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# Child Maltreatment and Brain Development: A Primer for Child Welfare Professionals

Abuse and neglect can have drastic short- and long-term effects on children's and youth's developing brains. Recently, research that links child maltreatment and changes in brain structure and development has strengthened considerably. This connection has many implications for the prevention and treatment of child maltreatment.

This publication provides introductory information on brain development and how it may be affected by abuse and neglect, including the resulting emotional, mental, and behavioral impacts. It also describes the implications and considerations for child welfare practice, such as prevention; early intervention; and working with caregivers, including parents, kin caregivers, foster parents, and others.

## WHAT'S INSIDE



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Children's Bureau
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## HOW THE BRAIN DEVELOPS

Learning about brain development can help you understand more about the roles both genetics and the environment play in a child's development. While genetics may predispose us to develop in certain ways, our experiences, including our interactions with other people, significantly impact how our genes are expressed. In fact, many capacities previously thought to be fixed at birth depend on the interplay of environment and heredity, with both factors being essential for the optimum development of the human brain (Shonkoff & Phillips, 2000).

Positive and negative experiences in our lives influence our brain development. For example, healthy brain development includes situations in which babies' babbles, gestures, or cries bring reliable, appropriate reactions from their caregivers. These caregiver-child interactions—sometimes referred to as "serve and return"—strengthen babies' neuronal pathways regarding social interactions and how to get their physical and emotional needs met. When children and youth live in a chaotic or threatening world—such as one in which their caregivers respond with abuse or chronically provide no response—their brains may become hyperalert for danger or not fully develop. These neuronal pathways that are developed and strengthened under negative conditions prepare children to cope in that negative environment, and their ability to respond to nurturing and kindness may be impaired (Shonkoff & Phillips, 2000).

The first areas of the brain to fully develop control the bodily functions necessary for life (e.g., breathing, heartbeat). At birth, these basic functions of the nervous system are very well developed. In contrast, the higher-level functions, such as emotion regulation, language, and abstract thought, are still rather primitive. These functions grow rapidly through the first 3 years of life and continue to expand beyond that time. Additionally, the lower-level brain functions serve as a foundation for developing more advanced functions. Therefore, impaired brain development early in a child's life can adversely affect their ability to cultivate higher-level functions.

The raw material of the brain is the nerve cell, called a neuron. During fetal development, neurons form the various parts of the brain and specialize in controlling specific functions. As the brain develops, it creates, strengthens, and discards connections—called synapses—among the neurons. Synapses organize the brain by forming pathways that connect the parts of the brain governing everything we do (e.g., breathing, sleeping, thinking, feeling). This is the essence of postnatal brain development because the synapses that formed before birth are primarily focused on basic bodily functions. The development of synapses occurs at an astounding rate during a child's early years in response to a child's experiences. Based on these experiences, some synapses are strengthened and remain intact, but many are gradually discarded—or pruned—as a part of normal development (Shonkoff & Phillips, 2000). By 3 years of age, a baby's brain has reached almost 90 percent of its adult size.

The growth in each brain region largely depends on receiving stimulation, which spurs activity in that region. However, if a child does not receive appropriate stimuli during this period of growth, certain neuronal pathways may not be fully developed. A key feature of receiving appropriate stimuli is developing a secure attachment with a caregiver. Attachment is the emotional bond between people, such as a child and their caregiver. When the attachment is secure, the child knows that the

caregiver will care for and support them, allowing the child to explore their environment safely. This occurs when the caregiver is consistent, nurturing, and responsive. The positive interactions and explorations that come with secure attachment promote healthy brain development, social and emotional development, and self-regulation (Children's Bureau, 2019). Conversely, children who do not develop secure attachments because their caregiver's interactions are threatening or erratic may experience suboptimal development or progress in those areas (Bourne et al., 2022).

The brain continues to grow and develop until a young person is in their mid-20s. Right before puberty, adolescent brains experience a growth spurt that occurs mainly in the frontal lobe, which is the area that governs planning, impulse control, and reasoning. Although teenagers' physical maturity can make them seem adultlike, their brains lag in development, especially in the areas that allow them to reason and think logically. Most teenagers sometimes act impulsively, using a lower area of their brains—their "gut reaction"—because their frontal lobes are not yet mature. Impulsive behavior, poor decisions, and increased risk-taking are part of the normal teenage experience.

### Sensitive Periods and Plasticity

Sensitive periods are the windows of time in the developmental process when certain parts of the brain may be most susceptible to particular experiences. If certain synapses and neuronal pathways are not activated repeatedly during a particular time period, they may be diminished or discarded. (These periods are general, however, and are not fixed to specific age parameters for each child.) For example, research shows that children from Romanian institutions who had been severely neglected tended to have a much better attachment response if they were placed in foster care—and thus received more stable parenting—before they were 24 months old than those who were not (Smyke et al., 2010). This indicates there is a sensitive period for attachment. Another example is language development. Although people can learn a second language as young adults or beyond, they generally should start to learn that language before ages 10 to 12 to reach the proficiency of a native speaker (Hartshorne et al., 2018).

Plasticity allows us to learn and adapt—both as children and adults—and make up for missed experiences later in life. However, it is likely to be more difficult than if the experiences occurred earlier, such as during a sensitive period. For example, even if a child is delayed in their language development, that does not mean they cannot become proficient in a first or second language. That just means it may be more difficult for the child to achieve fluency later in life. Because the brain adapts to its environment, however, it can adapt to a negative environment just as it would to a positive one, which can lead to children adopting what are viewed as "negative" traits (e.g., aggression) as a reaction to the maltreatment they experience. While plasticity decreases as a child ages, some plasticity remains. This highlights the importance of early intervention in helping children adapt and thrive.

For more detailed information about brain structures and functions, visit the Brain Basics: Know Your Brain webpage developed by the National Institute of Neurological Disorders and Stroke within the National Institutes of Health. For additional information about brain development, explore the What Is Early Childhood Development? A Guide to the Science (ECD 1.0) webpage from the Center on the Developing Child.

### HOW WE RESPOND TO STRESS

We all experience stress. It is a normal part of our lives, but it is important to learn ways to deal with stress in a healthy manner. The Center on the Developing Child (2016b) outlines three types of stress responses:


**Positive stress response** includes brief increases in heart rate and blood pressure and mild or brief increases in stress hormone levels, all of which will return to normal. This response is a normal part of healthy development. It could be triggered by experiences such as the first day of school or receiving an injection during a doctor's visit.

