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

Christine Tyrrell Baker, PhD
WellBeing CNY
www.wellbeingcny.com
Email: wellbeing.cny@gmail.com

Christine Tyrrell Baker, PhD © 2022

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.

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

Hemoencepahalography (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

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

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.

Christine Tyrrell Baker, PhD © 2022

Wide applicability of PFC training

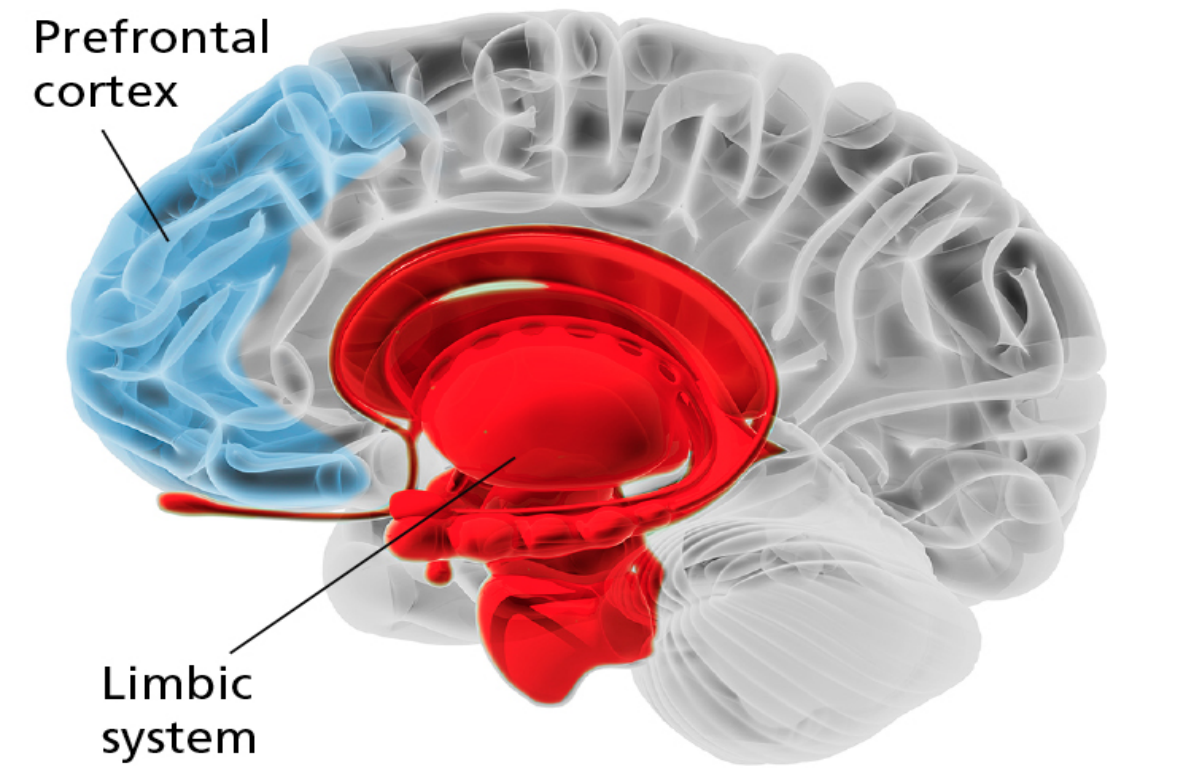
- One of the most important aspects of the frontal lobes is regulation of the other brain modules so that they all work together
- The PFC coordinates activation and inhibition for the rest of the brain
- Clinical problems are often associated with responses by the brain to relatively minor stimuli that 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

Christine Tyrrell Baker, PhD © 2022

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



Christine Tyrrell Baker, PhD © 2022

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)

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

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)

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

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!

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

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%

Christine Tyrrell Baker, PhD © 2022

Case Study: Melanie

- Extremely anxious, visably 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

Christine Tyrrell Baker, PhD © 2022

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”

Christine Tyrrell Baker, PhD © 2022

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”

Christine Tyrrell Baker, PhD © 2022

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 addcition
- 23 male, 62 female
- Most have been in psychotherapy already for some period of time

Christine Tyrrell Baker, PhD © 2022

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.

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

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.

