CHAPTER 3

Applying Principles of Neurodevelopment to Clinical Work with Maltreated and Traumatized Children

The Neurosequential Model of Therapeutics

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This chapter examines therapeutic work with maltreated children from a neurodevelopmental perspective. The overarching premises of this perspective are that an awareness of human brain development and functioning provides practical insights into the origins of the abnormal functioning seen following adverse developmental experiences (e.g., abuse, neglect, and trauma), and, furthermore, that an understanding of how neural systems change suggests specific therapeutic interventions.

This overview of the key principles related to human brain organization, function, and development provides the rationale for a specific process of assessment, staffing, and intervention that my colleagues and I call the "Neurosequential Model of Therapeutics" (NMT). During the last 20 years, our interdisciplinary group has been involved in the evaluation and treatment of more than 2,500 children ranging from infants to young adults. Most of these children were in the child protective system (CPS), whereas some were in the juvenile justice system, but all of them were traumatized or maltreated in some fashion. The NMT has been used by the ChildTrauma Academy and its clinical partners in various forms for the last 10 years. Most recently, this model has been most systematically implemented and evaluated by Rick Gaskill and his team at a therapeutic preschool program in Kansas, in collaboration with the ChildTrauma Academy (Barfield &, 2004; Barfield & Gaskill, 2005).

Prior to this, our work with maltreated and traumatized children, at least half of whom were in the CPS system, was primarily a medical model. We evaluated and treated children when they were brought to our clinic in a tertiary care academic setting. We conducted evaluations and provided conventional psychopharmacological, individual, group, and family therapies. We had limited success: Some children improved dramatically; most had minor to moderate improvement in primary neuropsychiatric symptoms (e.g., symptoms of posttraumatic stress disorder); and far too many truly did not get better. In parallel with our clinical work, our group was conducting research on the neurodevelopmental impact of trauma and neglect on the developing child. Over time, it became clear that our conventional medical model was essentially ignoring fundamental principles of neurodevelopment, which we now feel are essential to both understanding and helping traumatized or maltreated children and youth in an optimal fashion.

The present chapter is an overview of these principles; it is not a comprehensive description of the specifics of the assessment, staffing, and intervention components of the NMT. Interested readers are encouraged to learn more about the neurodevelopmental rationale and specific implementation of this approach elsewhere (Perry, Pollard, Blakely, Baker, & Vigilante, 1995; Perry & Pollard, 1998; Perry, 1999; Perry, Dobson, Schick, & Runyan, 2000).

CONTEXT: A DESCRIPTION OF THE PROBLEM

We live in strange times. Modern Western society has benefited from advances in technology, communications, transportation, social justice, and economy beyond the dreams of our ancestors. And yet our society seems to be incapable of ensuring that our children grow up in safe, predictable, relationally enriched, and humane environments. Hundreds of thousands of children each year in the United States are terrorized, abused, neglected, or otherwise maltreated in some fashion. Children growing up in chaos, neglect, and threat do not have the fundamental developmental experiences required to express their underlying genetic potential to self-regulate, relate, communicate, and think. These children are undersocialized and at great risk for emotional, behavioral, social, cognitive, and physical health problems. The costs are incalculable (Franey, Geffner, & Falconer, 2001). How can we truly measure the lost potential of millions of children, let alone the astounding economic burdens caused by the needs for special education, therapy, probation, and jail? How "advanced" is our society when we have to create governmental agencies—with budgets in the billions each year—whose primary responsibility is protecting children from their parents?

It is a sad reality that all of our best efforts—all of our governmental programs, our not-for-profits, our public and private institutions, our CPS, and our education, mental health, and juvenile justice systems—fail these highest-risk children. We recreate the chaos, fragmentation, trauma, and neglect these children have experienced in their homes. We fail maltreated children in many ways, not the least of which is an appalling lack of effective therapeutic services for these children. Most of these children have limited access to therapeutic services. Those who do get therapy get too little, too late; how can we possibly expect 45 minutes a week with a therapist to heal a child after 10 years of chaos, threat, humiliation, degradation, and terror?

THE IMPACT OF CHILDHOOD TRAUMA AND MALTREATMENT

Chaos, threat, traumatic stress, abuse, and neglect are bad for children. These adverse experiences alter a developing child's brain in ways that result in enduring emotional, behavioral, cognitive, social, and physical problems. Hundreds of studies in several fields (e.g., child welfare, education, developmental psychology, psychiatry) have documented various aspects of the negative impact of developmental trauma and other adverse childhood experiences (Perry & Pollard, 1998; Bremner & Vermetten, 2001; Read, Perry, Moskowitz, & Connolly, 2001; Teicher, Andersen, Polcari, Anderson, & Navalta, 2002; De Bellis & Thomas, 2003; Bremner, 2003; Anda et al., in press). All of these negative effects are caused by alterations in various neural systems in the brain. Simply stated, traumatic and neglectful experiences during childhood cause abnormal organization and function of important neural systems in the brain, compromising the functional capacities mediated by these systems.

A key question arises: If adverse experiences alter the developing brain and result in negative functional effects, can therapeutic experiences change the brain in ways that allow healing, recovery, and restoration of healthy function? The short answer is yes. The longer answer is also yes, but the nature, pattern, timing, and duration of the therapeutic experiences are very crucial in determining whether a "therapy" is genuinely therapeutic or just an expensive salve for a guilty and indifferent public. Much of what ends up being therapeutic is not in the context of conventional therapy, and much of what we do in conventional therapies is not therapeutic. Matching the correct therapeutic activities to the specific developmental stage and physiological needs of a maltreated or traumatized child is a key to success. Unfortunately, it is very difficult to do this within a conventional medical model. The majority of children who have been traumatized or maltreated do not get the therapeutic services required to help them heal and develop in optimal ways.

There are many reasons for this—not the least of which is that far too many of our intervention models have been developed in ignorance of fundamental principles of neurodevelopment and neurobiology. The primary assumption of the NMT is that the human brain is the organ that mediates all emotional, behavioral, social, motor, and neurophysiological functioning. Therefore, therapeutic interventions seek to change a person by changing the person's brain. Without an appreciation of how the brain is organized and how it changes, therapeutic interventions are likely to be inefficient or, sadly, ineffective. The following section discusses several of the key principles that provide the neurobiological rationale for the NMT.

