



TWO OPEN WINDOWS

INFANT AND PARENT NEUROBIOLOGIC CHANGE

In this paper, we highlight the evidence in support of investments in both parents and children during the paired sensitive periods of early life and the transition to parenting. A sensitive period is a specific and limited time when the individual is especially open to environmental inputs, typically because the brain and body are rapidly developing or reorganizing during that time window. Importantly, the openness to experience that occurs during sensitive periods provides both opportunity and vulnerability.

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The evidence for early life as a sensitive period is well-understood. Here we argue that recent neural and behavioral evidence from new parents makes a compelling case for the transition to parenting as a distinct and important sensitive period. Because the transition to parenting typically co-occurs with the first and most important sensitive period of life, well-timed two-generation approaches — approaches that meet the needs of both children and their parents together — have the potential to maximize their investment by targeting both parents and children in these paired sensitive periods to create a cycle of opportunity. Conversely, failure to do so may result in exacerbated negative outcomes during a special and vulnerable time for both parents and their children. Indeed, this possibility is highlighted in the toxic stress framework, which differentiates three types of stressful experiences: positive, tolerable, and toxic (Shonkoff, Boyce & McEwen, 2009). The toxic stress framework emphasizes that much of what makes a situation “toxic” instead of “tolerable” is the lack of a supportive buffering adult. In this framework, positive stress includes normative challenges experienced with supportive adults that are necessary for healthy growth and development. Tolerable stress includes stressful events that are serious enough to potentially disrupt healthy growth and development — for example, a natural disaster — but

do not disrupt healthy development because of the protective role served by supportive adults in the child's life. Toxic stress occurs when stressful events are particularly severe and unremitting and experienced *without* the support of a buffering adult — for example, maltreatment perpetrated by a primary caregiver or persistent poverty coupled with untreated parental mental illness. Thus, targeting parents and children together in prevention and intervention programs may help protect against toxic stress and foster healthy growth and development.

This paper is written for practitioners, policy makers, researchers, and parents. It aims to offer insights into how parents' brains develop and function during the transition to parenting — when both parents and children are in critical sensitive periods — with the goal of encouraging positive, healthy, and parent-driven change through well-designed two-generation approaches.

THE TRANSITION TO PARENTING AS A SENSITIVE PERIOD

Humans are able to live all over the globe, speak any language, choose adult career and life pathways completely divergent from their families of origin, and create and adapt to a rapidly evolving global community because we have big and malleable brains. It has been understood for some time that this plasticity is particularly evident early in life and in adolescence. However, very recent and exciting work in humans (built on an extensive research base using animal models) increasingly identifies the transition to parenting as an important sensitive period for opportunity and vulnerability in neural function,

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behavior, and health. Like all sensitive periods, the environmental supports and opportunities that exist during the transition to parenting can contribute to whether the changes that occur increase health, productivity, and well-being or whether new vulnerabilities emerge or existing ones are exacerbated.

THE LEGACY OF EARLY LIFE BRAIN DEVELOPMENT RESEARCH AS A CATALYST FOR CHANGE

Burgeoning work in the 1990s laid firm groundwork for our current understanding of early life as a sensitive period for brain development. The publication of *Neurons to Neighborhoods* in 2000 organized what was understood about the incredible speed and extent of neuron and synapse formation and differentiation that occurs prenatally and continues at a rapid pace throughout the first few years of life. This understanding and organizing framework provided the motivation and evidence to support a wide array of policies and programs investing in young children. Indeed, this science base has continued to serve as a key support for early education and home-visitation programs and has underscored the current focus on prevention and intervention targeted at reducing the impact of early life stress and deprivation.

INVESTING IN CHANGE FOR CHILDREN BY TARGETING PARENTS AS AGENTS OF CHANGE

Because parents are their children's first and most important teachers and the creators of their children's early environments, some programs that aim to promote early brain development have targeted *parenting*. For example, home-visitation programs typically include a focus on increasing parents'



knowledge about child development and on encouraging sensitive and contingent responsiveness to children's cues and needs. A number of current parenting programs also use video-coaching methodologies to support changes in parenting behaviors, with the personalized guidance and feedback that filming allows. For example, the Filming Interactions to Nurture Development (FIND, Fisher, 2012) video-coaching model (adapted from a popular model developed in Europe, *Marte Meo*), uses very short clips of parents interacting with their own child. These clips are used to illustrate and encourage extended "serve and return" interactions to build the child's brain architecture and support the parent-child bond. In this model, coaches help parents recognize a child's "serve," make an appropriate "return" that encourages extended interaction, and recognize when the child is signaling the beginning and end of an interactive bout.

Although many studies and programs focus on biological parents, substantial literature has targeted foster parents. Importantly, interventions targeting foster parents may also produce important