14. I am overwhelmed.
15. I am tired in my body.
16. I have symptoms of digestive problems.

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

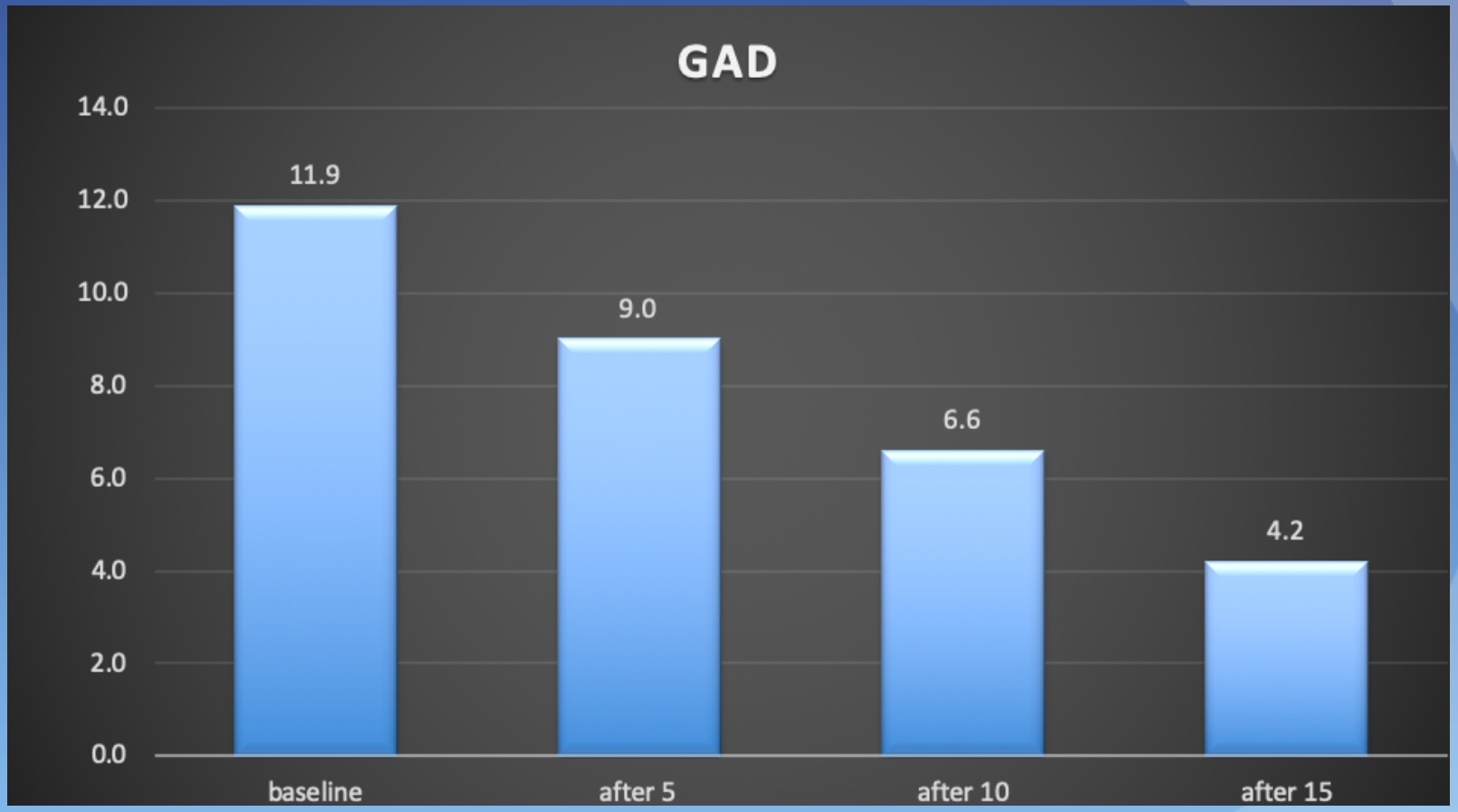
Preview of Data

- 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