KEY PRINCIPLES OF NEURODEVELOPMENT AND NEUROBIOLOGY

PRINCIPLE 1. The brain is organized in a hierarchical fashion, such that all incoming sensory input first enters the lower parts of the brain.

The human brain is comprised of billions of neurons and glial cells. These billions of cell divide, move, specialize, connect, interact, and organize during development into a hierarchical group of structures (Figure 3.1). The more simple regulatory functions (e.g., regulation of respiration, heart rate, blood pressure, body temperature) are mediated by the "lower" parts of the brain (the brainstem and diencephalon), and the most complex functions (e.g., language and abstract thinking) are mediated by its most complex cortical structures. Chains of interconnected neurons—neural networks—communicate and interact both within and across these structures, thereby allowing a remarkable range of functions.

The human brain is continually sensing, processing, storing, perceiving and acting in response to information from both the external and internal environments. The five senses of the human body transform forms of energy from the external world into the patterned activity of sensory neurons. The neural patterns of activity created by sensory input first come into the brain separately: Visual input comes into one group of nuclei, auditory another, olfactory another, and so on. The first "stops" for primary sensory input both from the outside environment (e.g., light, sound, taste, touch, smell) and from inside the body (e.g., glucose levels, temperature) are the "lower," regulatory areas of the brain—the brainstem and diencephalon, which are incapable of conscious perception. As this primary sensory input is further processed, these signals are sent to sensory association areas; images, sounds, scents, and touches co-occurring

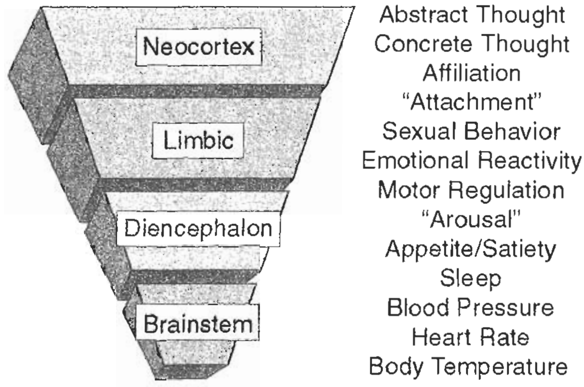

FIGURE 3.1. Hierarchy of brain function. The human brain is organized from the most simple (e.g., fewest cells–brainstem) to most complex (e.g., most cells and most synapses–frontal cortex). The various functions of the brain, from the most simple and reflexive (e.g., regulation of body temperature) to the most complex (e.g., abstract thought), are mediated in parallel with these various areas. These areas organize during development and change in the mature brain in a "use-dependent" fashion. The more a certain neural system is activated, the more it will "build in" this neural state–creating an internal representation of the experience corresponding to this neural activation. This use-dependent capacity to make internal representations of the external or internal world is the basis for learning and memory.

in time become connected. This remarkable biological gift of making associations–the capacity to connect patterns of neural activity that co-occur in time–is what allows us to create a complex, seamless, and dynamic internal representation of the world from a set of separate sensory inputs.

As these waves of neural activity move up the brain into the higher, more complex areas (e.g., limbic and cortical), these patterns of neural activity are matched against previously stored patterns of activation (i.e., stored memories: see Perry, 1999). If a pattern is novel or associated with previous threat (e.g., the pattern of neural activity created by a sudden loud noise), an initial alarm response begins. The internal state of arousal begins to shift, moving along the arousal continuum (see Figure 3.2 and Perry, 1999, 2001). This alarm system activation begins a wave of neuronal activity in key brainstem and diencephalic nuclei, which include neurons containing a variety of neurotransmitters (e.g., norepinephrine, dopamine, and serotonin), neuromodulators, and neuropeptides (e.g. adrenocorticotropic hormone, endorphins, corticotropin-releasing factor, and vasopressin).

Potential threat thus initiates a cascade of patterned neuronal activity in these primitive areas of the brain, which moves up to more complex

Ages	30 ←15	15 ←8	8 ←3	3 ←1	1 ←0
Develop-mental Stage	Adult / Adolescent	Adolescent / Child	Child / Toddler	Toddler / Infant	Infant / Newborn
Primary/ *Secondary* Brain Areas	Neocortex / *Subcortex*	Subcortex / *Limbic*	Limbic / *Midbrain*	Midbrain / *Brainstem*	Brainstem / *Autonomic*
Cognition	Abstract	Concrete	"Emotional"	Reactive	Reflexive
Mental State	Calm	Arousal	Alarm	Fear	Terror

FIGURE 3.2. State-dependent shifts in level of developmental functioning with shifts down the arousal continuum. When threatened, a child is likely to act in an "immature" fashion. Regression, a retreat to a less mature style of functioning and behavior, is commonly observed in all of us when we are physically ill, sleep-deprived, hungry, fatigued, or threatened. As we regress in response to the real or perceived threat, our behaviors are mediated (primarily) by less complex brain areas. If a child has been raised in an environment of persisting threat, the child will have an altered baseline, such that the internal state of calm is rarely obtained (or only artificially obtained via alcohol or drugs). In addition, the traumatized child will have a highly sensitized alarm response, overreading verbal and nonverbal cues as threatening. This increased reactivity will result in dramatic changes in behavior in the face of seemingly minor provocative cues.

Children exposed to significant threat will "reset" their baseline state of arousal, such that even at baseline—when no external threats or demands are present—they will be in a physiological state of persisting alarm. As external stressors are introduced (e.g., a complicated task at school, a disagreement with a peer), the traumatized child will become more reactive, moving into a state of fear or terror in the presence of even minor stressors. The child's cognition and behavior will reflect his or her state of arousal. This increased baseline level of arousal, and increased reactivity in response to a perceived threat, play a major role in the behavioral and cognitive problems exhibited by traumatized children.

parts of the brain. In addition to sending these signals to higher parts of the brain, this cascade of threat-responsive activity initiates a set of brainstem and midbrain responses to the new information from the environment, allowing the individual to react in a near-reflexive fashion. In many instances, the brain's responses to incoming sensory information will take place well before the signals can get to the higher, cortical parts of the brain, where they are "interpreted."

