Neurobiology of trauma and trauma treatment?

Simply stated, traumatic & neglectful experiences... cause abnormal organization & function of important neural systems in the brain, compromising the functional capacities mediated by these systems... Matching the correct therapeutic activities to the specific developmental stage and physiological needs of a maltreated or traumatized child is the key to success. (Perry, 2006)

The Child’s Brain

- The first three years of life are the prime times for billions of neural connections to be made in the child’s brain
- The brain of a 3-year-old is 2-½ times as active as that of an adult brain
- The experiences a child receives between birth & age 3 directly affect the way neural pathways develop in the child’s brain
- By age 4, a child’s brain is 90% adult size

(Healy, 1998; Perry, 2002)

Brain Plasticity

- Plasticity refers to the way that the brain creates, strengthens, & discards synapses & neuronal pathways in response to the environment.
- This means that the brain is capable of changing in response to experiences, especially repetitive and patterned experiences.
- It is this plasticity of the brain which holds out hope for interventions to ameliorate damage.

Issues in Trauma

- Intrusive reexperiencing
- Autonomic hyperarousal
- Numbing of responsiveness
  - Intense emotional reactions
  - Learning difficulties
  - Memory disturbances & dissociation
  - Aggression against self & others
  - Psychosomatic reactions

(van der Kolk, 1996)

Responses to Trauma

- Abnormal & heightened response to trauma-specific stimuli
- Abnormal arousal in response to stimuli which is not trauma-related, signifying a loss of stimulus discrimination

(van der Kolk, 1996)

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Basic Neurobiological Effects of Trauma

- Increased levels of catecholamines (epinephrine & norepinephrine), which results in increased SNS activity
- HPA axis is activated, which in turn stimulates the limbic system thru the locus coeruleus
- Resultant decrease in corticosteroids & serotonin, resulting in the inability to moderate the catecholamine-triggered fight, flight, or freeze response

Basic Neurobiological Effects of Trauma

- Initial increase in serotonin levels often leads to a long-term interruption of serotonin production, associated with possible depression, aggression, & suicidality
- Increased cortisol levels, associated with neural disruption & atrophy
- Increased levels of endogenous opioids, resulting in pain analgesia, emotional blunting, & memory impairment
- Immune system suppression

Basic Neurobiological Effects of Trauma

- Chronic exposure to stress/trauma affects both acute and chronic adaptation of these chemicals — it permanently alters how an organism deals with its environment on a daily basis.
- Endogenous opioids, which inhibit pain & reduce panic, are secreted after prolonged exposure to severe stress. The dissociation and stress-related analgesia experienced by trauma victims may be related to this.
- Medications that stimulate ANS arousal may precipitate visual images and affect states associated with prior traumatic experiences.

Basic Neurobiological Effects of Trauma

- While people with PTSD tend to deal with their environment by emotional constriction, their bodies continue to react to certain physical and emotional stimuli as if there were a continuing threat of annihilation.
- Traumatized people go immediately from stimulus to response without being able to make the intervening psychological assessment of the cause of their arousal, which causes them to overreact and intimidate others.

Neurobiological effects of childhood trauma [Perry]

Key points
- For children who have experienced trauma, abuse or neglect, their brains develop very adaptively to their negative environment – but maladaptively to other environments.
- The developing brain organizes & internalizes information in a use-dependent manner – the more children live in a disorganized state (physiologically & psychologically), the less they are capable of dealing with stress & the more likely their development is disrupted by exposure to trauma.

Neurobiological effects of childhood trauma

- Abused children suffering from PTSD excreted significantly greater concentrations of baseline norepinephrine & dopamine in comparison to nonabused anxious & healthy controls
- EEG abnormalities in the left side of the frontal and temporal region of the brain for children with trauma history (115 psychiatric inpatient children)
- MRI scans of abused & neglected children showed that over half showed evidence of cortical atrophy or ventricular enlargement (Perry, 1999)
**Neurobiological effects of childhood trauma**

- In response to stress, both abused and nonabused produce cortisol.
- In a study with sexually abused girls, they produced cortisol at a faster rate, & the nonabused children returned to baseline much faster than the abused children.
- PTSD children showed elevated urinary cortisol levels as compared with healthy controls (De Bellis).
- Emotionally neglected children from a Romanian orphanage had elevated cortisol levels compared to controls.

- Another study (131 9-yr-old maltreated girls) showed slightly elevated afternoon salivary cortisol levels, which may have been related to the anticipatory stress of returning to an abusive home.
- However, another study showed that in comparison to the control group, that maltreated children were shown not to have elevated salivary cortisol levels (Hart et al., as cited in Glaser, 2000).

