The Fundamental Role of Early Environments to Developing an Emotionally Healthy Brain

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Abstract
The quality of early socioemotional environments has a clear link to emotional health. Findings from neuroscientific and behavioral studies explain this enduring link, and findings focus on the plasticity of emotional brain development. Implications include (a) prioritizing individuals as early as possible and throughout development, (b) remaining mindful that stable caregiving is a basic need for children, and (c) supporting children’s emotional development which means supporting their families. Addressing these needs is a large task, but not addressing these needs confers an even larger mental health cost to the individual as well as to society more broadly.

Keywords
children, adversity, stress, parents, buffering, brain development, neural plasticity

Introduction
Mental illness constitutes the leading cause of societal burden (Insel, 2008), and more than half of all mental illnesses emerge during development (Kessler et al., 2005). Presumably, then, the converse is also true, namely, that mental health takes root during development. This association between developmental processes and mental health has been a research focus for decades, and the evidence supporting this link is clear. A healthy and productive society depends on the adults within that society having experienced healthy childhoods.

What makes a healthy childhood? Certainly, adequate housing, safety, nutrition, education, and medical care are essential. As a society, we tend to focus on these aspects of development when it comes to policy and governmental budgeting. These are certainly important. However, less attention and money are spent to support a core influence on human brain development: the quality of the caregiving environment. The nature of caregiving received during development has profound and enduring effects on brain development that can in some instances counteract the influences of other adversities. By this same token, adverse caregiving can increase the risk of poor outcomes for brain function, even in the context of adequate medical care and economic wealth. This article discusses the role of caregiving on the human brain’s emotional development and argues that adequate caregiving experiences are as essential to mental and physical health in adulthood as are physical, economic, and educational needs.

Why Focus on Development?
The answer to this question is straightforward. During the first two decades of life, children develop into highly complex humans with an incredibly powerful brain capable of sophisticated decision making, emotions, and behaviors. That tremendous rate of change is never again repeated after these first two decades, and it renders the developing brain (in contrast to the mature brain) highly susceptible to
environmental pressures. That is to say, the developing brain is highly plastic and will be modified by its environment.

Moreover, the brain develops hierarchically; influences on early-developing structures can cascade to later development because the changes to the initial structures project to later developing structures. Therefore, early experiences can have a more widespread impact on the brain than later experiences (reviewed in Tottenham, 2014).

Finally, the developing brain has a molecular and cellular make-up that differs from the adult. While these differences facilitate the rapid learning that the developing brain can perform (e.g., consider the ease with which young children learn a second language), they also render the developing brain more likely susceptible to adverse experiences than the adult. For example, major adversity experienced by an adult can be traumatizing; however, the effect on the adult is typically dwarfed by the effect that the same adversity can have on the developing brain (e.g., Chen & Baram, 2016). Often, these effects are overlooked because children may not express the trauma in adult ways (think of child vs. adult differences in grieving behavior). For example, in childhood, trauma can often manifest as hyperactivity, inattention, and dysregulation (D’Andrea, Ford, Stolbach, Spinazzola, & van der Kolk, 2012). Moreover, the traces of the developmental adversity can manifest in profound ways at later points in life.

**Parents as Children’s “Extended Brain”**

Despite this prolonged immaturity of children’s brain development, we as a species are typically not expected to experience the world independently; this long period of immaturity coincides with receiving parenting (biological or not). The presence of a parent (mother or father, biological or not) provides an external extension of the child’s regulatory system. For this reason, the psychoanalyst Winnicott (1960) stated that “there is no such thing as an infant” (p. 587), indicating that understanding the child requires understanding them in their caregiving context.

Parents exert a number of obvious influences on their offspring (e.g., feeding, clothing, disciplining them). However, in seminal biological studies, parents also exert a number of unobservable influences on offspring as well (Hofer, 1994). Hidden regulators from the parent serve to control the offspring’s physiology (e.g., sensorimotor, thermal, and nutrient). That is, parents can keep infants contained, warm, and fed—or not. The parents’ numerous hidden regulators coordinate the physiology of the offspring at a time when they are unable to do this independently. This idea echoes behavioral observations, supporting Attachment Theory, that the parent creates a scaffolding for the child that coordinates the child’s behavioral repertoire (Ainsworth, 1969).

