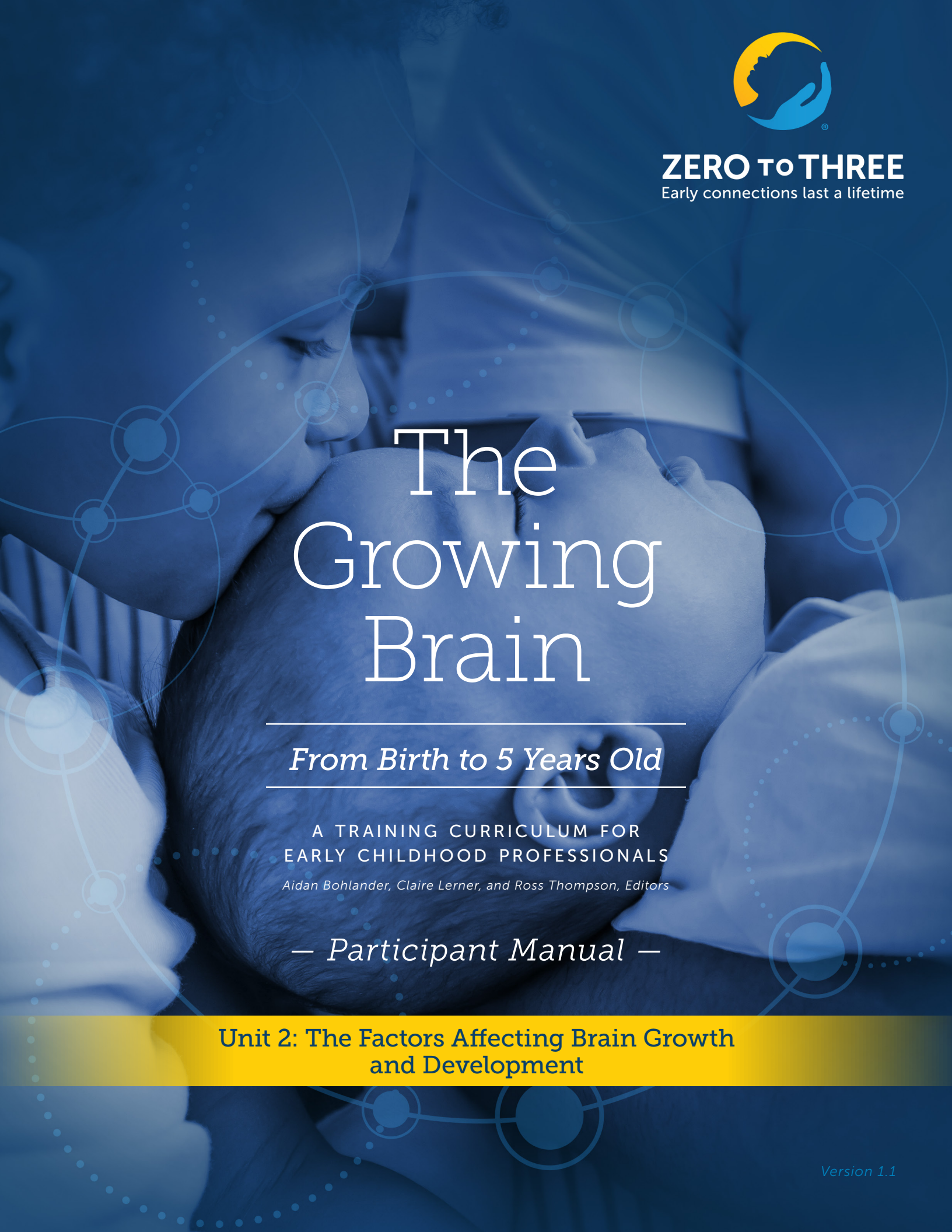

ZERO TO THREE
Early connections last a lifetime

# The Growing Brain

## *From Birth to 5 Years Old*

A TRAINING CURRICULUM FOR
EARLY CHILDHOOD PROFESSIONALS

*Aidan Bohlander, Claire Lerner, and Ross Thompson, Editors*

*— Participant Manual —*

## Unit 2: The Factors Affecting Brain Growth and Development

*Version 1.1*

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# Table of Contents

# Preface

## "The brain is a social organ of adaptation built through interactions with others." (Cozolino, 2014, p. xvi)

The development of the growing brain is one of the most important topics in early childhood development, with significant implications for early childhood professionals. Research on infant brain development is exploding. With the advent of the magnetoencephalography (MEG) for infants, researchers can now see more clearly into a young child's brain activity and learn what impact interactions have on certain aspects of development.

The greatest rate of brain growth and development is during the first few years of life. This rapid development occurs at the same time a child is making critical connections with his or her outside world. Because of such rapid brain growth during the first few years, early experiences have a disproportionately greater impact on the newly growing brain's development.

Often, an early childhood professional provides one of the earliest human interactions an infant or young child will experience. The professional will play a significant role in determining the experiences and environment that shape and influence the construction of the early brain. When an early childhood professional and an infant interact together, each is inducing the other's internal states of being. It's the basic day-to-day experiences, be they nurturing or non-nurturing, that set the young child on his or her course of brain development.

It is for these reasons that ZERO TO THREE, in partnership with the University of Arkansas Early Care and Education Projects, developed The Growing Brain (TGB) curriculum for early childhood professionals. Since 1977, ZERO TO THREE has been translating research that helps us understand how the young¬est children think, learn, and interact with the important adults in their lives. We turn that scientific knowledge into helpful tools and practical resources for parents, policymakers, and professionals, like yourself, to help make the lives of babies, toddlers, and their families better.

This Participant Manual, along with the other curriculum materials you've received, is intended to support your learning experience. In the Manual you will find key points from each presentation as well as discussion questions. Please use this Manual as a workbook during the course to record presentation and discussion highlights. Together with the other TGB materials, we hope it will serve as a valuable record of your learning and resource on early brain development that you will return to again and again as you work with young children.

Thank you for what you do each and every day to support the youngest and most vulnerable members of our society. Each interaction that you have with each young child is helping to shape the very structure of his or her brain. That is an incredible responsibility and privilege! Thank you for your participation in this course and your commitment to be a positive influence on the children and families you serve.

