

Introduction to Neurofeedback for Trauma: Mechanisms, Relevance, and Clinical Overview

A foundational overview for survivors and clinical practice.

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Course Objectives



Introduction to neurofeedback practice, science, and history



Research and outcomes on PTSD



Emerging clinical applications and the future use for PTSD



Important Frontloading:



“Neurofeedback” is not a regulated term. This lecture focuses on classic neurofeedback—specifically EEG biofeedback. Neurofeedback is often conflated with various “stim” devices, but these are distinct approaches, and such confusion can be misleading and triggering for some individuals.



The medical terms for brain waves are Greek letters, which carry symbolic meaning and may be triggering for some. These labels were chosen by early researchers based on the order of the Greek alphabet and the sequence in which the frequency bands were discovered.



If you feel overwhelmed, you are always free to pause, leave, or disengage without explanation; there is no expectation that you stay to the end.

History of Neurofeedback



1958-1964: Discovery

NASA & UCLA lab under Dr. Barry Sterman.



Accidental Finding

Cats became significantly more resilient to toxic exposure.



1969: Validation

Repeated experiment to validate findings (Sterman, et. al.)



Decades of Research

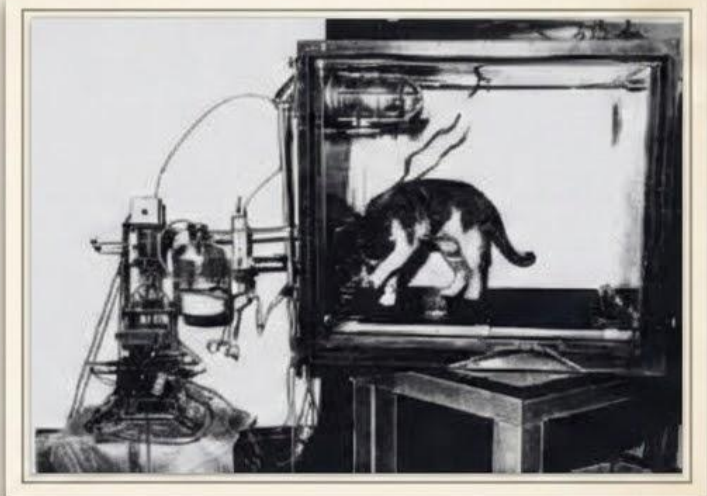
Hundreds of studies for epilepsy and trauma.



Efficacy Today

4 out of 5

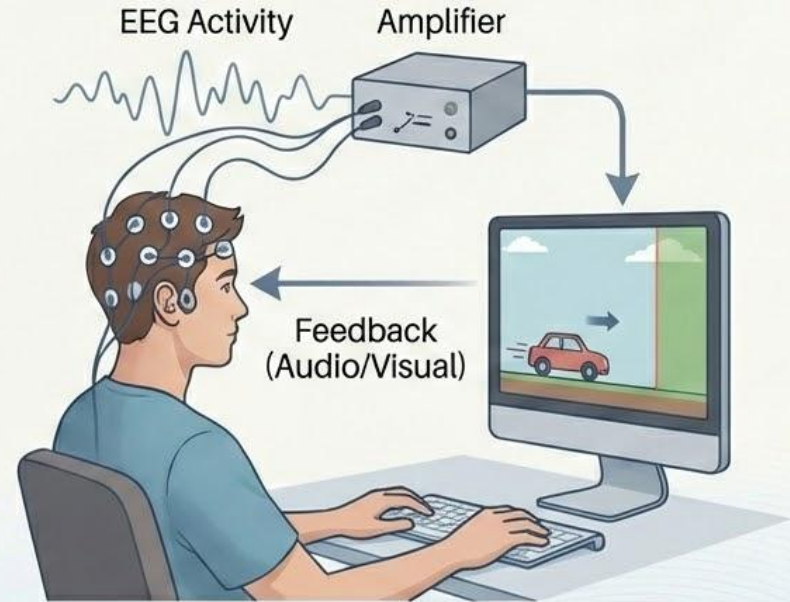
Efficacious for Epilepsy & PTSD
(Khazan, et. al., 2023)



Dr. Barry Sterman's Laboratory, c. 1960s.
The pioneering neurofeedback experiment.

What is Neurofeedback (EEG Biofeedback)?