Christine Tyrrell Baker, PhD © 2022

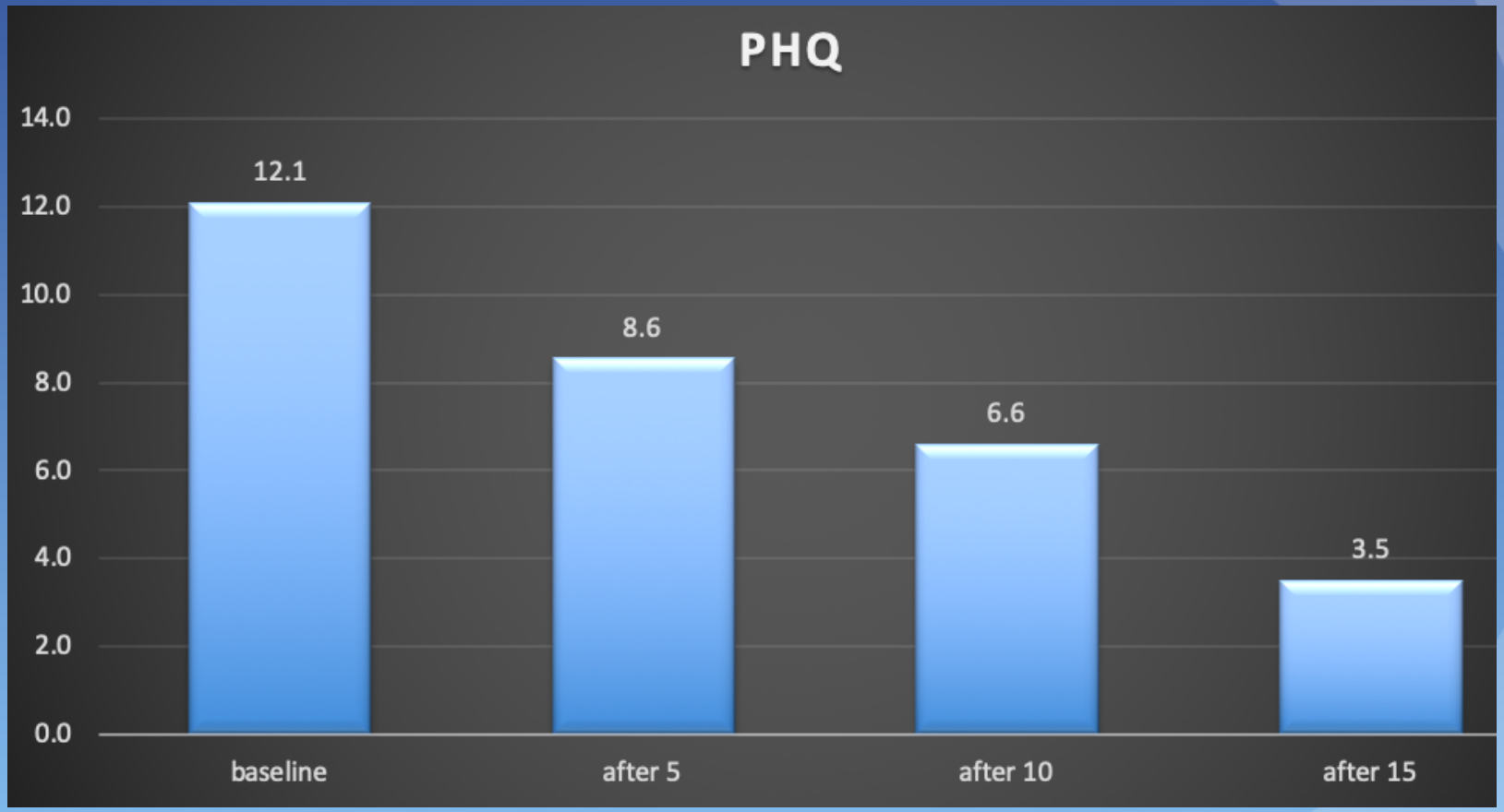
Anxiety One way paired ttests. Statistical significance after 5 sessions (n=40) p<.05; after 10 (n=25) ns, after 15 (n=11) p<.01



