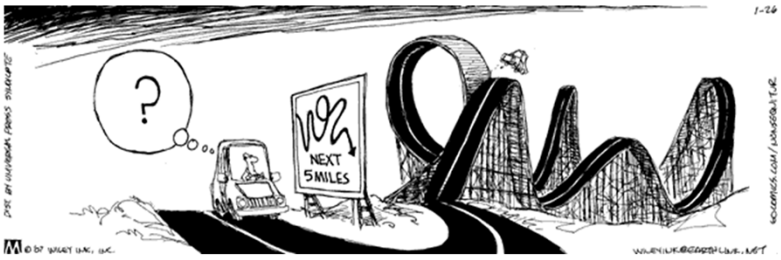
Welcome to
The Effects of Childhood Trauma on Brain Development



Compiled by Liz Rivera, MS, SSW
Utah Foster Care Foundation, 2010

Love is an act of faith, and whoever is of little faith is also of little love.
Erich Fromm

Key Processes	Age Beginning	Greatest Period of Activity	Age of equilibrium	Other
Neurogenesis	1st Trimester	In Utero	99% of 100 billion by birth	Evidence of hippocampal cell birth in adult
Migration	1st trimester	In utero, through 1st year	Regional specific, most by age 3	Some suggestion after brain injury
Differentiation	1st-2nd trimester	3rd trimester through 1st year	Region specific, most by age 3	Continues in some way through life
Apoptosis	3rd trimester	1st year	Age one	Majority done by age 3
Arborization	3rd trimester	1st year	Age 3	Experience dependent
Synaptogenesis	3rd trimester	8 months	Most by age 10	Lifetime activity dependent
Synaptic sculpting	Birth	1st 4 years	Age 6	2nd burst in puberty
Mylenation	Birth	1st 4 years	Continues through adolescence	Continues throughout life

Source: Bruce Perry

All of the neurodevelopmental processes described above are dependent upon both genetic and environmentally determined microenvironmental cues (e.g., neurotransmitters, neuromodulators, neurohormones, ions, growth factors, cellular adhesion molecules and other morphogens). Disruption of the pattern, timing or intensity of these cues can lead to abnormal neurodevelopment and profound dysfunction. The neuroarcheological perspective suggests that the ***specific*** dysfunction will depend upon the timing of the insult (e.g., was the insult *in utero* during the development of the brainstem or at age two during the active development of the cortex), the nature of the insult (e.g., is there a lack of sensory stimulation from neglect or an abnormal persisting activation of the stress response from trauma?), the pattern of the insult (i.e., is this a discreet single event, a chronic experience with a chaotic pattern or an episodic event with a regular pattern?).

While we are only beginning to understand the complexity of neurodevelopment, there are several key principles that emerge from the thousands of studies and years of focused research on these neurodevelopmental processes. These principles, as outlined below, suggest that while the structural organization and functional capabilities of the mature brain can change throughout life, the majority of the key stages of neurodevelopment take place in childhood.

Source: Bruce Perry

Malnutrition, both before and during the first few years after birth, has been shown to result in stunted brain growth and slower passage of electrical signals in the brain (Pollitt & Gorman, 1994; Shonkoff & Phillips, 2000). These effects on the brain are linked to cognitive, social, and behavioral deficits with possible long-term consequences (Karr-Morse & Wiley, 1997). For example, iron deficiency (the most common form of malnutrition in the United States) can result in cognitive and motor delays, anxiety, depression, social problems, and problems with attention (Shonkoff & Phillips, 2000).

Protein deficiency can result in motor and cognitive delays and impulsive behavior (Pollitt & Gorman, 1994). The social and behavioral impairments may be more difficult to "repair" than the cognitive impairments, even if the nutritional problems are corrected (Karr-Morse & Wiley, 1997).

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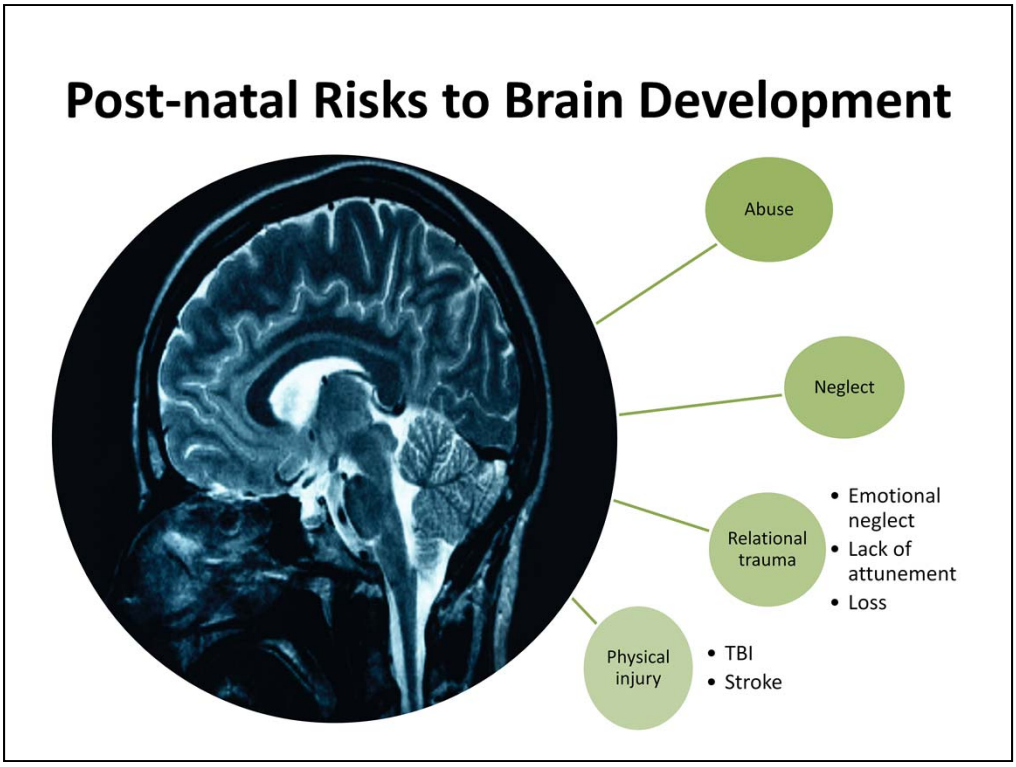
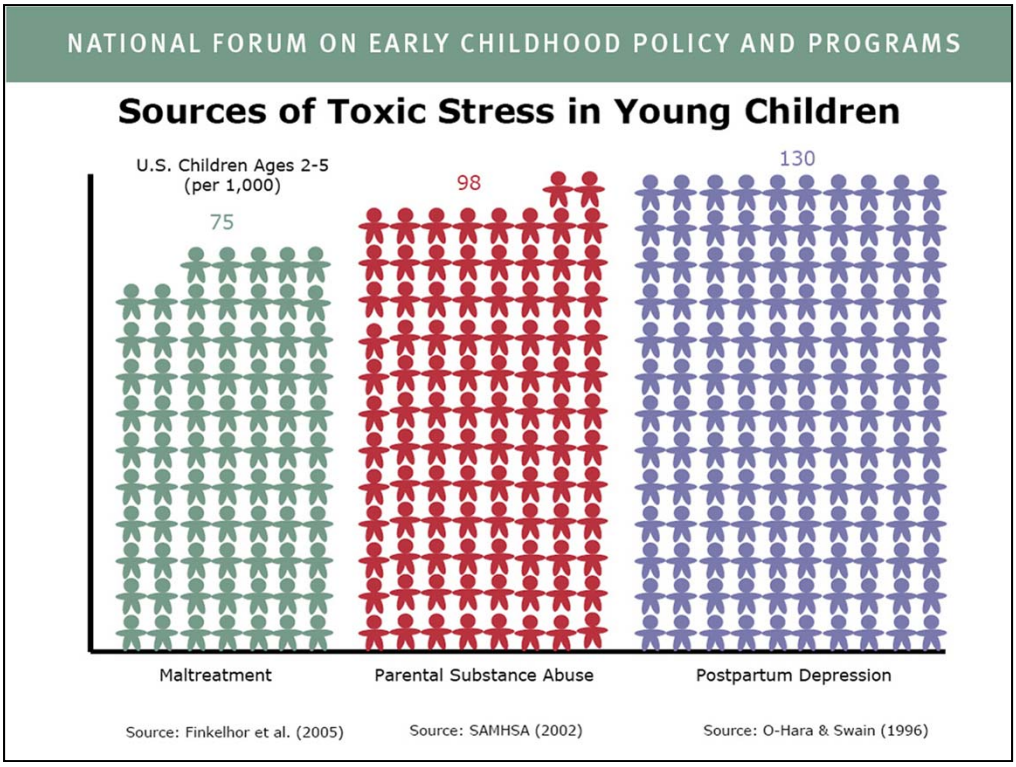


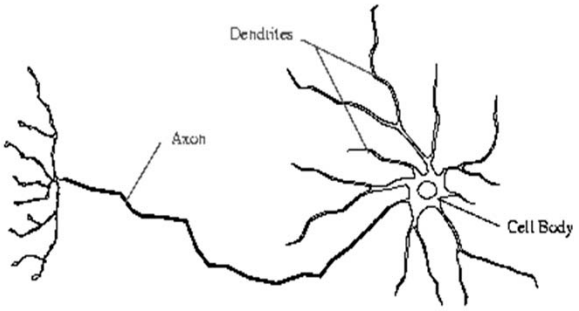
Because stable attachment bonds are vitally important for the infant's continuing neurobiological development, these dyadically regulated events scaffold an expansion of the childis coping capacities, and therefore adaptive infant and later adult mental health. In psychobiological research on mother-infant affiliative processes, Kalin, Shelton, and Lynn describe the long-enduring effects of such transactions (1995, pp. 740-741):

The quality of early attachment is known to affect social relationships later in life. Therefore, it is conceivable that the level of opiate activity in a mother and her infant may not only affect behaviors during infancy, but may also affect the development of an individual's style of engaging and seeking out supportive relationships later in life. In contrast to this scenario, the abusive caregiver not only shows less play with her infant, she also induces traumatic states of enduring negative affect. Because her attachment is weak, she provides little protection against other potential abusers of the infant, such as the father. This caregiver is inaccessible and reacts to her infant's expressions of emotions and stress inappropriately and/or rejectingly, and shows minimal or unpredictable participation in the various types of arousal regulating processes. Instead of modulating she induces extreme levels of stimulation and arousal, either too high in abuse or too low in neglect, and because she provides no interactive repair the infant's intense negative emotional states last for long periods of time. Such states are accompanied by severe alterations in the biochemistry of the immature brain, especially in areas associated with the development of the child's coping capacities (Schore, 1996; 1997a).