- Non-invasive brain training method
- Based on operant conditioning principles
- Real-time monitoring of brainwave activity (EEG)
- Provides immediate audio/visual feedback to reward desired patterns



Self-Regulation Loop

The Session: A Glimpse into the Process



- **Preparation:** Sensors placed on the scalp (specific sites determined by assessment)
- **Training:** Client engages with feedback (watching a movie/game) driven by their brainwaves
- **Role of Therapist:** Monitors EEG, adjusts thresholds, provides coaching and support
- **Duration:** Typically 30-45 minute sessions, multiple sessions required

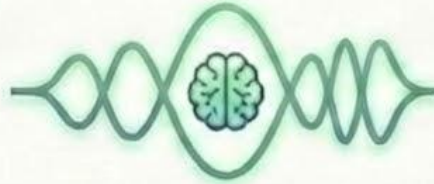
Common Neurofeedback Protocols for PTSD

Infra-Low Frequency (ILF) Training



- Focuses on very slow brain rhythms
- Stabilizes the nervous system (calming arousal)

Alpha-Theta and Alpha-Down Training



- Facilitates a deep meditative state
- Processes trauma and emotional integration

SMR (Sensorimotor Rhythm) Training



- Enhances physical calm and cognitive focus
- Reduces hypervigilance
- Stabilization

Outcomes & Path Forward

Benefits (Symptom Reduction & Regulation)

- ⬆️ Reduced symptom severity (flashbacks, anxiety, nightmares)
- 😊 Improved sleep quality and emotional regulation
- ⊕ Enhanced adjunctive therapy outcomes (e.g., talk therapy, EMDR, etc...)

Considerations (Clinical & Practical)

- ⚠️ Not a standalone "cure" (often adjunctive to psychotherapy)
- 🕒 Requires significant time commitment (multiple sessions over weeks/months)
- ⚠️ Importance of comprehensive assessment & specialized training



Integrative Treatment Approach



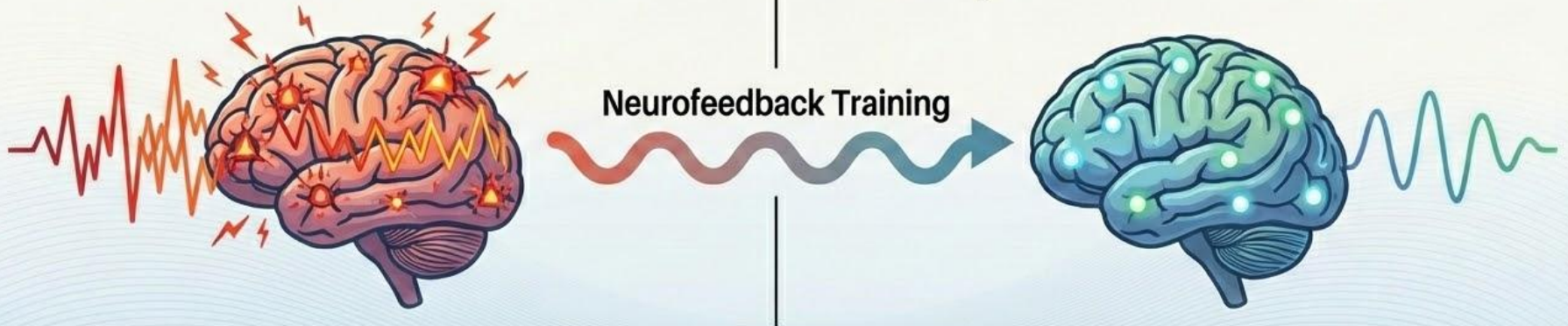
Neurobiology of PTSD & Neurofeedback's Role

PTSD Brain Dysregulation

- Autonomic nervous system (ANS) dysregulation (hyperarousal/hypoarousal)
- Altered connectivity in key brain areas (e.g., amygdala, prefrontal cortex)
- Chronic stress state, difficulty shifting states

Neurofeedback Goal: Enhanced Regulation

- Targets underlying neural dysregulation directly
- Trains self-regulation and neural flexibility
- Reduces symptom severity (flashbacks, anxiety)



Bibliography: Landmark Studies (Foundational Randomized Controlled Studies)

Gapen et al. (2016)

Gapen, M., van der Kolk, B. A., Hamlin, E., Hirshberg, L., Suvak, M., & Spinazzola, J. (2016). A pilot study of neurofeedback for chronic PTSD. *Applied Psychophysiology and Biofeedback*, 41(3), 251–261. <https://doi.org/10.1007/s10484-015-9326-5>

💡 (Proof-of-concept pilot in multiply-traumatized adults.)