**Tolerable stress response** is when the body's alert system activates to a greater extent due to more severe or longer-lasting events, such as losing a loved one or a natural disaster. This type of response is time limited and can be buffered by the support of a caring adult, which helps the body recover from what could be damaging effects of elevated stress levels (e.g., depression, substance use).

**Toxic stress response** occurs when a child experiences major, frequent, and/or prolonged stressors, such as chronic abuse or neglect or repeated exposure to domestic violence, community violence, or parental substance use. In these instances, the adult is potentially both the source of fear and support. Extreme or persistent activation of the body's stress system can impair brain development, causing an elevated perception of fear and a quick shift to a defensive mode when faced with stressors.

For more information about toxic stress, refer to the Center on the Developing Child at Harvard University.

## EFFECTS OF MALTREATMENT ON BRAIN DEVELOPMENT

Maltreatment can affect both the structure and chemical activity of a child's brain and their emotional and behavioral functioning. The specific effects of maltreatment may depend on factors such as the age of the child at the time of the maltreatment; whether the maltreatment was a one-time incident or chronic; the identity of the person who engaged in abuse or neglect (i.e., parent or other adult); whether the child had a dependable, nurturing caregiver or supportive adult in his or her life; the type and severity of the maltreatment; how long the maltreatment lasted; the type and effectiveness of the interventions used; and other individual and environmental factors.

### ADAPTATION OR DAMAGE?

The effects of maltreatment on a child's brain are often viewed as psychopathology or "damage" (Teicher et al., 2016). Another possibility, though, is that these alterations in development are adaptations for immediate survival, with the child's brain developing to allow the child to thrive in a stressful environment (Center on the Developing Child, 2016b). However, that harsh environment to which the child has adapted may not be the same type of environment the child finds themself in later in life (Teicher & Samson, 2016). In other words, the adaptations that allow a child to survive in a toxic environment—such as a hyperalert "fight-or-flight" response—may cause behaviors that are inappropriate in a healthy environment. For examples of how the brain may adapt to promote immediate survival, see "Effects May Vary by Maltreatment Type" later in this section. It is possible that both theories may be true, with some changes in development being adaptations for survival and others being caused by damage to the brain. Keeping these theories in mind can help caseworkers better understand and empathize with why a child—or adult—may be acting in a seemingly maladaptive manner in a situation that the caseworker does not view as being stressful or deserving of a particular reaction. For more information, see "Effects of Maltreatment on Behavioral, Social, and Emotional Functioning" later in this section.

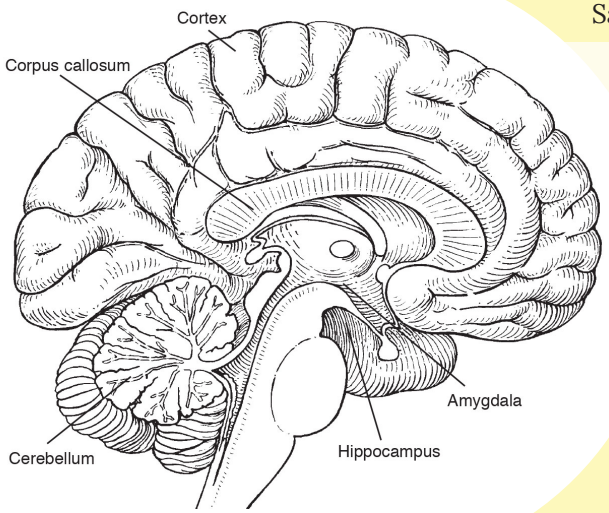
## EFFECTS OF MALTREATMENT ON BRAIN STRUCTURE AND ACTIVITY

Child maltreatment and other types of adverse childhood experiences (ACEs) can have a variety of negative effects on the structure of—and activity within—children's brains. Although the following includes what may be unfamiliar scientific terms for parts of the brain, it is being presented to emphasize the very real, physical impact of maltreatment on a child's developing brain:

Adults who were maltreated may have reduced volume in the **hippocampus**, which is central to learning and memory (Badura-Brack et al., 2020).

Maltreated children and adolescents tend to have decreased volume in the **corpus callosum**, which is responsible for left-right brain communication and other processes, such as emotion and higher cognitive abilities (Teicher & Samson, 2016).

Maltreated children and adolescents tend to have decreased volume in one or more portions of the **cerebellum**, which helps coordinate motor behavior and executive functioning (Teicher & Samson, 2016).




Although most studies have found that **amygdala** volume is not affected by maltreatment, maltreatment may cause overactivity in that area of the brain, which helps determine whether a stimulus is threatening and trigger emotional responses (Teicher et al., 2016).

Maltreatment has been linked to irregular **cortisol** levels. Cortisol is a hormone that helps mediate the body's stress response. Higher cortisol levels can cause heightened levels of stress, and lower levels of cortisol can cause a blunted response to stress (Ouellet-Morin et al., 2019).

Children who have been maltreated present reduced **global brain volume** compared with nonmaltreated children (Bick & Nelson, 2016), including reductions in volume in various areas within the **cortex** (also known as gray matter) (Lippard & Nemeroff, 2020).

Experiencing maltreatment may affect the **connections** between different regions of the brain (Teicher et al., 2016).

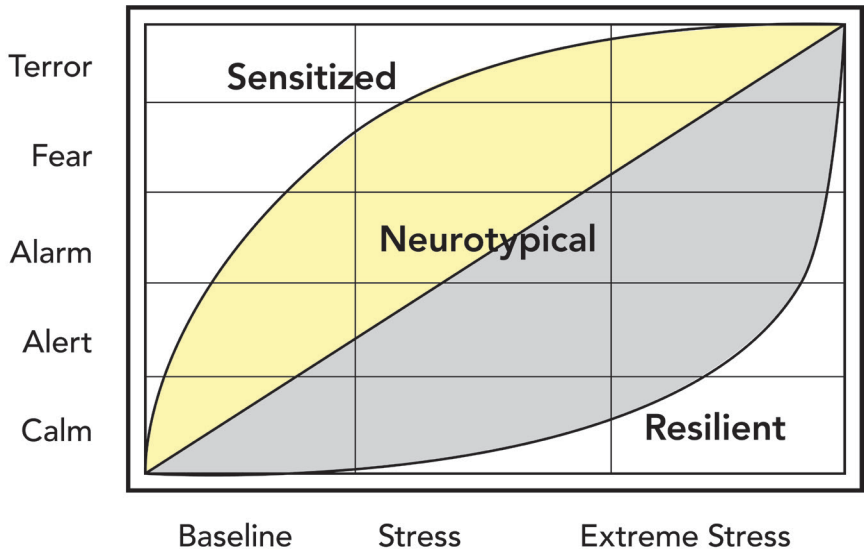
We also know that some cases of physical abuse can cause immediate direct structural damage to a child's brain. For example, abusive head trauma, including shaking, can lead to brain swelling and bleeding (Narang et al., 2020).