Providing supportive relationships and safe environments can improve outcomes for all children, but especially those who are most vulnerable. Between 75 and 130 of every 1,000 U.S. children under age 5 live in homes where at least one of three common precipitants of toxic stress could negatively affect their development.

The Neuron



A neuron typically has many dendrites & one axon. The dendrites branch & terminate in the vicinity of the cell body. In contrast, axons can extend to distant targets, more than a meter away in some instances.

Source: Synapse Web

We are born with over 100 billion brain cells, or neurons. These neurons have capacity to make a vast array of connections to other cells. These connections are called synapses. Most people have trillions of synaptic connections. Experience is the primary factor for the making and strengthening of synapses. Cognitive, emotional, social experience if patterned, repetitive, and consistent allow the brain to create an internal representation of the external world. Neurons are designed to change in response to patterned repetitive stimulation. The more a neural system is "activated", the more that system changes to reflect that pattern of activation.

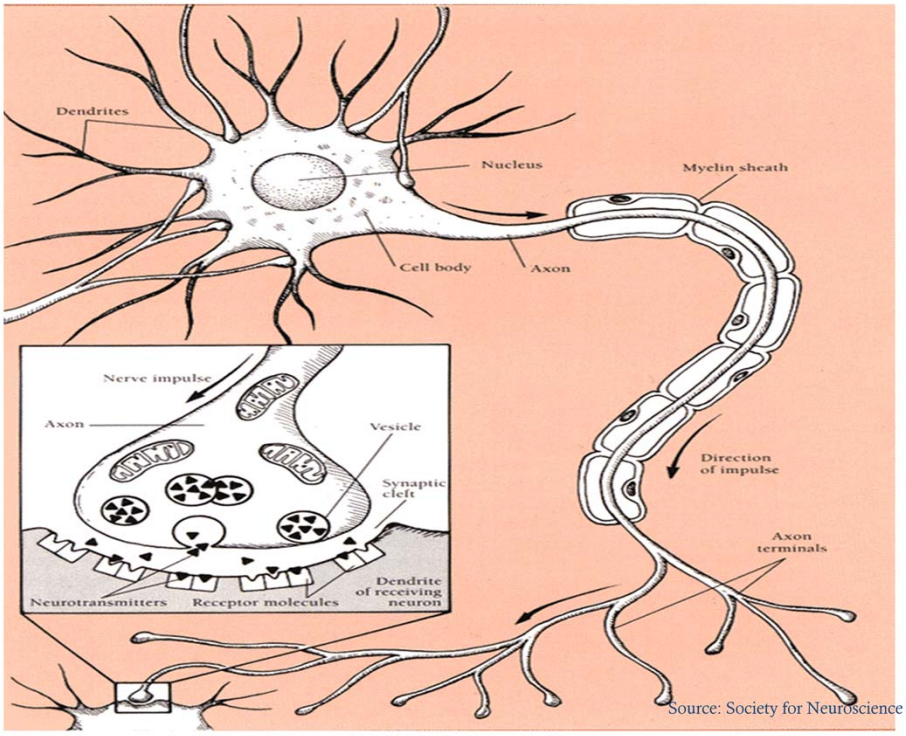
Neurons are designed to change in response to patterned repetitive stimulation. During development, patterns of activity define patterns of synaptic connectivity &, thereby, functional capacity. In adults, activity can alter pre-existing neural organization—in children, activity literally provides the organizing template for neural systems. All neurons change their molecular functioning in a "use" dependent fashion.

Therefore, patterned sensory input leads to patterned changes in neuronal systems. Patterned changes allow the brain to make internal representations (changes) of the external world.

Each neuron includes axon terminals that form synapses with other cells. These swellings at the ends of the axon contain small, compartments that hold a neurotransmitter. When a nerve impulse travels down the axon, the synaptic vesicles fuse with the membrane of the axon terminal & release neurotransmitters into the synaptic cleft, the tiny gap that separates one neuron & the next. The neurotransmitter floats across the cleft & binds to receptor molecules on the surface of the next

neuron, the post-synaptic cell. This interaction triggers the flow of specific ions into & out of the post-synaptic cell, which may stimulate or inhibit the firing of a nerve impulse.

Source: NIH

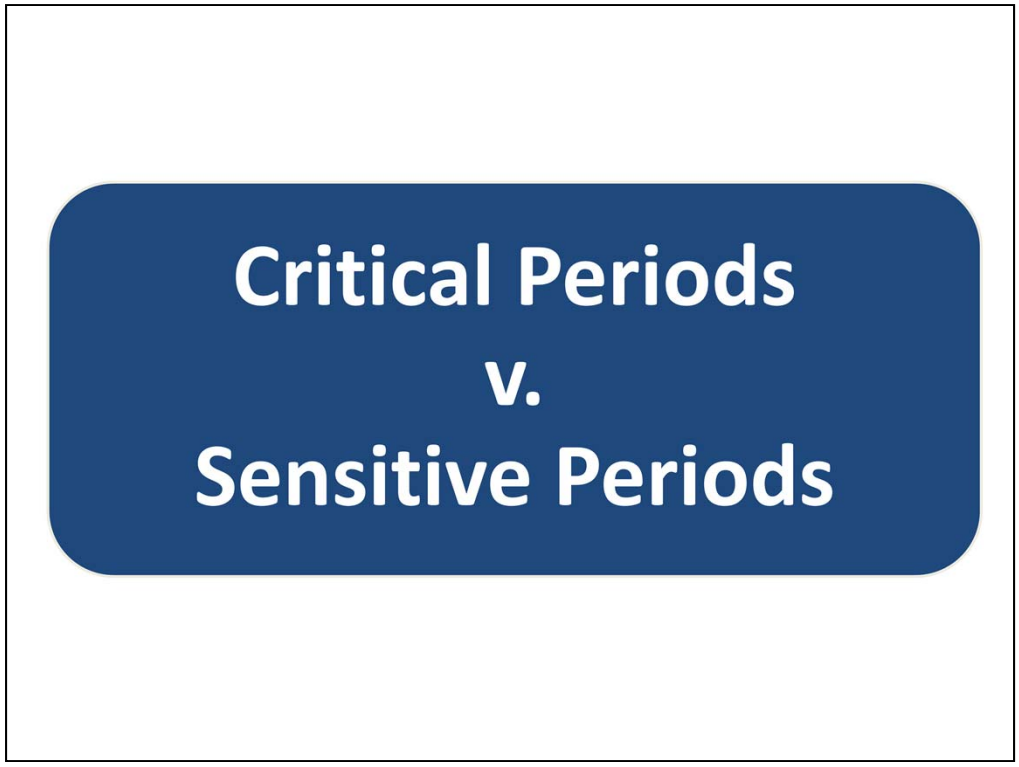


Chemical synapses are specialized junctions through which cells of the nervous system signal to one another and to non-neuronal cells such as muscles or glands.

Chemical synapses allow the neurons of the central nervous system to form interconnected neural circuits. They are thus crucial to the biological computations that underlie perception and thought. They also provide the means through which the nervous system connects to and controls the other systems of the body.

The human brain contains a huge number of chemical synapses, with young children having about 1016 synapses (10,000 trillion). This number declines with age, stabilizing by adulthood. Estimates for an adult vary from 1015 to 5 × 1015 synapses (1,000 to 5,000 trillion).

Wikepedia

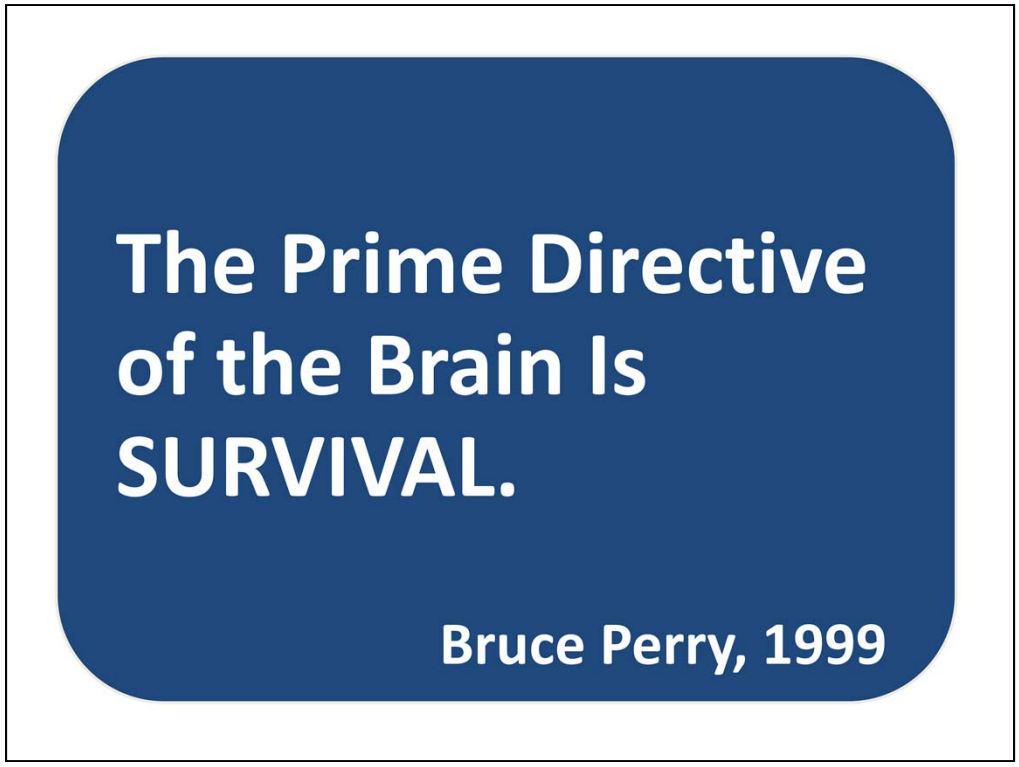


The difference between critical periods and sensitive periods is subtle. Theorists who believe in critical periods believe that children who do not get special stimulation during their window of receptivity are going to be "stuck" forever and never gain the abilities they should have gained in that period. However, other theorists believe that those very sensitive times in a child's life are just sensitive periods. They agree that children who do not get the right nurturing at the right times to jumpstart their developmental potential are going to have problems later in life, but they do not think that this inability to develop is permanent.

For example, infancy is the time when children first learn they can trust an adult or parent to take care of all their needs, keep them safe, and give them love. Some infants live in orphanages where there are far too many babies for the few nurses and staff members to take care of them. These children go through their first years with hardly any touch or affection that would teach them to trust and to show affection to caregivers. If these children are eventually adopted by a loving family later on in their childhood, they often have trouble adjusting to having an affectionate, loving parent. There have been many cases in which children who start out in that kind of orphanage environment never gain the ability to show affection and emotion toward family or even the ability to show remorse or compassion toward other people, no matter how loving and nurturing their adoptive family was being in their middle childhood and on. Such a child's ability to trust and love would have essentially become "stuck" in infancy, even though the rest of their body continued to grow. The question of whether the critical period idea or the sensitive period idea is more correct boils down to whether this stuckness can be overcome, in full or in part, in the child's later life.

