

The Traumatized Brain:

Understanding the Science Behind Trauma
and Why Music Works

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Objectives

1. To define trauma (abuse and neglect)
2. To identify trauma-based behaviors
3. To describe the underlying neurodevelopment responsible for those behaviors
4. To state how this understanding informs our clinical work
5. To state how and why music can help

About Trauma

Trauma is in the nervous system - not in the event!
Levine 2007

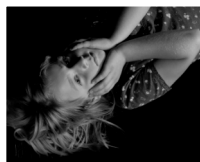
About Trauma

- Four components:
 1. Seriously threatens the health/survival of a person;
 2. Renders them powerless due to overwhelming fear/arousal;
 3. Overwhelms ability to cope; and
 4. Violates basic assumptions about the environment's (human/physical) safety

About Trauma

Different types of trauma:

- Abuse (physical, sexual, emotional)
- Neglect
- Removal from caregivers (adoption or foster care)
- Frequent moves or placements
- Parental Depression
- Emotional Absence



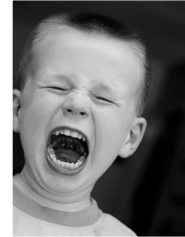
About Trauma

- Different types of traumas = different effects:
 - Isolated events (e.g. school shootings) = conditioned behavioral/biological responses
 - Chronic trauma = more pervasive effect
 - Natural resilience (e.g. inherent intelligence, access to support networks, positive coping skills)

The Behaviors

The Behaviors

- Poor Self-Regulation
 - Poor impulse control & attention span
 - Increased aggression
 - Difficulty sleeping (nightmares)
 - Running behaviors
 - Frequent Daydreams
 - Hypervigilance
 - High resting heart rate



The Behaviors

- Social Problems
 - Difficulty reading social cues
 - Socially withdrawn and inattentive
 - Aggressive, bullying behaviors
 - Poor peer relationships
 - Problems with trust and intimacy
 - Difficulty empathizing

The Behaviors

- Learning and Memory Difficulties
 - Hypervigilance
 - Uninterested or numb to learning/challenges/stimulating experiences
 - Generalized difficulties in learning and memory
 - Poor attention span
 - Poor impulse control

The Behaviors

- Motor-Vestibular Challenges
 - Difficulty writing
 - Poor coordination



The Behaviors

- Psychiatric manifestations:
 - Reactive Attachment Disorder
 - Oppositional Defiant Disorder
 - Post-Traumatic Stress Disorder
 - Attention-Deficit/Hyperactivity Disorder
 - Depression
 - Bipolar Disorder
 - Conduct Disorder

What Lies Beneath

It is useless to tell a child with a problem to control himself or try harder. He can't because the problem occurs below the conscious level of control.

DiMatties & Quirk, 1990

What Lies Beneath

- I. Sensory Systems
- II. Attachment Theory
- III. Stress Regulation

Central Nervous System

Central Nervous System

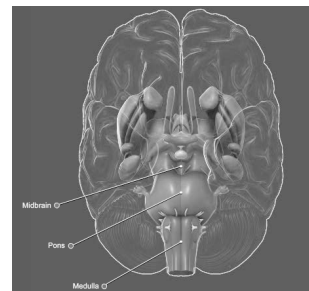
- Neurons = Brain cells
- Synapses = Neuronal connections (e.g. communications)
- Networks = Group of neurons
- Systems = Group of networks



Spinal Cord Communication Pathway

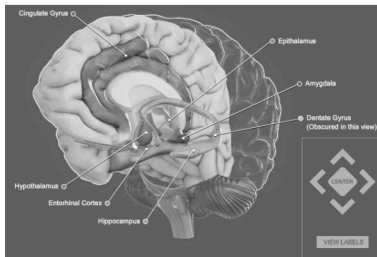


FIG. 12.—SAG. VIEW OF HUMAN SPINE.



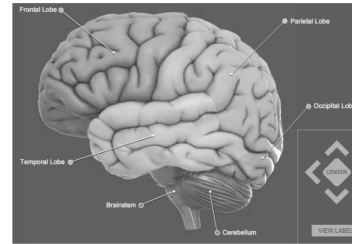
Brain Stem

Essential, Life-sustaining Function



Limbic System

Emotions, Memory, Drive, Motivation



Cortex

"Thinking," Language, Processing, Sensory, Motor

Central Nervous System

- Use-Dependency/Plasticity:
 - Neurons respond, change, and re-organize based on experiences
 - More network activation = Stronger information is learned (internalized)

Neurodevelopment

Neurodevelopment

- Most rapid brain development = Fetal stages - age 3/4
- Overproduction of neurons
- Pruning and Functional Connections
- Superhighways = Fasciculi

Neurodevelopment

- Infant brain 1/3 size of adult brain
- 90% of brain developed by age 3
- Most critical developmental opportunities
- Critical Periods

Neurodevelopment

- Predictable and Hierarchical
 - “Right-to-Left”
 - “Back-to-Front”--Primitive to Complex
 - Primary--Association--Integration
 - Success at one stage is dependent on previous success