### Reference

Cozolino, L. (2014). *The neuroscience of human relationships: Attachment and the developing social brain* (2nd ed.). New York, NY: WW Norton & Company.

# Introduction

How wonderful to have this new resource on the brain and child development! I remember when we wrote our curriculum, *Early Development and the Brain: Teaching Resources for Educators* (Gilkerson & Klein, 2008), a colleague asked: "Is the brain a fad? What will be next?" The brain has hardly been a fad; as one of the central regulators of the body and of our experience with the world, its critical importance in understanding young children's development and how best to nurture their growth will always be supremely important for anyone who cares about young children and is invested in nurturing their healthiest development.

We wrote the former curriculum for early childhood faculty and trainers so they could confidently teach about the brain and its role in early development to their students. While early educators had long focused on the whole child, brain imaging brought a seismic shift in our understanding about biopsychosocial development. Now students in early childhood development, as well as faculty, fully appreciate the power of brain health and functioning and are eager to learn how they can best build the brainpower of the children they serve.

This new curriculum, *The Growing Brain (TGB),* addresses the same vital areas that we covered: the structure and function of the brain; factors and experiences that can harm the growing brain, especially stress, and how to protect the brain from harm; and the connections between the brain, language development, and sensory functioning.

In the 9 years since we wrote our curriculum, much more has been discovered about the brain, especially regarding emotional regulation, the role of caregiving relationships, and the impact of trauma. Evidence that young children's early experiences shape the actual architecture of the brain and how it functions has grown dramatically, and it has put a spotlight on the importance of the interface between the brain and the environment and on the centrality of human interaction and relationships in brain development. Accordingly, *TGB* focuses heavily on the growing field of "affective neuroscience"—the science of emotions and the brain—and how the earliest interactions shape lasting patterns of relatedness. The link between brain, body, and behavior is ever clearer. Unmediated adverse childhood experiences (ACEs) are linked with problems in adult physical and mental health in ways we might not have imagined. Synchrony in mother-infant behavioral interactions also has a significant influence on the growing brain, as this synchrony is mirrored physiologically in the child's heart rate synchrony—heart to heart and brain to brain. This early synchrony relates to self-regulation in infancy and toddlerhood and even shapes the adolescent's capacity for empathy. In this *TGB* curriculum, you will learn about the impact of disrupted synchrony and how factors such as maternal depression affect the child's ability to read emotions. *TGB* also includes very important content on the impact of stress on the developing brain, which is heavily influenced by the availability of a caring adult to help mediate the stress—to provide protection and help make the experience manageable. One of the most powerful features of this curriculum is that it translates very complex concepts in a way that is digestible, is meaningful and relevant, and provides a range of interactive exercises that enable trainees to integrate and apply these concepts in their daily work supporting young children. In short, it engages trainees' brainpower in active learning!

Further, while professionals must be critical consumers of neuroscience, how do we help parents absorb this new information from science and build their confidence in what *they know* about their child? How can we help protect and grow parents' intuitive competence—a concept well-documented decades ago in studies of parenting? While brain and behavior research will continue to bring new discoveries, we are reminded of one of the most fundamental ideas of early care and education: the essential value of observation as a way of knowing. A child's behavior is one of the best windows into brain functioning. Our role is to encourage parents, teachers, and other caregivers to pause, watch, and truly notice the child's responses to his world—to see what this child can take in at this moment on this day. What experiences does he approach? What experiences does she pull away from—even a bit? What is too much input for him? What is too little for her? Where is the sweet spot—the space for moderate novelty in which the brain thrives?

The science of early development is an integrated science, and you are an integrated professional. Enjoy deepening your understanding of child development and the brain and sharing that knowledge with others!

**Linda Gilkerson, PhD**
Professor, Erikson Institute

# Note for Participant Manual: Unit 2

This section of the participant manual is comprised of important content and reflections related to Unit 2, The Factors Affecting Brain Growth and Development of *The Growing Brain.* All 7 Units are available separately from ZERO TO THREE, as well as available as a complete publication package. Please see the participant manual table of contents on page 3 for a list of all 7 Units.

We are proud of the participant manual as a way of enhancing participants' understanding of *The Growing Brain* as an interactive curriculum: it is a fully designed and functional workbook for learners to explore and exchange ideas. They can be purchased individually, or as a group purchase. Your learners can make the purchases or you can on their behalf.

Unit 2 covers:

- how the brain is the most plastic in early childhood;
- how the body's stress system is adaptive but needs an adult caregiver or may suffer damage; and
- how adult carers have a vital role to play in helping children regulate stress and build resilience.

The participant manual is available from the ZERO TO THREE bookstore as a digital download. This download is a single-use license for either you or your learners to print—in order to make best use of the workbook features.

# Teaching *The Growing Brain: Birth to 5 Years Old*

*The Growing Brain: From Birth to 5 Years Old* is a 21-hour course. The following is a suggested time schedule for teaching each unit based on the field test. Times may vary from trainer to trainer and based on the needs of participants.

| | |
|---|---|
| Unit 1: The Growing Brain: The Basics | 3 hours |
| Unit 2: The Growing Brain: The Factors Affecting Brain Growth and Development | 3 hours |
| Unit 3: The Growing Brain: Communication and Language Development | 3 hours |
| Unit 4: The Growing Brain: Cognition and Executive Function | 3 hours |
| Unit 5: The Growing Brain: Social-Emotional Development | 3 hours |
| Unit 6: The Growing Brain: Understanding Behavior | 3 hours |
| Unit 7: The Growing Brain: Everyday Play | 3 hours |

*Note: The 21 hours is training time and each unit includes only one 10-minute break. *Additional time must be scheduled for additional breaks of any kind.*

## *Critical Competencies* Areas and Sub-Areas

The *ZERO TO THREE Critical Competencies for Infant-Toddler Educators™* define the specific evidence-based teaching methods and practices that support and nurture young children's social-emotional, cognitive, and language and literacy development and learning.

ZERO TO THREE has completed a crosswalk between the *ZERO TO THREE Critical Competencies for Infant-Toddler Educators™* and *The Growing Brain: From Birth to 5 Years Old* training curriculum. Significantly for learners, these two professional development curricula and resources now closely align and complement each other. For more information on the *Critical Competencies* and how you can use them to inform your professional development goals, visit www.zerotothree.org/criticalcompetencies.