**Neurobiological effects of childhood trauma**

- Maltreated but medically healthy maltreated children and adolescents with a diagnosis of PTSD had significantly smaller intracranial and cerebral volumes than non-abused controls (De Bellis et al., 1999).
- In a 2002 study (De Bellis et al.), pediatric subjects with PTSD had smaller intracranial, cerebral, prefrontal cortex, prefrontal cortical white matter, right temporal lobe volumes, & areas of the corpus callosum & its subregions.

**Hyperarousal & Dissociation**

- **Hyperarousal**
  - Alarm reaction is mediated by the locus coeruleus.
  - Increased HPA activity.
  - Despite being away from the threat and original trauma, these parts of the child's brain are activated again & again – the memories of fear are seared into the child’s neurobiology.

- **Dissociation**
  - Found particularly in very young children & girls.
  - Child is faced with a traumatic experience & dissociates.
  - Vagus nerve, the parasympathetic part of the autonomic nervous system, becomes activated, leading to a slowing of the heart rate & a fall in blood pressure.
  - Possible that as part of the dissociation process, endogenous opiates are activated by stress & alter the perception of the negative stimuli.
Dissociation

“It is now established that ‘dissociation at the time of exposure to extreme stress appears to signal the invocation of neural mechanisms that result in long-term alterations in brain functioning (Chambers et al, 1999, p. 274). In other words, infants who experience states of terror and dissociation and little interactive repair, especially those with a genetic-constitutional predisposition and an inborn neurophysiological vulnerability, are high risk for developing severe psychopathologies at later stages of life.”

(Schore, 2001)

Trauma & learning

1) “Children who are aroused [from fear] can't take in cognitive information . . . they're too busy watching [the teacher or therapist] for threatening gestures, and not listening to what she's saying” (Bruce Perry, M.D., Ph.D.)

2) This behavior makes sense, given the constant threats in the child’s world. His brain has become exquisitely tuned to emotional and physical cues from other people.

3) At the same time, he may be failing to develop problem solving and language skills.

4) Perry has found that in a group of neglected children, the cortex, or thinking part of the brain, is 20 percent smaller on average than in a control group.

Hypertrophy

- Perry has hypothesized that persistent trauma leads to a “dysregulated” brain stem – which manifests with symptoms such as impaired cardiovascular regulation, extreme affective lability, & poor impulse control
- Certain brain areas may become “hypertrophied” at the expense of other brain structures that govern other functions
- Chronic activation of certain parts of the brain involved in the fear response (e.g., the HPA axis) can “wear out” other parts of the brain (e.g., the hippocampus)

Summary of psychobiological response to trauma

- The brain mediates threat with a set of predictable neurobiological, neuroendocrine, and neuropsychological responses.
- These responses may include different survival strategies – ranging from fighting or fleeing to giving up or surrendering.
- There are multiple sets of neurobiological and mental responses to stress. These vary with the nature, intensity, and frequency of the event. Different children may have unique and individualized sets of responses to the same trauma.

(Child Trauma Academy)

Summary of psychobiological response to trauma

- Two primary adaptive response patterns in the face of extreme threat are the hyperarousal continuum (defense – fight or flight) and the dissociation continuum (freeze and surrender response). Each of these response sets activates a unique combination of neural systems.
- These response patterns are somewhat different in infants, children, and adults – though they share many similarities. Adult males are more likely to use hyperarousal (fight or flight) response, while young children are more likely to use a dissociative pattern (freeze and surrender) response.

(Child Trauma Academy)
Clinical Implications of Neuroscience Research in PTSD
[van der Kolk]

- Traumatized individuals need to learn that it is safe to have feelings and sensations.
- If they learn to attend to inner experience, they will become aware that bodily experience never remains static.
- Unlike at the moment of a trauma, when everything seems to freeze in time, physical sensations and emotions are in a constant state of flux.

Clinical Implications of Neuroscience Research in PTSD
[van der Kolk]

- Once they realize that their internal sensations continuously shift and change, particularly if they learn to develop a certain degree of control over their physiological states by breathing and movement, they will viscerally discover that remembering the past does not inevitably result in overwhelming emotions.