At each level of the brain, as the incoming input is "interpreted" and matched against previous similar patterns of activation, a response is initiated (see Figure 3.3). The brain responds to the potential threat. This immediate response capability is very important for rapid response to potentially threatening sensory signals; classic examples of this include the immediate motor action of withdrawal of a finger after being burned, and the jump that takes place following an unexpected loud sound (startle

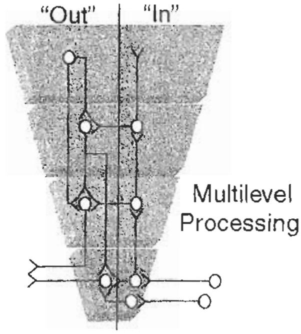

FIGURE 3.3. Precortical association and sequential processing. All incoming sensory information first enters the central nervous system at the level of the spinal cord or brainstem. This means that the first places where patterns of activation are matched against previously stored templates are these lower, more primitive areas. Indeed, the spinal cord and brainstem may process and act on incoming information before the integrated and interpreted signals even get up to the cortex (e.g., reflex withdrawal of a finger from fire).

response). Clearly, in order for the brain to react in this immediate, "uninterpreted" fashion, the more primitive portions of the brain (i.e., the brainstem and the midbrain) must store previous patterns of sensory neuronal input that are associated with threat. In other words, there must be "state" memories—memories of previous patterns of sensory input that were connected with bad experiences. This explains why a child who was sexually abused in early life by the mother's paramour will have an automatic threat reaction later to a friendly touch on the shoulder by a male math teacher.

It is important to understand that *this alarm activation can occur even before complete processing and interpretation of the information.* Activation of these key systems results in patterns of neuronal activation that move from the brainstem through the diencephalon to the thalamic, limbic, and cortical areas. At the level of the brainstem and midbrain, there is very little subjective perception. It is at the level of the thalamus and the limbic areas that the actual affective sensation of fear arises. Only after communication with cortical areas is the individual able to make the more complex cognitive associations that allow interpretation of this internal state of anxiety.

Clinical Implications. The clinical implications of this first neurodevelopmental principle. The brain's remarkable capacity to make associations between patterns of neural activity that co-occur in time is the origin of many trauma-related symptoms. The cue-specific increases in physiological reactivity, distress, fear, and other symptoms are due to the brain's making associations between incoming sensory signals that occurred during the traumatic experiences. A young child growing up in a home with pervasive threat, for example, will create a set of associations–primarily precortical and therefore out of his or her conscious awareness–between a host of neutral cues and threat. For the rest of the child's life, these neutral cues will have the capacity to activate a fear response and therefore to alter emotions, behaviors, and physiology (see Figure 3.2). These fear-inducing cues can range from expressions (e.g., eye contact can become associated with impending threat), to scents (e.g., an abusive father's after-shave), to music, to styles of interpersonal interaction. Among the saddest examples of this occurs when the primary caregiver–the source of food, warmth, comfort, and love for the dependent infant and child–is also the source of episodic, unpredictable threat, rage, and pain. The disorganized attachment that results can impair healthy relational interactions for a lifetime. Again, many if not most of the resulting dysfunctional relational interactions will be beyond the awareness and understanding of the developing child, youth, or adult.

These precortical associations can profoundly interfere with therapeutic work. When a child, youth, or adult is in a high state of fearful arousal, his or her brain will process and function differently (see Figures 3.2 and 3.4). During therapy or in school, if any emotionally charged content is present, the person's state will shift. If this shift is dramatic enough, the person will essentially be so anxious and regressed that his or her functioning will be "brainstem-driven." The individual will think and act in very primitive ways, and therefore will be less accessible to academic or therapeutic interventions using words or therapeutic relationships as the mutative agents of change.

Transference and countertransference are also related to this neurobiological principle. In order to break these inaccurate and false associations, the client must have opportunities for new experiences that will allow the brain either to break false associations or to decrease the overgeneralization of trauma-related associations. For example, the associations in the brain of a girl abused by one male may have generalized to all males. In order to modify this overgeneralization, this child will require many positive experiences with nonabusing males.

PRINCIPLE 2. Neurons and neural systems are designed to change in a "use-dependent" fashion.

Neurons are uniquely designed to change in response to activity. Neural stimulation or lack of stimulation will result in cellular modification; synapses, axons, cell bodies, and dendrites can all be shaped and altered by activity. Therefore, neural networks change in a "use-

Adaptive response	Rest	Vigilance	Freeze	Flight	Fight
Predictable deescalating behaviors *(behaviors of the teacher or caregiver when a child is in various states of arousal)*	Presence Quiet Rocking	Quiet voice Eye contact Confidence Clear, simple directives	Slow, sure physical touch "Invited" touch Quiet, melodic words Singing, humming music	Presence Quiet Confidence Disengagement	Appropriate physical restraint Withdrawal from class TIME!
Predictable escalating behaviors *(behaviors of the teacher or caregiver when a child is in various states of arousal)*	Talking Poking Noise Television	Frustration, anxiety Communicating from distance without eye contact Complex, compound directives Ultimatums	Raised voice Raised hand Shaking finger Tone of voice, yelling, threats Chaos in class	Increased or continued frustration More yelling Chaos Sense of fear	Inappropriate physical restraint Grabbing Shaking Screaming
Regulating brain region	Neocortex Cortex	Cortex Limbic	Limbic Midbrain	Midbrain Brainstem	Brainstem Autonomic
Cognition	Abstract	Concrete	Emotional	Reactive	Reflexive
State	Calm	Arousal Attention	Alarm	Fear	Terror

FIGURE 3.4. Altered functioning with change in state of arousal. As a child experiences some degree of perceived threat, he or she will move along this arousal continuum from a state of calm to a state of terror. In different states of arousal, different parts of the brain become the predominant areas of control. The styles of thinking and of behavioral functioning change. This chart gives some indication of the kinds of interactions between a teacher, clinician, or caregiver and with a traumatized or maltreated child that can influence movement along the arousal continuum. One of the major mistakes we make with maltreated children is misunderstanding their internal states. When these children are in a state of fear, we think they are in a state of attention and capable of understanding our directives—for instance, "Take out the garbage, and then take your backpack upstairs to your room." The children process our simple directives inaccurately, because of the fearful state they are in. When they forget one part of this compound command, we raise our voices and issue an ultimatum: "How many times do I have to tell you? If you don't do what I ask, you will not have any TV this week." The children's fear escalates, and they begin to act in a more hostile, inappropriate, and immature way. We ourselves get confused and frustrated, and can easily escalate the child further; the result may be a full-blown flight or fight reaction.