### Critical Competencies Sub-Areas

**Area 1: Supporting Social–Emotional Development**

- SE-1 Building Warm, Positive, and Nurturing Relationships
- SE-2 Providing Consistent and Responsive Caregiving
- SE-3 Supporting Emotional Expression and Regulation
- SE-4 Promoting Socialization
- SE-5 Guiding Behavior
- SE-6 Promoting Children's Sense of Identity and Belonging

**Area 2: Supporting Cognitive Development**

- C-1 Facilitating Exploration and Concept Development
- C-2 Building Meaningful Curriculum
- C-3 Promoting Imitation, Symbolic Representation, and Play
- C-4 Supporting Reasoning and Problem Solving

**Area 3: Supporting Language & Literacy Development**

- L&L-1 Promoting Communication Exchange
- L&L-2 Expanding Expressive and Receptive Language and Vocabulary
- L&L-3 Promoting Early Literacy

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# Unit 2

UNIT 2

# The Factors Affecting Brain Growth and Development

**Goal: To understand key factors that affect brain development and how to support healthy overall brain development**

**Objectives**

1: Identify Factors That Affect Brain Growth and Development

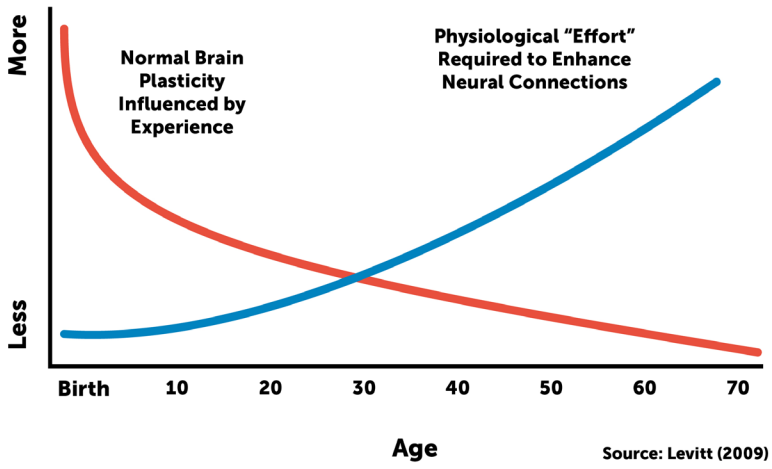
2: Understand the Effect of Stress on Brain Development

3: Learn About the 5 R's for Supporting Healthy Brain Development

## From Baby to Grown-Up

- The **brain** grows in both size and connectivity from birth through adulthood.
- The brain is most **plastic,** or adaptable to making connections based on experiences, in the early childhood years and becomes less adaptable as we grow older. In other words, it is easier to make connections and form new **neural networks** in early childhood than it is later in life (Thompson, 2014).
- For example, brains are much more open to making the connections necessary to learn a new language in the first few years of life than they are at 30, or 50, years old. It takes much more effort as we get older to effect change in our brains through our experiences (Thompson, 2014).

**The Ability to Change Brains Decreases Over Time**



# The Factors Affecting Brain Growth and Development

The brain does not know what type of an environment it is going to be born into, and it is amazingly flexible to making adaptations based on a child's experiences, particularly in the first few years of life. This amazing growth of new connections is called **transient exuberance.**

**Transient Exuberance**

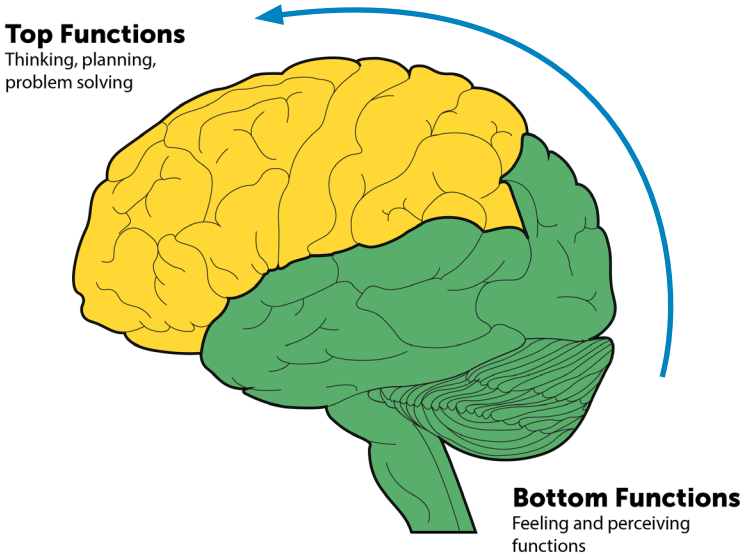
"Transient" because some of these connections are short-lived.

"Exuberance" because of the rapid growth of connections during the early years.

### Synaptic Pruning

As the child grows, and the brain learns more about what type of environment the child is living in, it "decides" what connections he needs and doesn't need to thrive in his world. The least used connections in the brain are pruned, or eliminated. The remaining connections, those that are most frequently used and most critical to the child's development, remain.

# The Factors Affecting Brain Growth and Development




### How the Brain Develops and Matures

- Although the basic structures of the brain are present at birth, they are not fully mature. The **brain stem** is fully formed at birth, but the **forebrain** takes a long time to mature, completing development in the mid-20s (Society for Neuroscience, 2016).
- When the brain grows, it grows from the bottom up, and back to front. The brain stem (**hindbrain** and **midbrain**) develops first, followed by the midbrain and forebrain, where the **cerebral cortex** is located (Society for Neuroscience, 2016).

Let's switch to thinking about functions of the brain.

- The top and bottom functions work together to help us navigate our environments. Human beings would have difficulty if they used only one of these functions. They need to perceive and feel, and then be able to think about how to act on their perceptions and feelings in functional ways that help them adapt to and thrive in their environments.
- At birth, children's bottom brain functions are initially maturing more rapidly. The key for providers is to help children integrate the top and bottom functions so that, over time, children can think through their feelings and manage them in ways that are acceptable. C-4 This is a process that continues into later childhood and adolescence as the top functions continue to develop into early adulthood (Siegel & Bryson, 2011).

**Think About It:** Adults help very young children integrate these functions through the everyday care they provide for them, for example, by helping toddlers label their feelings and guiding them to give back the toy they grabbed and choose a different one.