Peniston & Kulkosky (1991)

Peniston, E. G., & Kulkosky, P. J. (1991). Alpha-theta brainwave neuro-feedback therapy for Vietnam veterans with combat-related post-traumatic stress disorder. *Medical Psychotherapy*, 4, 47–60.

🧠 (Classic alpha-theta protocol origin; verified as foundational for PTSD symptom reduction via theta/alpha crossover training.)

van der Kolk et al. (2016)

van der Kolk, B. A., Hodgdon, H., Gapen, M., Musicaro, R., Suvak, M. K., Spinazzola, J., & Hamlin, E. (2016). A randomized controlled study of neurofeedback for chronic PTSD. *PLoS ONE*, 11(12), Article e0166752. <https://doi.org/10.1371/journal.pone.0166752>

⚙️ (Waitlist-controlled RCT, n=52; EEG neurofeedback significantly reduced PTSD symptoms.)

A pilot study of neurofeedback for chronic PTSD by the AAPB

Summary:

- Small “proof-of-concept” study with adults suffering from chronic PTSD and multiple traumas.
- Participants had strong symptoms that were treatment-resistant.
- Received neurofeedback sessions to help the brain learn to stay calm.
- **Results:** Clear improvements in PTSD symptoms and emotion management.
- **Conclusion:** Promising early sign for long-lasting trauma; bigger studies recommended to confirm.

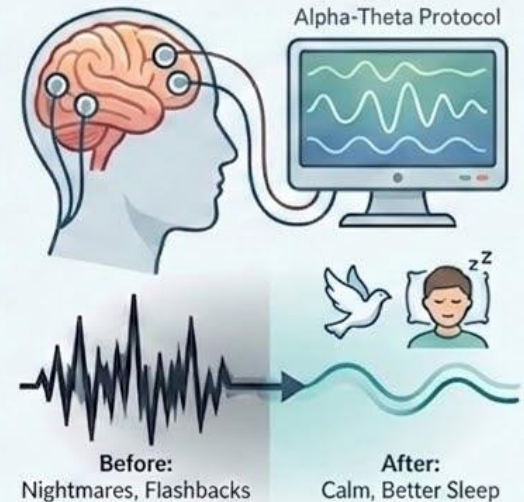


(Gapen, et. al., 2016)

Alpha-theta brainwave neurofeedback therapy for Vietnam veterans with combat-related post-traumatic stress disorder: Early Study (the one that started it all)

Summary:

In this early study, Vietnam veterans with severe combat PTSD learned to relax deeply using a special type of brain-training called alpha-theta neurofeedback. They sat quietly while sensors on their head gave them gentle feedback (like sounds or lights) whenever their brain waves slowed into a calm state. After the training, the veterans reported big drops in nightmares, flashbacks, and anxiety. Many felt calmer and slept better. This was one of the first times researchers showed that teaching the brain to produce these relaxed “alpha-theta” waves could help heal trauma symptoms.



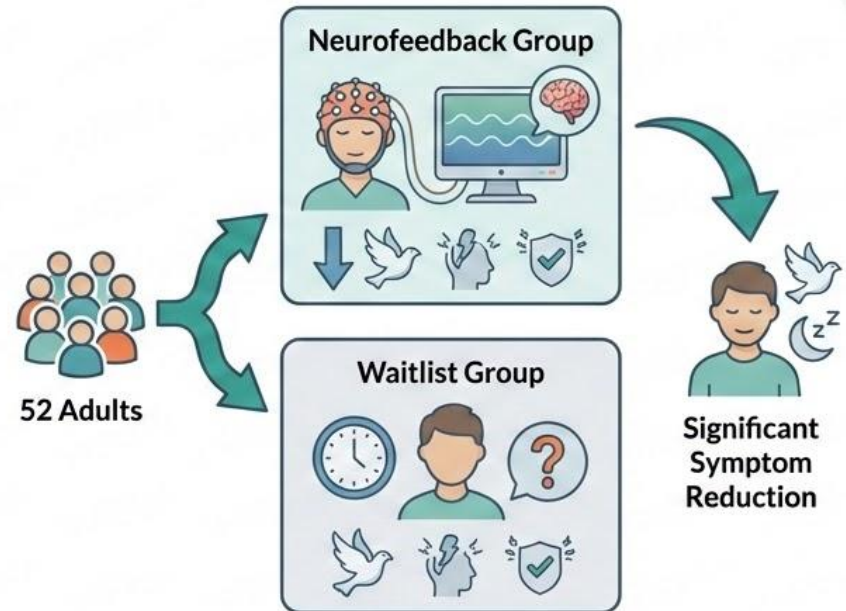
(Peniston & Kulkosky, 1991)