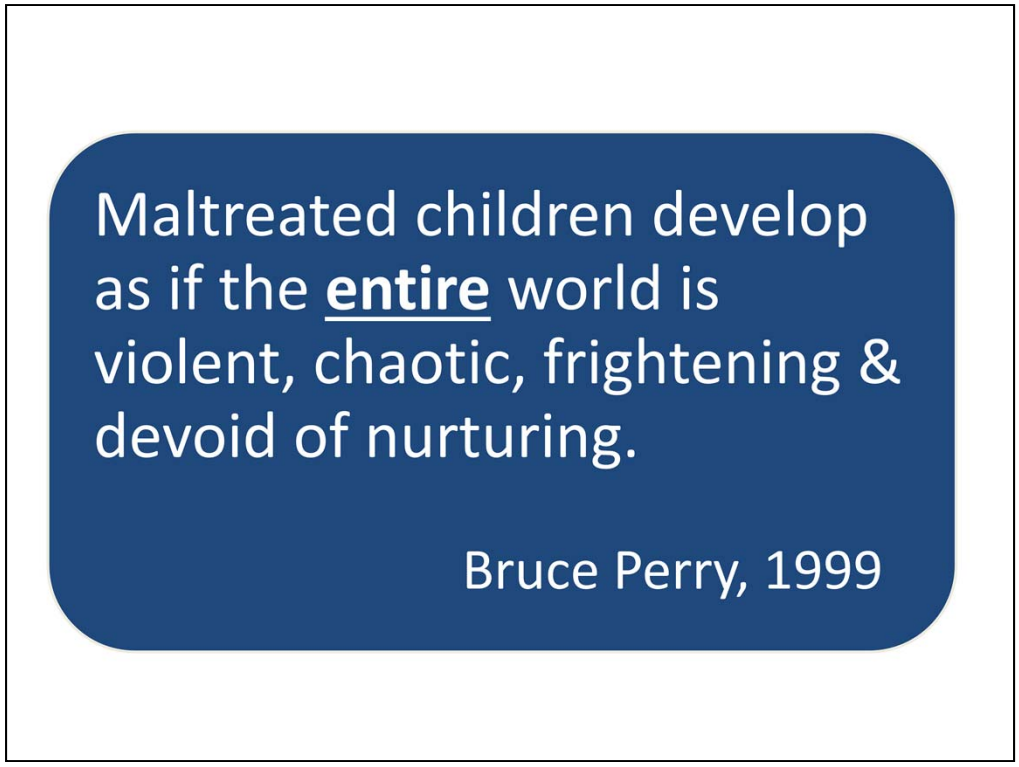
Theorists who support sensitive periods believe that while it will be far more difficult for the child and the child's teachers and caregivers to learn what was not learned during the window of opportunity, these children can still develop the missing capacities and skills later that they did not develop earlier. While some children do seem to get stuck permanently, there is evidence to support the sensitive period idea as well. Some children born in the same understaffed orphanages who are later adopted do go on to learn to love, to trust, and to show affection to their family and friends. In these situations, the families have to have extreme patience and perseverance as they nurture these older children because they are not going to be able to learn that trust and love as fast and as easily as infants.

Ozark Guidance, 2007



Sharks sense blood in water, dogs hear very high pitched sounds, bears detect scents from miles away, geese navigate thousand mile migrations somehow sensing magnetic fields of the earth, hawks see the movement of prey from hundreds of feet in the air and snakes "sense" body heat. Each of these unique capabilities is mediated by the animal's brain. Their brain's capacities to sense, process and act are designed to help keep them alive – to find food, to avoid threat, to procreate and keep the species going. It is, in many regards, the same for us. We need a brain to keep our species going. Without the unique properties of the brain, humankind would have long ago become extinct. Our brain helps keep us alive and thriving while we develop. And then, once mature, our brain allows us to create, protect, nurture and teach the next generation. Our brain is designed to help us survive, procreate and become caregivers.

Bruce Perry



The brain development that occurs in maltreated children is to help them survive. This adaptive response is effective in a threatening environment, but can be seen as problematic in non-threatening situations such as school.

A child raised with chaos and unpredictability will develop neural systems and functional capabilities that reflect this disorganization. Maltreated children develop as if the entire world in chaotic, unpredictable, violent, frightening and devoid of nurturing.

"States become Traits"- the persistence of hyperarousal or dissociation changes the brain chemistry.

"State-dependent storage and recall. In a state of fear, lower areas of the brain are in control. Children in a state of persisting arousal will have a difficult time storing and retrieving information from higher cortical areas."

Bruce Perry

Brain Function "mirrors" developmental experience…

Unpredictable or excessive stress	leads to…	Hyper vigilant, hyper-reactive stress-response systems.
Chaotic Environment	leads to…	Poor sensory integration, processing dysfunctions, cognitive delays
Emotional Neglect	leads to…	Problems in attachment, intimacy, affect regulation
Physical Abuse…	leads to…	Impulsivity, anxiety, cognitive distortions, aggression

Children who have been traumatized have emotional and state memories indelible burned into their brainstem and midbrain.

All experience is translated into chemical signals; these chemicals can activate or shut off genes.

Brain function "mirrors" developmental experience…

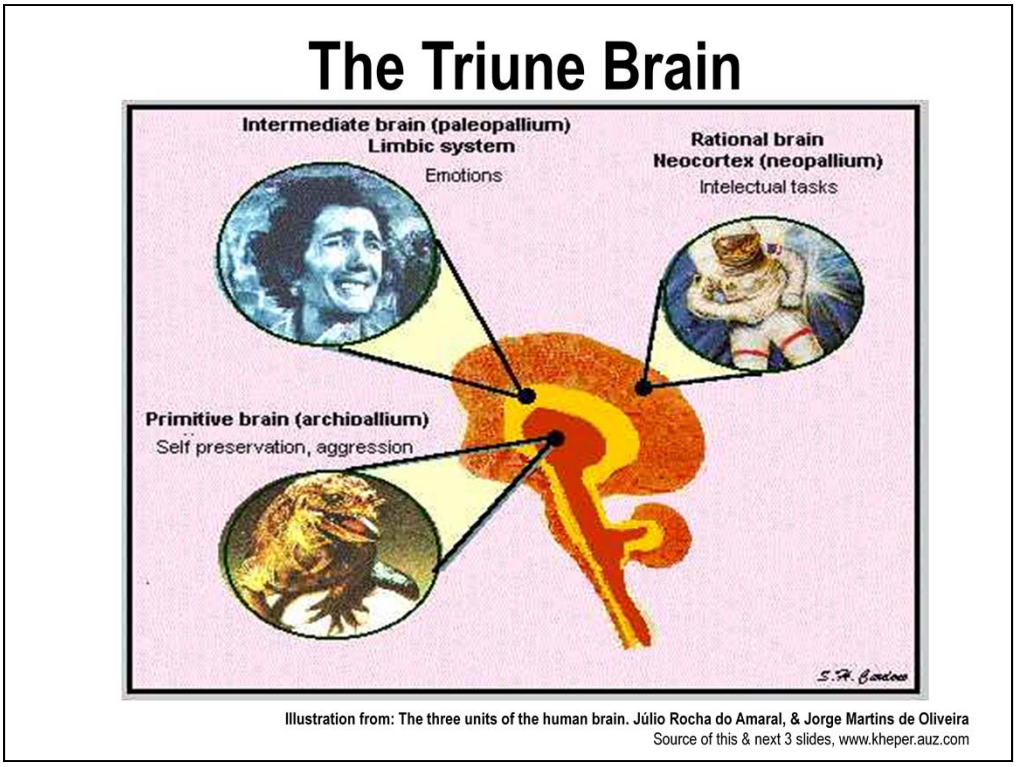


Illustration from: The three units of the human brain. Júlio Rocha do Amaral, & Jorge Martins de Oliveira
Source of this & next 3 slides, www.kheper.auz.com

The neurologist Paul MacLean has proposed that our skull holds not one brain, but three, each representing a distinct evolutionary stratum that has formed upon the older layer before it, like an archaeological site. He calls it the "Triune Brain."

MacLean says that the three brains operate like three interconnected biological computers, each with its own special intelligence, its own subjectivity, its own sense of time and space and its own memory. He refers to these three brains as the Neo-Cortex or neo-mammalian brain of the frontal lobes of the cerebrum; the Limbic or paleo-mammalian system of the mid-brain and thalamus; and the Reptilian brain - the brainstem and cerebellum. Each of the three brains is connected by nerves to the other two, but each seems to operate to some extent independently, as its own brain system with distinct capacities. Note: only humans have significant frontal lobes, which play a key role in many thinking processes that distinguish human beings from other animals. The frontal lobes are particularly important for abstract thinking, for imagining the likely consequences of actions, and for understanding another person's feelings or motives. Injury or abnormal development of the frontal lobes can result in the loss of these abilities.

This hypothesis has become a very influential paradigm, which has forced a rethink of how the brain functions. It had previously been assumed that the highest level of the brain, the neo-cortex, dominates the remaining lower levels. MacLean has shown that this is not the case, and that the physically lower limbic system, which rules emotions, can hijack the higher mental functions when it is aroused by an appropriate stimulus.

Mind Development

Reptilian Brain. The primitive brain, includes the brain stem & the cerebellum. In animals such as reptiles, the brain stem & cerebellum dominate. It is rigid, obsessive, compulsive, ritualistic & paranoid, it is "filled with ancestral memories". It keeps repeating the same behaviors over & over again, never learning from past mistakes. This brain controls muscles, balance & autonomic functions, such as breathing & heartbeat. This part of the brain is active, even in deep sleep.

Limbic System. The limbic system appears to be the primary seat of emotion, attention & affective memories. Physiologically, it includes the the *hypothalamus, hippocampus* & *amygdala*. It has vast interconnections with the neocortex, so that brain functions are not either purely limbic or purely cortical but a mixture of both. The Limbic system is the biological basis for the tendency of thinking to be subordinate to feeling. The limbic system tends to be the seat of our value judgments, instead of the more advanced neocortex. It decides whether our higher brain has a "good" idea or not, whether it feels true & right.

Neocortex. MacLean refers to the cortex as "the mother of invention & father of abstract thought". In man, the neocortex takes up 2/3 of the total brain mass. Although other animals have a neocortex, it is relatively small, with few or no folds (indicating surface area, complexity & development). A mouse without a cortex can act in a fairly normal way, whereas a human without a cortex is a vegetable. The cortex is divided into left & right hemispheres. The right brain is more spatial, abstract, musical & artistic, while the left is more linear, rational, & verbal.