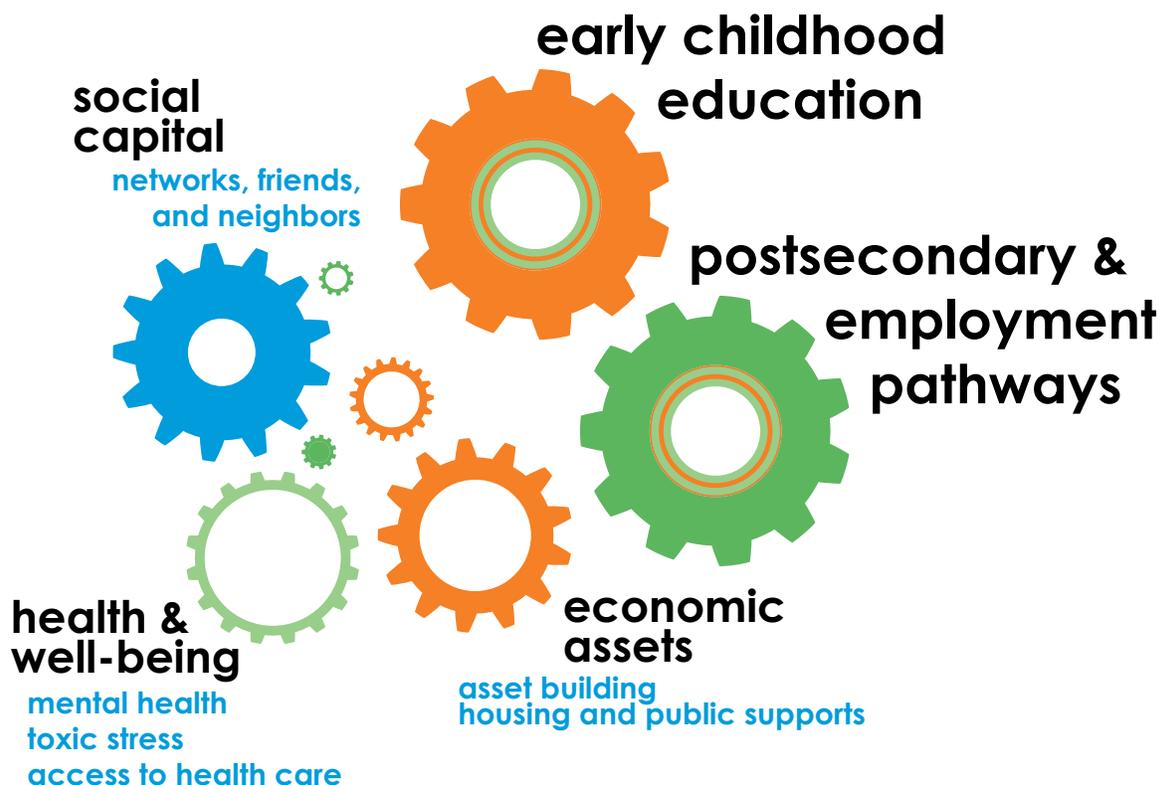
behavioral and brain changes in children, reinforcing that the adults in a child's life are impactful and important, even when not biologically related. For example, in a pilot study, neural responsivity to feedback appeared to be normalized in children receiving the Multidimensional Treatment Foster Care for Preschoolers intervention. Children in the treatment group showed more neural responsivity to feedback than foster children receiving treatment as usual, and were similar to non-maltreated low-income children (Bruce, McDermott, Fisher, & Fox, 2009).

ANTI-POVERTY PROGRAMS: INVESTING IN PARENTS AS PROVIDERS

Anti-poverty programs have targeted *parents as resource providers* — for example, with programs providing

educational or income supports or in-kind services like food assistance to help parents bring their families out of poverty. With the passage of the Personal Responsibility and Work Opportunities Act in 1996, for the first time, work requirements were enforced even for single mothers with children under five. To make it possible for families with young children to work, TANF (Temporary Assistance for Needy Families) funds, provided to states via block grants, can be used for child care subsidies. In addition, the Child Care Development Fund (reauthorized in 2014) provides child care subsidies for low-income families who are working or in educational or training programs. When resources are marshalled effectively, child care subsidies linked to economic supports for low-income working parents can result in the critical provision of high-quality child care. However, subsidies

CORE COMPONENTS OF A TWO-GENERATION FRAMEWORK



are not always sufficient to allow families to obtain high-quality child care, and high-quality child care, especially for infants and toddlers, is sometimes scarce. Without an explicit focus on integrating anti-poverty programs for adults with *high-quality* care and education for children, some families may have to choose between engaging in work or training at the expense of high-quality care for their children or foregoing the work or training opportunity.

THE CALL FOR INTEGRATED 2GEN INTERVENTION APPROACHES

Most commonly, programs that target parents are not coupled with programs that target children. Increasingly, this disconnect in services — often delivered to populations identified by similar risk factors (poverty, low parental education, involvement with child protective services) — has been challenged as illogical and inefficient, and efforts to provide integrated and explicit two generation interventions have been increasing. For example, a recent special issue of the journal *The Future of Children* examines past and current dual-generation programs and identifies stress, education, health, income, employment, and assets as important pathways of influence on a child's development. The national conversation on this topic is reflected in a recent *Washington Post* feature titled "The New War on Poverty: Tackling Two Generations at Once" and in National Public Radio coverage of two-generation demonstration programs. Ascend at the Aspen Institute has offered a framework for building a cycle of opportunity that views early childhood education, postsecondary and employment pathways for parents, economic assets, health and well-being, and social capital

as integrated core components of effective two-generation approaches.

INVESTING IN PARENTS: AGENTS OF CHANGE FOR CHILDREN AND IMPORTANT IN THEIR OWN RIGHT

A key question that emerges in two-generation approaches is whether explicit investments in parents are simply investments in *parents as agents of change*, or whether they are also investments in *parents as people*. Ascend at the Aspen Institute believes that investing in parents is a worthy endeavor because parents are critical agents of change for their children, because moving the whole family onto a path to educational success and economic opportunity requires investing in both children and the adults in their lives, and because parenting itself opens a window of opportunity for meaningful individual change. Indeed, the current spotlight on two-generation initiatives, coupled with pioneering breakthroughs in neurobiology, together provide the opportunity to create transformational rather than simply additive preventative interventions for families that can create intergenerational cycles of opportunity (Shonkoff & Fisher, 2013).

TWO-GENERATION PROGRAMS — EVIDENCE AND PROMISE

In the context of the current intensive call for integrated two-generation programs, a number of programs exist somewhere on a continuum, which starts with just beginning to provide integrated services to both parents and children and progresses to providing services to both children and parents *while* also systematically evaluating outcomes for both parents and children across an array of indicators. We are not

aware of any programs to date that explicitly target a) the needs of parents; b) the needs of children; and c) the parent-child relationship while systematically collecting long-term data to evaluate whether these program components separately or in combination lead to both behavioral and neurologic change as well as improved academic and economic achievement and physical and mental wellness in both parents and children.