## EFFECTS OF MALTREATMENT ON BEHAVIORAL, SOCIAL, AND EMOTIONAL FUNCTIONING

The changes in brain structure and chemical activity caused by child maltreatment can have a wide variety of effects on children's behavioral, social, and emotional functioning. In general, unreliable, inappropriate, or absent responses from caregivers during neglectful or abusive child-rearing can set the stage for impaired brain development and lead to issues in learning, behavioral challenges, and general health issues (Center on the Developing Child, 2016a). Additionally, abusive head trauma can have a wide range of effects on a child, leading to, for example, sensory impairments, motor deficits, developmental delays, learning disabilities, and behavioral disorders. Two functional areas affected by maltreatment that have received particular attention in the literature are children's (1) stress response and (2) executive functioning and self-regulation.

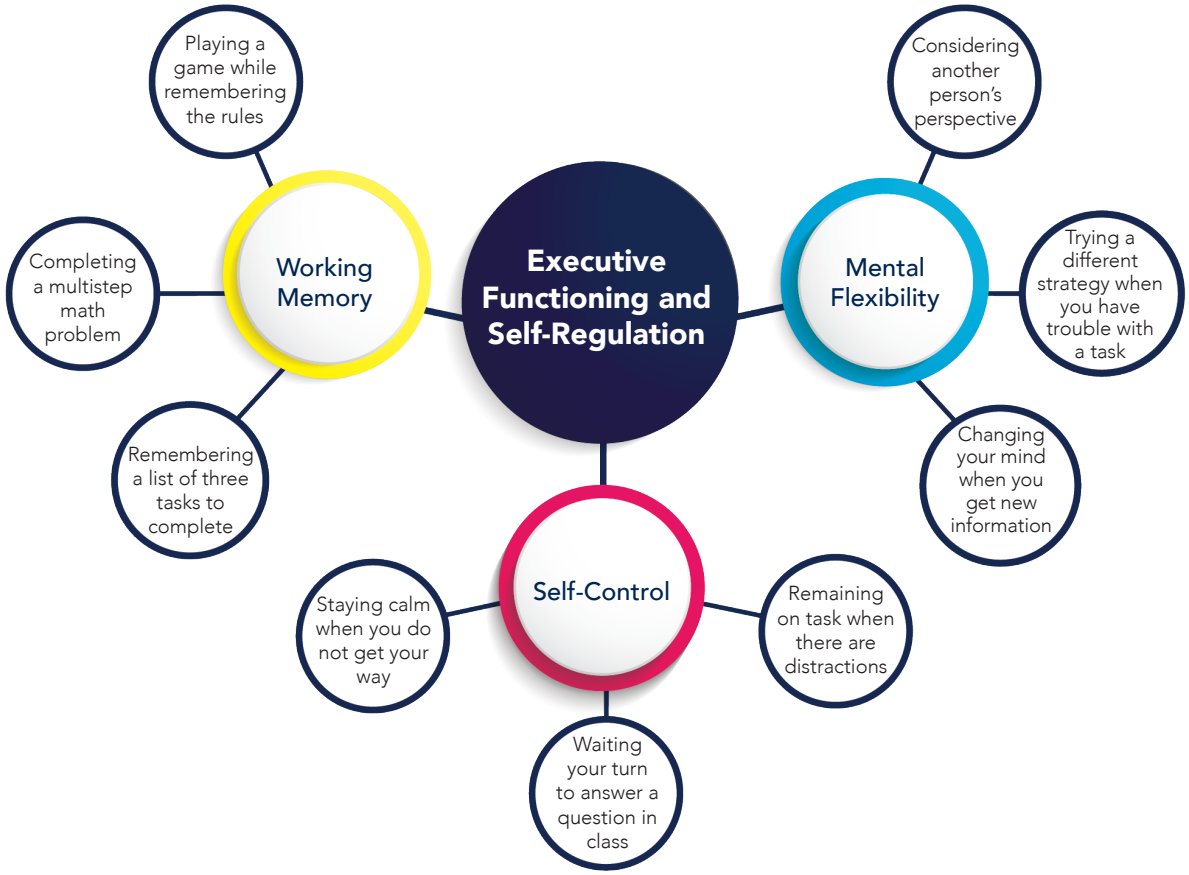
- **Sensitized stress response.** If a child experiences frequent or extreme stressful situations, their brain may adapt to become overly sensitized to stressful situations (Perry et al., 2018). This may trigger the child to shift into a defensive mode quickly, causing them to "overreact" or shut down in what others may view as nonstressful or minimally stressful situations (Center on the Developing Child, 2016b). In these situations, they may display impulsive, aggressive, or other maladaptive behaviors with little provocation (Perry et al., 2018). For example, a child who has been maltreated may become overly agitated by a touch intended to be caring (such as a hug or a gentle touch on the back) or may become quickly or overly fearful when a parent's or other caregiver's face shows minor anger or even a neutral expression. Essentially, their threat detection systems are on hyperalert, and they may see a threat in a nonthreatening situation. See figure 1 for a comparison of sensitized, neurotypical, and resilient stress responses.
- **Diminished executive functioning and self-regulation.** Executive functioning and self-regulation generally include three components: working memory (being able to keep and use information over a short period of time), self-control (filtering thoughts and impulses), and mental flexibility (adjusting to changed demands, priorities, or perspectives) (Center on the Developing Child, n.d.). (See figure 2 for more details.) Executive functioning and self-regulation skills help people achieve academic and career success, bolster social interactions, and assist in everyday activities. The trauma of maltreatment can create deficits in all areas of executive functioning and self-regulation (Kavanaugh et al., 2017).

**Figure 1. Sensitized Stress Response**




Adapted, with permission, from Perry, B. D., Griffin, E., Davis, G., Perry, J. A., & Perry, R. D. (2018). The impact of neglect, trauma, and maltreatment on neurodevelopment: Implications for juvenile justice practice, programs, and policy. In A. R. Beech, A. J. Carter, R. E. Mann, & P. Rotshtein (Eds.), *The Wiley Blackwell handbook of forensic neuroscience* (pp. 815–835). Wiley Blackwell.

