pIR HEG Neurofeedback for more than migraines: A qualitative and quantitative analysis

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Learning Objectives

- Participants will understand the use of pIR HEG in the treatment of anxiety, depression, stress, and trauma through an analysis of qualitative and quantitative findings.

- Participants will be able to describe 4 aspects of a more regulated brain across behavioral health diagnoses as informed by pIR HEG outcomes.

- Participants will be able to describe the key role for fostering self-efficacy and reflective learning as part of Neurofeedback treatment in order to achieve efficient and sustainable progress toward health.
Neurofeedback Methods

- EEGs – assess brain waves
- Hemoencephalography - assess heat in brain areas as an indicator of cerebral metabolism
- Trainees receive feedback in the form of graphic signals
Hemoencephalography (HEG)

- HEG was developed in late 1990’s as a newer alternative method of brain training
- niR HEG- near infrared HEG (Toomin)
  - Also referred to as fNIRS
- pIR HEG- passive infrared HEG (Carmen)
- Both systems are based on photon detection making them immune to electrical signal artifacts including eye movements. Both train the PFC using a headband.
- Both systems are particularly easy to use
The brain and heat (Toomin and Carmen, 2009)

- HEG is poor man’s MRI

- Brain weighs 3 lbs yet at rest uses about 1/5 of all fresh blood leaving your heart. It uses about 10x as much blood per pound than the rest of your body

- Voluntary increases in cellular activity in the PFC as measured through heat activity form the basis of cerebral exercise

- Cerebral exercise in brain regions affects dependent variables of blood flow and brain waves
Summary of HEG Clinical studies

- pIR HEG - improvement in migraine headaches
  - Carmen (2004)
  - Stokes & Lappin (2010)
  - Walker & Lyle (2016)

- nIR HEG (Kohl et al, 2020)
  - Majority of studies 5 sessions or less; most applied to healthy individuals
  - Several studies show that fNIRs-Neurofeedback can be used to regulate brain activity
  - Preliminary evidence for improvement of motor rehabilitation, executive functions and cognitive flexibility
  - Portable wireless FNIRS devices have been developed that can be used outside the office
pIR HEG (Carmen)

- All training at Fpz

- pIR HEG does not introduce any signal into the brain
  - “Measuring excess thermal energy generated by brain cells, vascular supply, and vascular return” (Carmen) as a measurement of PFC brain activity

- Sessions have been shown to produce a reduction of thermal variability as measured by infrared camera before and after training

- While Toomin’s work evolved in the direction of specificity of site monitoring, Carmen’s work evolved in the direction of generalized monitoring, creating a sensor with a very large field of view
pIR HEG infrared imaging studies

- Coben et al 2008
  - Reliability of infrared images
  - 87% of patients with TBI increased thermal readings after pIR HEG. Significant association between changes in IR images and EEG connectivity
HEG is Direct training of PFC

- Most behavioral problems are a result of PFC-related problems (Toomin)

- Regardless of the primary problem being targeted, both pIR and nIR result in a brain that functioned better in terms of self regulation.
Wide applicability of PFC training

- One of the most important aspects of the frontal lobes is regulation of the other brain modules so that they all work together.

- The PFC coordinates activation and inhibition for the rest of the brain.

- Clinical problems are often associated with responses by the brain to relatively minor stimuli that are “excessive in terms of both rate and magnitude” (Carmen).

- Increasing the level of control the brain exerts over its own activities may be useful across a wide variety of disorders or dysfunctions.
Long Term potentiation- most widely accepted learning theory. “What fires together wires together”

• The more a group of neurons in the amygdala fire together, the more apt they are to do that in a repetitive loop.
Activity in prefrontal area and limbic system are inversely related to each other.
Prefrontal cortex

- It has many important functions but its primary job is to inhibit the limbic system

- When the amygdala becomes overactive, the prefrontal cortex becomes underactive (it is not as essential for survival) leading to:
  - Attention problems
  - Impulsivity
  - Anxiety
  - Depression
  - Helplessness
  - Hopelessness
  - Lack of self management and effective problem solving (decreased executive functioning)
What happens when a brain is dominated by the Limbic system (across diagnoses)

- Inflexible
- Helpless, Stuck
- Hopeless (suicidal)
- On edge, tense, irritable
- Scattered, indecisive
- Overwhelmed
- Over-reactive
- Anxious
- Shut down, depressed
- Hypervigilant
- Numbing
- Procrastinating
- Ruminative
- Avoidant
- Tired
- Digestive problems
- Physical pain

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Stress Sensitization across diagnoses

- Stress sensitization results in a brain rigidly stuck in high arousal
- Stress sensitization is a major component of the manifestation of mental and behavioral problems
Increasing cellular activity in PFC increases overall brain regulation (Toomin & Carmen)