# The Factors Affecting Brain Growth and Development

## 1 Identify Factors That Affect Brain Growth and Development

**Factors That Affect Brain Growth and Development**

Now we will explore some factors that affect brain growth and development and think about how we can support healthy brain development. The factors that we will explore are:

- gene–environment interactions,
- nutrition,
- sleep,
- exposure to toxic substances,
- diseases and disorders of the brain in early childhood, and
- the role of relationships.

*Gene–Environment Interactions*

The development of the brain is largely based on the unique genetic blueprint, or DNA, that we are born with (Tebbenkamp, Willsey, State, & Šestan, 2014).

Both positive and negative experiences can affect whether or not a gene in the child's DNA is activated or deactivated. Positive experiences include sensitive, responsive caring or positive learning opportunities. SE-1 SE-2 Negative experiences include exposure to toxins, inadequate nutrition, and ongoing stress, among others (National Scientific Council on the Developing Child, 2010).

*Nutrition*

The development of the brain is influenced by the mother's nutrition prenatally and the nutrients the child receives through his diet, once born.

Severe malnutrition can

- slow brain growth
- thin the cerebral cortex
- reduce the number of **neurons,** connections between the neurons, and amount of myelination (Laus et al., 2011).

➡ Where do you get information regarding balanced nutrition for the children in your care?

➡ How do you promote balanced nutrition for the children in your care?

➡ Does your program have a way to learn whether a family might be experiencing food insecurity? How do you collect this information?

➡ How do you talk to families about this issue? What resources do you find helpful to share?

# The Factors Affecting Brain Growth and Development

*Sleep*

- Adequate sleep (especially deep or REM sleep) is extremely important for brain growth and development (Graven & Browne, 2008).
- The American Academy of Sleep Medicine (Paruthi et al., 2016) recommends children get this much sleep every day:
  - Infants (4–12 months): 12–16 hours
  - Toddlers (1–2 years): 11–14 hours
  - Preschoolers (3–5 years): 10–13 hours

➡ How do you communicate with parents about their children's sleep, and how do you provide recommendations about sleep?

➡ How have you seen children's sleep (or lack of it) affect their behavior and learning?

➡ What do you do to create nurturing sleep routines for children during the day?

➡ How do you handle daytime sleep challenges? What do you do or can you do to individualize children's sleep routines during the day?

*Exposure to Toxic Substances*

- Some substances used by the mother during pregnancy can negatively affect brain development.
  - Alcohol, cigarettes, street drugs, some prescription drugs, and more (National Scientific Council on the Developing Child, 2006).
  - Heavy metals such as mercury, lead, and manganese (National Scientific Council on the Developing Child, 2006).

# The Factors Affecting Brain Growth and Development

*Diseases and Disorders of the Brain in Early Childhood*

- Cause dysfunction in the brain or nervous system.
- Physical, psychological/behavioral, or cognitive symptoms may arise.
- May be present at birth or develop later.

➡ What do you think are some of the signals that might mean a child has a neurological disorder?

➡ What steps might you take if you are concerned about a child's development or behavior?

# 2 Understand the Effect of Stress on Brain Development

### The Role of Relationships

Relationships that very young children have with their regular providers play a powerful role in brain growth and development.

The first few years of life are a time of great opportunity and great vulnerability for brain growth and development. The experiences children have with their primary providers during this time have the power to shape the structure and alter the functions of the brain.

The way children are treated by their primary caregiver in early childhood shapes what they expect from that relationship and relationships in the future. It also shapes how comfortable they feel exploring their environment. SE-1 SE-2

When the caregiver is sensitive and responsive, the children form a secure **attachment** and feel comfortable to explore and learn—not overly stressed. When the caregiver is distant, disengaged, or inconsistent in their care, the children form an insecure attachment—unsure whether their needs will be met and not as willing to explore their environment, limiting their learning opportunities. They are focused on getting their emotional, or even physical, needs met.

It's important to note that children with initially insecure attachment relationships can form later secure attachments if their new caregivers are consistently sensitive and responsive, or if their former caregivers become consistently sensitive and responsive.

| Secure Attachment | Insecure Attachment |
|---|---|
| • Sensitive and responsive caregivers.<br>• Children feel safe and secure to explore. | • Distant, disengaged, or inconsistent caregivers.<br>• Children are unsure whether or when their needs will be met and do not explore their environment. |

- The quality of the relationship impacts how children deal with stress.
- How children handle stress affects their overall development and functioning.