However, a number of notable programs have begun to systematically provide, and in some cases evaluate, explicit and integrated two-generation programs. For example, the Jeremiah program provides single mothers and their children with support for a career-track college education, quality early childhood education, a safe and affordable place to live, and empowerment and life skills training (www.jeremiahprogram.org). The Community Action Project of Tulsa County (CAP Tulsa) also specifically focuses on a two-generation approach that aims to prepare young children for future success in school and provides their parents with programs designed to increase parenting skills, employability, and earning potential (captulsa.org). In a multi-year investigation, Lindsay Chase-Lansdale and Christopher King are collecting data regarding the CareerAdvance® Program at CAP Tulsa, which should provide important insights. Other programs that may have had the goal of ultimately changing child or adult outcomes at inception have also provided evidence to suggest changes in both parents and children. Perhaps most famously, Nurse-Family Partnership has reported changes in both child outcomes and maternal life course trajectory following home

visitation of first-time mothers by a nurse beginning during pregnancy and continuing through the first two years of the child's life (www.nursefamilypartnership.org). One study found that mothers most often enrolled in home-visitation programs to obtain information about job training followed by completing their education (Tandon, Parillo, Mercer, Keefer, & Duggan, 2008). Therefore, home visitation may be an excellent context for offering integrated two-generation programming. Another promising approach, Reach Out and Read (www.reachoutandread.org), takes advantage of the important relationship between pediatricians and families and uses well-baby visits as an opportunity to provide books and teach healthy and developmentally appropriate parent-child interactions around books beginning in infancy. Reach Out and Read has documented impacts on children, including enhanced child language skills (Mendelsohn, Cates, Weisleder, Berkule, & Dreyer, 2013). Federally funded randomized control trials have found that enhancements to Reach Out and Read, namely the Video Interaction Project (VIP), which uses video-coaching, have reduced parenting stress, demonstrated the potential to impact parent-child engagement, and reduced maternal depressive symptoms (Berkule et al, 2014).

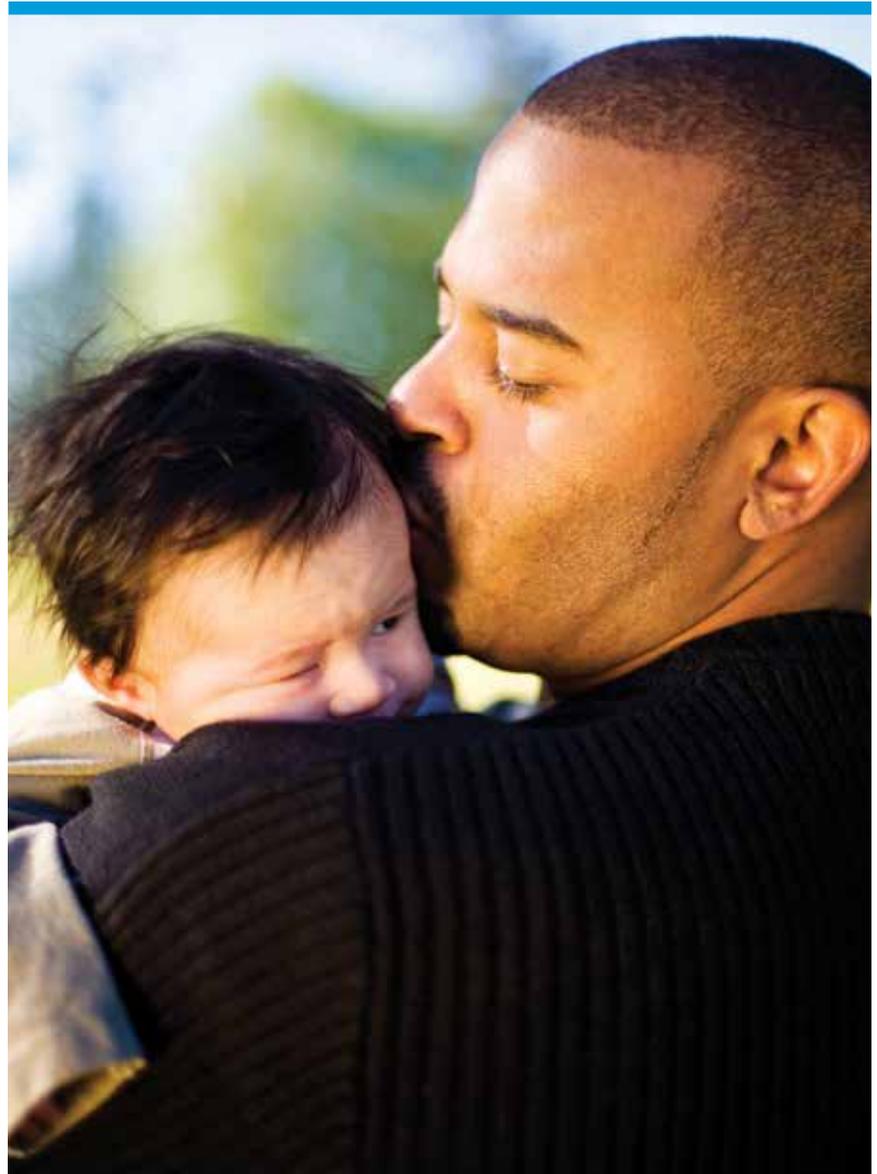
OVERALL THEORETICAL FRAMEWORK

The transition to parenting represents a major reorganization of individual priorities and goals to include a focus on caring for a new infant who is vulnerable, completely dependent, and initially presents what can be unclear signals regarding his or her needs. For example, in the first few days and weeks after birth, it may be unclear whether a crying infant

is hungry versus tired, and a sleeping newborn may even need to be woken up for feeding until a feeding routine and nursing/bottle-feeding skills are firmly established. To be maximally effective caregivers, adults must monitor their newborn's safety, establish synchronous caregiving routines, and develop an emotional bond, all in the context of resource depletion (e.g., financial strain, relationship strain, sleep deprivation). Viewed in this light, it is perhaps not surprising that this change in priorities and focus is supported by substantial neural reorganization or that this reorganization happens in regions of the brain that process rewards and social signals and that help to regulate emotion.

