Case Study: Applying the Neural-biopsychosocial Model to Post-Traumatic Stress Disorder (PTSD)

Understanding the Neural-biopsychosocial Model

The Neural-biopsychosocial Model distinguishes neural mechanisms as a primary component alongside biological, psychological, and social factors. This elevation recognizes that brain function is not merely another biological variable, but a dynamic, trainable system that both influences and is influenced by the other components. By treating neural function as a distinct domain, clinicians can directly target neuroplasticity while simultaneously addressing the interconnected systems that shape mental health outcomes.

Case Presentation

A 35-year-old military veteran presented with severe symptoms of PTSD following two combat deployments. His initial assessment revealed:

- PCL-5 score: 52 (indicating severe PTSD symptoms)
- Primary symptoms: intrusive memories (4-5 times daily), nightmares (5-6 nights per week), hypervigilance, and emotional numbness
- Sleep efficiency: 62% with fragmented REM cycles
- Social functioning: withdrawn from family activities, unemployed for 8 months
- Previous treatment: 6 months of trauma-focused therapy with minimal improvement

These symptoms significantly impacted his marriage, parenting capacity, and sense of purpose.

Application of the Neural-biopsychosocial Model

Neural Component: Neuroimaging-Guided EEG Neurofeedback

A combined MRI and PET scan provided the initial roadmap, revealing both the structural and metabolic patterns associated with PTSD. The MRI offered a detailed look at the brain's anatomy, showing:

- Reduced hippocampal volume (consistent with chronic stress exposure)
- Structural integrity of major white matter tracts
- Baseline for monitoring structural changes over time

The PET scan highlighted abnormal activity in key stress- and fear-related circuits:

- Hyperactivity in the amygdala (the brain's threat-detection center)

- Hypoactivity in the medial prefrontal cortex (involved in emotion regulation)
- Disrupted connectivity between prefrontal regions and limbic structures

Building on these neuroimaging findings, quantitative EEG assessment revealed the functional signatures of these circuit abnormalities: elevated frontal theta activity and reduced alpha coherence, patterns commonly associated with PTSD's day-to-day symptom expression.

The treatment protocol employed EEG-guided neurofeedback twice weekly, focusing on:

- Reducing excessive theta/beta ratios in frontal regions (addressing the cognitive fog and hypervigilance)
- Enhancing alpha wave production during relaxation states (improving emotional regulation capacity)
- Training sensorimotor rhythm (SMR) to improve sleep quality and reduce physiological hyperarousal

This approach leverages the brain's neuroplasticity, allowing the patient to actively participate in reshaping his own activity patterns. Unlike the static snapshot provided by MRI/PET, EEG neurofeedback offered real-time feedback, enabling the patient to learn self-regulation strategies that could strengthen prefrontal control over limbic reactivity.

By week 4, qEEG showed a 15% reduction in theta activity. By week 12, theta activity had decreased by 30%, and the patient reported noticeable reductions in the frequency and intensity of intrusive thoughts. These functional changes suggested that while the structural abnormalities seen on MRI couldn't be rapidly reversed, the brain's functional circuits were demonstrating remarkable plasticity and capacity for retraining.

Neural → Psychological Connection: As neurofeedback normalized his theta/beta ratios over 8 weeks, he reported decreased intrusive thoughts (from 4-5 daily to 1-2 daily), which made CBT exercises more tolerable and effective. He described being able to "stay with difficult memories" during exposure work without becoming overwhelmed.

Biological Component: Physical Health Optimization

The treatment plan included a comprehensive evaluation and targeted interventions:

- Sleep architecture monitoring showed REM fragmentation; neurofeedback combined with sleep hygiene protocols increased sleep efficiency from 62% to 84% by week 10
- Hormone panel revealed suboptimal testosterone (likely stress-related); referred to endocrinology for evaluation
- Cardiovascular exercise program (3x weekly) was introduced to support overall health and stress reduction

As his sleep improved, he reported increased energy levels, improved daytime focus, and reduced irritability. These biological improvements created a foundation that enhanced his capacity to engage with psychological interventions.

Biological → Neural Connection: Better sleep quality appeared to reinforce neurofeedback gains, as consolidated REM cycles supported memory consolidation and emotional processing.