These ideas have been more recently extended by neuroscience research. Most notably, the powerful effects of positive caregiving experiences on the child’s brain have begun to become recognized as one of the leading forces on development—especially for emotions. Psychological sciences and neurosciences continue to reach the same conclusion—namely, that the parent is the conduit for emotional experiences of the child. Parents can buffer or exacerbate emotional experiences of the child, and they can direct the child’s attention to or away from relevant emotional events to increase or decrease the event’s impact on brain development. That is, parents filter and convey, consciously or not, the emotional experiences of their children (consider a child’s re-evaluation of his or her scary dream and ability to go back to sleep following his or her parent’s sensitive consultation). However, effective parenting becomes more challenging in the context of the parent’s own stress, and conversely, it becomes facilitated when parents themselves are supported by their environments.

**Emotional Brain Development**

To understand why parents have this large influence early in life, it is necessary to know a little about the development of emotional neurobiology during childhood. At its foundation, mature emotional behavior is heavily influenced by the amygdala and its neural connections. The amygdala is an evolutionarily old collection of nerve cells, deep in the temporal lobes, and it is primarily responsible for helping people pay attention to emotionally arousing events and learn about the relative safety and danger of the environment (Likhtik & Paz, 2015). Therefore, when people are startled by some environmental event, amygdala metabolism increases to focus attention on that event and gather more information to avoid danger. As an illustration, individuals with clinical anxiety disorders tend to exhibit hyperactivity of the amygdala (Etkin & Schatzberg, 2011; Nitschke et al., 2009); this would be a case of the amygdala responding too much to environmental events.

By adulthood, the amygdala has formed many neural connections, which can be thought of as bridges, with other regions of the brain. One major set connects with the prefrontal cortex (Zikopoulos, Hoistad, John, & Barbas, 2017). These connections are a two-way street, where information can be sent from the amygdala to the prefrontal cortex and information can also be sent from the prefrontal cortex back to the amygdala (Likhtik & Paz, 2015). The amygdala can signal to the prefrontal cortex when something of particular emotional relevance occurs in the environment. The prefrontal cortex, which is better positioned for gathering input from several regions of the brain, can send information back to the amygdala. If it turns out that environment is not threatening after all, then the prefrontal cortex has connections that act to quiet the activity of the amygdala (Motzkin, Philippi, Wolf, Baskaya, & Koenigs, 2015). In this way, the prefrontal cortex is effective in regulating or dampening the activity of the amygdala to prevent overarousal. Thus,
stronger connections between the amygdala and the pre-frontal cortex tend to confer more emotionally regulated behavior in adulthood (Lee, Heller, van Reekum, Nelson, & Davidson, 2012) and less risk for mental illnesses such as anxiety, depression, and other emotionally dysregulating conditions (Etkin & Wager, 2007; Koenigs & Grafman, 2009; Murray, Wise, & Drevets, 2011).

While the amygdala exhibits relatively early development in the human, the regulatory connections from the prefrontal cortex are slow to develop (Tottenham & Gabard-Durnam, 2017). At birth, the amygdala already has its basic neuroanatomical architecture (Humphrey, 1968; Ulfig, Setzer, & Bohl, 2003) and shows tremendous, rapid growth within the first year of life (Gilmore et al., 2012). Although the amygdala continues to show growth at later ages (Bramen et al., 2011; Giedd et al., 1996; Goddings et al., 2014), the changes in the first year of life are massive. In terms of its activity, the amygdala typically shows strong reactivity to emotional stimuli in childhood (Decety, Michalska, & Kinzler, 2012; Gee et al., 2013; Silvers et al., 2017; Swartz, Carrasco, Wiggins, Thomason, & Monk, 2014; Vink, Derks, Hoogendam, Hillegers, & Kahn, 2014), and this activity can be stronger than what is often observed in adults.