Knowing where a child is on the arousal continuum—accurately knowing the child's internal state—can help us determine when to talk, and when to stop talking and start using simple, nonthreatening, nonverbal interactions to quiet and contain the escalating child.

dependent" fashion. As the brain is developing, normal organization of any brain area or capability is "use-dependent." If the developing child is spoken to, the neural systems mediating speech and language will receive the sufficient stimulation to organize and function normally. A child who does not hear words will not have this capacity expressed. This is true for any part of the developing brain: All functional capacities in the brain are dependent to some degree upon the presence of appropriately timed, appropriately patterned signals that will specifically stimulate the neural systems mediating that function. Normal motor organization requires the opportunity to crawl, stand, cruise, walk, and run; normal socioemotional development requires attentive, attuned caregiving and a rich array of relational opportunities during development; and so forth. Healthy organization of neural networks depends upon the pattern, frequency, and timing of key experiences during development. Patterned, repetitive activity changes the brain. Chaotic, episodic experiences that are "out of sync" with a child's developmental stage create chaotic, developmentally delayed dysfunctional organization.

Clinical Implications. A child exposed to consistent, predictable, nurturing, and enriched experiences will develop neurobiological capabilities that will increase the child's chance for health, happiness, productivity and creativity. Conversely, neglect, chaotic, and terrorizing environments will increase a child's risk for significant problems in all domains of functioning. The specific symptoms or physical signs a child develops following maltreatment or trauma will reflect the history of neural activation—or, in the case of neglect, the history of inactivation. Neuropsychiatric symptoms and signs present in maltreated or traumatized children are related to the nature, timing, pattern, and duration of their developmental experiences—both adverse and protective.

As the brain organizes and changes as a reflection of the pattern, nature and intensity of experience, fear and chaos, for example, will result in persistent, repeated activation of the stress response systems in the brain. The neurotransmitter networks (including epinephrine, norepinephrine, dopamine, and serotonin) involved in both major patterns of stress responses (the hyperarousal and dissociative responses; see Perry et al., 1995) originate in the lower parts of the brain—the brainstem and diencephalon—and send axonal connections throughout the rest of the brain. This allows these important systems to orchestrate and regulate a host of brain functions important to surviving challenges and overt threat. When these neural networks are altered by chronic stress or extreme traumatic stress, a whole cascade of brain areas and the functions these areas mediate are altered as well. The results are use-dependent alterations in these systems; they become sensitized, overreactive, and dysfunctional. Development threat, then, creates a *persisting* fear state (i.e., the state becomes a "trait"). The specific sets of maladaptive emotional, behavioral, and cognitive problems of a maltreated child are rooted in the original *adaptive* responses to a traumatic event. These symptoms may include hypervigilance, impulsivity, anxiety, affect regulation problems, sleep problems, and a host of other abnormalities related to dysfunctional stress response neural networks and the neurotransmitter systems in these networks (see Perry et al., 1995; De Bellis & Thomas, 2003; Bremner, 2003).

If a child is neglected—if he or she hears fewer words, has fewer relational opportunities, receives less physical comfort, and has less love—the rapidly organizing networks in the brain that mediate language, social affiliation, and attachment will not receive sufficient patterned, repetitive activation to develop normally. The result is a neglect-related set of deficits. The deficit will be in the domains where the neglect occurred (see Perry, 2002a; Smith & Fong, 2004).

The therapeutic implications of this second neurodevelopmental principle cannot be overstated. Repetition, repetition, repetition: Neural systems—and children—change with repetition. Furthermore, the repetition must be in those very neural systems that mediate the symptoms; Parts of the brain cannot be changed if they are not activated. Herein lies a problem with much conventional psychotherapy used with maltreated children. The original fear response will activate systems that are widely distributed in the brain: The threat response neural systems originate in the brainstem and send projections to (and thereby influence) diencephalic, limbic, and cortical functioning. Trauma-related symptoms originate in the lower parts of the brain. Therefore, therapeutic interventions that seek to influence trauma-related symptoms must influence the brainstem. Due to the orchestrating and communicating roles of the brainstem's stress response neural systems, any efforts to treat symptoms related to higher parts of the brain without first regulating the brainstem will be inefficient or unsuccessful.

A primary therapeutic implication for this is the repetitive nature of the replacement experiences that are required to help neglected children recapture normal functioning. If fundamental organizing experiences are missed when key brain areas are organizing, the number of repetitions required to learn or develop any capability is often so frustratingly high that adoptive parents, teachers, and clinicians become discouraged. Neglected children can change; however, the process is long, and it requires patience and an understanding of development. It is often true that these children age but do not develop. Therefore, the replacement (therapeutic) experiences required must be developmentally appropriate, but not completely age-inappropriate. This is a major challenge as these children get older.

Children with fundamental attachment problems due to early childhood neglect need many, many positive nurturing interactions with trustworthy peers, teachers, and caregivers. Unfortunately, the very pathology related to their neglect makes it difficult for them to engage in and benefit from relational interactions even when there are caring adults present. In some cases, beginning the recovery process for relational neglect can start with animals. Dogs have the capacity to provide the unconditional accepting and repetitive nurturing experiences required to help some of these children.

Children with brainstem-mediated hypervigilance, impulsivity, and anxiety require patterned, repetitive brainstem activities to begin to regulate and organize these brainstem systems; talking, or even therapeutic relational interactions, are not particularly effective at providing brainstem-altering experiences. Dance, drumming, music, massage—patterned, repetitive sensory input will begin to provide the kinds of experiences that may influence brainstem neurobiology to reorganize in ways that will lead to smoother functional regulation.

Enrichment or therapeutic services for maltreated children need to be consistent, predictable, patterned, and *frequent*. Clearly, this is not usually true of the fragmented, multiple-transition services that most children in the CPS system experience. If interventions with these children are going to work, the number of repetitions required cannot be provided in weekly therapy. Effective therapeutic and enrichment interventions must recruit other adults in a child's life—caregivers, teachers, parents—to be involved in learning and delivering elements of these interventions, in addition to the specific therapy hours dedicated to them during the week.

PRINCIPLE 3. The brain develops in a sequential fashion.

The brain, at birth, is undeveloped. During its development, it organizes and grows in a sequential fashion—starting from the lowest, most regulatory regions of the brain, and proceeding up through the more complex parts of the brain responsible for more complex functions. Brain development is characterized by (1) sequential development and sensitivity (from the brainstem to the cortex), and (2) use-dependent organization of these various brain areas. The stress response systems originate in the lower parts of the brain and help regulate and organize higher parts of the brain; if they are poorly organized or regulated themselves, they dysregulate and disorganize higher parts of the brain.