- Increase suboptimal function in PFC, increasing the brain’s inhibitory control over amygdala and other brain areas
- If no suboptimal function, level of inhibition may also compensate for malfunctioning brain modules far removed from the front of the brain
- Like other Neurofeedback methods, changes in the brain can be observed far from the site of training
Jeff Carmen’s EZPIR system

- It uses real emotional triggers (through movie) to elicit response
- Stimulates practice moving between brain states
- Regular movie DVD plays
- When heat decreases in prefrontal area as detected by headband, movie stops
- Bar graph appears that provides info on heat level in prefrontal area
- Raise the bar graph (and the heat) to the top to get the movie to play again (intentional effort to focus and relaxed attitude/muscles)
At the beginning, I was skeptical.
My approach:

- Experiment with people who I had been seeing (I know their baseline and presentation from week to week)
- Implemented it exactly as Jeff Carmen recommends. (First do not harm)
- Capture people’s exact words and changes in their behavior
- Evaluate carefully before implementing it more widely
- My observations are based on a pure test of pIR HEG, no other Neurofeedback methods used

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Changes noted at 4-5 sessions

- The pause
- “I” statements, decisions and boundaries, clarity
- More reflective, more open, thinking in new ways (integrated)
- What used to bother them and why, what they felt capable of doing and not doing, the stuck places all started to change
- Seen in both people with significant trauma and people with less
- Some non-responders but very few
- Some cases that made my head spin
Case Study - Abigail

- 22 years old, Pregnant with 1st child, inconsistent relationship with boyfriend and lots of relationship drama and changes

- Previously on Lithium, Klonapin, and Abilify to manage significant PTSD

- Regular Panic attacks, Nightmares

- A lot of anger escalations

- Many disruptions in treatment - irregular attendance

- 20 therapy sessions then 4 Neurofeedback sessions spread apart by at least a month in between each!
Abigail

By session 4 - Nightmares decreased

“It’s been all about self control lately”

By session 5 - Less panic and self doubt

“Everything is manageable” “Everything is temporary”

“I feel odd” - neutral in emotional conversations
Abigail

By session 10

- kicking dangerous people out of her life, less drinking
- more self control “No reaction is a reaction”
- “I never get sad anymore. I can feel resentful but not sad. I don’t fall into the depths of despair anymore.”
- “My head feels open”; “I am hopeful, confident, less timid”
- begins to open up about dissociation
Abigail

By Session 11

- got order of protection and custody/child support filed with courts so that can’t keep going back with father of child who is emotionally abusive
- setting clear limits with parents that she will not talk to them if they are abusive
- taking control of independent financial situation
- Re-evaluating medical providers and making new plans
- Stopped habitual drinking; Marijuana decreased by at least 50%
Case Study: Melanie

- Extremely anxious, visibly fidgeting
- Difficulty tolerating the process of therapy
- Too scared to get vaccinated for COVID, health anxiety in the way of medical appts
- “always anxious”, guilty, avoiding, self-doubting, overwhelmed
- When tried to process medical trauma with EMDR therapist: flooded, shut down

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After 4 sessions

- Emailed teacher to request a change in vaccine field trip policy
- Able to discuss sensitive topics (vaccines) without getting flooded
- Went to dentist appt, did not cancel, “I realized that all the worry was not necessary”

After 5 sessions

- “My anxiety gets high but I get over it quickly”
- “I am enjoying things more. I feel happy vs. in the past when I’d feel anxious or just not happy”

After 7 sessions

- “This is usually a hard week for me, I would be cleaning with intense aggravated energy. It’s not overwhelming me now.”
- “I am ruminating less. I am able to notice when I am ruminating and I can stop”

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After 8 sessions

- “My marriage is shifting in a positive way. I realized he is not doing anything wrong and either am I. My brain talked me out of reacting in anger”

After 10 sessions

- Able to tolerate (usually very stressful) visit with parents- “easier to manage and I could enjoy myself”

After 11 sessions

- Got vaccinated for COVID!