# The Factors Affecting Brain Growth and Development

## Stress

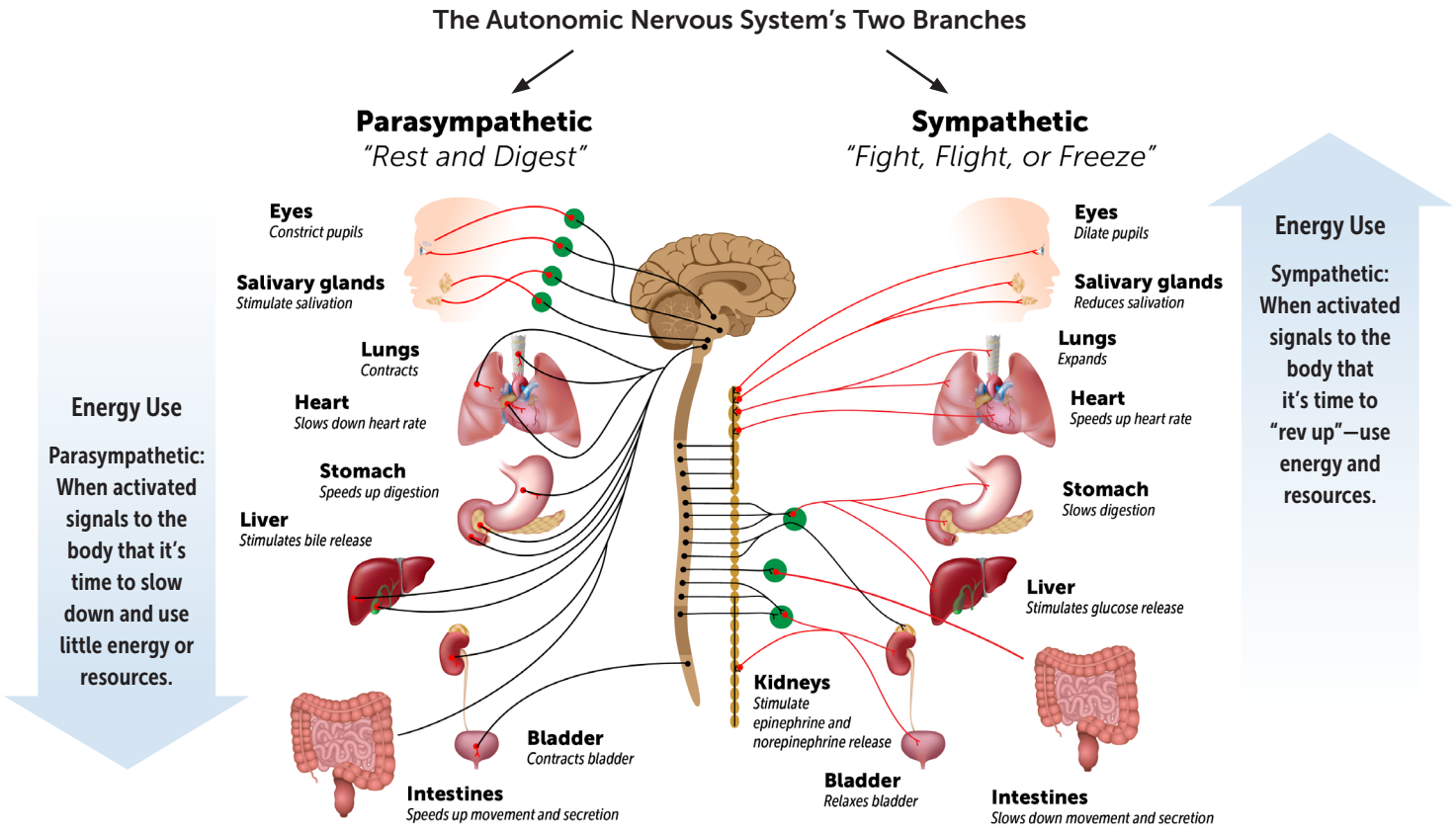
**Stress** is the physical and emotional response a person has to events and experiences.

➡ How do you respond—physically and emotionally—when things are getting to be "too much" or stressful?

➡ Now let's think about calming down from a stressful situation. What do you do to help yourself calm down from a stressful situation?

➡ How do you see children in your care calming themselves down?

When the brain interprets an event as stressful it activates the **sympathetic nervous system**—quickening the heart and focusing vision. **Cortisol,** a hormone produced to help the body prepare for and respond to stressful conditions, helps to slow down bodily systems that are not necessary for survival—reproduction, immune response, digestion, and growth. This slowdown is a useful function in short spurts of time when we experience stress. When we are calm again, the **parasympathetic nervous system** kicks in and returns us to normal functioning.



# The Factors Affecting Brain Growth and Development

There are times when a small amount of stress reaction can be helpful, such as when you are late for work and looking for your keys. You get activated to move around and search. Your heart rate elevates, and your pupils constrict so you can focus your vision.

The stress response system is especially useful in situations that are threatening. It leads us to run away from danger, or freeze in place if that's the safest option. This is often called the "fight, flight, or freeze" response.

➡ What might a "fight" response look like in toddlers or preschoolers?

➡ What might "flight" look like in infants who can't yet crawl or walk?

➡ What might "freeze" look like?

**Stress and the Brain**

- Very young children
  - have limited ability to cope with stress and
  - depend on adults to help them cope with stress.
- The part of the brain that controls reactions to stress is fully developed at birth. However, the forebrain, the part of the brain that controls *thinking* about feelings, memories, and experiences, is still maturing.

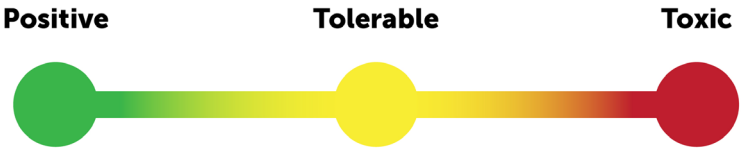
For example, this is why a toddler might have a tantrum in response to being denied a toy at the store, whereas a 9-year-old might still experience stress over the disappointment but can better manage his emotions due to his more mature top functions. His **frontal lobe,** part of the top function, can modulate his bottom function's stress response.

**Think About It:** Very young children are dependent on the caring adults in their lives to help them develop strategies to cope with stress while their top functions (thinking, planning, problem solving) are still maturing. SE-2

# The Factors Affecting Brain Growth and Development

## Types of Stress

### The Stress Continuum




**Normative stress**—reactions to normal life experiences that are not dangerous or threatening.

- A necessary aspect of healthy development for coping with everyday events
- Stress is short term in nature
- Often within the child's ability to cope, with some scaffolding (National Scientific Council on the Developing Child, 2005/2014).

**Tolerable stress** is is longer lasting and more intense but is relieved by supportive relationships.

- Associated with high cortisol release
- May disrupt brain architecture if prolonged
- Supportive relationships facilitate a child's ability to cope (National Scientific Council on the Developing Child, 2005/2014).

**Toxic stress** involves:

- STRONG AND PROLONGED activation of the body's stress response
- ABSENCE of adult support (National Scientific Council on the Developing Child, 2005/2014)
- Cortisol continuously floods the brain, which can alter the way it develops (National Scientific Council on the Developing Child, 2005/2014).