Clinical Implications of Neuroscience Research in PTSD
[van der Kolk]

- Traumatized people often lose the effective use of fight or flight defenses and respond to perceived threat with immobilization.
- Attention to inner experience can help to reorient themselves to the present by learning to attend to nontraumatic stimuli.
- This can open them up to attending to new, nontraumatic experiences and learning from them, rather than reliving the past over and over again without modification by subsequent information.

Therapy in light of Neurobiological Response

- In people with PTSD, specific deactivation of the dorsolateral prefrontal cortex (which is responsible for executive function) interferes with the ability to formulate a measured response to the threat. At the same time, high levels of arousal interfere with the adequate functioning of the brain region necessary to put one’s feelings into words: Broca’s area.
- Traumatized people suffer *speechless terror*.

Therapy in light of Neurobiological Response

- “Trauma by definition involves speechless terror: patients often are simply unable to put what they feel into words and are left with intense emotions simply without being able to articulate what is going on.”

  (van der Kolk, in Yehuda, 2002)

- “Fundamentally, words can’t integrate the disorganized sensations and action patterns that form the core imprint of the trauma.”

- “To do effective therapy, we need to do things that change the way people regulate these core functions, which probably can’t be done by words and language alone.”

  (van der Kolk, 2003)
"In a 1996 neuroimaging study using PET scans, we learned that when people relive their traumatic experiences, there is decreased activation of Broca's area in the brain (related to language) and increased activation of the limbic system in the right hemisphere of the brain. This suggests that when people with PTSD are reliving their trauma, they have great difficulty putting their experiences into words."

"The stress response is a primitive ingrained part of the CNS . . . the cortex, where we "think," is obviously involved, but the key parts of the CNS involved in PTSD are the brain stem and the midbrain. These brain areas mediate the physiological, hyper-reactivity, hypervigilance, anxiety, emotional lability, behavioral impulsivity, and sleep problems of PTSD. No matter how much you talk to someone, the words will not easily get translated into changes in the midbrain or the brain stem" (Perry & Pate, 1994).

According to Perry, in order to heal a "damaged" or altered brain, interventions must activate those portions of the brain that have been altered. Because brain functioning is altered by repeated experiences that strengthen and sensitize neuronal pathways, interventions can not be constrained to weekly therapy appointments. Interventions must address the totality of the child's life, providing frequent, consistent "replacement" experiences so that the child's brain can begin to incorporate a new environment – one that is safe, predictable and nurturing.

Maltreatment appears to impede normal development of the left hemisphere (Teicher). In fact, abused children are less able to use both hemispheres. Abnormalities in the corpus callosum, the fiber tract connecting the two hemispheres, may explain the challenges in lateralization that abused children sometimes experience.
Brain hemispheres & the treatment of child trauma

- The right hemisphere generally mediates negative emotions
- Trauma seems to be lodged in the right hemisphere of the brain
- Metaphor – the language of the right hemisphere – is ideally suited to accessing and expressing trauma

Brain hemispheres & the treatment of child trauma

<table>
<thead>
<tr>
<th>Left hemisphere</th>
<th>Right hemisphere</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logical</td>
<td>Metaphorical, holistic, visual/spatial</td>
</tr>
<tr>
<td>Linear</td>
<td>Focused on nonverbal language features (e.g., tone, facial expressions)</td>
</tr>
<tr>
<td>Organized</td>
<td>More self-soothing</td>
</tr>
<tr>
<td>Language focused</td>
<td>Dominant during the first three years</td>
</tr>
<tr>
<td>Sequential – words more involved in the sequencing of events</td>
<td></td>
</tr>
</tbody>
</table>

Brain hemispheres & the treatment of child trauma

“To have a coherent story, the drive of the left to tell a logical story must draw on the information from the right. If there is a blockage, as occurs in PTSD, then the narrative may be incoherent” (Siegel, 2003).

Neurodevelopment & Play

With play, we have an inexpensive & efficient means to help children develop. Proactive is better than reactive. Simple music & movement activities provided early in life for high-risk children, for example, appear to have powerful & positive impact on young children. We must teach young mothers & caregivers how important it is to play with their young children. The best toy for a young child is the invested, caring adult – someone to pay attention, to engage and to play with the child using words, song, touch & smile.”

Neurodevelopment & Play

“Play and exploration are crucial activities for young children. They help the child's brain develop in optimal ways. Child sensitive spaces, semi-structured activities and opportunities for exploration are safe, nurturing and enriched in developmentally appropriate stimulation should be the core elements of all child-focused programs. Play and exploration grow the brain – healthy play and exploration grows healthy brains.”