STRESS DURING THE TRANSITION TO PARENTING

During the first year after a baby's arrival, parents face the highly challenging task of taking care of a newborn. Both mothers and fathers, particularly first-time parents, report high levels of anxiety and concern about their infant's well-being and health (Kim, Mayes, Feldman, Leckman, & Swain, 2013). This concern for the infant's well-being can, of course, be healthy and adaptive and is something all parents experience to some degree. However, high anxiety along with heavy demands on financial resources, lack of sleep, and changes in marital relations can create levels of stress that parents often find overwhelming (Barnard & Solchany, 2002; Condon, Boyce, & Corkindale, 2004). Difficulties in managing the stress of the transition to parenting is a risk factor for severe mood regulation problems, such as postpartum depression, marital problems, and harsh parenting (a term that can include a range of



parenting behaviors, from corporal punishment and verbal aggression to child maltreatment), in both men and women (Hayes, Roberts, & Davare, 2000; Perren, Von Wyl, Burgin, Simoni, & von Klitzing, 2005).

NEURAL SUPPORTS OF THE TRANSITION TO PARENTING

Given how important reproduction and parenting are from an evolutionary and survival point of view, it is not surprising that there are changes occurring in the brain to support parenting, including those that help with stress management, the promotion of positive feelings

Mothers who reported more positive feelings about their infant also had more structural growth in the reward circuit in the first few months of the infant's life. Mothers also showed increased brain activity in this region when looking at images of their baby as compared to other babies. This increased activity appears significant as it is also associated with more sensitive and caring maternal behaviors.

and supportive caregiving behaviors, and the formation of the deep emotional connections that parents experience with their babies. In fact, human parents share very similar biological bases of parenting with other mammals (Numan & Insel, 2003). Studies with rodents, for example, revealed that changes in the brain right around birth cause a switch from avoidant to approaching behaviors toward pups (Numan & Insel, 2003; Rosenblatt & Mayer, 1995). Virgin female rats tend to avoid being near pups and in some cases even kill them because they usually find pups aversive. However, after giving birth, new mother rats exhibit tireless efforts to protect, care for, and feed their own pups, sometimes while sacrificing their own safety and well-being. In biparental species, such as prairie voles and California mice, male rodents also show similar changes in the brain that cause the onset of parental behaviors (Young, Wang, & Insel, 1998). This intriguing neural and behavioral switch in rats' response to pups during the transition to parenting is triggered by increased levels of hormones, including oxytocin and vasopressin. These hormones prime several brain regions to respond more sensitively and specifically to pup-related information, including their vocalizations and smell and to elicit strong parental motivation (Fleming & Li, 2002). Once parental

motivation is activated in the brain, continuous interaction with pups maintains parental motivation and behaviors. This important fact suggests that support during the transition to parenting that results in a positive parent-child bond and healthy mutually rewarding interaction patterns sets into motion a positive feed-forward loop that maintains positive parenting. Interestingly, during the postpartum period, female rats also exhibit dampened reactivity to stressors in the environment. This reduced reactivity to stress may help female rats effectively protect their offspring from potential or real threats and dangers in the environment (Carter & Lightman, 1987).

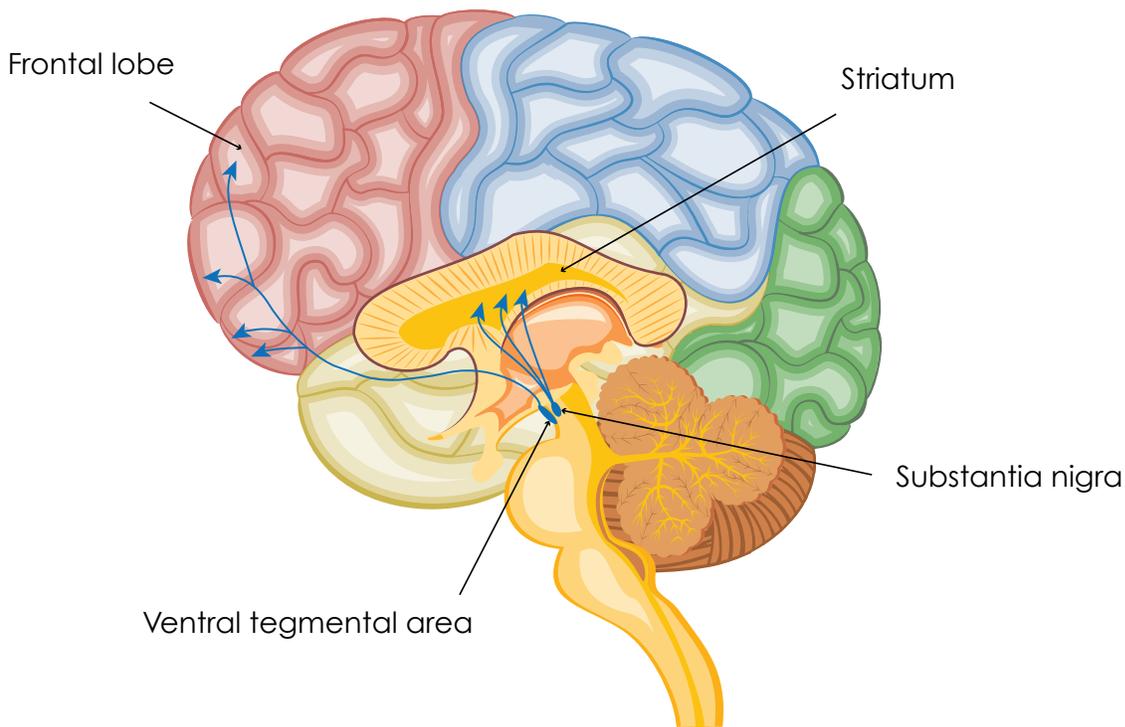
NEURAL CHANGES IN HUMAN PARENTS

Studies of human parental brains are much more recent due to the development of new neuroimaging techniques. These techniques allow investigation of both structural changes and changes in brain activity in response to specific events or stimuli. Overall, work with human parents supports what has been documented in animal models: Neural changes likely play an important role in supporting the transition to parenthood. We will review the evidence for changes in three major brain circuits that are involved in parenting — the reward circuit, the social information circuit, and the emotion regulation circuit.