A randomized controlled study of neurofeedback for chronic PTSD: Landmark Study

Study Summary:

- ✓ 52 adults with long-term PTSD randomly split into two groups.
- ✓ **Neurofeedback Group:** Received 24 sessions of EEG neurofeedback (safe, non-drug brain-training).
- ✓ **Waitlist Group:** Continued usual care.
- ✓ **Results:** Neurofeedback group showed much bigger improvements in PTSD symptoms:
 - Fewer flashbacks
 - Less anxiety
 - Better emotional control
- ✓ **Benefits** comparable to leading trauma therapies.
- ✓ **Cited** for using a real comparison group.

(van der Kolk, et. al., 2016)





Let's look at some meta-analysis studies

Additional studies also listed for your reference

Neurofeedback for Post-Traumatic Stress Disorder

Systematic Review and Meta-analysis of Clinical and Neurophysiological Outcomes



Symptom Reduction:
Flashbacks, anxiety, feeling “on edge” are reduced.



Moderate Effect Size:
Clearly helpful improvements, not a “miracle cure”.



Healthier Brain Patterns:
Observed neurophysiological changes post-training.



Conclusion: Promising, safe option alongside other trauma treatments.

(Askovic, et., al., 2023)

A systematic review and meta-analysis of neurofeedback for PTSD

Summary:



Scientists examined every recent neurofeedback study for PTSD (Berman, et al., 2025).



Confirmed most helpful approaches: Alpha/theta training and alpha-down protocols.



Gently teaches brain to calm down and stay balanced.



Shows real improvements in PTSD symptoms.



Meaningful brain changes measured on EEG.



One of the core EEG-based tools for lasting relief.



Safe, non-drug, and works well as an add-on to regular therapy.

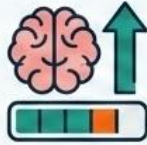
Emerging clinical Application and Future Use

Emerging clinical Application and Future Use



Federal CPT Board Lobbying

- Currently lobbying federal government.
- New CPT codes anticipated for 2027.
- New hope for insurance reimbursement via “valuation” process.



Efficacy Rating Potential

- Reasonable hope for upgrade from 4 (efficacious) to 5 (efficacious and specific).
- Driven by better recent research.



Field Growth & Challenges

- Improved access to neurofeedback.
- Increased quality control concerns with rapid growth.

Bibliography



Shaffer, F., Zerr, C. L., & Crawford, C. (Eds.). (2023). *Evidence-based practice in biofeedback and neurofeedback* (4th ed.). Association for Applied Psychophysiology and Biofeedback. (PTSD chapter rates BFB/NFB for PTSD as Level 4 / efficacious based on available RCTs)



Sterman, M. B., LoPresti, R. W., & Fairchild, M. D. (1969). *Electroencephalographic and behavioral studies of monomethylhydrazine toxicity in the cat* (AMRL-TR-69-3). Aerospace Medical Research Laboratory, Aerospace Medical Division, Air Force Systems Command, Wright-Patterson Air Force Base. <https://apps.dtic.mil/sti/pdfs/AD0691474.pdf>

Meta-Analyses & Systematic Reviews (Evidence Synthesis, 2020–2025)

Additional High-Relevance Studies (Children, Developmental Trauma, Adjunctive)

Askovic, M., Soh, N., Elhindi, J., & Harris, A. W. F. (2023). Neurofeedback for post-traumatic stress disorder: Systematic review and meta-analysis of clinical and neurophysiological outcomes. *European Journal of Psychotraumatology*, 14(2), Article 2257435. <https://doi.org/10.1080/20008066.2023.2257435> (Moderate effect sizes; highlights alpha/theta and alpha-down protocols.)

Berman, D. E., et al. (2025). Systematic review and meta-analysis of neurofeedback for PTSD. (PMC-indexed; confirms alpha/theta and alpha-down as core EEG-NF approaches with clinical gains.)