Clinical Implications. Traumatic stress will result in patterned, repetitive neuronal activation in a distributed and diverse set of brain systems. Trauma can have an impact on functions mediated by the cortex (e.g., cognition), the limbic system (e.g., affect regulation), the diencephalon (e.g., fine motor regulation, startle response), and the brainstem (e.g., heart rate, blood pressure regulation). *The key to therapeutic intervention is* *to remember that the stress response systems originate in the brainstem and diencephalon.* As long as these systems are poorly regulated and dysfunctional, they will disrupt and dysregulate the higher parts of the brain.

All the best cognitive-behavioral, insight-oriented, or even affect-based interventions will fail if the brainstem is poorly regulated (see Figures 3.2 and 3.4). Extreme anxiety, hypervigilance, and a persistently activated threat response will undermine academic, therapeutic, and socio-emotional learning opportunities. The internal state of arousal can have a profound impact on how individuals think and act. The sensitized stress response system in maltreated children keeps them in a persistent state of high arousal; furthermore, these children will be very labile. When a traumatized child perceives any challenge or threat, he or she will be easily moved along the arousal continuum. The child must feel safe to start to heal. A sense of safety will help keep the child's state of arousal during therapy, school, and other important learning opportunities at a manageable level. Once state regulation has improved, the child can begin to benefit from more traditional therapy. The sequence of providing therapeutic experiences matters. Just as healthy development does, healing following childhood trauma starts from the bottom up.

Accordingly, therapeutic activities will be most effective if they are provided in the sequence that reflects normal development—from the brainstem up. As described above, a poorly regulated brainstem will make most conventional therapeutic interventions ineffective or useless. The major conventional approach to "constraining" the brainstem has been psychopharmacology. The majority of psychotropic medications used with traumatized children (e.g., antidepressants, clonidine, and neuroleptics) influence the key monoamine neurotransmitters involved in the various neural responses to stress and threat. The specificity and efficacy of these agents in children are still not clear, and the effects tend to be nonspecific.

Alternative brainstem-modulating interventions are beginning to emerge—or, rather, are being rediscovered and appreciated for their fundamental therapeutic value. Music and movement activities that provide patterned, repetitive, rhythmic stimulation of the brainstem are very successful in helping modulate brainstem dysregulation (see Miranda, Arthur, Milan, Mahoney, & Perry, 1998; Miranda, Schick, Dobson, Hogan, & Perry, 1999). Several therapeutic approaches, including eye movement desensitization and reprocessing (EMDR), involve patterned, rhythmic activation of the brainstem as part of the intervention. We have hypothesized that EMDR is effective because it can short-circuit the chain of traumatic memory that follows a specific traumatic event by tapping into a much more powerful brainstem–diencephalic memory—the association created *in utero*. Powerful associations are made during the prenatal development of the brainstem and diencephalon between rhythmic auditory, tactile, and motor activity at 80 beats per minute (i.e., the maternal heart rate heard and felt *in utero*) and the neural activation mediating the sensation of being warm, satiated, safe, and soothed. EMDR, dancing, drumming, music, and patterned massage can all "quiet" the brainstem through rhythmic activity that provides brainstem stimulation at 80 bests per minute or subrhythms (40, 60) of this primary "soothing" pattern (Perry, 2002b). Such patterned, repetitive, rhythmic activity has always been a central element of healing and grief rituals in aboriginal cultures. The use of music and movement interventions with traumatized children has been very promising (e.g., Miranda et al., 1999).

Therefore, therapeutic and enrichment experiences must be provided to a child in an appropriate sequence and matched to the child's level of neurodevelopment (see Table 3.1). In turn, this matching process is dependent upon adequate assessment of the child's development in the key areas of physical/motor, behavioral, emotional, social, and cognitive domains (see the later discussion of assessment).

PRINCIPLE 4. The brain develops most rapidly early in life.

The majority of this sequential and use-dependent development of the brain takes place in early childhood. Indeed, by age 4, a child's brain is 90% adult size. The organizing brain is very malleable and responsive to the environment. This means that of all the experiences throughout the life of an individual, the organizing experiences of early childhood have the most powerful and enduring effects on brain organization and functioning! Three years of neglect can cause a lifetime of dysfunction and lost potential. As discussed below, the brain continues to be capable of change, but it is much easier to organize the brain in healthy ways than it is to take a poorly organized neural system and try to reorganize it.

Clinical Implications. The primary clinical implication of this fourth principle is that early childhood trauma or maltreatment has a disproportionate capacity to cause significant dysfunction, in comparison with similar trauma or maltreatment later in life (see Rutter & English and Romanian Adoptees Study Team, 1998; Rutter et al., 1999). In contrast to prevailing bias, children are more vulnerable to trauma and neglect than adolescents and adults. Indeed, the younger a child is, the more likely the child is to have enduring and pervasive problems following trauma. Severe neglect in the first years of life can have a devastating impact even if a child is removed from the neglectful environment (see Figure 3.5; Perry, 2002a). And the longer a child remains in such an environment, the more vulnerable he or she becomes (e.g., Rutter & English and Romanian

TABLE 3.1. Sequential Neurodevelopment and Therapeutic Activity

Age of most active growth	"Sensitive" brain area	Critical functions being organized	Primary developmental goal	Optimizing experiences (examples)	Therapeutic and enrichment activities (samples)
0–9 mo	Brainstem	• Regulation of arousal, sleep, and fear states	• State regulation • Primary attachment • Flexible stress response • Resilience	• Rhythmic and *patterned* sensory input (auditory, tactile, motor) • Attuned, responsive caregiving	• Massage • Rhythm (e.g., drumming) • Reiki touch • EMDR
6 mo–2 yr	Diencephalon	• Integration of multiple sensory inputs • Fine motor control	• Sensory integration • Motor control • Relational flexibility • Attunement	• More complex rhythmic movement • Simple narrative • Emotional and physical warmth	Music and movement • Reiki touch • Therapeutic massage • Equine or canine interactions
1–4 yr	Limbic	• Emotional states • Social language; interpretation of nonverbal information	• Emotional regulation • Empathy • Affiliation • Tolerance	• Complex movement • Narrative • Social experiences	Play and play therapies • Performing and creative arts and therapies • Parallel play
3–6 yr	Cortex	• Abstract cognitive functions • Socioemotional integration	• Abstract reasoning • Creativity • Respect • Moral and spiritual foundations	• Complex conversation • Social interactions • Exploratory play • Solitude, satiety, security	Storytelling • Drama • Exposure to performing arts • Formal education • Traditional insight-oriented or cognitive-behavioral interventions

Note. This table outlines the sequential development of the brain, along with examples of appropriately matched experiences that help organize and influence the respective parts of the brain that are most actively developing at various stages. For maltreated children, developmental "age" rarely matches chronological age; therefore, the sequential provision of therapeutic experiences should be matched to developmental stage and not chronological age.