Christine Tyrrell Baker, PhD © 2022

Depression

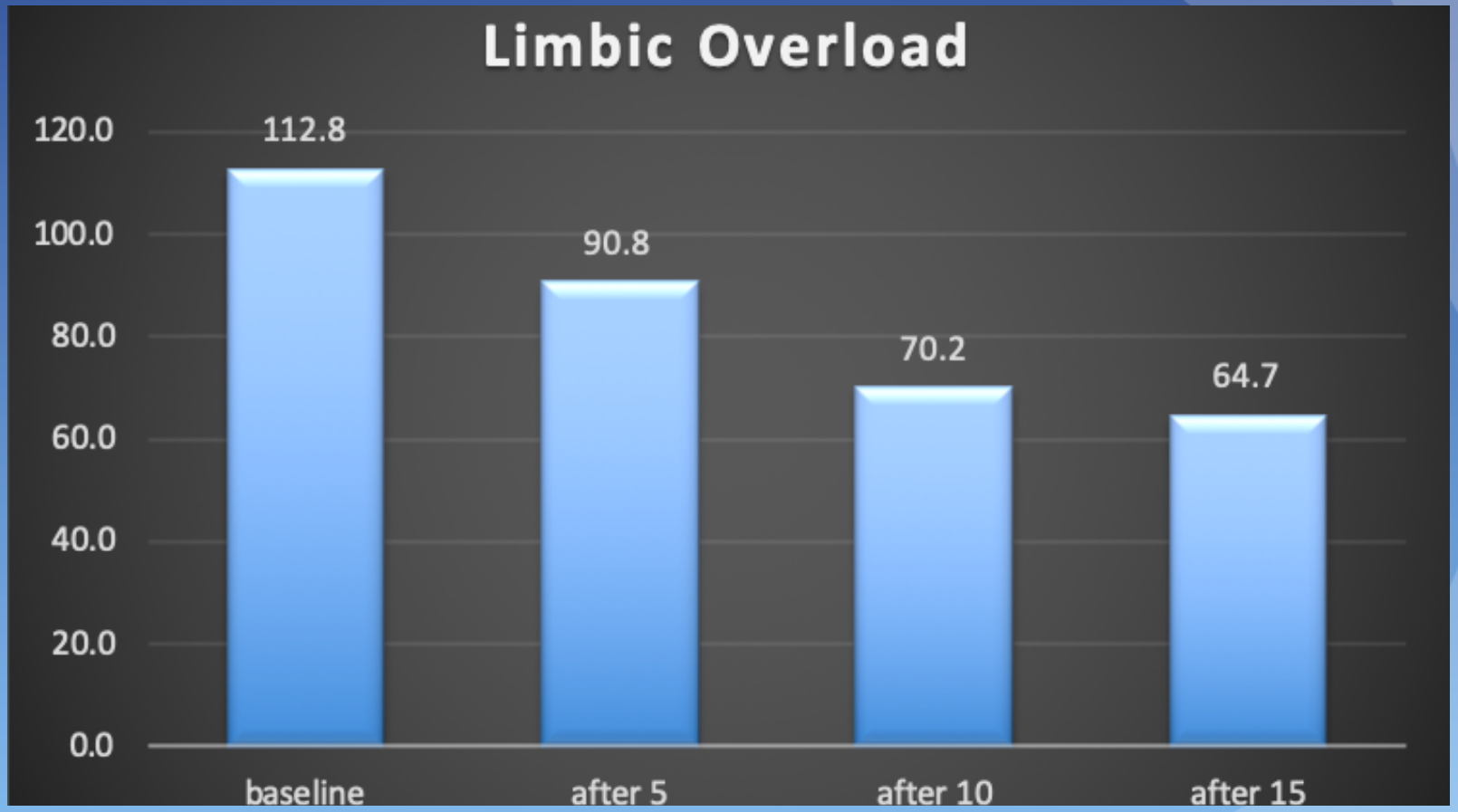
One way paired ttests. Statistical significance after 5 sessions (n=40) ns; after 10 (n=25) <.01, after 15 (n=11) p<.01