NEURAL CHANGES IN THE REWARD CIRCUIT

The reward circuit includes the midbrain (hypothalamus, ventral tegmental area, nucleus accumbens, and substantia nigra), striatum, and medial prefrontal cortex. This circuit is activated by the release of dopamine in response to a number of naturally occurring stimuli, like food

REWARD / MOTIVATION CIRCUIT



Key brain regions related to reward and parental motivation processes.

and positive physical contact, and is also activated by drugs like nicotine and amphetamines. Interestingly, during the postpartum period, the increased levels of hormones such as oxytocin together with dopamine sensitize this circuit to focus on infant-related information. During the first few months after their child's birth, new mothers exhibit growth of the midbrain region. Further, the amount of growth was associated with the degree to which mothers reported positive feelings about their baby (e.g., beautiful, perfect) (Kim, Leckman, Mayes, Feldman, et al., 2010). That is, mothers who reported more positive feelings about their infant also had more structural growth in the reward circuit in the first few months of their infant's life. Along with this anatomical growth, mothers also showed increased levels of activity in the reward circuit in response to

their babies — for example, when looking at images of their baby's smile compared to images of other babies' smiles (Noriuchi, Kikuchi, & Senoo, 2008; Strathearn, Li, Fonagy, & Montague, 2008). Importantly, the increased activity in this region appears significant because it has been associated with more sensitive and caring maternal behaviors toward their babies (Atzil, Hendler, & Feldman, 2011). These changes are not limited to mothers and therefore are not only the result of the many changes that happen as part of pregnancy and giving birth. Human fathers also exhibited structural growth in the striatum, a part of the reward circuit, during the first few months after their child's birth (Kim et al., 2014). As with mothers, this structural growth in fathers is accompanied with greater activation in the reward circuit while looking at images of their child

compared to images of other children (Mascaro, Hackett, & Rilling, 2013).

NEURAL CHANGES IN THE SOCIAL INFORMATION CIRCUIT

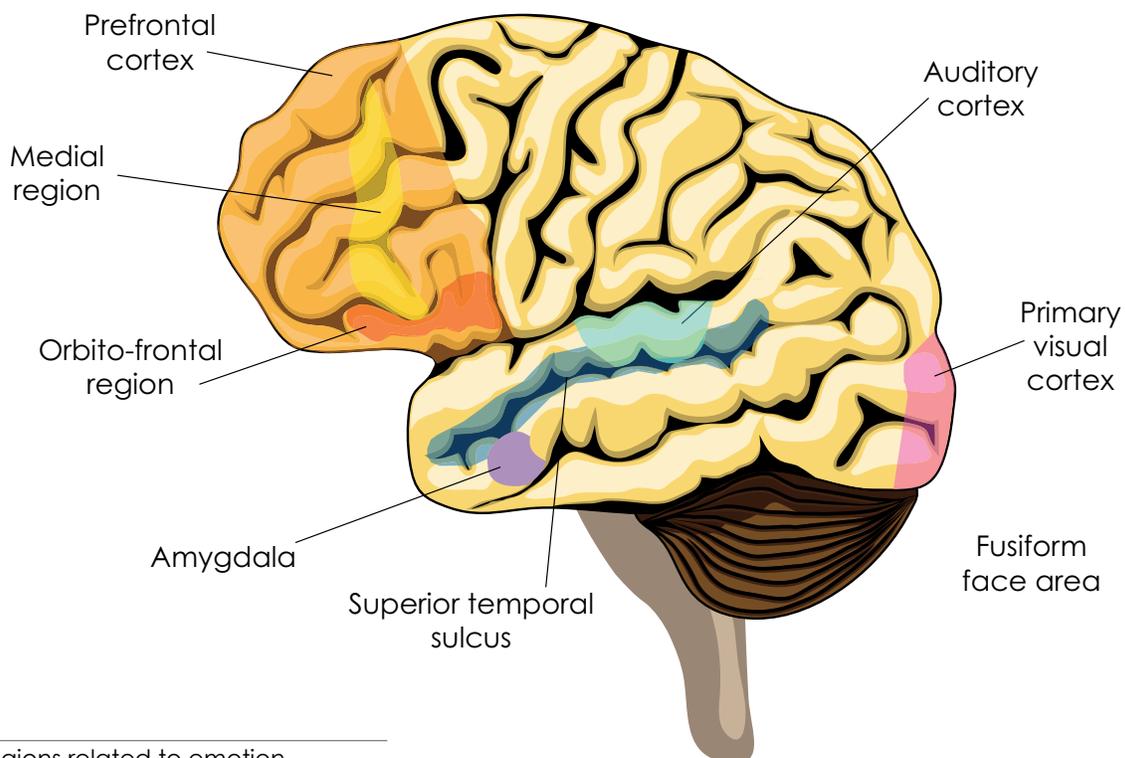
The social information circuit includes the insula, precuneus, superior temporal gyrus, and fusiform gyrus. Activation in this circuit has been associated with empathy as well as self-monitoring and reflection. Aberrant structure and function in this circuit has been documented in cases of severe impairment in social competence, such as in autism (Uddin, Iacoboni, Lange, & Keenan, 2007). New mothers and fathers exhibit neural plasticity in this circuit, including structural growth (Kim, Leckman, Mayes, Feldman, et al., 2010; Kim et al., 2014) and heightened responses to infants' cries and images of infants (Swain et al., in press). These neural changes

have been interpreted as reflecting the importance of this circuit for accurately understanding infant emotional and social cues during interactions and in appropriately responding to the cues. Thus, changes in this circuit may help new parents interpret their infant's behavior and learn how to parent sensitively and responsively.