Arousal—Male

Norepenephrine—Adrenaline

Fight/flight
Increased ❤ rate
Avoidance
Sleep difficulties
Difficulty concentrating
Increased startle
Anxiety
Impulsive
Irritable

Hyperactive
Aggression

When a child is exposed to chronic, traumatic stress, his brain sensitizes the pathways for the fear response and literally creates memories such that his fear response becomes almost automatic; he doesn't really think about it. This is called a state of "hyper-arousal." His brain has adapted to a world that is unpredictable and dangerous; it is hyper-vigilant, focused on non-verbal cues that may be threatening (Perry, 1996). The regions of the brain involved in the hyper-arousal response are always "on," and because of this, the child may frequently experience hyperactivity, anxiety, impulsivity, and sleep problems (Perry, Pollard, Blakely, Baker & Vigilante, 1995). Hyper-arousal is most common in older children and in males (Perry, Pollard, Blakely, Baker & Vigilante, 1995). In the state of hyper-arousal, similar to Post Traumatic Stress Disorder (PTSD), the brain's alarm system becomes particularly sensitive to "threatening" environmental cues, and the child may respond anxiously or aggressively. The regions of the brain involved in the hyperarousal response become re-activated when the child is exposed to a reminder of the earlier trauma (such as thinking or dreaming about it), to perceived threats (which may not seem threatening to others), and sometimes to generalized reminders (signals) (Perry, Pollard, Blakely, Baker & Vigilante, 1995). Perry (1997) presents an example of an 8-year-old boy who became extremely agitated—sobbing and hysterical —when the staff at his group home refused to cut up his hot dog before he ate it. The child had been sexually abused by his father and other men. Foods such as hot dogs, bananas, and popsicles evoked his brain's fear response, and until the "signal" was removed or altered, his brain experienced it as a threat. Another example is that of a child who had committed an impulsive, violent act and explained it by saying "I could tell he was going to jump me—he looked me in the eyes" (Perry, 1997, p. 6). In his mind, his brain, the simple act of looking him in the eye was perceived as a threat that required a defensive response. Not only may children in a state of hyperarousal react anxiously or aggressively to perceived threats, they may actually provoke threatening behavior from others in order to have some control over it. Predictability of threat is important (Perry, 1997). Children who have been victims of unpredictable physical or sexual abuse learn (consciously or unconsciously) that if abuse is going to happen, it is better to control when it happens. They may engage in aggressive, provocative behavior to elicit a predictable response (Perry, 1997).

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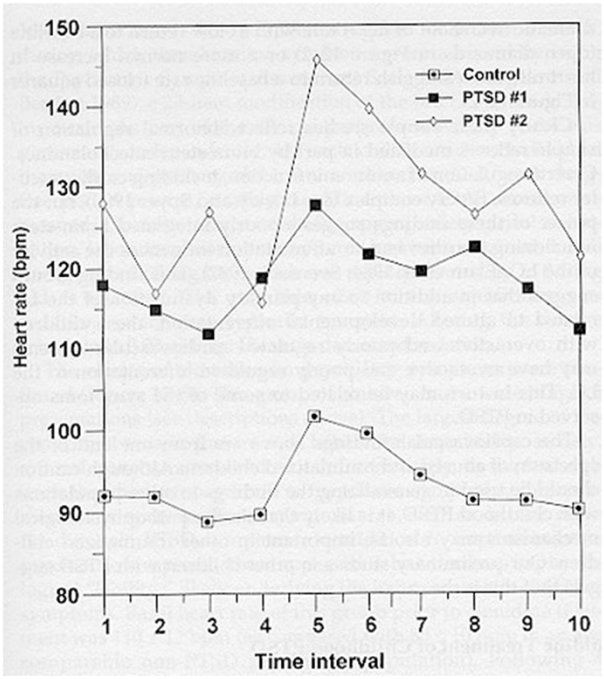

Heart rate changes following orthostatic challenge in children with PTSD. Examples of the two major patterns of change in heart rate observed in children with severe chronic PTSD. Heart rate was monitored each 2 minutes for 20 minutes. During the first 4 time intervals children were resting quietly in a supine position; after 9 minutes (4.5 time intervals) children stood up and remained standing for the duration of the challenge period. A control pattern is illustrated by the open squares (non-PTSD, psychiatric disordered child, age 11.4). The two PTSD patterns are generally described by higher than control basal rate and 1) a dramatic overshoot of heart rate with a slow return to a baseline (closed squares) or 2) a more normal increase in heart rate but a sluggish return to a baseline rate (closed diamonds).

Bruce Perry

Dissociation—Female

Opiates/Dopamine

a stressed individual passively disengages in order "to conserve energies...to foster survival by the risky posture of feigning death, to allow healing of wounds and restitution of depleted resources by immobility" Powles, 1992

Detachment
Numb
Restricted affect
Dysphoria
Daydreams
Psuedomaturity

Sense of foreshortened future
Over-compliance
Somatic complaints
Low ❤ rate
Regression

While hyper-arousal is more common in older children and males, dissociation is more common in younger children and in females—children who often feel or are immobile or powerless (Perry, Pollard, Blakely, Baker & Vigilante, 1995). Dissociation is characterized by first attempting to bring caretakers to help, and if this is unsuccessful, becoming motionless (freezing) and compliant and eventually dissociating; this is often called the "surrender" response (Perry, Pollard, Blakely, Baker & Vigilante, 1995). People describe children in a dissociative state as numb, non-reactive, or "acting like they aren't there." Just as children in a state of hyper-arousal have sensitized neural pathways controlling their response to a threatening environment, children in a state of dissociation have sensitized neural pathways that elicit a different response. A child in a dissociative state, when presented with a threat, may "freeze," both physically and cognitively (Perry, Pollard, Blakely, Baker & Vigilante, 1995). When an adult asks or tells them to do something, they don't respond. If the adult becomes angry and more threatening, the child becomes even more anxious and moves further into full dissociation (Perry, Pollard, Blakely, Baker & Vigilante, 1995).

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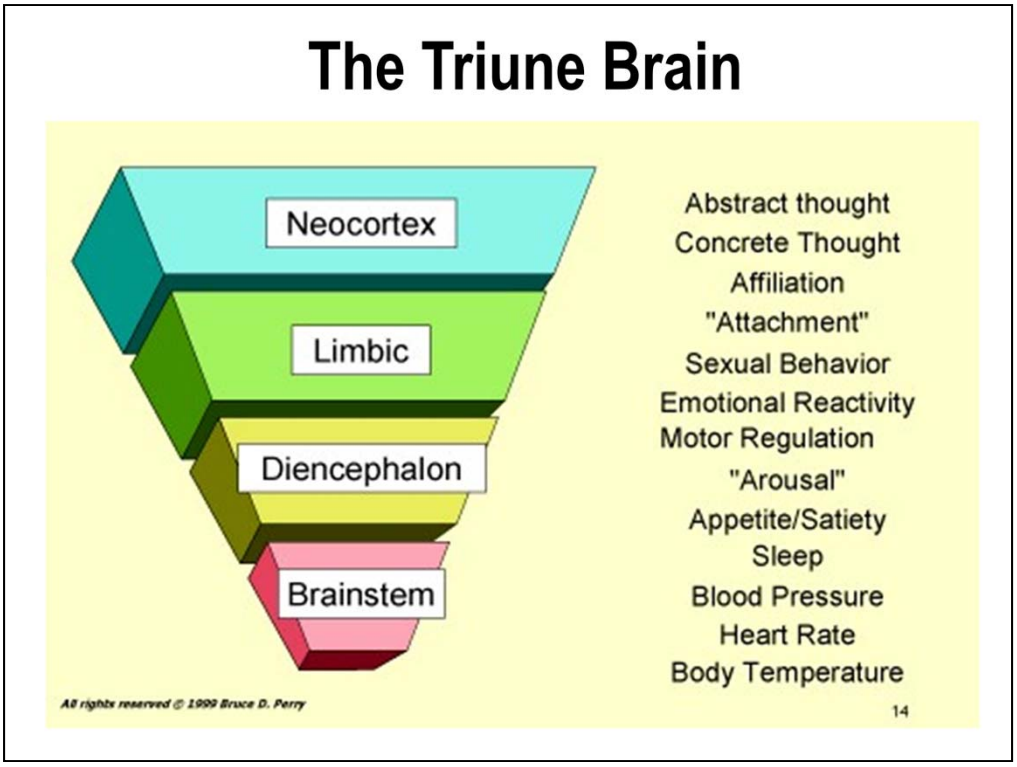
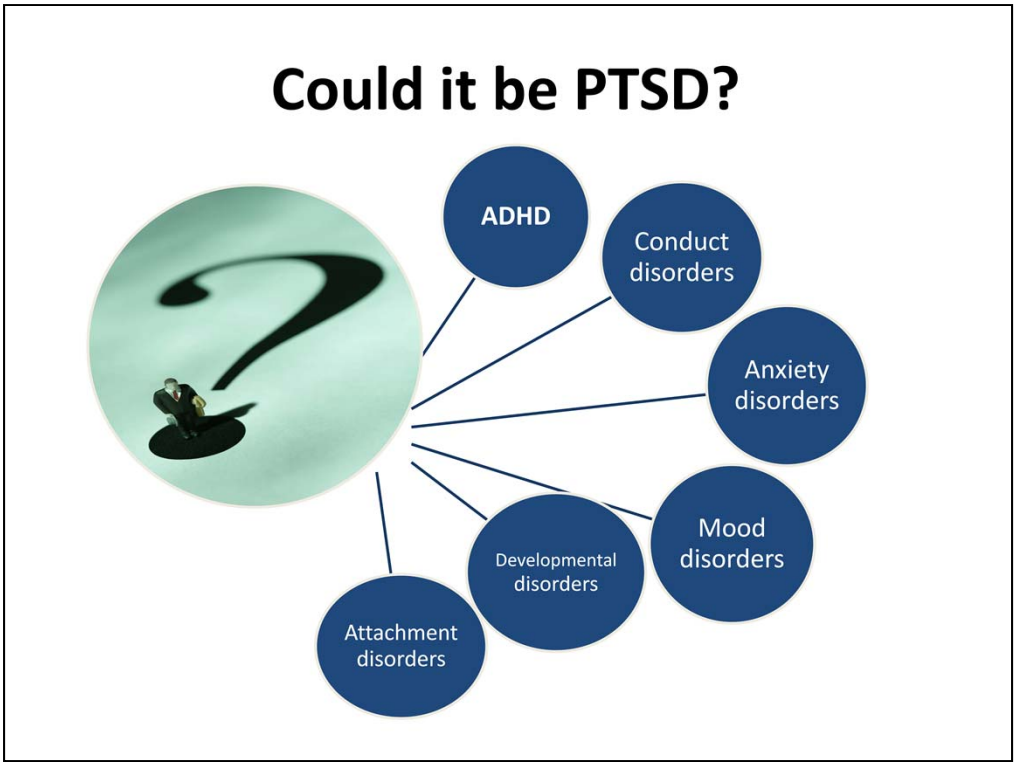


The brain can be divided into four interconnected areas: brainstem, diencephalons, limbic and neocortex. The complexity of structure, cellular organization and function increases from the lower, simpler areas such as the brainstem to the most complex, the neocortex.