Christine Tyrrell Baker, PhD © 2022

Limbic Overload©

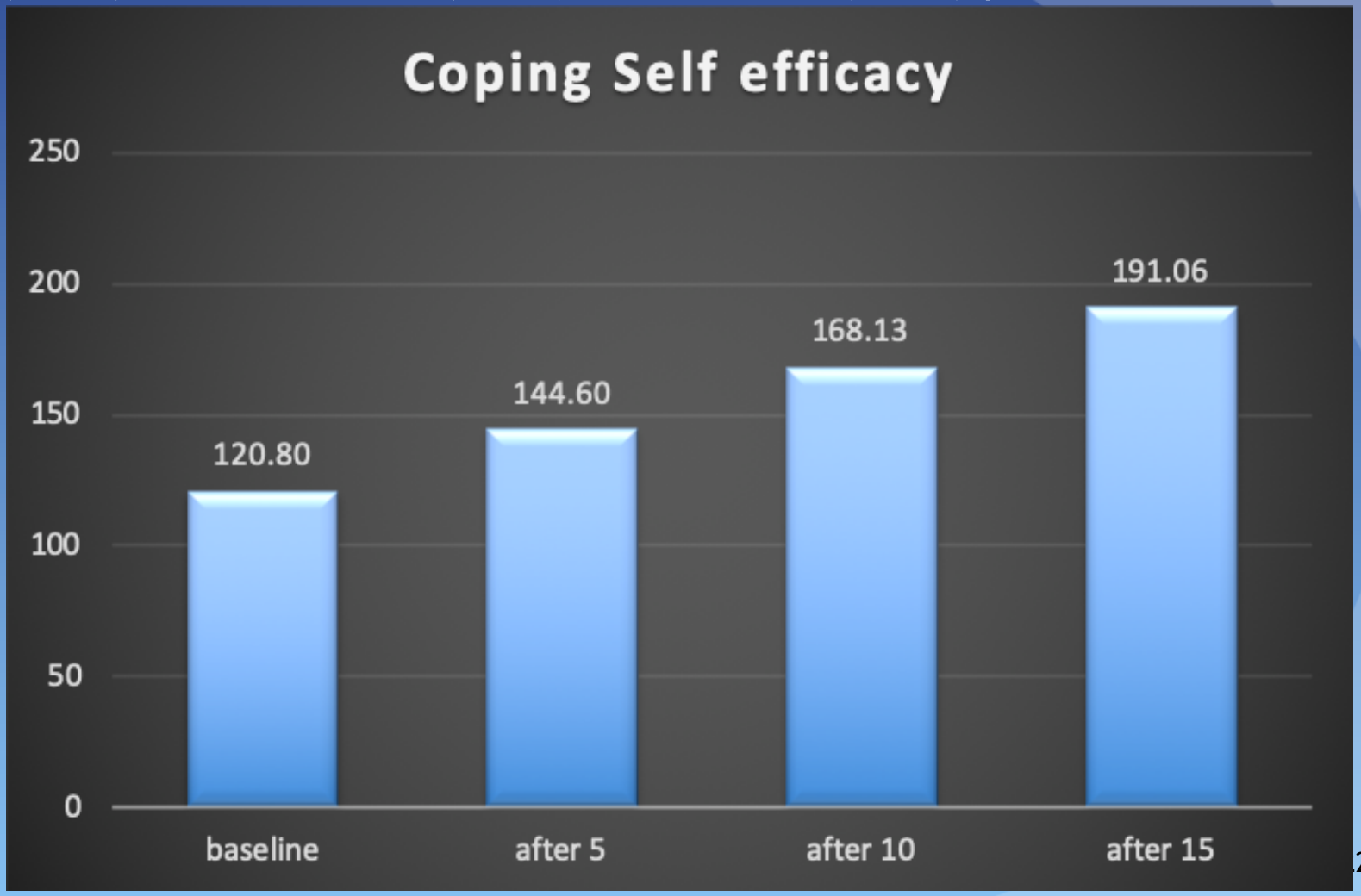
One way paired ttests. Statistical significance after 5 sessions (n=40) ns; after 10 (n=25) ns, after 15 (n=11) p<.01