NEURAL CHANGES IN THE EMOTION REGULATION CIRCUIT

The emotion regulation circuit includes the amygdala, anterior cingulate cortex, and medial and lateral prefrontal cortex. Increased amygdala activation is associated with negative reactions to emotional information, and the amygdala helps detect threats in the environment. Its size and function can be impacted by stress exposure, resulting in larger volume and faster processing of

EMOTION REGULATION AND THE SOCIAL BRAIN



Key brain regions related to emotion regulation and social information processing.

negative stimuli. In contrast, increased anterior cingulate cortex and prefrontal cortex activation are associated with regulation of negative emotional reactions (Ochsner, Silvers, & Buhle, 2012). Similar to animal findings, human mothers exhibit reduced reactivity to acute social and cognitive stressors, such as preparing to give a speech or performing mental arithmetic out loud with corrective feedback (Hillerer, Neumann, & Slattery, 2011). During the postpartum period, in both mothers and fathers, there was structural growth (Kim, Leckman, Mayes, Feldman, et al., 2010; Kim et al., 2014) and increased activation in the prefrontal cortex regions supporting emotion regulation while listening to and processing the social signal of infant cries (Barrett & Fleming, 2011; Kim et al., 2011; Kuo, Carp, Light, & Grewen, 2012). High levels of oxytocin in mothers during the postpartum period were also associated with reduced amygdala reactivity to negative emotional stimuli (Riem et al., 2011). The reduced neural responses to stressful experiences coupled with increases in size and function in emotion regulation regions may play an important role in effective emotion regulation in the face of the increased stress and demands of parenting.

FEWER SUPPORTIVE NEURAL CHANGES IN PARENTS WITH GREATER TRAUMA, STRESS, AND DEPRESSION HISTORY

The neural changes discussed above are likely adaptive and supportive of positive parenting. However, the postpartum period is also a time when parents can be vulnerable to severe difficulties in mood regulation and stress. Both new mothers and fathers are exposed to heightened levels of risk for mood disorders, such

Changes in the social information circuit may help new parents to interpret their infant's behavior and to learn how to parent sensitively and responsively.

as postpartum depression. During the first few months after a child's birth, a significant proportion of new parents will experience depressed and highly anxious moods (Kim & Bianco, 2014; Segre, O'Hara, Arndt, & Stuart, 2007). Specifically, 60 to 80 percent of new mothers report "postpartum blues," and up to 25 percent of all new mothers and fathers report postpartum depression. This is important because parental depression has consistently been linked to adverse long-term outcomes for both parents and their children (Goodman et al., 2011; Kim & Swain, 2007; Ramchandani, Stein, Evans, & O'Connor, 2005).

In parental brains, increased responses to infant cries and images were associated with a more warm and caring style of parenting, and decreased responses to infant cries and images were associated with chronic stress, depression, and substance abuse among parents. Mothers who were depressed at the time of the study exhibited reduced neural responses in the emotion regulation and social information circuits in response to their own infant's cry sounds compared to mothers who were not depressed (Laurent & Ablow, 2011). Mothers who used one or more substances (e.g., tobacco, alcohol) during pregnancy also showed reduced responses in the emotion regulation circuit in response to infant cry sounds (Landi et al., 2011). This reduced sensitivity in the brain to areas that regulate emotional responses to



infant cries and that process social signals may diminish mothers' abilities to regulate their own emotions in response to their infant's cries and perhaps interfere with their ability to detect the nature of the cry signal. This pattern of higher emotionality and less effective detection might lead over time to more frustration, less parenting self-efficacy, and lower motivation to care for infants. These neural differences also help explain differences in caregiving that have been documented in parents suffering from depression. If the supportive brain changes that help mothers and fathers parent responsively and sensitively are diminished when parents are depressed, they must cope with their own emotional and physical depression symptoms while trying to override this less effective and efficient signal.

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Mothers' current or childhood trauma may also significantly reduce neural sensitivity toward their infant. Mothers with interpersonal violence-related post-traumatic stress disorder (IPV-PTSD) report feeling more stressed while watching their children on video during a separation paradigm (where mother and child are in different rooms for a few minutes in an unfamiliar lab setting) compared to mothers without IPV-PTSD (Schechter et al., 2012). Mothers with IPV-PTSD in this study also exhibited increased limbic activity (reactive to negative stimuli) coupled with reduced activation in the prefrontal cortex (supportive of emotion regulation), suggesting that the increased stress they report may be due to both more elicited emotion and less effective emotion regulation during even mild stress exposure (Schechter et al., 2012).