Landmark & Foundational RCTs (High-impact early studies that shaped the field)

Peniston, E. G., & Kulkosky, P. J. (1991). Alpha-theta brainwave neurofeedback therapy for Vietnam veterans with combat-related post-traumatic disorder. *Medical Psychotherapy: An International Journal*, 4, 47–60.

van der Kolk, B. A., Hodgdon, H., Gapen, M., Musicaro, R., Suvak, M. K., Hamlin, E., & Spinazzola, J. (2016). A randomized controlled study of neurofeedback for chronic PTSD. *PLoS ONE*, 11(12), e0166752.
<https://doi.org/10.1371/journal.pone.0166752>

Gapen, M., van der Kolk, B. A., Hamlin, E., Hirshberg, L., Suvak, M., & Spinazzola, J. (2016). A pilot study of neurofeedback for chronic PTSD. *Applied Psychophysiology and Biofeedback*, 41(3), 251–261.
<https://doi.org/10.1007/s10484-015-9326-5>

Alpha / Alpha-Down / Alpha-Theta Protocol Studies (Core modern alpha-focused work, especially the Lanius series)

Nicholson et al. (2023). Homeostatic normalization of alpha brain rhythms to moderate network of synaptic transmission, 3.7 (II), 83).
<https://doi.org/10.1371/journal.pone.0166733>

Shaw et al. (2023). Increased top-down control of emotions during symptom provocation on neurofeedback changing system modulation (Im., et al., Ingion. PLoS ONE, 10.(2)034.
<https://doi.org/10.1371/journal.pone.0166772>

Nicholson et al. (2020). Restoring default mode and salience network connectivity using neural point dominated anisotropic alpha network connectivity using fMRI, 41. - (3), e51–636.
<https://doi.org/10.1007/s10484-015-9326-5>

Alpha / Alpha-Down / Alpha-Theta Protocol Studies (Core modern alpha-focused work, especially the Lanius series)

Nicholson, A. A., Ros, T., Frewen, P. A., Densmore, M., Théberge, J., Kluetsch, R.C., Jetly, R., & Lanius, R. A. (2016). Alpha oscillation neurofeedback modulates amygdala complex connectivity and arousal in posttraumatic stress disorder. *NeuroImage: Clinical*, 12, 506–516. <https://doi.org/10.1016/j.nicl.2016.07.006>

Noohi, S., Miraghaie, A. M., Arabi, A., & Nooripour, R. (2017). Effectiveness of neuro-feedback treatment with alpha/theta method on PTSD symptoms and their executing function. *Biomedical Research*, 28(5), 2019–2027.

du Bois, N., Bigirimana, A. D., Korik, A., Gaju Kéthina, L., Rutembesa, E., Mutabaruka, J., Mutesa, L., Prasad, G., Jansen, S., & Coyle, D. H. (2021). Neurofeedback with low-cost, electroencephalography (EEG) reduces symptoms in chronic Post-Traumatic Stress Disorder. *Journal of Affective Disorders*, 295, 1319–1334. <https://doi.org/10.1016/j.jad.2021.08.071>

Amygdala-Targeted & Amyg-EFP Studies (fMRI-informed EEG and direct amygdala approaches)

Fruchtman-Steinbok, T., Keynan, J. N., Cohen, A., Jaljuli, I., Mermelstein, S., Drori, G., Routledge, E., Krasnoshtein, M., Playle, R., Linden, D. E. J., & Hendler, T. (2021). Amygdala electrical-finger-print (AmygEFP) NeuroFeedback guided by individually-tailored Trauma script for post-traumatic stress disorder: Proof-of-concept. *NeuroImage: Clinical*, 32, 102859. <https://doi.org/10.1016/j.nicl.2021.102859>

Fine, N. B., Helpman, L., Armon, D. B., Gurevitch, G., Sheppes, G., Seligman, Z., Hendler, T., & Bloch, M. (2024). Amygdala-related electroencephalogram neurofeedback as add-on therapy for treatment-resistant childhood sexual abuse posttraumatic stress disorder: Feasibility study. *Psychiatry and Clinical Neurosciences*, 78(1), 19–28. <https://doi.org/10.1111/pcn.13591>

Amygdala-Targeted & Amyg-EFP Studies (fMRI-informed EEG and direct amygdala approaches)