Adoptees Study Team, 1998; Rutter et al., 1999; O'Connor, Rutter, & English and Romanian Adoptees Study Team, 2000).

This principle informs policy, programming, and practice. The primary policy implication is that even a minimal investment in early childhood surveillance models to find highest-risk children and families will be wise. We do not capitalize on this window of opportunity in early childhood. Indeed, we typically wait until a child is clearly impaired and dysfunctional (e.g., acting out and failing in school) before we initiate services. Those few resources that are dedicated to early childhood tend to be inefficient and unfocused.

Early intervention with high-risk children works (Reynolds, Temple, Robertson, & Mann, 2001). The primary programming implication is that the earlier we can begin to provide appropriate services to children, the more effective we will be. The interventions will cost less, and the children's progress will be more dramatic (see Figure 3.5). A few promising practices demonstrate the powerful impact of proactive interventions; the Rameys' Abecedarian projects (Ramey et al., 2000) and Old's home visitation interventions (Olds, Henderson, & Eckenrode, 2002), for example,

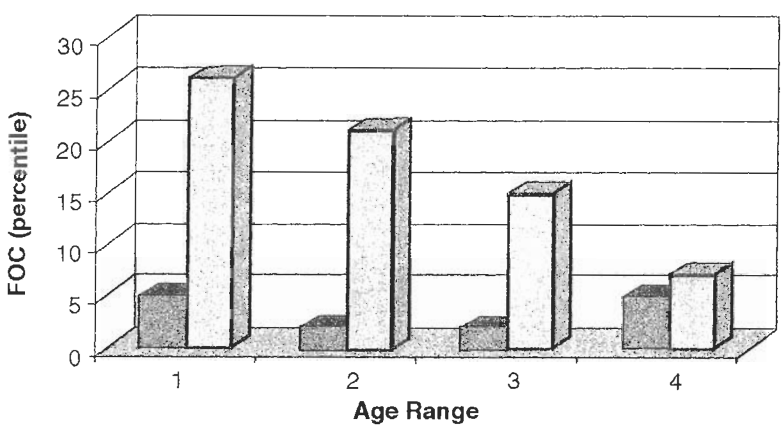

FIGURE 3.5. Sensory deprivation neglect: Effects of early removal on recovery. Children were removed from severely neglectful environments at different ages (ages 8 months to 4 years, 8 months). Their frontal-occipital circumference (FOC; a crude indicator of brain size) was measured (black bars) and compared to same-age norms. Children were placed in foster care and were reevaluated 1 year later . FOC was measured (white bars) and increased in each group; with increasing age, however, the improvement after a year of foster placement started to decrease, such that after 3 years in the neglectful environment (group 4), there was no longer any statistically significant improvement 1 year later. It is interesting to note that 100% of the children in group 4, 74% in group 3, 46% in group 2, and only 27% in group 1 required special educational services when they reached school age.

have a long-term impact on high-risk children when services are provided during the first years of life.

Proactive therapeutic interventions are better than reactive ones. It is easier and more cost-effective to provide enrichment, educational, and therapeutic services earlier than later. The longer we wait to help these children, the more difficult the therapeutic challenge will be.

PRINCIPLE 5. Neural systems can be changed, but some systems are easier to change than others.

The primary assumption of therapy is that a person can change. The parallel assumption is that the person's brain is capable of being changed with therapeutic intervention. As discussed above, the human brain is remarkably malleable while it is being organized during development. Once organized, the brain is still capable of being influenced, modified, and changed. The ease with which the brain's neural networks can be modified, however, changes as the child grows and the brain becomes more organized.

The degree of brain plasticity is related to two main factors—the stage of development, and the area or system of the brain. Once an area of the brain is organized, it is much less responsive to the environment; in other words, it is less plastic. For some brain areas such as the cortex, however, significant plasticity remains throughout life, such that experiences can still easily alter neurophysiological organization and functioning. A critical concept related to memory and brain plasticity is the differential plasticity of various brain systems. Not all parts of the brain are as plastic as others (see Figure 3.6). Once the brain has organized (i.e., after age 3), experience-dependent modifications of the regulatory system are much less likely than experience-dependent modifications of cortically mediated functions such as language development.

Clinical Implications. As described in detail above, trauma-related symptoms are related to dysfunction of neural systems in the lower, less plastic parts of the brain. The number of repetitions required to change brainstem neural organization is far greater than the number required to change the cortical neural organization. In other words, it is easier to change beliefs than feelings. It is not that a child won't change; it is just that change will not occur unless sufficient repetitions are provided. The current medical model does not provide sufficient repetitive, patterned experiences for brainstem-related neural systems to reorganize. We try to modify these symptoms by using medications that alter the functioning of these brainstem neural systems—sometimes with effect. No medication, however, can provide the specific patterns of neural activation required to

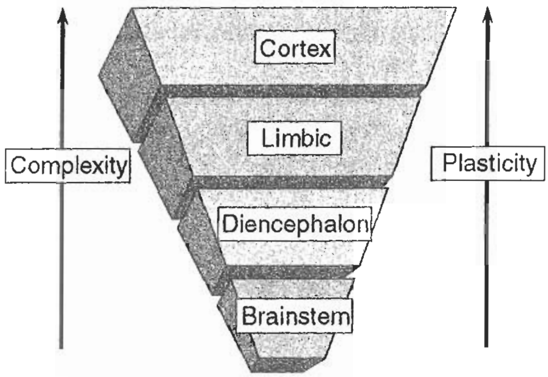

FIGURE 3.6. Differential plasticity across different regions of the organized brain. The malleability of specific human brain areas is different. The most complex area of the brain—the cortex—is the most plastic. Some cortex-related functions can be modified throughout life with minimal effort. For example, even a 90-year-old person can learn a new phone number. The lower parts of the brain—those mediating core regulatory functions—are not very plastic. And this is for good reason: It would be very destructive for these basic and life-sustaining functions to be easily modified by experience once they were organized.

organize and reorganize dysfunctional neural networks. We can contain behavior by regulating emotional dysfunction with medications, but we cannot create new, healthy neural networks. Therefore, medication use alone does not have an enduring positive impact on maltreated children. This is not to say that medications should not be used; medications can be very helpful in containing brainstem dysregulation enough to allow positive, repetitive healing experiences to take place through other therapeutic activities (e.g., individual cognitive-behavioral therapy).