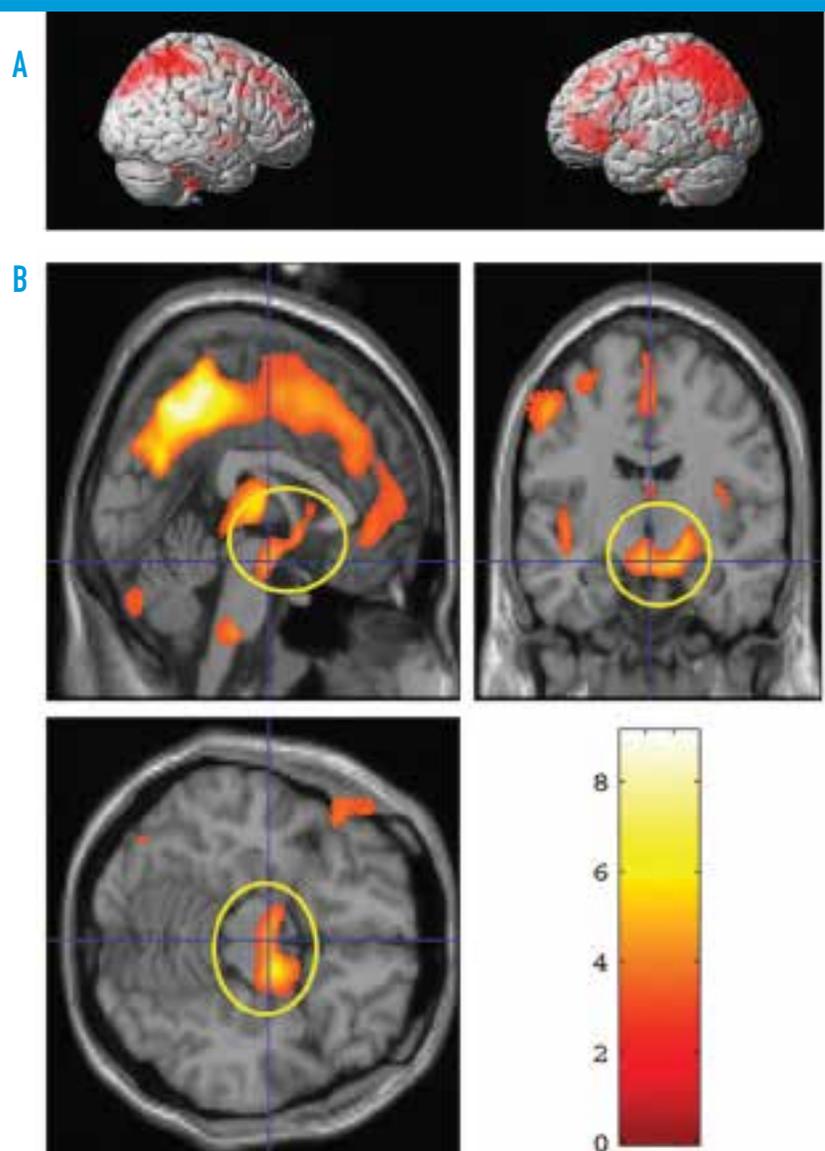
Mothers who report having received less warm and caring parenting from their own mothers in childhood exhibit reduced activation in the emotion regulation and social information circuits in response to infant cry sounds compared to mothers who reported receiving more warm and caring parenting in childhood (Kim, Leckman, Mayes, Newman, et al., 2010). Insecure attachment, which is likely based on negative early social experience, is also associated with greater amygdala reactivity to infant cries, which may lead to a tendency toward more avoidant and negative responses to infants (Riem, Bakermans-Kranenburg, van Ijzendoorn, Out, & Rombouts, 2012). Fathers' individual differences in neural responses to infants are much less understood; however, one study demonstrated that childhood abuse and neglect for fathers was also associated with altered responses to

infant cry sounds in the insula, a part of the brain's social information circuit (Bos, Montoya, Terburg, & van Honk, 2014). These findings are noteworthy because they provide one possible mechanism for intergenerational transmission of insensitive parenting — in addition to the behavioral transmission mechanisms of poor modeling (i.e., not having witnessed or received sensitive parenting) and cycles of coercion (i.e., explicitly experiencing harsh or coercive parenting and subsequently using similar strategies with one's own children at increasing intensity as child compliance decreases). If new parents who received less sensitive parenting themselves have brains that respond more negatively to infants' cry sounds and that are less able to regulate these negative emotional responses when they become new parents, they come to the table with less supportive parenting biology. This is of course not at all definitive; parents can and do bring assets like increased motivation and learned behaviors since childhood to override the challenges of their own experiences. However, understanding that one's own caregiving history can change the way something as important and basic as how the cry signal is processed in the brain may help parents attend to and better override their own negative caregiving experiences.

RESEARCH CHALLENGES AND FORWARD-LOOKING OPPORTUNITIES

The pioneering emerging research on the transition to parenting so far has only looked at the immediate changes that happen in the first few months postpartum and has focused on biological mothers and fathers. As this line of work is very new (published since 2010), beginning with biological

The reduced sensitivity in the brain to areas that regulate emotional responses to infant cries and that process social signals may diminish mothers' abilities to regulate their own emotions in response to their infants' cries and perhaps interfere with their ability to detect the nature of the cry signal. This pattern of higher emotionality and less effective detection might lead over time to more frustration, less parenting self-efficacy, and lower motivation to care for infants.



A: Anatomical (gray matter) increase from 2-4 weeks to 3-4 months postpartum among new mothers. Regions showing the increase are highlighted in red. **B:** A cluster of the reward and motivation (midbrain) regions are circled in yellow. The anatomical increase 2-4 weeks and 3-4 months postpartum was predicted by mothers' positive perception of their own baby at 2-4 weeks postpartum.

Source: Kim, Leckman, Mayes, Feldman, et al., 2010.

Understanding that one's own caregiving history can change the way something as important and basic as how the cry signal is processed in the brain may help parents attend to and better override their own negative caregiving experiences.

parents and looking at immediate changes makes sense. However, questions of how long-lasting these changes may be, whether similar changes are seen in subsequent births, whether non-biological parents are similarly affected, and what mechanisms are at play are still to be explored. Although using different methodology, there is promising evidence that similar supportive neurobiology may be present and important in foster parents (Bick, Dozier, Bernard, Grasso, & Simons, 2013). Specifically, during initial relationship formation with a new infant, foster parents with greater oxytocin production had greater neural activity in response to images of infants and greater delight in their foster infant. This result suggests that adults differ in their neural-hormonal preparedness for parenting, even when they are not biologically related to the child they have begun caring for. Three months later, oxytocin production in foster parents was related to neural activity to their own foster infant's image specifically and not to all babies, suggesting foster parents' brains changed in response to parenting their foster infant. These results support taking a broad lens when defining family to include children and all the important adults in their lives. Future work would benefit from assessing whether interventions that change parenting behavior and parent-child relationships do so in part or most effectively when they also change supportive parenting neurobiology.