**Figure 2. Examples of Executive Functioning and Self-Regulation**



Although the science highlighting the relationship between maltreatment and changes in brain structure and development has strengthened considerably recently, the research showing the connection between these brain alterations and subsequent psychopathology (i.e., functional issues) lags somewhat behind (Teicher & Samson, 2016). Additionally, the functional effects of maltreatment described in this section are not the full catalog of how maltreatment impacts children; it is only a brief summary of impacts directly connected to brain development.

### EFFECTS MAY VARY BY MALTREATMENT TYPE, CHRONICITY, AND SEVERITY

The type, frequency, and severity of the maltreatment a child experiences may affect how their brain develops.

**Type.** Studies have shown that the type of maltreatment a child experiences may influence how it affects a child (Teicher & Samson, 2016). For example, a study of adult women who experienced maltreatment as children found thinning in areas of the brain responsible for self-awareness and self-evaluation among the women who experienced emotional abuse (Heim et al., 2013). Furthermore, it found there were reductions in areas of the brain responsible for facial recognition and processing tactile sensations from the genitals among the women who experienced sexual abuse. It is possible that these adaptations shield the victims from the sensory processing of these types of maltreatment.

Additionally, although neglect and emotional abuse may not cause the bodily damage of physical abuse, they may cause more harm to a child's development. For example, data from a large study found that those who experienced neglect or emotional abuse had adverse outcomes in nearly all life areas that were assessed (e.g., sexual health, substance use) (Strathearn et al., 2020). This highlights the importance of considering the type of maltreatment and other factors rather than lumping all maltreatment and other ACEs together when determining appropriate services and supports to promote healthy development in children (Teicher & Samson, 2016).

**Chronicity and Severity.** More chronic or severe maltreatment may have a greater impact on regions or connections within a child's brain, particularly during sensitive periods (Bick & Nelson, 2016). (Chronic maltreatment is abuse or neglect that repeatedly occurs over time.) For example, one study found that children who were chronically maltreated showed greater executive function deficiencies than children who were not maltreated or those with less chronic maltreatment (Cowell et al., 2015). Another example is a study that highlighted how children who experienced more severe or frequent forms of maltreatment had a significantly more blunted cortisol response to stress and higher daytime cortisol levels compared with nonmaltreated children or children maltreated less frequently or severely—with both of those effects being detrimental (Marques-Feixa et al., 2021).

### Epigenetics

A growing area of research related to brain development is epigenetics. Epigenetics refers to alterations to how your genes work that do not include structural changes to the DNA. An epigenetic modification occurs when chemical "signatures" attach themselves to genes, which, in turn, helps determine how the genes are expressed (i.e., whether they are turned on or off). These changes may be permanent or temporary and can be inherited by the person's offspring (Center on the Developing Child, 2016b). The chemical signatures are initiated by positive and negative life experiences as well as nutrition and exposure to toxins or drugs. For example, studies of one particular gene (NR3C1) have found an association between childhood maltreatment and increases in the methylation (i.e., chemical signature) of that gene (Cecil et al., 2020). These increases are related to negative outcomes, such as increased externalizing behaviors[1] and higher depressive symptoms (Cicchetti & Handley, 2017).

For additional information about epigenetics, refer to the Centers for Disease Control and Prevention website and the Gene-Environment Interaction webpage on the Center on the Developing Child website.

[1] Externalizing behaviors are actions in the external world, such as tantrums, aggression, and defiance. This is in opposition to internalizing behaviors, which are focused inward and may include, for example, depression, social withdrawal, or anxiety.

## THE IMPACT OF RESILIENCE

Even in instances when maltreatment does alter children's brain structure or activity, some children do not present any psychopathologies (i.e., mental disorders or other functional impairments) or have outcomes that are much better than expected considering the circumstances they have faced (Teicher et al., 2022). Scans of their brains show the effects of maltreatment, but they are not experiencing the expected emotional, behavioral, or other effects from those alterations. These children are showing resilience (the ability to adapt to adversity). One recent study found that maltreated children who showed resiliency had different levels of connectivity between various regions of the brain than those who showed symptoms, even though both had the same levels of brain alterations (Ohashi et al., 2019). Researchers are still trying to determine why this happens (Teicher et al., 2022). Are there preexisting neurobiological characteristics of a child that allow them to be resilient? Are there certain protective factors—conditions or attributes that reduce risk and promote healthy development—within their environment that help buffer the effects? Is it a mix of those reasons?

However, just because a child does not *outwardly* appear to be affected by maltreatment, it does not necessarily mean that the child is unaffected. Even if a child who has been maltreated appears to be resilient and functioning well, practitioners should periodically screen and assess them for trauma throughout the life of the case, particularly since the effects of maltreatment can show up later in childhood or change over time.

To learn more about the importance of resilience and how positive experiences can ease toxic stress and help children and youth grow into more resilient, healthier adults, visit the HOPE (Healthy Outcomes from Positive Experiences) website.

## IMPLICATIONS FOR PRACTICE

Research is providing scientific evidence for what professionals and caregivers have long described in behavioral, emotional, and psychological terms. It also shows that children reared in severely stressful environments can see positive effects on brain development and functioning when they and their families receive supports and services. While child welfare aims to protect children, many child welfare interventions—such as investigations, appearance in court, removal from home, placement in a foster home, etc.—can reinforce the child's view that the world is unknown, uncontrollable, and frightening.

This section presents ways child welfare professionals can assist children who have already experienced or are at risk for alterations in the brain due to maltreatment through prevention efforts, early intervention, and working closely with families and caregivers.

### STRENGTHENING PREVENTION

Child welfare systems that devote significant efforts to prevention may be the most successful in helping children and families and promoting healthy brain development. By the time a child who has been abused or neglected comes to the attention of child protective services, some negative effects are likely. Prevention efforts should focus on supporting and strengthening children's families so that children have the best chance of remaining safely in their homes and communities while receiving loving, nurturing care.