# The Factors Affecting Brain Growth and Development

### Long-Term Effects of Stress

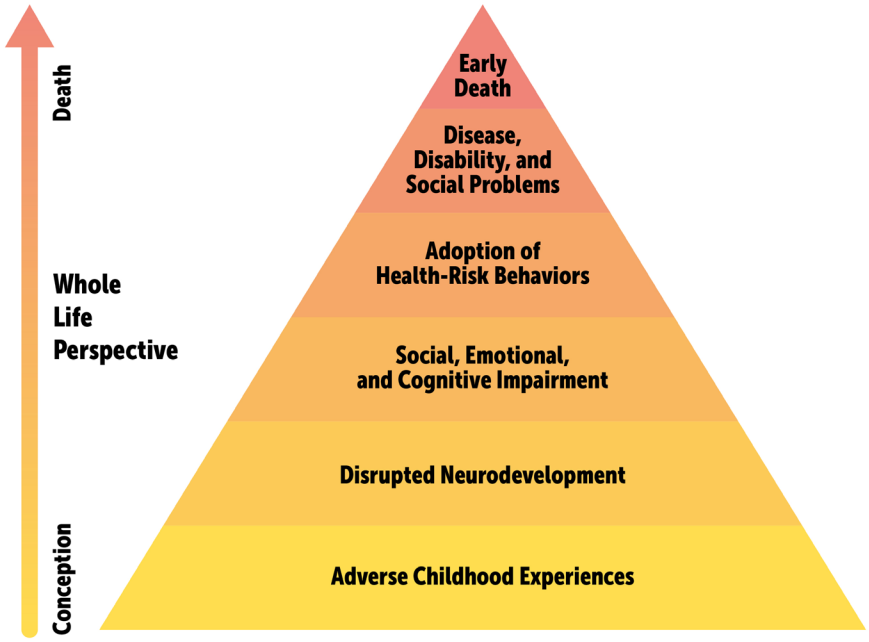
Adverse Childhood Experiences (Centers for Disease Control and Prevention, 2016).

Excessive elevations in:

- Heart rate
- Blood Pressure
- Stress Hormones

Can impair

- Brain Architecture
- Immune Status
- Metabolic Status
- Cardiovascular Function




### Resiliency and Protective Factors

The good news is that studies reveal that there are protective factors that can buffer children against adverse experiences in the early years. For example, in a long-term study, researchers found that children who had experienced adverse events in early childhood fared better as adults—in terms of employment status, relationship status, and high school graduation rates—*IF they had a caring adult in their lives when they were young.*

Similarly, a large review of the literature by the Center for the Study of Social Policy (2012) identified several additional protective factors for children, including:

- strong social connections for the family within the community,
- parental knowledge of child-rearing and child development,
- parental resilience,
- family access to concrete support in times of need, and
- parents' ability to support the social and emotional competence of children. SE-1 SE-2

All of these factors have been found to mitigate or eliminate risk and enhance the well-being of children and families.

# The Factors Affecting Brain Growth and Development

## 3 Learn About the 5 R's for Supporting Healthy Brain Development

Let's begin to think about resources and strategies we can use to help build healthy brains. By using the 5 R's we can help children feel safe, secure, and ready to explore and cope with stress so they can reach their full brain power and potential.

**What are the 5 R's?**

1. Relationships
2. Responsive interactions
3. Respect
4. Routines
5. Repetition

*Relationships*

Warm, loving, secure attachment relationships give children the foundation they need for healthy development. SE-1 SE-2

➡ What are some of the ways you build strong, trusting relationships with the children in your care?

➡ What about children whom you find difficult?

➡ How do you support parents in providing nurturing and responsive care to their children?

➡ When it comes to caring for young children, most of us have a preference—an age group that we feel most comfortable with. What about you—do you find it easier or harder to provide sensitive, responsive care to babies, toddlers, or preschoolers?

*Responsive Interactions*

Responsive interactions are the "how" of interacting with very young children. In a responsive interaction with a very young child, the adult is reading the child's verbal and nonverbal cues to understand the child's experience and intent and then responding on the basis of that information (Seibel, Britt, Gillespie, & Parlakian, 2009). A responsive interaction means that the adult is following the child's lead rather than being driven by his agenda.

Back-and-forth, responsive interactions are sometimes referred to as "serve and return." Much like in a game of tennis or volleyball, the child "serves up" some information, and the adult responds based on the cues she receives. The child and adult go back and forth, with each person responding to the other's gestures, sounds, facial expressions, and words. SE-1 SE-2 SE-4 C-3 L&L-1

*Respect*

Respect means treating even the youngest infants as valuable individuals whose efforts to communicate preferences and needs are important (Seibel et al., 2009). SE-6

➡ What are some examples of how we might demonstrate respect to very young children?

*Routines*

Routines are the predictable sequences of events that happen every day in the same way. The use of routines helps build brain connections that support memory and organizational skills. They also create a sense of security by helping children know what, how, and when things will happen (Seibel et al., 2009).

Routines create a sense of safety, calming the bottom functions of the brain and thus allowing children greater access to more top functions such as working memory and focused attention. SE-2 SE-4

➡ What is a routine that you do with the children in your care that is working well? How do you see this benefiting the children in your care? What about a routine that could use some fine-tuning?

*Repetition*

The brain establishes connections in response to experiences. The more an experience is repeated, the stronger the brain connection related to that experience. SE-1 SE-2 C-1 C-4 L&L-2 L&L-3

Keep in mind that repetition is helpful for cementing developing skills. Introducing and making children repeat activities or skills way beyond their reach will not build positive brain connections and can even cause too much stress. The child might come to associate the activity with negative emotions, which may interfere in a child's love of learning.

# The Factors Affecting Brain Growth and Development

## Let's Review! Key Messages:

- The brain is the most plastic in early childhood.
- The body's stress response is adaptive, but it can be harmful to brain development if it goes on too long without the help of a caring adult.
- We have a powerful role to play in helping children regulate their stress and build healthy brains.

**Closing: Start, Reflect, Continue**

Take a moment to consider an idea or practice that you might consider starting, one thing that you might reflect on doing differently, and one idea or practice that you have already been doing and will continue to do that supports healthy brain development.