After 19 sessions

- Tolerating EMDR

After 21 sessions

- Went to a full exam visit with Dr. “It was really good. I was in my body. I was present”
Neurofeedback sessions in 5 years in my practice

- Over 95 patients
- Over 1400 sessions; Mean number of sessions= 15, median=12 (number of sessions ranged 3-53)
- Primary diagnosis:
  - 41% PTSD
  - 26% Anxiety
  - 9% Depression
  - 7% ADHD
  - 11% Adjustment D/O
  - 7% other
  - 12% comorbid addiction
- 23 male, 62 female
- Most have been in psychotherapy already for some period of time
Implementation

- Sessions are no more than 1x/week
- Pause time is no more than 10 min (less pause time if there are signs of fatigue)
- Pause time is the critical independent variable
- **Attention to frontal fatigue** (ideal is 1:3 Pause time to Elapsed time, e.g., 10 minutes of pause time in 30 min of elapsed time from the beginning of the baseline period)
- Selecting movies. This was relatively across more than 95 patients. People intuitively pick movies that work. Many good movies resonate with people emotionally- mild-moderate emotions are sufficient to provide a drop in the signal and allow the program to work.
Added Quantitative measures

- GAD-7 Generalized Anxiety Disorder-7
- PHQ-9 Patient Health Questionnaire-9 (major depressive disorder)
- CSE- Coping Self Efficacy
- GSE- Global Self Efficacy

- Limbic Overload© – created it intuitively based on the actual reports from my initial clients
Limbic Overload®

Sample questions: (rated on 10 pt scale from NEVER to ALL THE TIME)

2. I feel stuck, unable to change.
3. I feel panicky and anxious in my body.
4. I feel helpless.

5. I feel on edge/ hypervigilant.
6. I am scattered in my mind and can’t focus.

7. I find myself overreacting emotionally.

9. I numb, distract, and/or avoid things

11. I can’t make decisions.

13. I feel like hiding rather than reaching out.

15. I am tired in my body.
16. I have symptoms of digestive problems.
Multiple data points

- Measures are collected after 5 sessions, 10 sessions, 15 sessions, and 20 sessions
- Ask several questions each session to collect individualized observations with the direct quotes
Preview of Data

- N=40 T1 and T2 (after 5)
- N=25 T1 and T3 (after 10)
- N=11 T1 and T4 (after 15)

- Of the 40, 19/40 have PTSD
- 12 male, 28 female
Anxiety

One way paired ttests. Statistical significance after 5 sessions (n=40) p<.05; after 10 (n=25) ns, after 15 (n=11) p<.01
Depression  One way paired t-tests. Statistical significance after 5 sessions (n=40) ns; after 10 (n=25) <.01, after 15 (n=11) p<.01
One way paired t-tests. Statistical significance after 5 sessions (n=40) ns; after 10 (n=25) ns, after 15 (n=11) p<.01
Coping Self-efficacy

One way paired t-tests. Statistical significance after 5 sessions (n=40) < .01; after 10 (n=25) ns, after 15 (n=11) p< .01
General Self Efficacy

One way paired t-tests. Statistical significance after 5 sessions (n=40) < .01; after 10 (n=25) < .01, after 15 (n=11) p < .05
Significant differences

• 15 sessions of pIR HEG Neurofeedback leads to statistically significant changes across all measures (paired one way t-tests)

**15 sessions occur over at least 15-20 weeks.

• Gains are progressive. The gains that occur after 5 sessions continue to increase after 10 and further increase after 15 sessions.
  • After 10 (T3) means are significantly different from After 5 means (T2)
  • After 15 means (T4) means are significantly different from After 10 means (T3)
  • Anxiety shows a mixed pattern
4 key aspects of the changes unfolding from a more regulated brain

• Quieting the nervous system
• Window of Tolerance expands
• Spontaneous self agency, self efficacy
• Spontaneous self observations and capacity for reflective learning
Self Efficacy

- “Self efficacy refers to people’s beliefs in their capabilities to exercise control over their own functioning and over events in their lives” (Bandura, 1997)

- GSE linked is correlated with both mental health and physical health behaviors and outcomes

- Bandura theorized that emotional states are one of 4 main determinants of self efficacy

- Predictor of learning, coping, motivation
BANDURA'S SELF-EFFICACY THEORY

Influences
- Performance Accomplishments
- Vicarious Learning
- Social Persuasion
- Emotional Arousal

Perceived Self-Efficacy

Possible Outcomes
- Persistence
- Performance
- Approach versus Avoidance
“Neurofeedback prepares the brain for new learning as it relaxes firing patterns that sustain fear”

- Sebern Fisher, PhD, Neurofeedback in the treatment of developmental trauma: Calming the fear-driven brain, p. 73
Led to a new focus in sessions

- Notice where there is new learning. Facilitate it.

- Questions to ask to enhance self agency/empowerment and reflective learning/self awareness/integration of changes, for example
  - What surprised you? (Sebern Fisher, 2014)
  - What did you notice about your reactions to stressful moments?
  - Is that different than in the past?
  - Is that a new thought?
  - How did you experience it this time?
  - What led to that decision?