Prevention efforts for vulnerable or at-risk families should focus on strengthening the family and building on the family's positive attributes. Identifying protective factors helps parents find resources, supports, or coping strategies that allow them to parent effectively. Here are the six protective factors that can strengthen families, help prevent abuse and neglect, and promote healthy brain development:

- Nurturing and attachment
- Knowledge of parenting and of child and youth development
- Parental resilience
- Social connections
- Concrete supports for parents
- Social and emotional competence for children

For additional information about preventing child maltreatment, visit Child Welfare Information Gateway's Preventing Child Abuse & Neglect webpage and the Centers for Disease Control and Prevention's Essentials for Childhood webpage. Additionally, visit the Title IV-E Prevention Services Clearinghouse website to view descriptions and ratings of evidence-based or evidence-informed programs and services that provide enhanced support to children and families and prevent foster care placements.

## FOCUSING ON EARLY INTERVENTION

Intensive, early interventions that occur when the brain is most plastic are much more effective than reactive services as the child ages (Perry, 2009). In recognition of this fact, Federal legislation requires States to develop referral procedures for children ages 0 to 36 months involved in a substantiated case of child abuse or neglect. Once a child is identified, States must provide intervention services through Early Intervention Plans funded under Part C of the Individuals With Disabilities Education Improvement Act (IDEA).

Merely removing a child from a harmful environment will not automatically improve brain development or reduce the effects of child maltreatment and other ACEs (Center on the Developing Child, 2016b). A child's removal from their family and home can be a traumatic experience (Mitchell, 2018). Because brain functioning is altered by repeated experiences that strengthen and sensitize neuronal pathways, interventions should not be limited to traditional therapy. Services should take a holistic approach to treating the child and the caregiver (e.g., two-generation approaches) and also provide frequent, consistent replacement experiences so that the child's brain can begin to incorporate a new environment—one that is safe, predictable, and nurturing. Approaches and interventions that show promise or evidence of helping children overcome the effects of impaired brain development include Attachment and Biobehavioral Catch-up (ABC), Treatment Foster Care Oregon for Preschoolers (formerly known as Multidimensional Treatment Foster Care), and the Neurosequential Model of Therapeutics. To learn about additional interventions that may be appropriate for children and youth with impaired brain development, visit the California Evidence-Based Clearinghouse for Child Welfare website.

To best serve the children and families in your caseload, child welfare professionals should learn about the available services and supports in their community and work with their agency to determine if they may be appropriate for children whose brain development has been affected by maltreatment. Establishing strong working relationships with providers and other supports in the community, such as schools, therapists, physicians, and others, is essential. By casting a wide net on who is included in the support team—and by including families in the process—child welfare professionals can better understand the child's and family's needs and find accessible services that match the family's unique circumstances.

For additional information about early childhood services, including Part C of IDEA, visit Information Gateway's Early Childhood and Child Care Services web section.

### Prenatal Substance Exposure and Brain Development

Prenatal substance exposure—particularly alcohol use, which can lead to fetal alcohol spectrum disorders—can have numerous harmful effects on the development of a child's brain, many of which can last into adulthood (Ingoldsby et al., 2021). Substance exposure can alter the structure and chemical activity of a child's brain as well as their emotional and behavioral functioning, such as executive functioning, auditory processing, and motor development (Lowell et al., 2022). To learn more about the effects of substance use during pregnancy, visit the Centers for Disease Control and Prevention website.

State laws vary on whether prenatal substance exposure is considered child maltreatment. As of July 2019, 23 States and the District of Columbia included prenatal exposure to controlled substances in their definitions of child abuse or neglect in civil statutes, regulations, or agency policies (Child Welfare Information Gateway, 2020). For more information about State laws related to substance exposure and child welfare, see Information Gateway's *Parental Substance Use as Child Abuse* and *Plans of Safe Care for Infants With Prenatal Substance Exposure and Their Families*. To learn how you can support parents with substance use disorders, read Information Gateway's *Parental Substance Use: A Primer for Child Welfare Professionals*.

## INFORMING CAREGIVERS ABOUT HEALTHY BRAIN DEVELOPMENT

Since a child's environment is critical to supporting healthy brain development, child welfare professionals should educate caregivers about the possible effects of maltreatment on brain development, the resulting symptoms, and how to promote healthy brain development. Additionally, research has consistently shown that having at least one stable and responsive supportive adult in a child's life is a key factor for resiliency (Center on the Developing Child, 2016b). This supportive adult could be a parent, another caregiver, a mentor, or another important adult in the child's life. When talking with caregivers, emphasize the importance of being a supportive, caring figure in their life. Also, check in with the children with whom you work to help them build and sustain a healthy relationship with at least one supportive adult. For more information about being a supportive adult for children and youth in care, refer to *Caring Adults Guide: How to Support Older Youth With Foster Care Experience Through Co-Regulation* by the U.S. Department of Health and Human Services as well as *Becoming a Better Mentor: Strategies to Be There for Young People* by MENTOR.

Caregivers should have realistic expectations for their children and youth. Children who have been abused or neglected may not be functioning at their chronological age in terms of their physical, social, emotional, and cognitive skills. You can help caregivers by talking with them about child development, including important developmental milestones, how each child or youth has different timetables for reaching milestones, and how quality interactions can enhance their development.

Children also may display unusual and/or difficult coping behaviors (e.g., being unable to control their emotions, having difficulties learning in school, being unresponsive to affection). Understanding the neurobiology basics underlying many challenging behaviors may help caregivers shape their responses more effectively. Additionally, some caregivers may have encountered trauma in their childhood, and learning about how that affects brain development may help them better understand their own history and current coping mechanisms (Center on the Developing Child, 2016a). It is important for treatment providers to work with parents to explore their history of trauma, as those experiences may impact their parenting practices, ability to cope with stress and regulate emotions, and the extent to which they are attuned to their children's needs.

Information Gateway developed *Child Maltreatment and Brain Development: A Primer for Caregivers* as a companion piece to this publication. This factsheet for families can be shared with caregivers to help educate them about child maltreatment and brain development.

### REDUCING CAREGIVER AND CHILD STRESS

A stressful home environment can be a barrier to promoting healthy brain development. Caregivers facing poverty, housing insecurity, racism, substance use, domestic violence, or other adverse conditions may not be able to fully focus on nurturing their children. By providing concrete supports to caregivers, as well as referrals and access to services that match their needs, child welfare professionals can help caregivers build a more stable and nurturing home environment that does not initiate toxic stress response in the child and promotes healthy brain development. For more information about providing comprehensive services to families, visit Information Gateway's Service Array web section.