CONCLUSION

Real and lasting change happens when people are biologically open to change. Decades of research strongly supports early life as a critical time for supportive and appropriate environmental inputs. New evidence suggests that the transition to parenting is another distinct and important sensitive period when major structural and functional changes are happening in the brain, and that these changes are supportive of positive parenting. Indeed, these changes are less evident in parents with risk factors like postpartum depression and a history of insensitive parenting or among parents who feel less positive about their new infant. Without this supportive biology, new parents face an even more challenging task, and this co-occurs with the infant's first and most important sensitive period. Supporting positive, healthy, self-actualizing, and enabling changes in well-designed two-generation approaches during the transition to parenting — particularly when new parents have a legacy of risk — can build a cycle of opportunity for parents as people *and* for parents as agents of change for their children by capitalizing on these shared sensitive periods. Conversely, failure to provide effective supports may exacerbate risk during a special and vulnerable time for both parents and their children.

5 RECOMMENDATIONS FOR PRACTICE

- Direct-service providers often focus on filling the material gaps families face (e.g., the lack of food or housing). This research offers compelling evidence for thinking about mental health services for families in a similar fashion — as a key part of wrap-around services that families need to achieve stability.
- Direct-service organizations should consider the implications of this research in terms of how they prioritize services for families. For example, services could be allocated more deliberately near the birth of a child, or the type of services provided could take into consideration how recently the birth occurred.
- Providers of early education should provide proactive and positive support to new parents. These findings point to the critical neural changes in both fathers and mothers, supporting expanded efforts to strengthen family connections, parent-child involvement, and mental health for both fathers and mothers.
- Health care practitioners serving new mothers and their babies should maximize well-baby and similar opportunities to provide supportive interventions for the parents and the child together within an integrated behavioral health model. Awareness that the already difficult task of becoming a parent is magnified when parents come to this role with less supportive biology may be a key component of well-designed services.
- Direct-service agencies should consider including screening for parents' own trauma, parents'

preparedness for parenting (including parenting self-efficacy and exposure to positive parenting models), and for early signs that parents feel overwhelmed by the parenting role. Parents with these risk factors, and also those with depression and anxiety during or before pregnancy, should be prioritized for additional services around their child's birth.



5 RECOMMENDATIONS FOR POLICY

- Increase efforts to support economic security outcomes in home-visiting programs. Funding streams, such as Maternal, Infant, and Early Childhood Home Visiting, require that programs demonstrate not just improved child outcomes but also adult outcomes. For example, front-line home-visiting staff members should be provided with professional development to enhance their knowledge and ability to connect interested parents with opportunities to improve family economic self-sufficiency.
- Leverage opportunities in the Affordable Care Act (ACA) to improve economic security and family health and well-being. For example, states should expand Medicaid coverage and also build on progress made by community health centers and patient-centered medical homes.
- Maximize opportunities for whole-family diagnosis and treatment for mental health. For example, diagnosis, screening, and treatment of mental health concerns can be encouraged for both parents and children using the new preventive services coverage under the ACA. Parity in coverage between mental and physical health for those newly enrolled in Medicaid and other health insurance plans can further destigmatize mental health issues and allow both families and providers to cooperate around screening, diagnosis, and treatment.
- Expand paid family leave coverage to enable families, especially low-income families, to be able to take time off to care for a new baby during this critical and stressful time.
- Support additional research efforts to deepen the understanding of the biological changes that occur during the transition to parenting and the ways in which programs and policies can support both parents and their children.



AUTHORS

Dr. Sarah Enos Watamura is an Associate Professor of Psychology at the University of Denver, where she directs the Child Health and Development Lab and co-directs the Stress, Early Experience and Development Research Center. She has longstanding interests in children's physiologic regulation, their development within caregiving contexts, and in understanding mechanisms and trajectories from early life stress to later physical, mental health, cognitive/educational, and socio-emotional outcomes. Her work examines the unique stressors and buffers in families experiencing poverty and among newly immigrated families, and includes testing promising intervention approaches. Dr. Watamura is also an Aspen Institute Ascend Fellow.

Dr. Pilyoung Kim is Assistant Professor of Psychology and a director of the Family and Child Neuroscience lab at the University of Denver. Kim received her BA in Psychology and English Literature from Korea University in South Korea, her EdM in Human Development and Psychology at Harvard Graduate School of Education, and her PhD in Developmental Psychology from Cornell University. Dr. Kim completed a post-doctoral fellowship in Developmental Affective Neuroscience at the National Institute of Mental Health. She was a recipient of the Victoria S. Levin Award for Early Career Success in Young Children's Mental Health from the Society for Research in Child Development in 2014. Her long-term research career trajectory is to examine the early life origins of socioeconomic disparities in health from a neurobiological perspective. Her current work focuses on the prospective effects of perinatal exposures to poverty-related chronic stress on the neural systems in new mothers and infants. She aims that the knowledge gained from her research will advance understanding of specific neurobiological processes by which poverty is associated with magnified risks for parental depression, harsh parenting in new parents, and for mental illness for infants and young children. See more at: <http://www.pilyoungkim.org/>

ORGANIZATIONS

Stress, Early Experiences and Development Research Center: The SEED Research Center is focused on understanding and mitigating the effects of early life stress utilizing a psychobiological approach. In particular, we focus on explicating the mechanisms underlying the effects of early life stress on physical and psychological health and development. Our current cluster utilizes cutting-edge methodologies including neuro-imaging (i.e. functional and structural

magnetic resonance imaging, and diffusion tensor imaging), genotyping, bioassays (e.g. hormones, immunological markers, indices of cellular aging) and in-depth behavioral and observational approaches (e.g., neurocognitive assessments of children and adults, assessments of emotional regulation, temperament, and parenting, noise-level monitoring, and neighborhood and housing quality indices). Our innovative approach employs prospective longitudinal designs and sophisticated statistical analysis techniques in order to identify pathways from the prenatal period through adolescence by which early life stress lead to increased disease risk. Further we focus on important contextual and relational influences (e.g. parenting, culture) on the experience of early life stress – including both the contributing and buffering potential of caregivers.

<http://www.du.edu/ahss/psychology/seedresearch/index.html>

Ascend at the Aspen Institute: Ascend is the national hub for breakthrough ideas and collaborations that move children and the adults in their lives toward educational success and economic security. We take a two-generation approach to our work and embrace a commitment to gender and racial equity lenses.

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