Fear is necessary to our basic survival. We must be able to detect threats and respond. Indeed, the brain is uniquely designed to sense, process, and store threatening information and to mobilize the body in response to threats. All parts of the brain and body are used in this response. "This total neurobiological participation in the threat response is important in understanding how a traumatic experience can impact and alter functioning in such a pervasive fashion" (Perry, 1999, p.3). Chronic stress or repeated traumas can result in a number of biological reactions. Neurochemical systems are affected which can cause a cascade of changes in attention, impulse control, sleep, and fine motor control (Perry, 2000a; 2000c). Chronic activation of certain parts of the brain involved in the fear response (such as the hypothalamic-pituitary-adrenal [HPA] axis) can "wear out" other parts of the brain such as the hippocampus, which is involved in cognition and memory (Perry, 2000c). Early experiences of trauma can also interfere with the development of the subcortical and limbic systems which can result in extreme anxiety, depression, and difficulty forming attachments to other people (Shore, 1997). And chronic activation of the neural pathways involved in the fear response can create permanent "memories" which shape the child's perception of and response to his environment. While this adaptation may be necessary for survival in a hostile world, it can become a way of life that is difficult to change, even if the environment improves.

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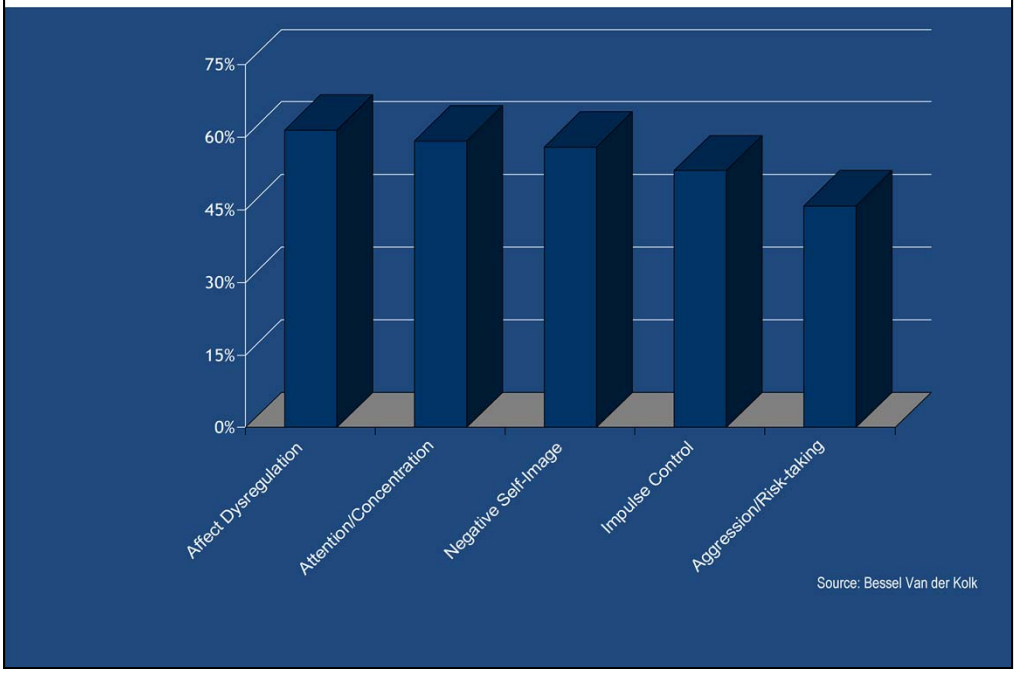
Prevalence of Psychiatric Disorders in Sample of 204 Physically and Sexually Abused Children

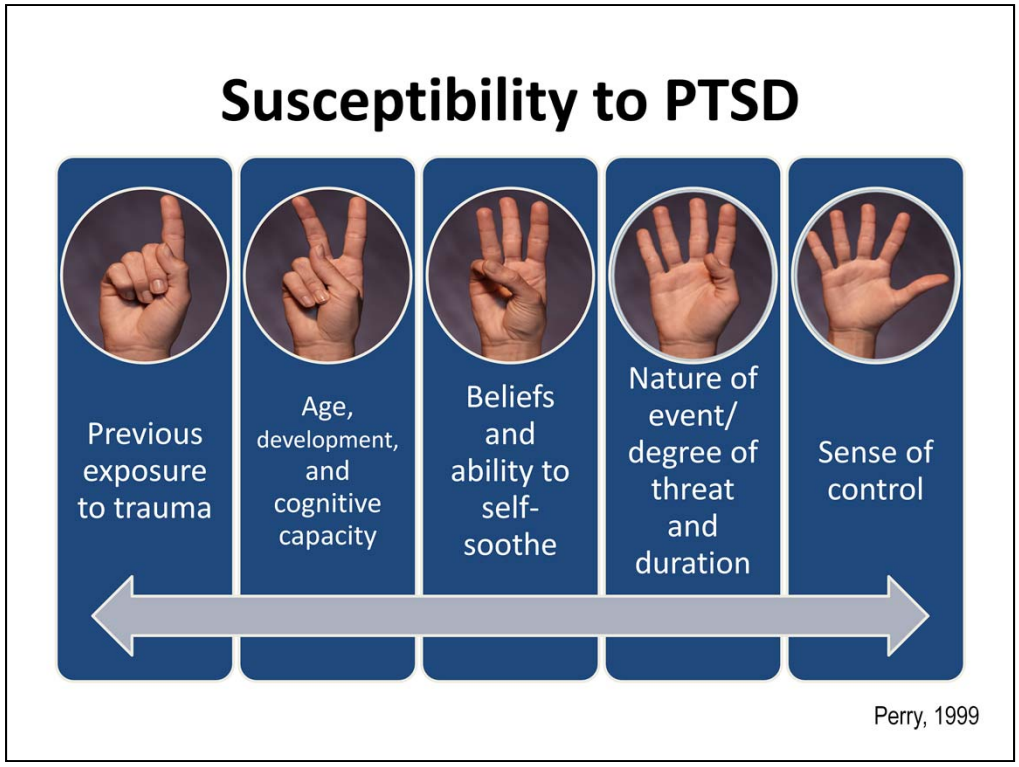
		ABUSE GROUPS					
	Total	Boys	Girls	Boys	Girls	Boys	Girls
Diagnoses	%	%	%	%	%	%	%
Separation Anxiety/Overanx	59	44	58	48	100	59	79
Oppositional Defiant Disorde	36	46	22	56	20	64	47
Phobic	36	44	36	24	30	25	58
PTSD	34	20	35	18	50	58	53
ADHD	29	40	22	36	10	67	26
Conduct Disorder	21	44	11	21	10	67	21
Dysthymia	19	16	13	24	20	17	42
Obsessive-Compulsive	14	0	14	18	20	8	27
Major Depression	13	12	11	12	20	8	32
Avoidant	10	12	7	18	30	8	0
Bipolar Disorders	9	4	9	9	20	0	21
		Sexual (N=127)		Physical (N=43)		Both (N=34)	

Source: Ackerman et al. "Prevalence of Post Traumatic Stress Disorder and Other Psychiatric Diagnoses in Three Groups of Abused Children (Sexual, Physical, and Both)." *Child Abuse and Neglect,* 1998, Vol. 22, No. 8.

While PTSD can be co-morbid with other diagnoses (both diagnoses exist at same time), many "disorders" or diagnoses might be better viewed as symptoms of PTSD rather than distinct disorders. For instance, children with PTSD who present with a conduct disorder is so common in boys with traumatic histories, it is very likely an expression of PTSD.

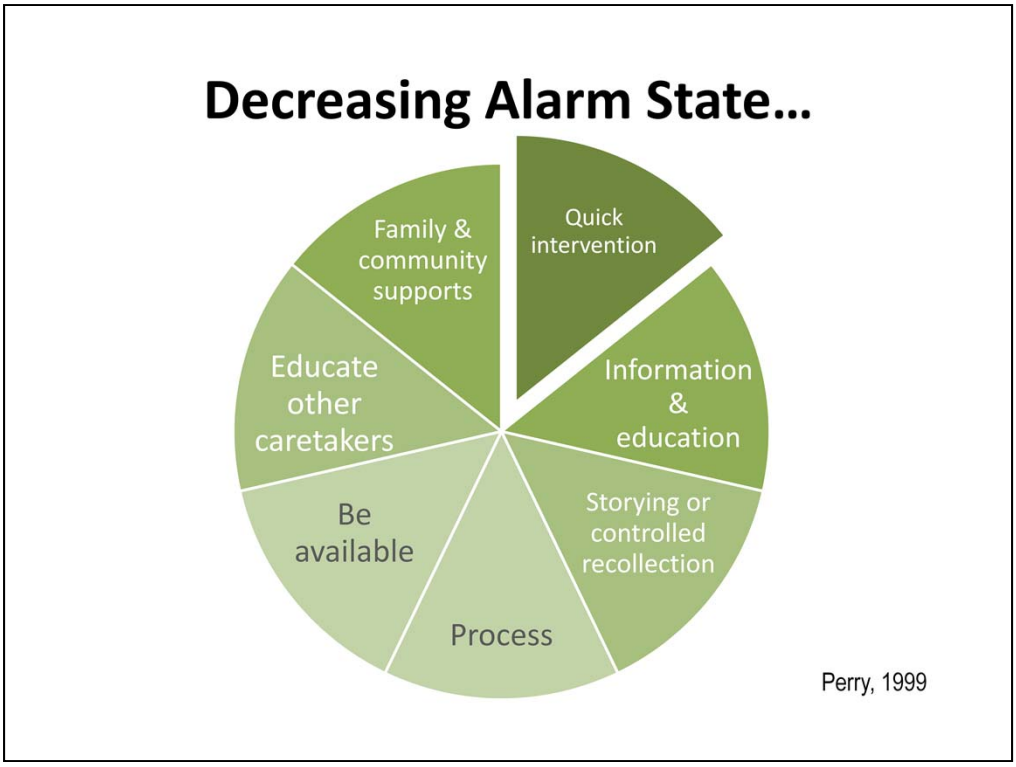
Complex Posttraumatic Sequelae: Most Frequent Difficulties





Children exposed to various traumatic events have much higher incidence (from 15 to 90+ %) and prevalence rates than the general population (Pfefferbaum. 1997). Furthermore, the younger a child is the more vulnerable they appear to be for the development of trauma-related symptoms. The percentage of children developing PTSD following a traumatic event is significantly higher than the percentage of adults developing PTSD following a similar traumatic stress. Several studies published in 1998 confirm previous reports of high prevalence rates for PTSD in child and adolescent populations. Thirty five percent of a sample of adolescents diagnosed with cancer met criteria for lifetime PTSD (Pelcovitz, Kaplan, Goldenberg, Mandel, Lehane, & Guarrera. 1994); 15 % of children surviving cancer had moderate to severe PTSS (Stuber, Kazak, Meeske, et al. 1997); 93 % of a sample of children witnessing domestic violence had PTSD (Kilpatrick & Williams. 1998); over 80 % of the Kuwaiti children exposed to the violence of the Gulf Crisis had PTSS (Hadi & Llabre. 1998); 73 % of juvenile male rape victims develop PTSD (Ruchkin, Eisemann, & Hagglof. 1998); 34 % of a sample of children experiencing sexual or physical abuse and 58 % of children experiencing both physical and sexual abuse all met criteria for PTSD (Ackerman, Newton, McPHerson, Jones, & Dykman. 1998). In all of these studies, clinically significant symptoms, though not full PTSD, were observed in essentially all of the children or adolescents following the traumatic experiences.

