systems perspective can frame support programs and policies for developing children. Knowledge gained from infant research, emphasizing experiences within the context of the home and parental interactions, is vital for the development of targeted prevention strategies aimed at increasing neurocognitive and socioemotional development. These factors are basic needs for healthy development, and efforts should be made to ensure they are available to all caregivers and infants. The lack of these basic needs cascade down to families, parents, and infants and increase the risk for delayed or maladaptive outcomes.

Recommendations: The Case for Paid Parental Leave

Families should receive adequate resources and support, given the importance of a supportive and consistent home environment for early neurobehavioral development. One way to facilitate early trajectories of brain development is through the implementation of paid family leave. Despite overwhelming support for paid parental leave policies across the political spectrum, this cornerstone of legislation to invest in families has been historically deprioritized, keeping the U.S. as the only high-income country in the world that does not provide any paid leave for new parents. Across the U.S., existing family leave policies are moving targets, as changes are made often and inequities exist both within and across employers. Although the Federal Medical Leave Act enables new caregivers to receive 12 weeks of job-protected *unpaid* leave, eligibility criteria severely restrict access to this policy for most working parents. Currently, to qualify the caregiver must work for an employer with 50 or more employees within a 75-mile radius and must have documented at least 1,250 h of work in the 12 months prior to childbirth. Thus, even this unpaid benefit is typically only accessible for women who are college-educated or live in two-parent households (Han et al., 2009).

Paid leave could benefit early brain development in several ways. First, the positive impact of paid leave on the health of both infants and mothers is well documented across the world (Van Niel et al., 2020). Working mothers in the US who planned to use paid leave through state-based temporary disability insurance programs had a reduced rate of low-birth-weight births (Stearns, 2015). Paid leave also increases the duration

of breastfeeding (Huang & Yang, 2015), which is associated with health benefits for both infants and mothers (Dieterich et al., 2013). Paid leave affords parents the ability to take their infants to doctor's appointments and receive immunizations (Berger & Waldfogel, 2004). These early well-baby visits may facilitate the early detection of potential developmental delays at a time when problems can be most effectively addressed and interventions identified.

During the first few months of life, parents and infants are learning to read each other's cues, and ample bonding time prior to returning to work may result in better attunement and more secure attachments between the dyad (Plotka & Busch-Rossnagel, 2018). Access to paid leave is likely to alleviate some of the stressors caregivers face, from reduced income during their time off, pressure to return to work too early, and other changing life circumstances. The transition to parenthood represents a nexus of many co-occurring biological, psychological, social, economic, and behavioral changes and can be one of the most taxing periods of life. New parents report increases in mental health issues and relationship conflict, as well as decreases in the ability to maintain health-protective behaviors, such as sleep and exercise (Saxbe et al., 2018).

Although stress is a common experience for caregivers in the first several months after birth, high levels of chronic stress can disrupt a caregiver's ability to respond to their infant's cues in a sensitive and timely manner (Crnic et al., 1983). Chronic maternal stress has been linked to alterations in early brain development (Troller-Renfree et al., 2020), even in infants as young as two months (Pierce et al., 2019). Among women who returned to work within three months after childbirth, those who received paid leave had lower depression scores than women who took unpaid leave (Mandal, 2018). In addition, Black and Latine individuals are currently less likely to take unpaid leave compared to White individuals (National Partnership for Women and Families, 2018), highlighting inequities within the current system. Increasing access to paid family leave is likely to have a larger benefit for under-resourced families, potentially leading to reductions in sociodemographic disparities.

Finally, paid leave may also indirectly increase the predictability and consistency of the infant's environment. Family routines such as regular bedtimes, bathtimes, mealtimes, and other shared experiences are associated with positive outcomes for children. These predictable, responsive interactions between the parent and child are highly beneficial for learning language and self-regulation skills. Mothers who had access to paid leave had toddlers with significantly higher language scores than children whose mothers took unpaid leave, regardless of household SES. Additionally, paid leave was also linked to fewer socioemotional/behavioral problems during toddlerhood, specifically for lower SES mothers (Kozak et al., 2021).

The science of infant development and the successful implementation of generous paid leave policies in other countries can be used to develop programs to support US families and best promote child development. Based on the importance of parents for infant learning and brain development, paid family leave programs will undoubtedly facilitate long-lasting neurobehavioral outcomes for our children. Policymakers need to prioritize paid parental leave and child care options that are accessible, affordable, and equitable.

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