PRINCIPLE 6. The human brain is designed for a different world.

We humans have not always lived the way we do now. Human beings are biological creatures. Of the 250,000 years or so that our species has been on the planet, we spent 245,000 years living in small transgenerational hunter–gatherer bands of 40–50 individuals. The human brain has evolved specific capabilities that are hominid and prehominid adaptations to millions of years of living in the natural world in these transgenerational groups. One of the most important features of this natural world was the relational milieu. We lived in a far richer relational environment in the natural world. For each child under the age of 6, there were four developmentally more mature persons who could protect, educate, enrich, and nurture the developing child—a ratio of 4:1. In contrast, our modern world is defining a caregiver-to-child ratio of 1:4 as a "best-practice" ratio for young children (1/16th the relational ratio the human brain is designed for). Our children also spend many hours each day watching television; they spend very few hours in the socioemotional learning opportunities created by interactions with older children, younger children, aunts, uncles, nephews, grandparents, or neighbors. In contrast to our ancestors, we live in a relationally impoverished world.

The relationally enriched, developmentally heterogeneous environment of our past is what the human brain "prefers." The brain is not well designed for artificial light, pervasive visual overstimulation from television, distracting sounds and images, anonymous social interactions, and numerous other phenomena related to life in the modern Western world. The impact of these changes on the way we live, work, and raise our children has not been completely examined. Many of our current lifestyle choices, though well intended, are probably contributing to emotional, social, cognitive, and physical health problems in our children. The most alarming of these is the relational poverty that many of our children are experiencing. This is most disturbing, because we humans are fundamentally relational creatures.

We are born dependent and grow to be interdependent. We need each other, and we are neurobiologically connected to each other. Indeed, our survival as a species is dependent upon our ability to form and maintain successful relationships with others. The most essential functions that the brain mediates—survival, procreation, and protecting/nurturing offspring—depend upon the capacity to form and maintain relationships. Our human neurobiology reflects our functional interdependence. The most powerful rewards and the most intense pain come from relational experiences. The attention and approval of a loved or respected person stimulates the reward systems in the brain, and disapproval or loss of attention and affection activates pain-mediating neural systems (rejection, humiliation, and loss actually hurt). The neural systems mediating stress response, procreation, reproduction, social affiliation, and communication are all interrelated; indeed, they often share the very same fundamental neurotransmitter networks and brain regions (see Perry, 1999, 2001, 2002a).

Clinical Implications. On average, our child care settings have 1 caregiver for 6–8 children. Our elementary schools have 1 teacher for 30 children. Our children take 6 hours a day to watch television. Fragmented, mobile nuclear families separate children from extended family members. A host of factors combine to produce hundreds of thousands of children growing up in homes and communities that are impoverished in relationships. This poverty of relationships contributes to a host of neuropsychiatric problems. The more isolated physically and socially a family becomes, the more vulnerable a child becomes.

Some children have so few relational experiences that they never fully develop their capacity to be socially appropriate, empathic, self-regulating, and humane. By the time they reach age 10, they have only had the number and quality of social interactions that a typical 5-year old gets. This socioemotional immaturity leads to a mismatch between the expectations of teachers, parents, and peers on the one hand and a child's capacity on the other. The child acts like a 5-year-old, but lives in a world of 10-year-old expectations, challenges, and opportunities. The child falls behind, frustrates teachers, and puzzles peers; as a result, he or she begins to feel inadequate, useless, and stupid. If this socioemotional poverty is significant enough, it can result in a child who is persistently selfish, self-absorbed (but also self-loathing), and incapable of empathic, humane behavior. Such characteristics, in combination with exposure to domestic violence and to violence on the media, place a child at great risk for aggressive or even violent behaviors.

The primary therapeutic implication is the need to increase the number and quality of relational interactions and opportunities for the high-risk child. One therapy session a week will not provide sufficient healthy relational interactions to permit the child to catch up from years of relational poverty. The therapeutic approach must address the process of helping to create a "therapeutic web." Using any healthy and invested people in the child's life—teachers, coaches, foster parents, siblings, extended family, neighbors, youth ministers—can help provide therapeutic opportunities. This simple but powerful fact appears to underlie the efficacy of a host of intervention models with high-risk young children. Increasing the number and quality of relational interactions by bringing more healthy adults into the lives of these children and their parents is a key element of home visitation models, mentoring programs, and after-school programs. The more developmentally delayed the children are, the more desperately they need relational interactions; how often have we heard that a difficult child in a preschool group does just fine one on one? This child is 5, but actually requires the relational richness of the 1:1 interaction typically reserved for infants. A neglected, maltreated child is all too often an infant emotionally. If given this relational attention for a sufficient length of time, the child will begin to "develop" (i.e., to resume a more typical developmental trajectory), and over time will no longer require this level of relational attention. Unfortunately, our systems are rarely capable of providing this level of reparative interaction. We tend to be stingy with our relational attentions in these therapeutic preschool and school settings, choosing to label these children with pejorative diagnostic labels rather than to understand their developmental difficulties as very predictable consequences of their chaotic, relationally distorted, and impoverished early lives.

THE NEUROSEQUENTIAL APPROACH

Each of these principles points to the wisdom of, and need for, a more developmentally informed, biologically respectful approach to working with traumatized children in the CPS system. Through examining the history of success and failure with thousands of maltreated children over a 20-year period, and integrating this with an emerging understanding of fundamental principles of neurobiology (many of which have been discussed above), our group has developed a neurodevelopmental approach to clinical work and program development. This approach continues to be modified for implementation in various settings, such as residential treatment for youthful offenders, conventional mental health outpatient clinical settings, the postremoval CPS assessment process, the special education classroom, and therapeutic preschool and nursery settings (see various descriptions on the ChildTrauma Academy website, www.childtrauma.org).