Play Therapy & Brain Development

- When children are not helped with overwhelming feelings, the neural pathways from limbic circuits to prefrontal regions can be insubstantial & fragile, leaving them vulnerable to limbic surges
- Stress system becomes hyperactive, pulling children from developing self-regulation
- Thus, we have the neurochemicals of stress rather than connection flowing
**Play Therapy & Brain Development**  
[Badenoch, 2008]

"With a caring and balanced play therapist, all of these experiences can be reversed over time. Being able to hold a clear picture of these children's pains, fears, and strengths in our minds provides the soil and sunshine in which these children can develop. The warmth of this contingent constant, communicated through the resonance circuits, quickly or gradually settles them into enough security to move into play."

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**Traumatized people need to have physical & sensory experiences to:**

- Unlock their bodies
- Activate effective fight/flight
- Tolerate their sensations
- Befriend their inner experiences
- Cultivate new action patterns

(Bessel van der Kolk, 2009)

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**Sensory Nature of Trauma**

- All trauma is sensory in nature – or at least has a large sensory component.
- The diagnostic criteria (DSM-IV-TR) for PTSD is sensory in nature
  - Persistent re-experiencing of traumatic event
  - Avoidance of cues associated with trauma
  - Persistent physiological hyper-reactivity or arousal
- Perhaps – trauma treatment should be sensory in nature (expressive therapies?)

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**Possible multi-dimensional tx plan for PTSD/CD child**

- Play therapy
- Psychopharmacology
- Psychoeducation about trauma
- Group therapy (Play? Peer skill building?)
- Parent training (Filial? Behavior mgmt.? Token economy?)
- Coordination of tx with school, medical professionals, etc.
- Plan for & monitoring of diet, exercise, sleep
Trauma Interventions

- Respite care
- Filial therapy
- Play therapy
- Behavior management
- Pharmacotherapy
- Sandtray therapy
- Art therapy
- Massage therapy
- CBT [TF-CBT]
- Drama therapy
- Psychoeducational training
- Group therapy
- Other expressive therapies
- Animal-assisted therapy
- Music therapy
- Sensory integration (OTR)
- EMDR

Play Therapy with Traumatized Clients
(Schaefer, 1994)

- symbolization – clients can use the media (e.g., a predatory animal puppet, sandtray miniature, etc.) to represent an abuser
- "as if" quality – clients can use the pretend quality of expressive therapy (e.g., drama) play to act out events as if they are not real life
- projection – clients can project intense emotions onto the media (clay, puppets, etc.), which/who can then safely act out these feelings
- displacement – clients can displace negative feelings onto the media (sand, dolls, etc.) rather than expressing them toward family members

Play of Traumatized Children
Reenactment vs. Retraumatizing

Reenactment Play
- Leads to mastery
- Child feels free to express emotion
- Child feels in control
- Satisfactory conclusion

Retraumatizing Play
- Fails to provide resolution
- Creates rather than relieves anxiety
- Magnifies feelings of helplessness
- May need to be interrupted

What Traumatized Children Learn in Play Therapy

- Learn the world can be safe, consistent & predictable
- Learn that feelings (both positive & negative) are acceptable
- Develop capacity to trust & attach with other persons
- Learn to be creative & resourceful in confronting problems
- Develop a greater capacity to cope
- Experience behaviors and feelings of control/mastery
- Develop an internal source of evaluation
- Learn to be more self-directed, responsible & autonomous
- Develop an enhanced sense of self & become more self-accepting

(adapted from Landreth, 2002)

Process of Play Therapy with Traumatized Children

- Mere re-enactment of trauma in the play therapy process – without movement towards resolution is not helpful, and may be dangerous.
- The play therapy process needs to be both facilitated and monitored. Traumatic play may need to be interrupted.
- This interruption, if necessary, should work towards the child maintaining power and control.
- The goal of play therapy is to help the child process the trauma – verbally or nonverbally.
- The meaning of the trauma to the child is not as important as processing it so that it can become tolerable and manageable.