Bruce Perry



Many children who have suffered abuse and neglect are removed from their homes by the child welfare system for their safety. These children may be temporarily cared for by extended family, foster parents, or group home staff, and some will be adopted. While many caregivers have an innate sense about how to raise children, familiarity with the effects of maltreatment on brain development and the possible manifestations of those effects are not likely to be "common knowledge." It is important for caregivers to have realistic expectations for the children in their care. 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. They may also be displaying unusual and/or difficult coping behaviors. For example, abused or neglected children may:

Be unable to control their emotions and have frequent outbursts

Be quiet and submissive

Have difficulties learning in school

Have difficulties getting along with siblings or classmates

Have unusual eating or sleeping behaviors

Attempt to provoke fights or solicit sexual experiences

Be socially or emotionally inappropriate for their age

Be unresponsive to affection.

"It is easy for foster parents to become confused, frustrated, and sometimes devastated from the lack of response and reciprocity to the love, affection, attention, and care they offer" (Comfort, 1997, p. 29). Even caregivers with the best of intentions can misunderstand a child's behavior, fashion their response based on that misunderstanding, and then wonder why their response was not effective.

To be more effective in their roles, caregivers who serve abused and neglected children could benefit from training and support related to the effects of maltreatment on early brain development. Understanding some basic information about the neurobiology underlying many challenging behaviors may help caregivers shape their responses more effectively. But while a general understanding is helpful, foster parents and other caregivers need to know the history of their particular foster children's experiences in order to tailor their approaches (Comfort, 1997). They may need to develop some special skills to cope with the children's special needs. In general, children who have been abused or neglected need nurturance, stability, predictability, understanding, and support (Committee on Early Childhood, Adoption and Dependent Care, 2000). They may need frequent, repeated experiences of these kinds to begin altering their view of the world from one that is uncaring or hostile to one that is caring and supportive. Until that view begins to take hold in the child's mind, the child may not be able to truly engage in a positive relationship. And the longer the child lived in the abusive or neglectful

environment, the harder it will be to convince his brain that his world can change. But one thing we have learned from research is that environment does make a difference. Consistent nurturing from caregivers who receive training and support may offer the best hope for the children who need it most. Child Welfare Information Gateway

Memory

Implicit

Early, present at birth
Mental models
Not consciously recalled
Behavioral, emotional memory
Focal attention not required
Repeated activation strengthens potential for future activation

Siegel, 1999

The “organizing framework” for children’s development is based on the creation of “memories.” When repeated experiences strengthen a neuronal pathway, the pathway becomes “sensitized,” and, at some point, it becomes a memory. Memories are an indelible impression of the world (Perry, 1999); they are the way in which the brain stores information for easy retrieval. There are different types of memories, such as motor, cognitive, and emotional memories. Memories help us to navigate our world without having to really think about it (Perry, 1999). Children learn to put one foot in front of the other to walk. They learn words to express themselves. And they learn that a smile usually brings a smile in return. At some point, they no longer have to think much about these processes—their brains manage these experiences with little effort because the memories that have been created allow for a smooth, efficient flow of information. The creation of memories is part of our adaptation to our environment. Our brains attempt to understand the world around us and fashion our interactions with that world in a way that promotes our survival and, hopefully, our growth. But if the early environment is abusive or neglectful, our brains will create memories of these experiences that may adversely color our view of the world throughout our life.

Child Welfare Information Gateway

Explicit

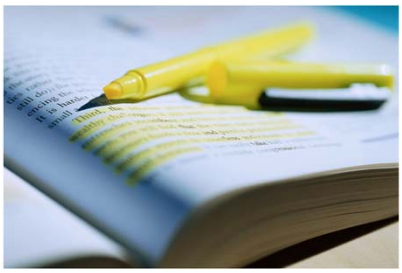
Later memory

Semantic: Develops by 2 years of age

Autobiographical: Progressive after 2nd year

Requires conscious awareness for encoding

Cortical consolidation selects events for storage in permanent memory



Siegel, 1999

Explicit (declarative) memory:

The term "declarative memory" has been used for this kind of memory, because you can talk about what you remember: you can declare it.

a. Episodic memory: memory of your personal history, of when and where you encountered someone, learned that there is no Santa Claus, etc.

b. Semantic memory: your general knowledge, including word meanings, knowledge of science, history, facts about yourself and others that are not specific memories of a particular experience.

Mary C. Potter

Attachment & the Brain

It is theorized that attachment processes are particularly mediated by the right brain.

Siegel offered an example of an attuned interaction. "Imagine that an 11-month-old baby is excited about having just gotten up. She is cruising along the side of a table, her face filled with glee, and says "Aaaawwww!' The parent's attuned response would be "Wow!" reflecting the same crescendo and decrescendo, the same profile of energy."

Extrapolating from animal research, and from an ever-growing body of brain imaging studies on humans, Schore locates these attunement interactions in the infant's right orbitofrontal cortex and contends that they are essential to its synaptic development. Schore conceptualizes psychobiological attunement as "direct right brain to right brain communication" in which the mother's right brain, "involved in the unconscious expression and processing of emotional information," serves as a template for the infant's developing neural circuitry (Schore, 1997).

These attachment experiences occur at the same time that the neonatal brain is undergoing a growth spurt. Brain researchers Greenough and Black (1992) first described a model of the brain's "experience-dependent synaptogenesis" in which there is a surge of metabolic activity--an over-proliferation of synapses. Regardless of genetic encoding, synapses that fail to form connections die off in a process of pruning. Schore contends that abuse, neglect and chronic states of misattunement lead to an overpruning of synapses in the right orbitofrontal cortex, leaving individuals with impaired ability to modulate and regulate emotion in response to stress.

By regulating affect, the caregiver is also regulating the release of neurohormones in the infant's brain. High levels of cortisol, a stress hormone that may well be released in the brain during states of distress, has been shown in some animal studies to destroy synapses.

In the inevitable event of distress states in the infant, the caregiver's moving in to repair the connection and comfort the infant reduces the levels of cortisol and related stress hormones. As a result, the frontal cortex develops a greater concentration of glucocorticoid receptors that can modulate stress responses (Schore, 1996).

When there is no interactive repair; when the caregiver is abusive, neglectful or continually misattuned, infants may remain in chronically negative states, their corticosteroid levels chronically elevated. This results in a reduction in the number of synapses, even the death of neurons, according to Schore's hypothesis.

Deborah A. Lott

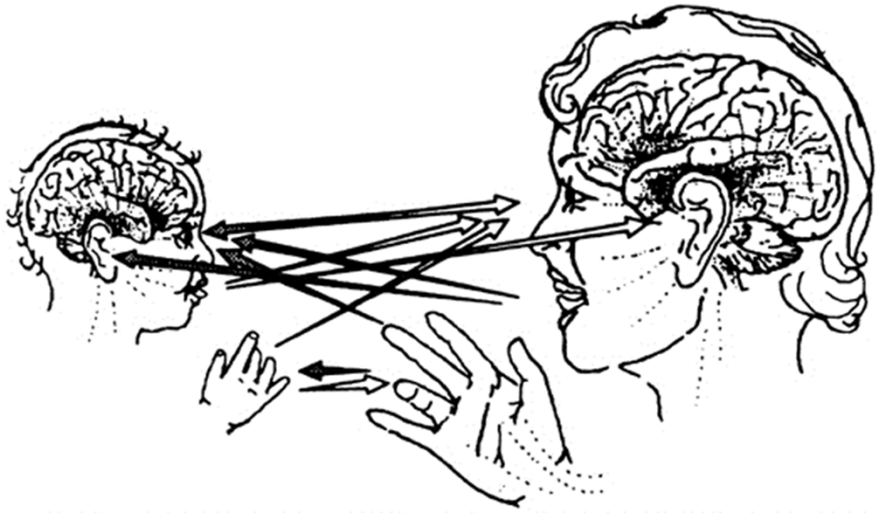


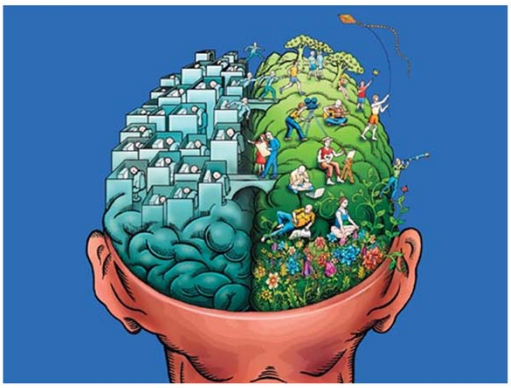
FIGURE 1. Brain–brain interactions during face-to-face communications of proto-conversation, mediated by eye-to-eye orientations, vocalizations, hand gestures, and movements of the arms and head, all acting in coordination to express interpersonal awareness and emotions. Adapted from Aitken & Trevarthen (1993) and used with permission of Cambridge University Press.

Attachment is a multi-sensory process (Perry refers to it as a "somatasensory bath"). The integration of multiple messages (non-verbal and verbal) allow the brain to integrate attachment messages into a coherent whole. Daniel Seigel (2000) postulates that unintegrated attachment experiences lead to a host of problems with the attachment, or regulatory, system.