Clinical application of this neurodevelopmental approach is best demonstrated by NMT. The approach for use in a therapeutic preschool setting has been developed in collaboration with Rick Gaskill and colleagues. In a quasi-experimental study (Barfield & Gaskill, 2005) replicated their findings in a 2003 cohort of children in a therapeutic preschool (Barfield, 2004) in a group of 14 children in a therapeutic preschool setting. The 2004 study used a single-subject, time series design, both individually and aggregated. During the regular school year, the Conscious Discipline (CD) curriculum was used. During the summer program, the NMT was used exclusively along with the other services described (e.g., case management and family therapy). The children served as their own control group. The last 3 weeks of the regular classroom, when the CD model was used, served as the baseline for comparison with the NMT model, which was used exclusively during the summer program. Children showed significantly more improvement in the NMT program on overall social/emotional development, emotion regulation, helpfulness, fair assertiveness, impulse modulation, cooperation, and empathy compared to the CD model ($p = < .006$). Of the 14 children, 13 showed more improvement using the NMT model than CD. Other specific applications will vary, depending upon the age of the child, the involvement of the family, the availability of clinicians and practitioners, and the clinical setting. In all settings, however, three key steps are present: assessment, staffing/training, and therapeutic interventions/activities. An overview of the key elements for each step is presented below.

Assessment: Determining Developmental "Ages"

Children age chronologically at the same rate. Children born on the same day of the same year are exactly the same chronological age. Yet each of these children will develop differently. The rate of physical, emotional, social, cognitive, and behavioral development can vary remarkably from child to child. As discussed above, the rate and nature of development in any given neural system (and therefore function) is related to the nature, pattern, and timing of experience. Children in chaotic, neglectful, relationally deprived, and cognitively impoverished environments will have a much slower rate of development in key functional capabilities. A maltreated 5-year-old boy may only have heard the same number of words that a healthier 3-year-old would have heard; he may have only had the same number of socioemotional learning opportunities as a typical 2-year-old. When this boy enters preschool, he will be 5, but he will think and communicate like a 3-year-old and will relate to peers and teacher like a 2-year-old. The mismatch will result in a host of problems for the child, his peers, and the teacher—most of them related to misunderstandings of the child's developmental "ages."

This becomes a fundamental challenge of caregiving, education, and therapeutic work with maltreated children. Misunderstanding of a child's true "ages" will lead to mismatching expectations and learning/therapeutic activities. A 17-year-old boy in the juvenile justice system may only have the relational skills of a 3-year-old. To expect this boy to function well in a group is unrealistic; such an expectation will only lead to problems in the group, and there will be no true therapeutic impact of the group "therapy." No 3-year-old could manage a complex, insight-oriented group—and neither can the 17-year-old with the relational skills of a toddler.

In order to understand any maltreated child, youth, or adult, then, assessment is crucial. We have developed several multidimensional assessment processes that help us begin to understand a child's multiple "ages" (e.g., chronological, emotional, social, cognitive, physical, moral, spiritual). The specific elements of this assessment process are described in detail elsewhere (Perry et al., 2000). In brief, some objective or psychometric measures in combination with a semistructured subjective interview will yield the necessary information to provide the developmental anchors for the key domains.

The most essential element of assessment is history. The most essential element of assessment is history of primary caregiving during early childhood. And the key to this history is the caregiver's own history of primary caregiving. In general, we humans parent the way we were parented. The brain is a historical organ; as described above, it stores experience. Awareness of the nature, timing, duration, and pattern of developmental trauma and neglect can tell us which systems in the brain are likely to be affected and in what fashion. Furthermore, this history will predict the symptoms and signs the child is likely to express.

As part of the assessment process, we have developed a set of brain-region-specific questions to target the functioning and development of each of the four major regions of the brain. These questions help anchor the child's strengths and vulnerabilities, and suggest clear reparative and therapeutic activities.

Staffing and Training

A primary challenge of the neurosequential model is the need to integrate a fundamental understanding of neurodevelopment and early childhood into the existing working models used by the different professionals collaborating in the interdisciplinary team. The range of educational background, personal history, and experience among these professionals can complicate the process of creating an integrated, developmentally sensitive set of interventions. The most effective way we have found to address this is to provide cross-disciplinary training activities that are "case-based." When possible, all staff members and affiliated collaborating professionals receive both didactic and case-based training in the neurodevelopmental principles and the impact of maltreatment and trauma on children. In addition, an ongoing staffing process is used for the purposes of clinical problem solving and continuing education. This process slowly builds capacity and comfort with the approach, which may often involve intervention approaches that seem counterintuitive or even opposite to an approach suggested by conventional educational or mental interventions.

Interventions

Each child is different and will have a unique set of strengths and vulnerabilities. As indicated above, each maltreated child will have a range of developmental "ages." When clinicians are creating the child's individualized plan of therapeutic activities, the primary objectives are to ensure that the experiences are relevant, relational, repetitive, and rewarding. Activities and interventions are selected that match the child's developmental status in any given domain of function (i.e., social, emotional, cognitive, and physical); in other words, they are relevant. The second key is that the activities are provided in a healthy relational context; this is necessary to provide the sense of safety and predictability necessary for optimal healing and learning. Third, the activities must be provided with sufficient repetition and duration to produce actual change in the target neural systems. Finally, the activities must have some element of reward; therapeutic and learning experiences will generalize and ultimately be most successful if some pleasure is gained from the activities themselves or from the mastery that the activities lead to.

The selection and timing of experiences will depend upon the findings of the assessment. In all cases, it is wisest to start with simple rhythmic and repetitive activities that help the brainstem neural systems become well organized and regulated. As therapy progresses and evidence of brainstem regulation emerges, the activities can begin to target higher, more complex parts of the brain. Over time—once the lower stress response systems in the brainstem and diencephalon become well regulated—the effective use of more conventional individual therapies becomes possible (see Table 3.1).

SUMMARY

A clinical approach to helping maltreated and traumatized children that is informed by principles of neurobiology can provide insights regarding assessment, training, and intervention. The present overview is merely an introduction to some of these principles. The NMT is intended to complement and restructure therapeutic efforts and activities. The central clinical implication of this model is that successful treatment with traumatized children must first regulate the brainstem's sensitized and dysregulated stress response systems. Only after these systems are more regulated can a sequence of developmentally appropriate enrichment and therapeutic activities be successfully provided to help the children heal. More outcome-based studies will be required and are planned to fully document this approach in various clinical settings.

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