Nicholson, A. A., Rabellino, D., Densmore, M., Frewen, P. A., Paret, C., Kluetsch, R., Schmahl, C., Théberge, J., Neufeld, R. W. J., McKinnon, M. C., Reiss, J., Jetly, R., & Lanius, R. A. (2017). The neurobiology of emotion regulation in posttraumatic stress disorder: Amygdala downregulation via real-time fMRI neurofeedback. *Human Brain Mapping, 38*(1), 541–560. <https://doi.org/10.1002/hbm.23402>

Nicholson, A. A., Rabellino, D., Densmore, M., Frewen, P. A., Paret, C., Kluetsch, R., Schmahl, C., Théberge, J., Ros, T., Neufeld, R. W. J., McKinnon, M. C., Reiss, J., Jetly, R., & Lanius, R. A. (2018). Intrinsic connectivity network dynamics in PTSD during amygdala downregulation using real-time fMRI neurofeedback: A preliminary analysis. *Human Brain Mapping, 39*(11), 4258–4275. <https://doi.org/10.1002/hbm.24244>

Posterior Cingulate Cortex / Multi-Target fMRI-Neurofeedback Studies

Lieberman, J. M., Rabellino, D., Densmore, M., Frewen, P. A., Steyrl, D., Scharnowski, F., Théberge, J., Hosseini-Kamkar, N., Neufeld, R. W. J., Jetly, R., Frey, B. N., Ros, T., Lanius, R. A., & Nicholson, A. A. (2023). A tale of two targets: Examining the differential effects of posterior cingulate cortex- and amygdala-targeted fMRI-neurofeedback in a PTSD pilot study. *Frontiers in Neuroscience*, 17, Article 1229729.

<https://doi.org/10.3389/fnins.2023.1229729>

Nicholson, A. A., Rabellino, D., Densmore, M., Frewen, P. A., Steyrl, D., Scharnowski, F., Théberge, J., Neufeld, R. W. J., Schmahl, C., Jetly, R., & Lanius, R. A. (2022). Differential mechanisms of posterior cingulate cortex downregulation and symptom decreases in posttraumatic stress disorder and healthy individuals using real-time fMRI neurofeedback. *Brain and Behavior*, 12(1), Article e2441.

<https://doi.org/10.1002/brb3.2441>

LORETA Z-Score & Network-Targeted Studies

Bell, A., Moss, D., & Kallmeyer, R. J. (2019). Healing the neurophysiological roots of trauma: A controlled study examining LORETA z-score neurofeedback and HRV biofeedback for chronic PTSD. *NeuroRegulation*, 6(2), 54–72.
<https://doi.org/10.15540/nr.6.2.54>

Infra-Low Frequency (ILF) Studies

Winkeler, A., Winkeler, M., & Imgart, H. (2022). Infra-low frequency neurofeedback in the treatment of patients with chronic eating disorder and comorbid post-traumatic stress disorder. *Frontiers in Human Neuroscience*, 16, **Article 890682**.

<https://doi.org/10.3389/fnhum.2022.890682>

Pediatric / Developmental Trauma Studies

Rogel, A., Loomis, A. M., Hamlin, E., Hodgdon, H., Spinazzola, J., & van der Kolk, B. (2020). The impact of neurofeedback training on children with developmental trauma: A randomized controlled study. *Psychological Trauma: Theory, Research, Practice, and Policy*, 12(8), 918–929. <https://doi.org/10.1037/tra0000648>

Other Controlled Trials & Practical/Adjunctive Studies

Leem, J., Cheong, M. J., Lee, H., Lee, S. Y., Kim, G.-W., & Kang, H. W. (2021). Effectiveness, cost-utility, and safety of neurofeedback self-regulating training in patients with post-traumatic stress disorder: A randomized controlled trial. *Healthcare*, 9(10), Article 1351. <https://doi.org/10.3390/healthcare9101351>

Nicholson, A. A., Ros, T., Jetly, R., & Lanius, R. A. (2020). Regulating posttraumatic stress disorder symptoms with neurofeedback: Regaining control of the mind. *Journal of Military, Veteran and Family Health*, 6(S1), 3–15. <https://doi.org/10.3138/jmvfh.2019-0032>

Questions & Answers

Open discussion on neurofeedback for trauma.

- Mechanisms & Science
- Clinical Applications
- Patient Experiences & Outcomes
- Future Directions