Hemispheric Specialties

Left

Linear
Logical
Linguistic
Syllogistic reasoning (cause & effect)
Right vs. wrong



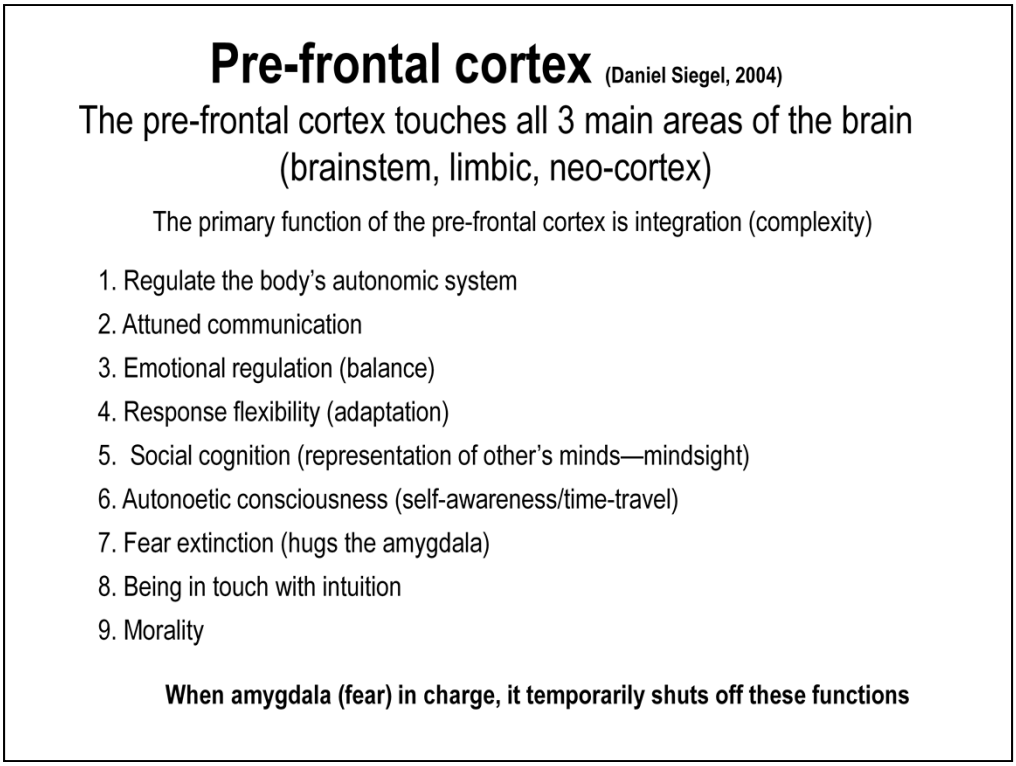
Right

Non-linear
Holistic
Visuo-spatial
Autobiographical information
Non-verbal signals
Awareness
Social Cognition
Mindsight

However, it is a myth that people are primarily "right-brained" or "left-brained". Most activities require an integration of both sides for full function.

In a study of adolescents, Teicher et al. (1997) recently found abnormal EEG readings in the frontotemporal or anterior regions in 42.9% of those with a history of psychological abuse, 54.4% of those with physical/sexual abuse, and 71.9% of the subsample with serious physical/sexual abuse, as compared to 26.9% of patients with no abuse. Early abuse was associated with left hemisphere abnormalities and a reversed left/right hemisphere asymmetry, causing Teicher to hypothesize that early abuse exerted a deleterious effect on left cortical and hippocampal development, and impeded hemispheric integration and the establishment of left cortical dominance.

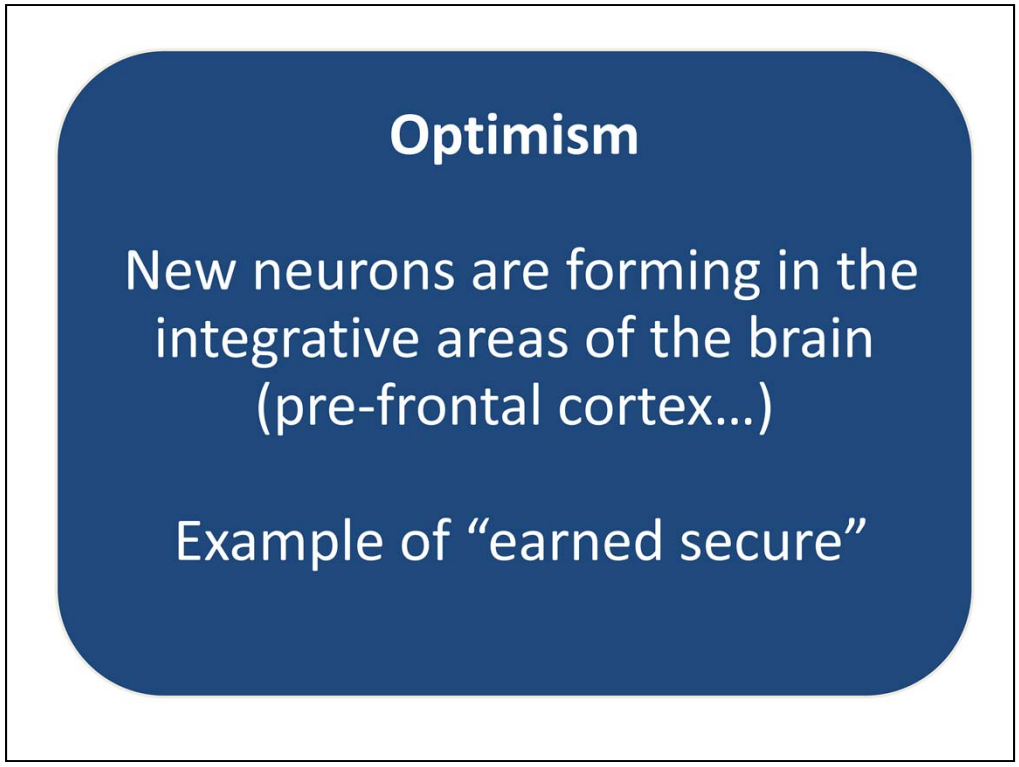
Deborah A. Lott



This prefrontal region comes to act in the capacity of an executive control function for the entire right cortex, the hemisphere that modulates affect, nonverbal communication and unconscious processes ... . In this manner, the child's first relationship, the one with the mother, acts as a template for the imprinting of circuits in the child's emotion-processing right brain, thereby permanently shaping the individual's adaptive or maladaptive capacities to enter into all later emotional relationships .... Indeed, the right brain is thought to contain the essential elements of the self system (Mesulam and Geschwind, 1978; Schore, 1994). The mother's face--particularly her eyes--is the most potent stimulus in the infant's environment. Schore quotes studies by Hoffman (1987) and Panksepp, et al (1985), which show that interactive mutual gazes between the mother and her infant trigger high levels of endogenous opiates in the child's growing brain. These findings are related to Schore's Regulation Theory, which emphasizes that attachment is essentially the right brain regulation of biological synchronicity between organisms. ... the infant's psychobiological response to trauma is comprised of two separate response patterns, hyperarousal and dissociation ... In the initial stage of threat an alarm reaction is initiated, in which the sympathetic component of the ANS is suddenly and significantly activated, resulting in increased heart rate, blood pressure, and respiration. Distress is expressed in crying and then screaming ... This state of fear-terror is mediated by sympathetic hyperarousal, and it reflects increased levels of the major stress hormone corticotrophin releasing factor, which in turn regulates noradrenaline and adrenaline activity .... But a second, later-forming, longer-lasting traumatic reaction is seen in dissociation, in which the child disengages from stimuli in the external world and attends to an "internal" world .... Traumatized infants are observed to be staring off into space with a glazed look. This parasympathetic dominant state of conservation-withdrawal occurs in helpless and hopeless stressful situations in which the individual becomes inhibited and strives to avoid attention in order to become "unseen." ... This primary regulatory process for maintaining

organismic homeostasis ... is characterized by a metabolic shutdown ... and low levels of activity .... It is used throughout the lifespan when the stressed individual disengages in order "to conserve energies ... to foster survival by the risky posture of feigning death, to allow healing of wounds and restitution of depleted resources by immobility" (Powles, 1992, p 213).

Milton Richlin, PhD



If attachment experiences shape the circuitry of the brain and faulty circuitry leaves individuals vulnerable to later emotional dysregulation, what evidence is there for neuronal plasticity once the critical period has passed? And if plasticity remains, which psychotherapeutic interventions stand the best odds of growing new synapses?

As both psychotherapists and integrative thinkers, Siegel and Schore have come to some tentative assumptions. In general, the research suggests that "talking therapy" must do more than talk if the problem is in areas of the right brain unresponsive to verbal interventions. Schore believes that particularly when there is a therapeutic rupture, a misattunement with the therapist, the patient may move into a highly emotional state where the right brain becomes dominant. "What will get through is tone of voice, demeanor, facial expressions and a sense of empathy that is rooted in the early psychobiological attunement between mother and infant," says Schore.

For Siegel, aligning with the patient's state--direct right-brain to right-brain communication--and then expressing that affective state in fairly straightforward terms can be helpful to many patients. "I find myself saying things that I would never consciously think of saying like ‘Oh, that was too much.' These sorts of clarifying and attuned statements of feeling emerge unconsciously and can be the most helpful." Of course, right-brain to right-brain communication alone does not constitute psychotherapy. For Siegel, co-constructing a more linear narrative that integrates left- and right-brain functions is also essential.

Deborah A. Lott

Changing the Brain

The brain changes only with use…

In order for the brain to change, the experience needs to be consistent, patterned, sequential, specific & long-term. The older the child is, the longer it will take to make changes. And some things might never fully change, thus we teach them how to navigate & negotiate those tendencies or areas of limitation.

The brain's plasticity (ability to change) increases with complexity. Therefore the higher levels of the brain are easier to change than the lower levels.
The higher areas are also the "integrative" areas.