| Start | Reflect | Continue |
|---|---|---|
| | | |

*Notes*

# The Factors Affecting Brain Growth and Development

## References

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Handout 2.1

# Brain Vocabulary

1. **Nervous system:** Takes in information from our environment through our senses and makes decisions, via the brain, about how to respond and adapt to the environment.
2. **Brain:** Organ of the nervous system located in the skull that is the control center for the body—receiving, organizing, and responding to information from the senses.
3. **Sympathetic nervous system:** The sympathetic nervous system is activated when the brain must respond to a perceived threat. It helps us spring into action, increasing our heart rate and breathing rate, and shutting down nonessential survival functions such as digestion and reproduction.
4. **Neuron:** A nerve cell used to pass messages across the nervous system.
5. **Parasympathetic nervous system:** The parasympathetic nervous system responds when the brain reduces its activation to recover from a stressful experience. It allows us to "rest and digest," slowing the heart rate and breathing and activating bodily systems such as digestion.
6. **Brain stem:** Made up of the hindbrain and midbrain. Its functions include those needed for daily living, such as: controlling breathing, heart rhythm, blood sugar levels, sleep/wake patterns, alertness, motor control, and eye movement.
7. **Forebrain:** Sits "on top" of the brainstem and is the last part of the brain to fully develop. Responsible for higher order functioning (thinking, planning, problem solving, emotions, sensory processing, etc.). It includes the cerebrum—the largest part of the brain—that includes all four lobes of the cerebral cortex.
8. **Frontal lobe:** Part of the outer layer of the forebrain, located in the very top, front of the brain. It is the last part of the brain to fully develop. Functions include: starting and coordinating motor movement, higher-order cognitive skills such as thinking, planning, and problem solving (also known as executive functioning), as well as personality and emotional processing.
9. **Parietal lobe:** Part of the outer layer of the forebrain. Its functions include sensory processing, such as orientation, as well as how a person sees print or objects in relation to one another. Also responsible for regulating attention or how well a person can focus. In addition, it is involved in language development—specifically, recall of words at appropriate times.
10. **Occipital lobe:** Part of the outer layer of the forebrain. Its main function is to process visual information, such as shapes or colors.
11. **Temporal lobe:** Part of the outer layer of the forebrain. Its many functions include: processing auditory information, language recognition, short- and long-term memory, and processing emotions.

Handout 2.2

# Key Terms

- **Amygdala:** A structure located in the temporal lobe of the forebrain that perceives and evaluates a potentially threatening event or circumstance. Its functioning can be affected by an increase in stress-induced cortisol. The amygdala matures early in life and plays a critical role in the body's learned response to fear (National Scientific Council on the Developing Child, 2010; Society for Neuroscience, 2016).
- **Attachment:** The enduring bond that children form with their regular caregivers based on the experiences they have with those primary adults in their lives beginning in their early years. Classical attachment theory sets forth that our early relationships with our caregivers influence our expectations of relationships throughout our lives.
- **Bottom brain functions:** This is a term used to refer to the brainstem and structures in the temporal lobes, most importantly the amygdala, hypothalamus, and other structures of the limbic system (Ochsner et al., 2009).
- **Brain:** Organ of the nervous system located in the skull that is the control center for the body—receiving, organizing, and responding to information from the senses.
- **Brain stem:** The part of the brain made up of the hindbrain and midbrain. Its functions include those needed for daily living, such as controlling breathing, heart rhythm, blood sugar levels, sleep/wake patterns, alertness, motor control, and eye movement.
- **Cerebral cortex:** The outer layer of the cerebrum that consists of four lobes: frontal, parietal, occipital, and temporal. The four lobes of the cerebral cortex are responsible for the important functions of processing cognitive, emotional, behavioral, and sensory information (Society for Neuroscience, 2016).
- **Cortisol:** A hormone produced to help the body prepare for and respond to stressful conditions (Thompson, 2014).
- **Epigenetics:** The study of changes in organisms caused by environmental influences that modify gene expression.
- **Epinephrine:** A stress hormone, also known as adrenaline. It is released into the bloodstream to ensure that the body is alert and up to the challenge at hand (Society for Neuroscience, 2016).
- **Forebrain:** The forward or front part of the brain. It includes the cerebrum—the largest part of the brain—which is responsible for higher order, more complex functions like thinking, perceiving, planning, and processing language.
- **Frontal lobe:** The frontal lobe of the cerebral cortex is located at the very top, front of the brain, and is the last part of the brain to develop fully.

  Functions of the frontal lobe include (Society for Neuroscience, 2016):

  - starting and coordinating motor movement;
  - higher order cognitive skills: thinking, planning, problem solving—all necessary for executive functioning; and
  - personality and emotional processing.
- **Hindbrain:** The part of the brain located at the base of the brain near the spine. It includes the cerebellum, pons, and the medulla oblongata. It is intact and well developed at birth (Society for Neuroscience, 2016). The hindbrain is responsible for the basic functions for human life. It controls breathing, heart rhythm, and blood sugar levels (Society for Neuroscience, 2016).
- **Hypothalamus:** The hypothalamus is the structure responsible for controlling our body temperature, thirst, hunger, sleep, circadian rhythm (sleep/wake cycle), moods, and the production of many of the body's essential hormones that help control different cells and organs (Society for Neuroscience, 2016).

- **Limbic system:** A complex set of structures that lies on both sides of the thalamus, just under the cerebrum. It includes the hypothalamus, the hippocampus, the amygdala, and several other nearby areas. It is primarily responsible for our emotional life. It controls the basic emotions (e.g., fear, pleasure, anger) and drives (e.g., hunger, sex, dominance, care of offspring). It also plays a major role in the formation of memories.
- **Midbrain:** The midbrain is located between the hindbrain and forebrain. Its functions include eye movement, hearing, motor control, sleep/wake patterns, alertness, and temperature regulation. The midbrain and hindbrain together are often called the "brain stem."
- **Myelin sheath:** The fatty material that insulates the neurotransmitter that helps it travel smoothly down the axon from the cell body to the axon terminals. The axon serves as the pathway; the myelin sheath keeps the impulse on the path so it doesn't escape and also helps the signal move faster. The more insulated the axon is by the myelin sheath, the more accurately and quickly the message is sent (Society for Neuroscience, 2016).
- **Nervous system:** The nervous system consists of the brain, spinal cord, and a complex network of neurons that extend throughout the body. The nervous system is responsible for sending, receiving, and interpreting information from all parts of the body. The nervous system monitors and coordinates internal organ function and responds to changes in the external environment. The nervous system is made up of two parts: the central nervous system and the peripheral nervous system (Society for Neuroscience, 2016).
- **Neuron:** A nerve cell used to pass messages across the nervous system.
- **Neurotransmitter:** "Messages" that cross synapses sent from one neuron to another to tell it either to pass the message along to the next cell or to stop there (Society for Neuroscience, 2016).
- **Norepinephrine:** A stress hormone that mobilizes the brain and body for action. It reaches much higher levels during situations of stress or danger, and it triggers the "fight, flight, or freeze" response. It increases arousal and alertness, promotes vigilance, enhances formation and retrieval of memory, and focuses attention; it also increases restlessness and anxiety.
- **Occipital lobe:** The function of the occipital lobe is to process visual information, such as shapes and colors (Society for Neuroscience, 2016).
- **Parasympathetic nervous system:** A part of the autonomic nervous system which helps to soothe the body to regain its equilibrium, or homeostasis. It signals the body to conserve energy or "rest and digest" by slowing the heart rate and breathing and relaxing the body to allow digestion, reproduction, and other systems to function again (Society for Neuroscience, 2016).
- **Parietal lobe:** The parietal lobe is one of four lobes of the cerebral cortex. The parietal lobe's functions include sensory processing, such as knowing where your body is in space and how you see print or objects in relation to one another. The parietal lobe also regulates attention, or how well a person is able to tune in and focus on a thought or action. Another important function of the parietal lobe is its involvement in the ability to learn and recall words to communicate at appropriate times (Society for Neuroscience, 2016).
- **Positive stress:** Positive stress, or normative stress, are reactions to normal life experiences that are not dangerous or threatening to the person. Positive stress is a necessary aspect of healthy development that occurs as a result of exploring or learning something new or coping with everyday events. The stress is short term in nature and often within the child's ability to cope with some scaffolding and support by an adult (National Scientific Council on the Developing Child, 2005/2014).
- **Prefrontal cortex:** The front part of the frontal lobe. This region of the brain is widely considered the center of executive functions and is responsible for regulating thought, emotions, and actions.
- **Pruning (or synaptic pruning):** The process by which neural connections are refined. Neural circuits and connections that fire more often (i.e., are used more often) are retained, whereas those that are not used are removed (Society for Neuroscience, 2016). Pruning allows brain circuits to run more efficiently. Early experiences affect the nature and quality of the brain's developing architecture by determining which circuits are retained and which are pruned through lack of use. In this way, each child's brain becomes better tuned to meet the challenges of his or her particular environment (Siegel, 1999; Society for Neuroscience, 2016).