Sensory Systems

Sensory Systems

- Development of Sensory Systems (Back-to-Front)
 - Level I - Sensory Systems
 - Level II - Sensory-Motor
 - Level III - Perceptual-Motor
 - Level IV - Cognitive-Behavioral

Level I-Sensory Systems

- Development of traditional senses
- Problem = Interferes with ability to function
 - Learning
 - Processing
 - Concentrating



Sensory Systems

- Hyper-sensitive (avoids)
 - Holds hands over ears
 - Prefers darkened room
 - Avoids certain foods/smells
 - Walks on toes
 - Avoids climbing, jumping
 - Avoids getting messy (glue, sand, water)
 - Seems anxious

Sensory Systems

- Hyposensitive (seeks out, oblivious)
 - Oblivious within active environment
 - Stares intensely at people/objects
 - Routinely smells non-foods
 - Hangs on people, furniture, objects
 - Takes excessive risks
 - Decreased awareness of pain, temperature
 - Overly affectionate with others

Attachment

An emotional bond...



Attachment

- Use-Dependent Development
 - Repetition = Infant internalizes feelings and behaviors
 - External regulation $\Rightarrow$ Internal regulation
- 3 protective factors:
 - Trust, Empathy, Emotional connectedness
 - Self-Regulation
 - Higher-level cognitive processing

Attachment

- Attachment Theory
 - John Bowlby (late 1960s)--> relationship between early development and later mental health
 - Ainsworth, Blehar, Waters, & Wall (1978)--> Stranger Situation
- Three Attachment Behaviors:
 - Secure
 - Anxious/Avoidant
 - Anxious/Insecure

Attachment

- Fourth Attachment Behavior: Disorganized
 - Main & Solomon (1986, 1990)
 - Introduce fear:
 - Seek closeness is disorganized/distorted ways
 - Extreme stress responses
 - Do not trust they will be cared for
 - Cyclical

Attachment

- Structural and neurochemical processes handle stressful and erratic responses
- Internalized by 10-12 months
- Vulnerable with no experience coping with stress
- 80% traumatized children have disorganized attachment patterns

Attachment

- **Maladaptive behaviors:**
 - Lack of variability to adapt to environmental changes.
 - Aggression
 - Disorganized self-soothing (e.g. rocking, head-banging)
 - Tendency to focus on negative thoughts & feelings
 - Poor ability to initiate or engage in play
 - Fearful of new situations.
 - Learning is compromised
 - Hypervigilant or escapes into a fantasy world.

Classic Stress Response

Survive and Procreate

- Brain is sensitive to perceiving internal/external threats and mobilizing the body

Stress Response ("Fight, Flight, Freeze")

- A cascade of biological and chemical events
- Primitive reflexes $\Rightarrow$ Higher level processing



Classic Stress Response

- Many structural and chemical systems involved:
 - Autonomic Nervous System (ANS) - Sympathetic
 - Hypothalamic-Pituitary Axis (HPA)
 - Corticotrophin-releasing factor (CRF), cortisol
 - Immune system
 - Other stress-response neurons and systems
 - Locus Coeruleus (LC) in pons
 - Ventral Tegmental Nucleus (VTN) in pons
 - Limbic system (esp. the amygdala)

Classic Stress Response

- ANS: To maintain homeostasis & respond to stress
- Sympathetic: Expends energy (catabolic) $\Rightarrow$ "Fight, Flight or Freeze")
 - Increase HR and blood flow to skeletal muscles
 - Restrict digestion
 - Dilates pupils and airways
 - Increase secretion of epinephrine from adrenal glands (longer lasting effect)
- Dysregulation: Experiencing stress outside one's window of tolerance

Classic Stress Response

- Parasympathetic: Conserves energy (anabolic) to return to homeostasis $\Rightarrow$ "Rest and Digest"
 - Decrease HR and blood flow to skeletal muscles
 - Promotes digestion
 - Constricts pupils and airways
- Regulation: Experiencing and maintaining stress within one's window of tolerance.
 - Feeling calm, focused, or relaxed

Classic Stress Response

- Overgeneralization and Association:
 - Brain associates sensory information with a threat. Brain generalizes the information.
 - Adaptive function (rapid stress response)
 - Maladaptive = false association and generalizations

Classic Stress Response

- Optimally self-regulating and adaptive
- Dysregulation = No cortical involvement
- Chronic dysregulation = fundamental in many psychiatric disorders
- With chronic stress, the thought can activate stress response
 - Not verbal memories; may not know *why* they feel anxious

Classic Stress Response

- Classic Stress Response not as practical for infants and children
 - Hyperarousal Response
 - Dissociated Response
- Different neurochemical events. Different manifestations.