Process of Play Therapy with Traumatized Children

- As previously noted, it is my goal to provide children with safe, reparative & relational experience.
- This takes priority over a focus on insight and/or cognitive restructuring.
- My role is therapeutic, not investigative – to be fellow sojourner on the journey & a witness to the story.
- The need for safety extends beyond the therapeutic experience. There may be a need to work with family, school, etc.
**Trauma & sleep disturbances**

- Children are particularly prone to NREM sleep disturbances & parasomnia symptoms (night terrors, somnambulism, motor restlessness)
- Chronic sleep disturbance leads to decreased daytime concentration & increased daytime irritation  
  - Affects family life, peer relationships, & school
- Effects of caffeine

**A Major Forgotten Aspect of Trauma Tx is the Parent-Child Relationship**

- Changes in Parent-Child Relationship after Trauma
  - Impaired affect regulation
  - Mutual negative attributions
    - Changed mental representations
    - Traumatic expectations
  - Parent and child as traumatic reminders for one another

**Parent-Child Therapy & Trauma**

- Filial Therapy has been demonstrated to be effective with trauma cases (Barabash, 2004; Costas, 1999; Smith, 2000)
- Some trauma treatment goals of parent-child therapy
  - Increased capacity to respond realistically to threat
  - Differentiation between reliving and remembering
  - Normalization of the traumatic response
  - Placing the traumatic experience in perspective

**Child-Centered Play Therapy Tracking!**

- Children who experience neglect often experience a poverty of words
- This is in addition to the negative language they have endured
- The neural systems which mediate language & social interaction therefore do not receive adequate patterned, repetitive stimulation
- Neural systems – and, children – change with repetition (Perry, van der Kolk)
- Tracking in play therapy works on these impoverished neural systems

**Benefits of Rhythmic Activities**

- Music, dancing, drumming, EMDR are all very rhythmic activities
- Repetitive, rhythmic, & archetypal activities have long been part of aboriginal cultures in healing & grief rituals
- The brainstem can be soothed thru rhythmic activity that provides neural stimulation at 80 beats per minute
  - This matches the prenatal experience of the mother’s heart rate
- Every play room should have a drum and additional musical instruments

**Psychopharmacology & Trauma Symptoms**

- Medications may be helpful in dampening emotional & behavioral arousal that is out of control
- This may create a window for psychotherapeutic interventions to succeed
- Meds can not, however, replace the specific & repetitive patterns of brain activation need for traumatized children
- “We can contain behavior by regulating emotional dysfunction with medications, but we cannot create new, healthy neural networks” (Perry, 2006)
Sandtray Therapy & Trauma

- Advantages of Sandtray
  - No artistic talent needed
  - Can be completely nonverbal
  - Gives expression to non-verbalized emotional issues & cuts through verbalization used as a defense
  - Has a unique kinesthetic quality
  - Serves to create necessary therapeutic distance for clients
  - Helps deal with issues of transference

Other Sandtray/Art Applications

- Kinetic Family Sandtray/Drawing
- Kinetic School Sandtray/Drawing
- Solution-Focused "miracle question"
- "Pain All Gone" Sandtray/Drawing
  - Adapted from Mills & Crowley (1988)
    - 1st: Sandtray/Drawing of the pain
    - 2nd: Sandtray/Drawing of pain all gone
    - 3rd: Sandtray/Drawing of how to get from 1st to 2nd

Puppet Play

Puppets provide a means for expression & projection → therapeutic distance → safety
- It is important to have a wide variety of puppets available
- A puppet stage is also necessary
- Process: (1) Selection of puppets; (2) Planning the puppet show; (3) Presentation of the puppet show; (4) Process
- Videotape?

Photo Collage

Collage work can be engaging & nonthreatening – essentially a self portrait
- Photos – either brought in by client or taken in session by the therapist
- Collage created around the photo
- Basic materials: a variety of magazines, crayons & colored markers, paints, glue, scissors, tissue paper, ribbons & yarn, & basic poster board
- The final product should be titled by its creator
- Encouraged (not compelled) to share how "portrait" represents self

Other “Techniques”

- Bubbles
- “Treasure” Boxes
- “Memory” Quilts
- Clay / Play-Doh®
- Scribble technique
- Mask making
- Shield

Summary quotes . . .

"As long as children are unable to talk about their traumatic experiences, they simply have no story, and instead, the trauma is likely to be expressed as an embodiment of what happened. . . The task of therapy is to help these children develop a sense of physical mastery and awareness of who they are and what has happened to them to learn to observe what is happening in the present time & physically respond to current demands instead of recreating the traumatic past behaviorally, emotionally, & biologically.”

(van der Kolk, 2006)
Summary quotes . . .

“It is the ‘relationship’ which enables access to parts of the brain involved in social affiliation, attachment, arousal, affect, anxiety regulation and physiological hyper-reactivity. Therefore, the elements of therapy which induce positive changes will be the relationship and the ability of the child to re-experience traumatic events in the context of a safe and supportive relationship.”

(Perry & Pate, 1994)

Thank you!

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