- **Sympathetic nervous system:** A part of the autonomic nervous system that is responsible for mobilizing the body's physiological capacity to respond to a perceived threat. It is responsible for our "fight, flight, or freeze" reactions that require us to increase our energy expenditure. It tells the body to be on alert and use energy and resources that make the heart beat faster, signals the lungs to take in more air, and shuts down nonessential functions such as digestion and reproduction (Society for Neuroscience, 2016).
- **Synaptogenesis:** The process of creating connections between neurons, also known as synapse formation. Neurons that communicate with each other more often form stronger connections across their synapses (Society for Neuroscience, 2016).
- **Temporal lobe:** The temporal lobe has a variety of important functions, which include (Society for Neuroscience, 2016):
    - processing auditory information—such as hearing different pitches of sound,
    - language recognition—understanding what words mean,
    - storing visual memory—such as remembering a familiar face,
    - short-term and long-term memory—through a structure called the hippocampus, and
    - emotional responses—through a structure of the temporal lobe called the amygdala.
- **Tolerable stress:** Stress that is relieved by supportive relationships that help the child cope. Examples of tolerable stress are when a caregiver helps a child manage challenging situations like moving to a new home, adjusting to a new child care provider, or the death of a family pet.
- **Top brain functions:** The brain areas associated with higher forms of cognition, most notably, the parietal and frontal lobes, and especially the prefrontal cortex (Ochsner et al., 2009).
- **Toxic stress:** Toxic stress involves strong and prolonged activation of the body's stress response system in the absence of the buffering protection of adult support (National Scientific Council on the Developing Child, 2005/2014). Toxic stress might be the result of: recurrent child abuse and neglect, severe maternal depression, parental substance abuse, family violence, and the ongoing effects of living in poverty. Toxic stress includes events that are continuously activating the stress response system, with no protection or comfort to help the very young child feel safe, secure, and calm (National Scientific Council on the Developing Child, 2005/2014).
- **Transient exuberance:** The overproduction of neural connections during early childhood; "exuberance" because of the rapid growth of connections during this time, and "transient" because some of these connections are short lived.

Parent Handout—Unit 2

# Building a Healthy Brain

## Did you know?

- The brain grows most rapidly and is most adaptable in early childhood. It makes more than 1 million new connections every second (Center on the Developing Child, 2017).
- A child's experiences in the world shape how the brain grows.

## Here's how to help your child build a healthy brain:

**Be sure your child gets the sleep he needs.** Young children need lots of sleep. The American Academy of Pediatrics (Paruthi et al., 2016) recommends the following:

- newborns (birth–3 months): 14–17 hours
- infants (4–11 months): 12–15 hours
- toddlers (1–2 years): 11–14 hours
- preschoolers (3–5 years): 10–13 hours

**Ensure that your child gets the nutrition she needs.** Once your child is eating solid foods, be sure she eats a balanced diet that includes vegetables, lean protein, and healthy fats. For more information, go to www.cdc.gov.

**Protect your child from danger in the environment.** This includes lead paint, prescription/illegal drugs, and second-hand smoke. Ask your doctor about other substances that can be harmful to your child.

**Help your child cope with stress.** Experiencing prolonged stress can have a negative impact on a child's developing brain. You can help by providing comfort and support during stressful times. For children older than 2, help them talk about stressful experiences and make sense of them. "That dog was big, and that made you scared. When he went to lick you, you were afraid he might bite you. But you see that he was actually very nice and friendly, and you are okay." Or, "I know you don't like it when Daddy leaves. I will miss you too—it's hard to say goodbye. Let's do our good-bye hug, and if you are feeling sad, you can look at the photo of you and me in your cubby. And then we will be together at the end of the day."

## Continue the learning at home:

You play a powerful role in helping to create the best environment for your child's growing! The 5 R's below can provide a good guide:

- **Relationships:** The loving bond you create with your child is the single most important factor in supporting healthy brain development. Always keep that top of mind.
- **Responsive interactions:** Tune in to your child's cues—her facial expressions, gestures, sounds, and words—to understand how she is feeling and what she is thinking, and then respond in ways that are supportive and sensitive to what she is "telling" you she needs.
- **Respect:** Try to see the world through your child's eyes and respect his "perspective"—what his unique experience is.
- **Routines:** Create daily routines so your child knows what to expect. This helps her feel safe and secure, which calms her brain and enables her to focus on play and exploration.
- **Repetition:** Repeat your child's favorite songs, rhymes, and stories to help build brain connections.