## CONCLUSION

Child maltreatment, particularly neglect and emotional abuse, can cause long-term, critical impairment to brain development. These alterations can affect a wide variety of functioning in the child, including affecting memory, self-control, and responses to stress. Early intervention and the support of at least one caring adult can have a profound positive effect on a young person's trajectory. By developing a broader understanding of brain development and the effects of maltreatment, caseworkers can better connect children, youth, and families with services and supports that can properly assess and address their unique needs. Sharing information with caregivers about the importance of healthy brain development and assisting them in learning how they can create a nurturing, healing environment for the children in their lives is key to promoting healthy brain development in children and youth.

## ADDITIONAL RESOURCES

For additional information about promoting healthy brain development, refer to the following resources:

- Adolescent Brain Development (Annie E. Casey Foundation)
- Adverse Childhood Experiences (ACEs) (Centers for Disease Control and Prevention)
- *The Body Keeps the Score: Brain, Mind, and Body in the Healing of Trauma* [Book] (van der Kolk)
- "Brain Basics" [Video] (National Training and Development Curriculum for Foster and Adoptive Parents)
- Center on the Developing Child (Harvard University)
- Child Trauma Academy
- *From Neurons to Neighborhoods: The Science of Early Childhood Development* [Book] (Committee on Integrating the Science of Early Childhood Development, J. P. Shonkoff and D. A. Phillips, eds.).
- National Child Traumatic Stress Network

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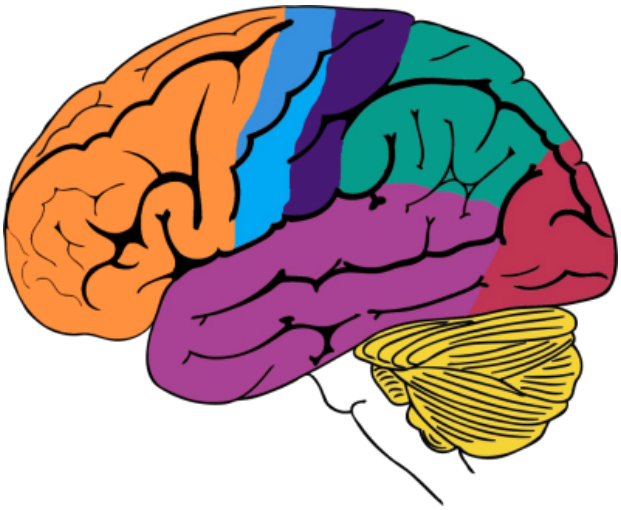
U.S. Department of Health and Human Services
Administration for Children and Families
Administration on Children, Youth and Families
Children's Bureau

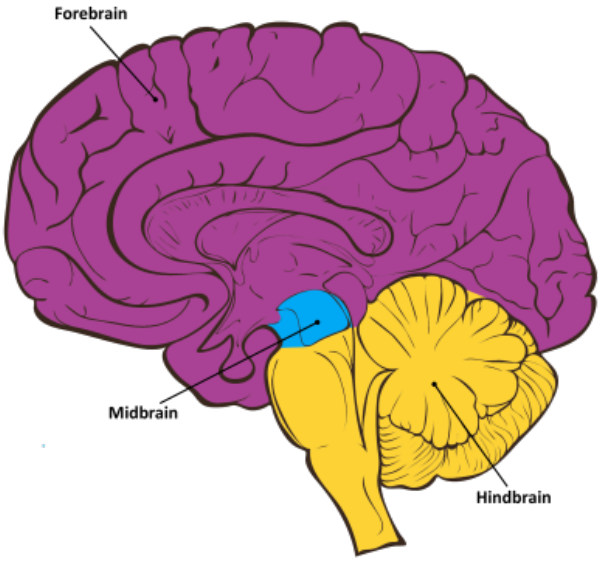
# Brain Basics: Know Your Brain



The brain is the most complex part of the human body. This three-pound organ is the seat of intelligence, interpreter of the senses, initiator of body movement, and controller of behavior. Lying in its bony shell and washed by protective fluid, the brain is the source of all the qualities that define our humanity. It is the crown jewel of the human body.

This fact sheet is a basic introduction to the human brain. It can help you understand how the healthy brain works, how to keep your brain healthy, and what happens when the brain doesn't work like it should.

## The Structure of the Brain



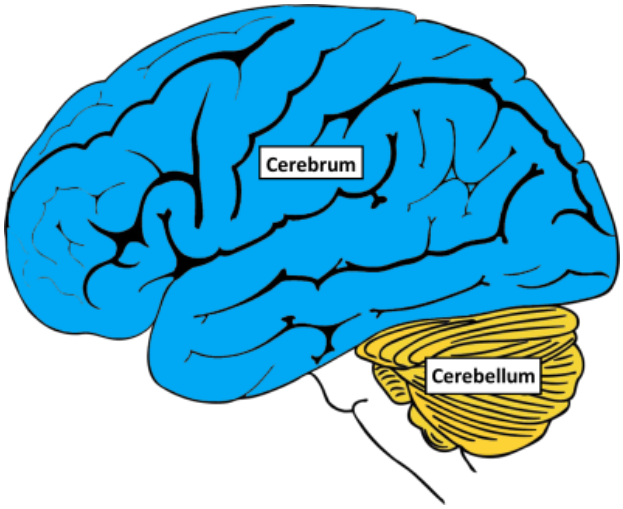

The brain is like a group of experts. All the parts of the brain work together, but each part has its own special responsibilities. The brain can be divided into three basic units: the **forebrain**, the **midbrain**, and the **hindbrain**.

The hindbrain includes the upper part of the spinal cord, the brain stem, and a wrinkled ball of tissue called the **cerebellum**. The hindbrain controls the body's vital functions such as respiration and heart rate.

The cerebellum coordinates movement and is involved in learned movements. When you play the piano or hit a tennis ball, you are activating the cerebellum.

The uppermost part of the brainstem is the midbrain, which controls some reflex actions and is part of the circuit involved in the control of eye movements and other voluntary movements. The forebrain is the largest and most highly developed part of the human

brain: it consists primarily of the **cerebrum** and the structures hidden beneath it (*see "The Inner Brain").*




When people see pictures of the brain it is usually the cerebrum that they notice. The cerebrum sits at the topmost part of the brain and is the source of conscious thoughts and actions. It holds your memories and allows you to plan, imagine, and think. It allows you to recognize friends, read, and play games.