However, the connections between the prefrontal cortex and the amygdala are much slower to develop, often exhibiting continued maturation until young adulthood (Decety et al., 2012; Gabard-Durnam et al., 2014; Gee et al., 2013; Perlman & Pelphrey, 2011; Qin et al., 2014; Silvers et al., 2017; Wu et al., 2016). This profile of strong amygdala reactivity, coupled with weak regulatory control from the prefrontal cortex, is especially pronounced during childhood prior to puberty. This profile would render an individual highly susceptible to emotional over arousal. However, during development, parents can provide influences that support regulated emotional development in offspring.

An emotionally regulating parent is a critical agent in the integrity of the neurobiology that supports emotional development. Findings from the rodent literature show that the parent provides regulation over the amygdala during sensitive periods in development. Sensitive periods are moments during brain development when neurobiology is especially likely to be shaped by experience. Therefore, this regulation by the parent during a sensitive period can have long-term implications for adult emotional development. The mechanism has been carefully worked out showing that in the parent’s presence, amygdala reactivity is momentarily quieted by lowering the pup’s physiological stress reactivity (e.g., dopamine and glucocorticoids [cortisol in humans]; Barr et al., 2009; Moriceau & Sullivan, 2006).

If the parent is removed, its regulatory influence is removed, and the pup shows amygdala increases during fear learning. The pup’s emotional behavior changes as a consequence. When a rat pup without its parent is presented with an emotional learning opportunity (e.g., pairing an odor with an aversive stimulus), the pup will quickly learn to fear the odor and avoid it. However, in the physical presence of the parent, this fear learning is effectively blocked (Moriceau & Sullivan, 2006), and the rat pup even shows a paradoxical preference for the odor. This seemingly paradoxical behavior, namely, that in the presence of the parent, the pup will approach the odor even if it was paired with an aversive stimulus, provides a neurobiological explanation for the strong approach/attachment that is formed early in development, even in the context of noxious stimuli. Many case workers might be familiar with the strong attachment that children have with their parent, even in the context of maltreatment.

Of course, the pup will also approach rewarding stimuli encountered in the presence of its parent. However, the striking approach behavior of the pup for stimuli associated with the parent speaks to the powerful influence of the parent on the pup’s brain, emotional, and behavioral development. If the noxious stimulus continues to be routinely presented to the pup in the presence of the parent (Moriceau, Shionoya, Jakubs, & Sullivan, 2009), or if the parent is exhibiting fear in the pup’s presence (Debiec & Sullivan, 2014), the parent may lose the ability to effectively buffer the fear/stress systems of the pup. The implication here is that distressed or anxious behaviors of a parent can increase the emotional distress of the offspring.

These specific modulatory effects of the parent can only occur during development. Once amygdala connections mature and the pup begins to show independence, parental effects decline (Moriceau & Sullivan, 2006). However, the integrity of the emotion regulation neurobiology in maturity will reflect the type of parenting experiences that the pup had during its sensitive period (reviewed in Callaghan & Tottenham, 2016). This encoding of the early experiences into brain development provides an explanation for the enduring link between early caregiving experiences and mental health in adulthood.

### Parental Effects on Human Emotional Brain Development

The effects of human parents on children’s emotional behavior have been documented in several scientific literatures. Children routinely use social referencing—observing how adults react—to learn from their parents and other caregivers about the relative safety or danger of the environment ( Campos, 1981). This type of learning is rapid and robust during childhood (Gerull & Rapee, 2002; Muris et al., 1996). Parents can also effectively buffer against elevated stress hormones (i.e., cortisol) following aversive experiences (e.g., inoculations; Gunnar, Talge, & Herrera, 2009).