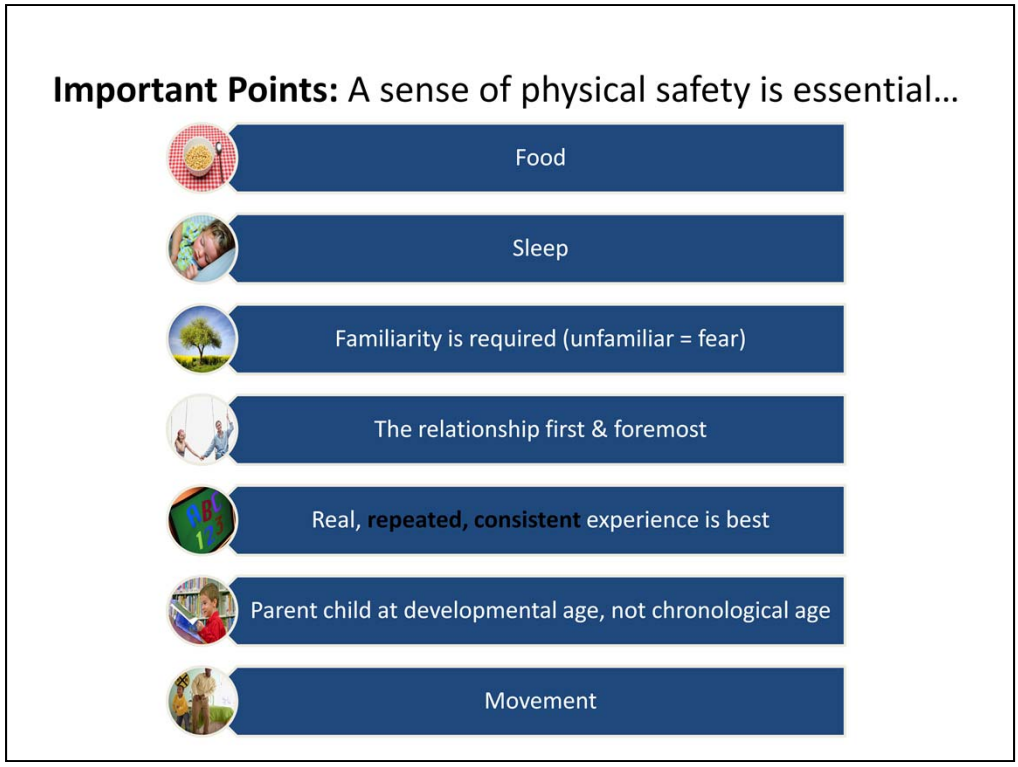
Bruce Perry, MD PhD

Brain Functionality is "State Dependent"

Primary Secondary Brain Areas	Neocortex Subcortex	Subcortex Limbic	Limbic Midbrain	Midbrain Brainstem	Brainstem Autonomic
Cognition	Abstract	Concrete	Emotional	Reactive	Reflex
Mental State	CALM	AROUSAL	ALARM	FEAR	TERROR
Sense of Time	Extended Future	Days Hours	Hours Minutes	Minutes Seconds	Loss of sense of time
Sphere of concern	World	Community	Family	Self	Body Integrity

Imagine yourself in the corner of a dark room trying to see a dim flickering light at the other end of the room. Although you would probably perceive the light most of the time, you may occasionally make mistakes. We will, of course, blame our brains for our imperfect performance. However, the reason why we sometimes make errors, even in the simplest tasks, could stand behind a fundamental principle of neuronal information processing. The brain is not a passive camera-like device that records every event in the environment, but is an active device interpreting rather than simply reporting external events. Understanding this interpretative act requires knowledge about what happens in the brain in the absence of stimulation. Indeed, the brain is never at rest. Even in the absence of sensory inputs, brain cells spontaneously fire electrical impulses to make neuronal networks wander through different states. It is these intrinsic fluctuations that filter our perception of the world to make us see things differently depending on the brain's internal context. For instance, if a stimulus is presented at the 'wrong' time, when neuronal fluctuations are very large, the stimulus may not be distinguished from internal noise, hence it will most likely go unnoticed.

University of Texas Health Science Center, Houston, Texas
Principal Investigator: Valentin Dragoi,



“Among fourth-grade students, those having the lowest amount of protein in their diet had the lowest achievement scores." (*School Board Food Service Research Review*, 1989)

"Children who suffer from poor nutrition during the brain's most formative years score much lower on tests of vocabulary, reading comprehension, arithmetic and general knowledge." (*Scientific American*, 1996)

"Teachers reported higher levels of hyperactivity, absenteeism and tardiness among hungry/at risk children than not hungry children." (*Journal of American Academic Child Adolescence Psychiatry*, 1998)

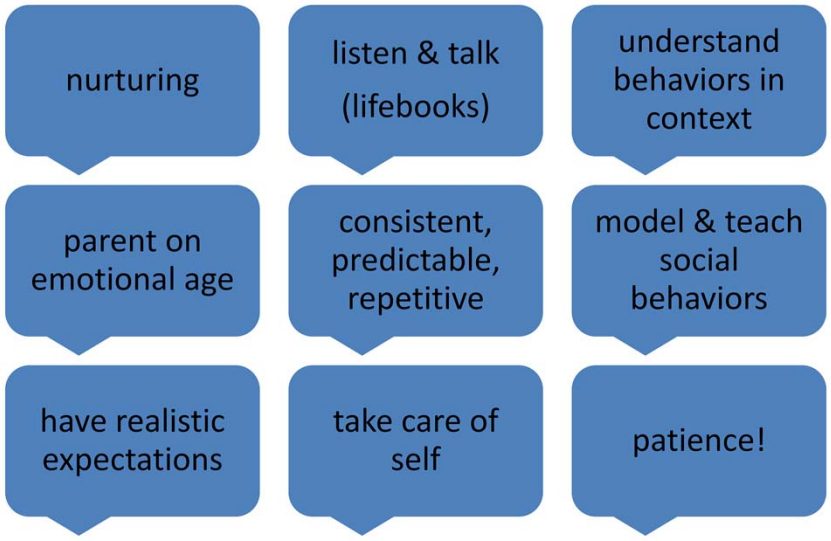
"Six months after the start of the free school breakfast programs, students who decreased their nutritional risk showed significantly greater improvements in attendance and school breakfast participation, decreases in hunger, and improvements in math grades and behavior ... ." (*Annals of Nutrition Metabolism*, 2002)

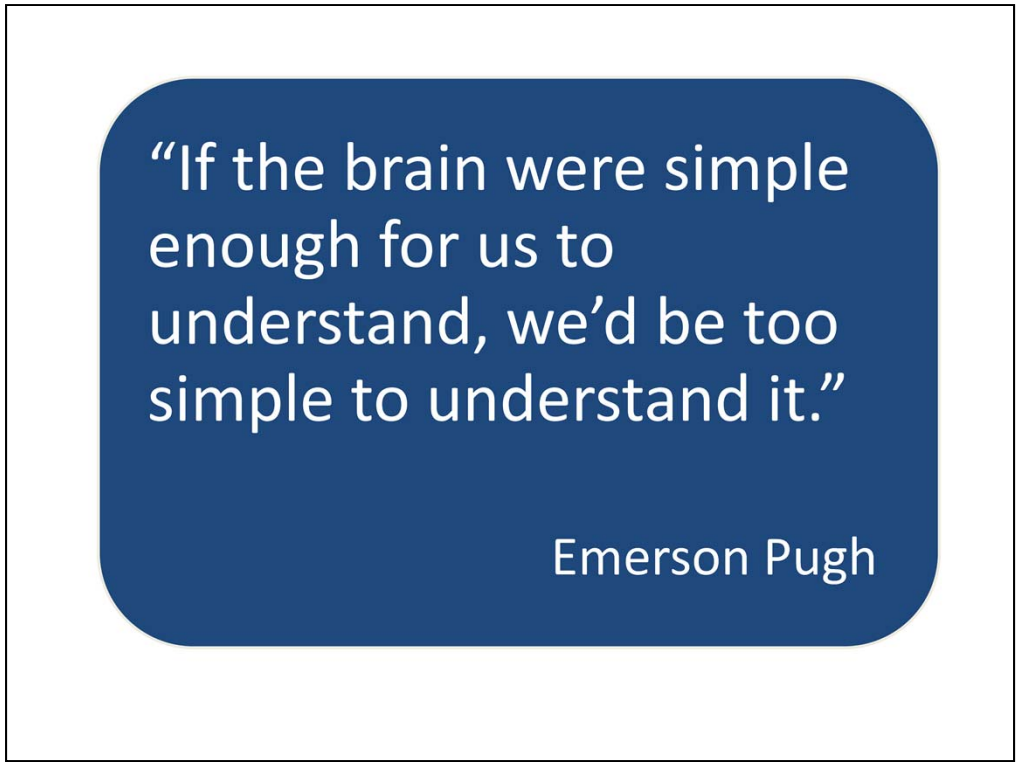
“A Northwestern University study of 500 preschoolers found that those who slept less than 10 hours in a 24-hour period (including daytime naps) were 25% more likely to misbehave. They were consistently at greatest risk for "acting out" behavioral problems, such as aggression and oppositional or noncompliant behavior. Research shows that sleep disturbances in children are not only associated with medical problems (allergies, ear infections, hearing problems), but also with psychiatric and social issues. Children who were aggressive, anxious, or depressed had more trouble falling and staying asleep. Although sleep problems usually decline as children get older, these early patterns are the best indicator of future sleep troubles.” (fi.edu)

"Snoring should always be considered a problem, since snoring indicates the presence of increased upper airway resistance during sleep," says Dr. David Gozal, a researcher at the University of Louisville. Gozal and his colleague Dennis W. Pope Jr. interviewed more than 1,500 middle-school students. About 13% of those ranking in the bottom quarter of their class reported loud and frequent snoring in early childhood, compared to only 5% in the top quarter. Half the loud snorers lived with adults who smoked. The disordered breathing – and disrupted sleep – associated with snoring can lead to attention-deficits and hyperactivity, asthma and allergies, as well as aggression, the investigators found. Because these problems can adversely affect academic performance, snoring can be considered a serious threat to a child's intellectual potential. "These findings suggest that children who experienced sleep-disordered breathing during a period traditionally associated with major brain growth and substantial acquisition of cognitive and intellectual capabilities may suffer from a partially irreversible compromise of their. . . potential for academic achievement," reported the researchers.Gozal believes

"that the presence of frequent and loud snoring in children who also demonstrate behavioral problems, learning problems, bedwetting, or failure to thrive, should prompt referral to a primary care physician and strong consideration of an evaluation by a pediatric sleep specialist.“ (fi.edu)

Dr. Perry's advice…





Charlie Rose interviewed Susan Hockfield, the president of MIT. Prior to going to MIT, she was a noted neuro-scientist at Yale with a special focus on the development of the brain. As Charlie probed how and why she had given up her love of the laboratory for the challenges of administration, you could see that her intense curiosity in the brain still burned strong. At one point toward the end of the interview Charlie asked her what ‘big’ question she most wanted an answer to. After a brief pause to gather her thoughts she mused:

“I would love to know — I would love to know — how the brain, given the relatively small number of genes in the human genome, how do they, time after time, person after person, elaborate an organ [that] is as complex as the brain with such fidelity.” And then with sheer amazement in her voice, “what — what are the rules? How does this work? The complexity far exceeds anything we can calculate based on anything we know about the human genome.”
Kenn Hermann (In Awe of the Brain’s Complexity)