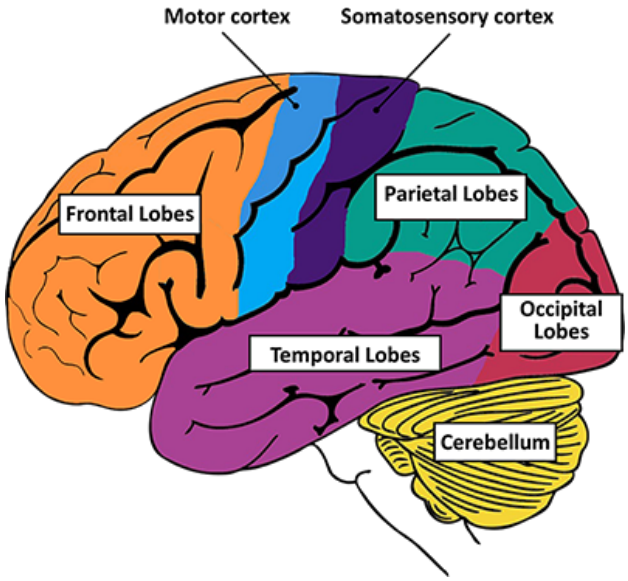
The cerebrum is split into two halves (hemispheres) by a deep fissure. The two cerebral hemispheres communicate with each other through a thick tract of nerve fibers that lies at the base of this fissure, called the corpus callosum. Although the two hemispheres seem to be mirror images of each other, they are different. For instance, the ability to form words seems to lie primarily in the left hemisphere, while the right hemisphere seems to control many abstract reasoning skills.

For some as-yet-unknown reason, nearly all of the signals from the brain to the body and vice versa cross over on their way to and from the brain. This means that the right cerebral hemisphere primarily controls the left side of the body, and the left hemisphere primarily controls the right side. When one side of the brain is damaged, the opposite side of the body is affected. For example, a stroke in the right hemisphere of the brain can leave the left arm and leg paralyzed.

**The Cerebral Cortex** −

Coating the surface of the cerebrum and the cerebellum is a vital layer of tissue the thickness of a stack of two or three dimes. It is called the cortex, from the Latin word for bark. Most of the actual information processing in the brain takes place in the cerebral cortex. When people talk about "gray matter" in the brain, they are talking about the cortex. The cortex is gray because nerves in this area lack the insulation that makes most other parts of the brain appear to be white. The folds in the brain add to its surface area and therefore increase the amount of gray matter and the volume of information that can be processed.

**The Geography of Thought** −



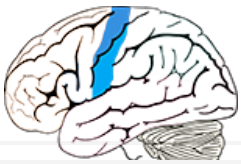

Each cerebral hemisphere can be divided into sections, or lobes, each of which specializes in different functions. To understand each lobe and its specialty, we will take a tour of the cerebral hemispheres.

**Frontal lobes** −

The two **frontal lobes** lie directly behind the forehead. When you plan a schedule, imagine the future, or use reasoned arguments, these two lobes do much of the work. One of the ways the frontal lobes seem to do these things is by acting as short-term storage sites, allowing one idea to be kept in mind while other ideas are considered.

**Motor cortex** −

In the back portion of each frontal lobe is a **motor cortex**, which helps plan, control, and execute voluntary movement, like moving your arm or kicking a ball.

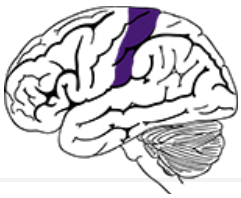


**Parietal lobes** −

When you enjoy a good meal—the taste, smell, and texture of the food—two sections behind the frontal lobes called the **parietal lobes** are at work. The parietal lobes also support reading and arithmetic.

**Somatosensory cortex** −

The forward parts of these lobes, just behind the motor areas, is the **somatosensory cortex**. These areas receive information about temperature, taste, touch, and movement from the rest of the body.



## Occipital lobes

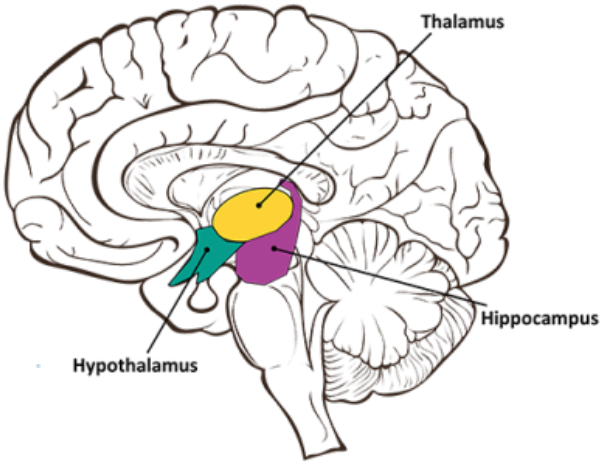
As you look at the words and pictures on this page, two areas at the back of the brain are at work. These lobes, called the **occipital lobes**, process images from the eyes and link that information with images stored in memory. Damage to the occipital lobes can cause blindness.

## Temporal lobes

The last lobes on our tour of the cerebral hemispheres are the **temporal lobes**, which lie in front of the visual areas and nest under the parietal and frontal lobes. Whether you appreciate symphonies or rock music, your brain responds through the activity of these lobes. At the top of each temporal lobe is an area responsible for receiving information from the ears. The underside of each temporal lobe plays a crucial role in forming and retrieving memories, including those associated with music. Other parts of this lobe integrate memories and sensations of taste, sound, sight, and touch.

## The Inner Brain

Deep within the brain, hidden from view, lie structures that are the gatekeepers between the spinal cord and the cerebral hemispheres. These structures not only determine our emotional state, but they also modify our perceptions and responses and allow us to initiate movements that without thinking about them. Like the lobes in the cerebral hemispheres, the structures described below come in pairs: each is duplicated in the opposite half of the brain.