- Nervous system informed Motivational Interviewing
  - Build self efficacy- Interpret changes in light of regulation, inhibition, self agency, capability, stress resilience, emotional tolerance.
  - Help affirm observations, decisions, and the reasons for them
  - Draw attention to past successes, strengths, internal and external resources

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Lessons learned

- pIR HEG is non-invasive, safe and easy to implement with no concerning or negative responses observed
- Useful across diagnoses for stress, trauma, anxiety, depression, ADHD, addiction
- For people with developmental trauma, it is not just a method to enhance learning, it is a game changer in the experience of an embodied self.
- Changes can be observed quickly, in the matter of weeks and when motivational interviewing is applied, 12-20 sessions can lead to significant changes
- Can be successfully implemented 1x per week; very complementary to psychotherapy suggesting wide applicability of clinical use in mental/ behavioral health
- Changes appear to be self perpetuating
Hypothesis of Stress Regulation and Learning Model©:

- What we see in pIR HEG Neurofeedback is a global movement toward health mediated by an enduring increase in Self Efficacy and Sense of Coherence.

- pIR HEG Neurofeedback ignites a dynamic process of learning and adaptability that progresses toward health
“It is not the strongest of the species that will survive nor the most intelligent, but the one most responsive to change.
-Charles Darwin
Salutogenic model of Health (Antonovsky, 1979)

- Stressors create tension which if unresolved creates disease. Successful management of tension leads to health.

- Successful tension management/active adaptation to stressors is achieved when one has a Sense of Coherence (SOC) – “global orientation of enduring confidence that stressors are predictable, comprehensible, manageable, and that the demands are challenges, worthy of investment and engagement (meaningful)”

- Studies have shown the that a high SOC determines the stable development of SOC (self perpetuating)
pIR HEG can help people resolve arousal/tension in their systems

- Better brain regulation relieves tension in the system
- Emotions are less overwhelming
- People bounce back from difficult experiences more easily
- People can process grief and loss without being flooded; less inhibited grief means less tension which moves people in the direction of health
- People can tolerate trauma-based therapy like EMDR
Preliminary results BDES (dissociation)

- Pt 1
- Pt 2
- Pt 3
- Pt 4
- Pt 5

Baseline: Pt 1 = 14, Pt 2 = 12, Pt 3 = 9, Pt 4 = 6, Pt 5 = 8
After 5: Pt 1 = 14, Pt 2 = 10, Pt 3 = 8, Pt 4 = 4, Pt 5 = 4
After 10: Pt 1 = 14, Pt 2 = 9, Pt 3 = 8, Pt 4 = 4, Pt 5 = 8
After 15: Pt 1 = 14, Pt 2 = 6, Pt 3 = 6, Pt 4 = 5, Pt 5 = 4
After 20: Pt 1 = 14, Pt 2 = 1, Pt 3 = 8, Pt 4 = 1, Pt 5 = 8
Limbic Overload© Analysis Dx

- At baseline, there is a significant difference in scores between PTSD and Non-PTSD groups.

- After 5, PTSD group’s mean resembles non-PTSD group.

<table>
<thead>
<tr>
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<th>PTSD Group (n=19)</th>
<th>Non-PTSD Group (n=23)</th>
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<tbody>
<tr>
<td>Baseline (T1)</td>
<td>119</td>
<td>103</td>
</tr>
<tr>
<td>After 5 (T2)</td>
<td>95.7</td>
<td>83.48</td>
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- Across both groups, 82% had scores over 85 at baseline.
- 19 people dropped 25 points or more (half PTSD and half not PTSD).
- Change from T1 to T2 significant for both PTSD and Non-PTSD group.
Stress Regulation and Learning Model ©

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Health

Sense of Coherence

Self Efficacy/Empowerment and Reflective Learning
(nervous system informed motivational interviewing)

Neurofeedback (Neuroplasticity through brain learning; Foundation of emotional tolerance)
December clinical training

- Key brain principles to inform use of pIR HEG clinically like stress sensitization, stress resilience, dissociation, window of tolerance, states, inhibited grief, tension-relieving activities, etc
- More case studies
- More data will be shared, diagnosis focused analysis, especially in regard to PTSD
- Clinical observation and understanding of changes with pIR HEG Neurofeedback - how to assess them in real time and use them to make quick progress
- SRL© will be discussed in more depth - connection to motivational interviewing and salutogenic model
- Visit wellbeingcny.com for more information.

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Future Research ideas

- Controlled outcome study of pIR HEG in clinical mental health
- Pre/post QEEG analysis before and after 15 sessions of pIR HEG
- Follow up study- symptom and behavioral outcomes 6 or 12 months post pIR HEG Neurofeedback for clinical mental health conditions
- Collaboration on these ideas welcomed. Email me wellbeing.cny@gmail.com

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