Psychological Component: Trauma-Focused Therapy

Cognitive Processing Therapy (CPT) was integrated into the treatment plan to address stuck points and maladaptive beliefs related to his trauma:

- Weekly CPT sessions focused on challenging guilt, self-blame, and safety-related cognitions
- The improved focus and reduced hyperarousal from neural and biological interventions enhanced his ability to engage deeply with therapy
- By week 8, he was able to complete full trauma narratives without dissociating—something he couldn't do in previous treatment attempts

He developed practical coping strategies, including grounding techniques and cognitive reframing, that he could apply during daily triggers.

Psychological → Social Connection: CPT-derived emotion regulation skills enabled him to remain present during family conversations, reducing conflict frequency from 4-5 times weekly to once weekly by month 3. His wife reported that he "seemed more like himself" and could discuss difficult topics without shutting down.

Social Component: Rebuilding Connection

The treatment approach recognized that recovery occurs within a social context:

- Monthly family therapy sessions helped his spouse understand PTSD neurobiology and develop supportive communication strategies
- Participation in a weekly veterans' support group reduced isolation and provided peer modeling of recovery
- Gradual reintegration into community activities (coaching his son's soccer team, attending church)

As social connections strengthened, his sense of purpose and identity beyond "broken veteran" began to re-emerge. He reported feeling "seen and understood" rather than judged or pitied.

Social → Neural Connection: Increased social engagement and reduced isolation appeared to correlate with improved alpha wave coherence on follow-up qEEG, suggesting that social connection itself may have neuroplastic effects. The positive feedback from reconnecting with family and peers seemed to reinforce the neural regulation he was developing.

Integrated System Dynamics

This case demonstrates the model's core principle: these components don't operate hierarchically but as a dynamic, interconnected system. While neurofeedback initiated measurable change at

the neural level, psychological interventions provided him with conscious tools to support that change, biological optimization created the physical foundation for sustained improvement, and social support reinforced both his identity and his motivation to continue treatment. The patient's progress wasn't linear but showed clear positive feedback loops where gains in one area amplified improvements in others.

Outcome

Over 16 weeks of integrated treatment (32 neurofeedback sessions, 16 CPT sessions, 4 family sessions, ongoing group participation), the patient demonstrated:

- **Clinical improvement**: 60% reduction in PTSD symptom severity (PCL-5: 52→21, below clinical threshold)
- **Neural changes**: Normalization of theta/beta ratios and 35% improvement in alpha coherence
- **Biological markers**: Sleep efficiency improved to 84% with consolidated REM cycles, reported energy levels "better than pre-deployment"
- **Psychological gains**: Able to discuss trauma without dissociation, developed robust coping toolkit, reduced guilt and self-blame
- **Social reintegration**: Returned to part-time work (with plan for full-time), resumed active parenting, reconnected with veteran community

At 6-month follow-up, improvements were sustained (PCL-5: 23), and he had transitioned to monthly "maintenance" neurofeedback sessions. Notably, when asked what helped most, the patient stated: "I can't point to one thing. It felt like all the parts of me that were broken were being fixed together. The neurofeedback gave me a way to feel my brain changing, therapy gave me tools to use that change, and my family gave me a reason to keep going."

Clinical Implications

This case illustrates several key principles of the Neural-biopsychosocial Model:

Neuroplasticity as Active Process: By treating neural function as a trainable, primary component rather than a passive biological substrate, we empowered the patient to participate actively in his neurological recovery.

Bidirectional Causality: Changes in any component influenced others—neural regulation improved psychological capacity, psychological tools reinforced neural patterns, biological health supported both, and social connection amplified all three.

Timing and Sequencing: Early gains in neural and biological domains (weeks 1-6) appeared to create a foundation that made psychological work more effective (weeks 4-16), which then enabled social reintegration (weeks 8-16 and beyond).

Patient Experience: The comprehensive approach addressed the veteran's lived experience of PTSD as affecting "all of him," which enhanced engagement and hope compared to his previous single-modality treatment.

Considerations and Limitations

While this case demonstrated excellent outcomes, clinicians should consider:

- **Resource intensity**: This approach requires coordinated multidisciplinary care, which may not be accessible in all settings
- **Individual variability**: Response to neurofeedback varies; approximately 20-30% of individuals are considered "non-responders"
- **Contraindications**: Active seizure disorders, certain medications, and acute psychosis may require modified protocols
- **Time investment**: Full benefits emerged over 16 weeks; patients must be prepared for gradual, cumulative change rather than rapid symptom resolution

The Neural-biopsychosocial Model offers a framework for understanding and treating complex conditions like PTSD by honoring the interconnected nature of human functioning while providing specific, actionable intervention points across all domains of health.