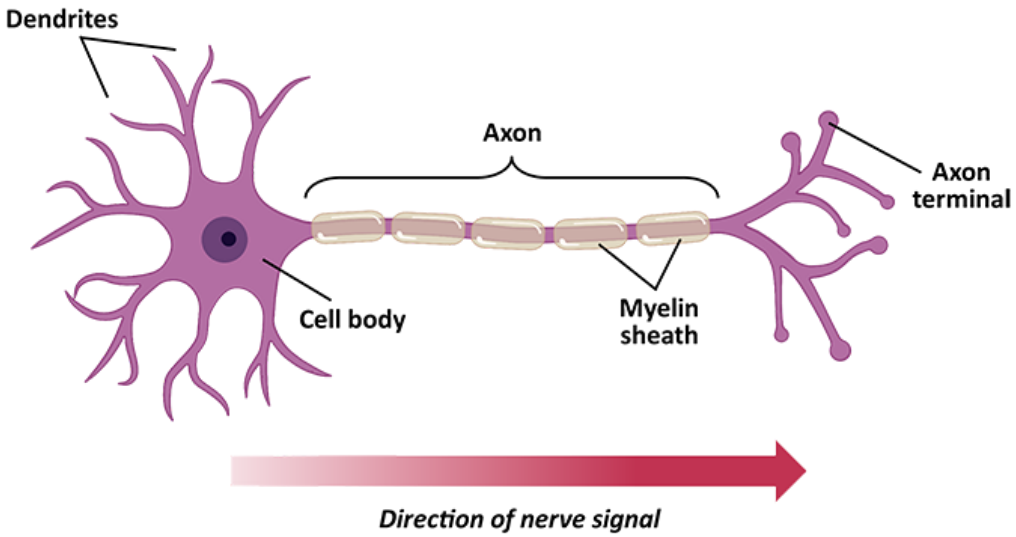

The **hypothalamus**, about the size of a pearl, directs a multitude of important functions. It wakes you up in the morning and gets the adrenaline flowing during a test or job interview. The hypothalamus is also an important emotional center, controlling the chemicals that make you feel exhilarated, angry, or unhappy. Near the hypothalamus lies the **thalamus**, a major clearinghouse for information going to and from the spinal cord and the cerebrum.

An arching tract of nerve cells leads from the hypothalamus and the thalamus to the **hippocampus**. This tiny nub acts as a memory indexer—sending memories out to the appropriate part of the cerebral hemisphere for long-term storage and retrieving them when necessary. The **basal ganglia** (not shown) are clusters of nerve cells surrounding the

thalamus. They are responsible for initiating and integrating movements. Parkinson's disease, which results in tremors, rigidity, and a stiff, shuffling walk, affects the nerve cells in the basal ganglia.

## The Neuron

The brain and the rest of the nervous system are composed of many different types of cells, but the primary functional unit is a cell called the neuron. All sensations, movements, thoughts, memories, and feelings are the result of signals that pass through neurons. Neurons consist of three parts: the **cell body**, **dendrites**, and the **axon**.

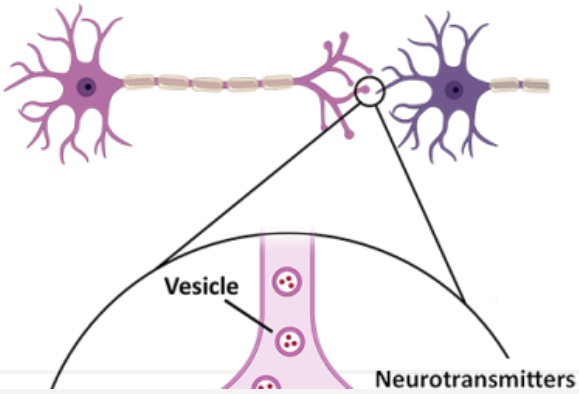



The cell body contains the nucleus, where most of the molecules that the neuron needs to survive and function are manufactured. Dendrites extend out from the cell body like the branches of a tree and receive messages from other nerve cells. Signals then pass from the dendrites through the cell body and travel away from the cell body down an axon to another neuron, a muscle cell, or cells in some other organ.

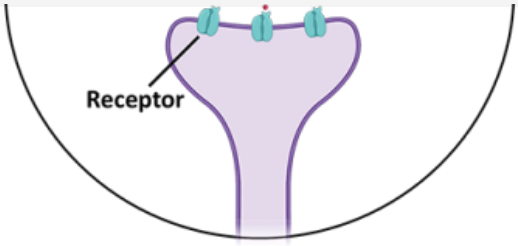
The neuron is usually surrounded by many support cells. Some types of cells wrap around the axon to form an insulating **myelin sheath**. Myelin is a fatty molecule which provides insulation for the axon and helps nerve signals travel faster and farther. Axons may be very short, such as those that carry signals from one cell in the cortex to another cell less than a hair's width away. Other axons may be very long, such as those that carry messages from the brain all the way down the spinal cord.

## The Synapse

Scientists have learned a great deal about neurons by studying the synapse—the place where a signal passes from the neuron to another cell. When the signal reaches the end of the axon it stimulates the release of tiny sacs called **vesicles.** These vesicles release chemicals known as **neurotransmitters** into the **synaptic cleft.** The neurotransmitters cross the synapse and attach to **receptors** on the neighboring cell. These receptors can change the properties of the receiving cell. If the receiving cell is also a neuron, the signal can continue the transmission to the next cell.




## Some Key Neurotransmitters At Work




**Neurotransmitters** are chemicals that brain cells use to talk to each other. Some neurotransmitters make cells more active (called *excitatory*) while others block or dampen a cell's activity (called *inhibitory*).

- **Acetylcholine** is an excitatory neurotransmitter. It governs muscle contractions and causes glands to secrete hormones. Alzheimer's disease, which initially affects memory formation, is associated with a shortage of acetylcholine.
- **Glutamate** is a major excitatory neurotransmitter. Too much glutamate can kill or damage neurons and has been linked to disorders including Parkinson's disease, stroke, seizures, and increased sensitivity to pain.
- **GABA** (gamma-aminobutyric acid) is an inhibitory neurotransmitter that helps control muscle activity and is an important part of the visual system. Drugs that increase GABA levels in the brain are used to treat epileptic seizures and tremors in patients with Huntington's disease.
- **Serotonin** is a neurotransmitter that constricts blood vessels and brings on sleep. It is also involved in temperature regulation. Low levels of serotonin may cause sleep problems and depression, while too much serotonin can lead to seizures.
- **Dopamine** can be excitatory or inhibitory and is involved in mood and the control of complex movements. The loss of dopamine activity in some portions of the brain leads to the muscular rigidity of Parkinson's disease. Many medications used to treat mental health disorders and conditions work by modifying the action of dopamine in the brain.

## Neurological Disorders

The brain is one of the hardest working organs in the body. When the brain is healthy it functions quickly and automatically. But when problems occur, the results can be devastating. NINDS supports research on hundreds of neurological disorders. Knowing more about the brain can lead to the development of new treatments for diseases and disorders of the nervous system and improve many areas of human health.

Last reviewed on November 15, 2023