Christine Tyrrell Baker, PhD © 2022

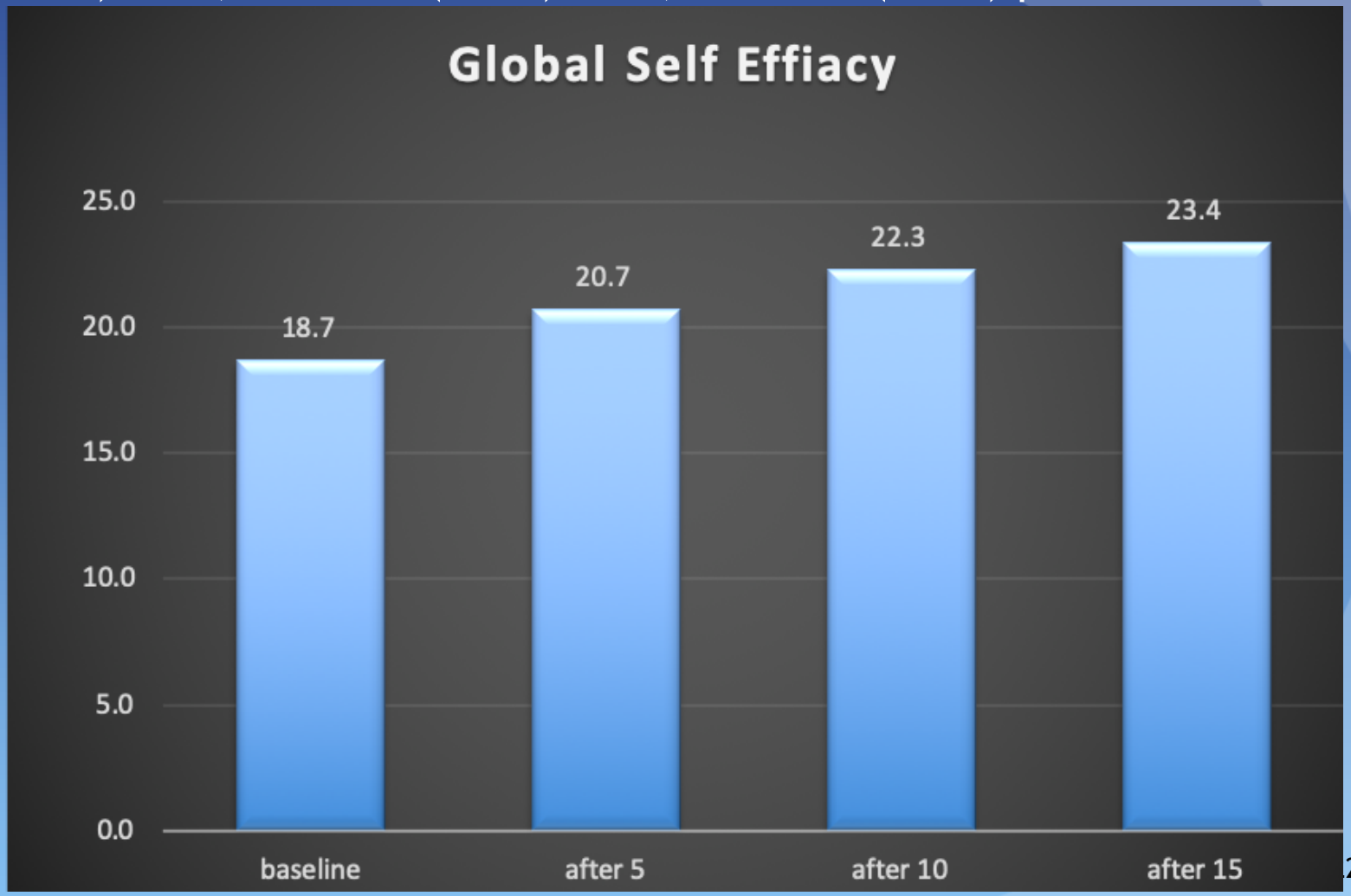
Coping Self-efficacy

One way paired ttests. 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 ttests. 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 the 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

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

BANDURA'S SELF-EFFICACY THEORY

Influences

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

Perceived Self-Efficacy

Possible Outcomes

- Persistence
- Performance
- Approach versus Avoidance

Christine Tyrrell Baker, PhD © 2022

“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

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022

“It is not the strongest of the species that will survive nor the most intelligent, but the one most responsive to change.
-Charles Darwin

Christine Tyrrell Baker, PhD © 2022

Salutogenic model of Health (Antonovsky, 1979)

