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

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

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  - Socially withdrawn and inattentive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

- 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

- Motor-Vestibular Challenges
  - Difficulty writing
  - Poor coordination

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

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

Spinal Cord
Communication Pathway

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
- 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

Level I - Sensory Systems
- Development of traditional senses
- Problem = Interferes with ability to function
  - Learning
  - Processing
  - Concentrating

Level II - Sensory-Motor
Level III - Perceptual-Motor
Level IV - Cognitive-Behavioral

Sensory Systems

- Development of Sensory Systems (Back-to-Front)
- 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

- 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...

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

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

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

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
  - 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) - "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)
  - Parasympathetic: Conserves energy (anabolic) to return to homeostasis - "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

- 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

- **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)

- 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

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

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

- 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

6 Reasons Why Music

- 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
- Sensory integration
- Musical Mnemonics Training (MMT)

Works Cited

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