Classic Stress Response

- Hyperarousal Response ("Fight or Flight")
 - Increase in norepinephrine
 - Affects brainstem and midbrain - arousal, vigilance, affect, irritability, locomotion, attention, sleep, and startle response
 - Thoughts/Dreams can reactivate the response
 - Behaviors: motor hyperactivity, sleep problems, impulsivity, hypertension, anxiety, or neuroendocrine abnormalities, exaggerated reactions to stressors

Classic Stress Response

- Dissociative Response ("Freeze")
 - Increase in epinephrine and dopamine, Decrease in BP & HR
 - Cognitive (e.g. cannot process directions) or physical (e.g. standing still)
 - Significant threat ⇨ Dissociation
 - Simple (e.g. daydreaming) or complex (e.g. loss of consciousness)

Classic Stress Response

- Thought/Dream ⇨ Reactivate response
- Repeated Activation ⇨ Use-Dependent changes



Developmental Changes

Developmental Changes

- Enlarged amygdala
- Overdeveloped adrenal glands (↑ cortisol)
- Decrease hippocampal volume (left)
- Underdeveloped left hemisphere
- Less integrated bilateral processing (smaller corpus callosum)
- ↑ Norepinephrine (arousal) = Impaired prefrontal cortex (orbitofrontal cortex)

Clinical Implications

Clinical Implications

- *Therapist's Response: Regulate First*
 - Keep yourself regulated and calm
 - Low voice, non-threatening body language
- Focus on your relationship
 - Nurturance, calm, understanding, trust, flexibility
- Allow time to respond
- Physical sense of safety and predictability
- Validate feelings
- Remember: Behaviors are unconscious.

Therapeutic Goals

- *Develop into functional, mentally healthy adults*
 - Create a safe space
 - Shield from potential (or perceived) danger
 - Novelty can feel threatening
 - Provide boundaries and rules
 - Predictable transitions and structure
 - Help overcome extreme stress response
 - Balance arousing and regulating experiences (practice self-regulation)

Therapeutic Goals

- Increase focus and attention
- Build ability to observe before reacting
 - Increase ability to have flexible responses
- Tolerate body sensations and emotional states
 - Body-focused experiences - coordinate and integrate perceptions
 - Awaken curiosity and exploration
 - Practice feeling relaxation and enjoyment

Clinical Implications

- Remember and talk about trauma
- Express, process, and understand the emotions
- Children do this nonverbally
- Cognitive awareness → Diminish symptoms
- Don't process the behaviors
- Wait to process until the child is regulated
- Can teach how to regulate body and emotions
- Need lots of repetition and practice

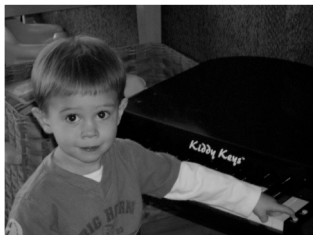
Trauma and Music Therapy

Behavioral Research

- Regulation
 - Creates an atmosphere of safety and support
 - Decreases anxiety and increases relaxation
 - Increases frustration tolerance
- Emotions
 - Provides socially-acceptable ways of releasing fear and anger
 - Facilitates self-expression
 - Elicits emotional responses
 - Improves ability to empathize

Behavioral Research

- Social
 - Promotes positive social interactions
 - Increases social awareness and cooperation
 - Decreases disruptive behaviors
- Cognitive
 - Stimulates verbalizations
 - Enhances developmental opportunities
 - Improves on-task behavior and attention span
 - Improves self-esteem and self-confidence



Why is music so effective?

6 Reasons Why Music

- 1) *Biologic, Evolutionary, Adaptive basis*
- Producing/perceiving music engages and changes the brain
- We are hard-wired to produce and perceive music
- Music meets many criteria for being considered adaptive

6 Reasons Why Music

- Infant-Directed Singing
 - Strengthens attachment/bonding
 - Expresses emotional information
 - Assists in regulation (arousal, attention, calming)
 - Enhances infant survival = facilitating feeding, sleeping, and learning
- Social bonding

6 Reasons Why Music

- 2) *Autonomic (physiologic) changes*
 - Physical responses (laughter and tears)
 - “Shivers” down the spine
 - Changes in respiration
 - Changes in heart rate

6 Reasons Why Music

- 3) *Emotional responses*
 - Passive involvement
 - Music activates the same cortical, limbic, and autonomic systems
- 4) *Motor involvement*
 - Stimulates primary and secondary motor pathways
 - Rhythmic entrainment
 - Rhythmic rocking = calming (cerebellar vermis)

6 Reasons Why Music

- 5) *Cognition*
 - Attention
 - Musical elements arouse and cue
 - Executive Functioning
 - Composition, Improvisation
 - Memory
 - Mnemonic device
 - Working Memory

6 Reasons Why Music

- 6) *Neurotransmitters*
 - Norepinephrine--New connections, Novelty
 - Acetylcholine--Arousal, Pay attention
 - Dopamine--Motivation, “Save”

Trauma and Music Therapy

- Self-regulation
 - Session structure
 - Rocking (cerebellar vermis)
- Pro-social skills
 - Practice & learn turn-taking, sharing
- Nurturance

Trauma and Music Therapy

- Basic attention
 - Musical Attention Control Training (MACT)
- Sensory stimulation and integration
 - Auditory Perception Training (APC) - Sensory Integration

Trauma and Music Therapy

- Self-expression (Emotional Expression)
 - Music Psychotherapy and Counseling Training (MPC)
 - Musical Executive Function Training (MEFT)
- Process trauma
 - MPC
 - Musical Mnemonics Training (MMT)

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