Recent neuroscience has demonstrated how parental stimuli influence developing neurobiology in humans. The high reactivity of the amygdala and the slow development of
regulatory influences from the prefrontal cortex in childhood (reviewed in Tottenham & Gabard-Durnam, 2017; see also Decety et al., 2012; Gee et al., 2013; Swartz et al., 2014; Vink et al., 2014) makes this system amenable to environmental influences. This suggests a neural mechanism for observations that parents can dampen of negative emotions in children. In striking similarity to the rat pup, children will dampen amygdala activity in the presence of parent-relevant cues. For example, presentation of a parent’s photo effectively attenuates children’s normally high amygdala response and momentarily instantiates connections between the amygdala and prefrontal cortex (Gee et al., 2014). Similarly, the presence of a parent will dampen stress hormone production in children while they prepare for a stressful task (Hostinar, Johnson, & Gunnar, 2015).

These data are not to say, however, that parents need to concern themselves with being available at every possible moment of their child’s lives to buffer them. Indeed, overprotecting parenting can also interfere with effective buffering (Bokszczanin, 2008). Experiencing a balance with autonomy is an additional component for healthy development. We have hypothesized that the regular daily separations and reunions that occur between sensitive parents and children (e.g., parents can go to work, and children can go to school) may benefit emotional circuitry (Callaghan & Tottenham, 2016).

Implications

Taken together, the findings show that amygdala circuitry and emotional learning show great plasticity during childhood. The implications for child mental health are significant. The growing recognition that ACEs (Adverse Childhood Experiences) are a leading cause of physical and mental disease, disability, and even mortality (https://www.cdc.gov/violenceprevention/acestudy/journal.html) points to the fundamental role that early experiences play in our adult lives. This critical link between early experiences and adult outcomes has been formalized into the Developmental Origins on Adult Health hypothesis (see Shonkoff, Boyce, & McEwen, 2009). Importantly, ACEs are inherently defined by the caregiving environment (e.g., abuse, neglect, emotional maltreatment, interpersonal violence, family incarceration, poor parental romantic relationships, family mental illness). These types of findings indicate that 
ining childhood adversity is a highly effective way to improve the lives of millions of individuals. Indeed, the World Health Organization’s Mental Health Survey (Kessler et al., 2010) estimates that addressing childhood adversities would lead to a 29.8% reduction in worldwide psychiatric illness.

Therefore, care has to be taken to ensure that children experience mental health–promoting beginnings. In many ways, this is a much larger challenge than ensuring that children receive adequate food, shelter, and medical care. As challenging as these initiatives are, they seem dwarfed by the challenge of addressing more systemic and embedded issues of family mental health, social inequalities, and psychosocial stress within a household.

Nonetheless, the data are clear—healthy children will grow from healthy beginnings. Among several implications of these findings, the following three implications emerge from the data:

1. Prioritize individuals while they are developing: Dr. James Heckman showed in his Nobel Prize winning research that investing in childhood gives the highest rate of return to a society (Heckman & Mosso, 2014). Unfortunately, the long span of human development exceeds election cycles. Therefore, despite the clear links between investments in childhood, the long-delayed deliverables of investments in childhood are often less practical for policy than are shorter term, immediate ones.

2. Stable and secure parenting is important: Stable and secure parenting is not just important because it subjectively feels good to a child, but because these elements form the basis of future physical, mental, and academic health. All children deserve this beginning in the same way that they deserve other basic needs (food, shelter, medical care). In cases where children’s caregiving must be disrupted (e.g., parental death, incarceration), placement in stable and secure care must be the priority and occur in the swiftest fashion possible. Decision makers should stay mindful that each day a child is not in a secure caregiving situation is important. Decision makers should remain mindful of the powerful effects of attachment relationships and be able to make decisions on a case-by-case basis.

3. Supporting children means supporting their families: To provide children with these healthy beginnings, their families also need supporting. No amount of individual therapy to a single child is going to foster mental health if the child’s family is not supported as well. No excellent early educational curriculum is going to improve academic success if children’s emotional needs are not first met. Therefore, supporting parents is a first step to providing optimal outcomes for children.

Conclusion

In the current article, evidence was presented linking the brain’s emotional development to a child’s early environment. The plasticity of the developing brain magnifies these environmental influences. Children live within a larger context of the family, and thus, families need supporting as well. Although the measures that must be taken to address early socioemotional environments are massive, the costs of not taking action are even greater and farther reaching.
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