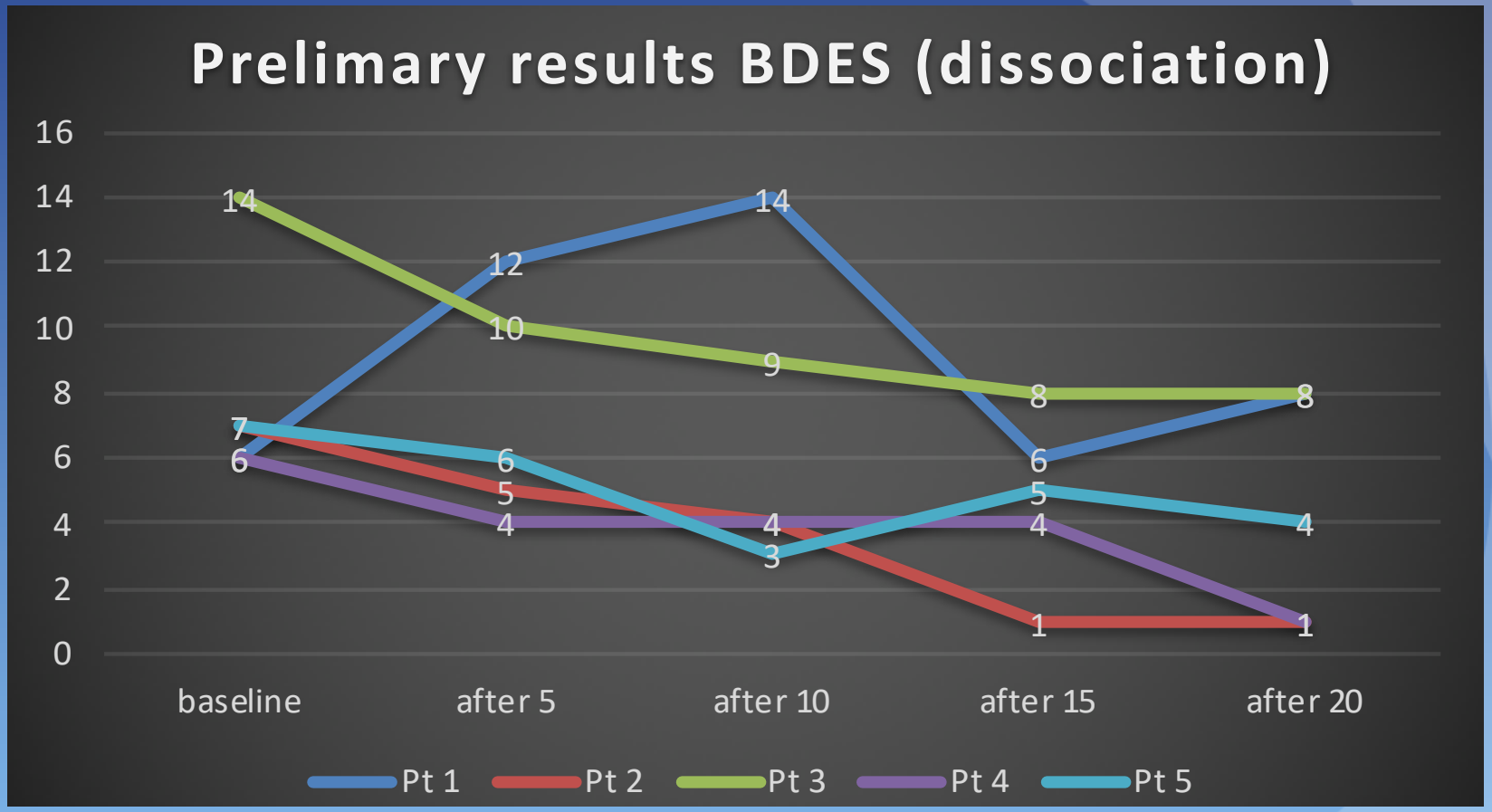
- Stressors create tension which if unresolved creates disease. Successful management of tension leads to health
- Successful tension management/active adaptation to stressors is achieved when one has a **Sense of Coherence (SOC)** – "global orientation of enduring confidence that stressors are predictable, 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)

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022



Christine Tyrrell Baker, PhD © 2022

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

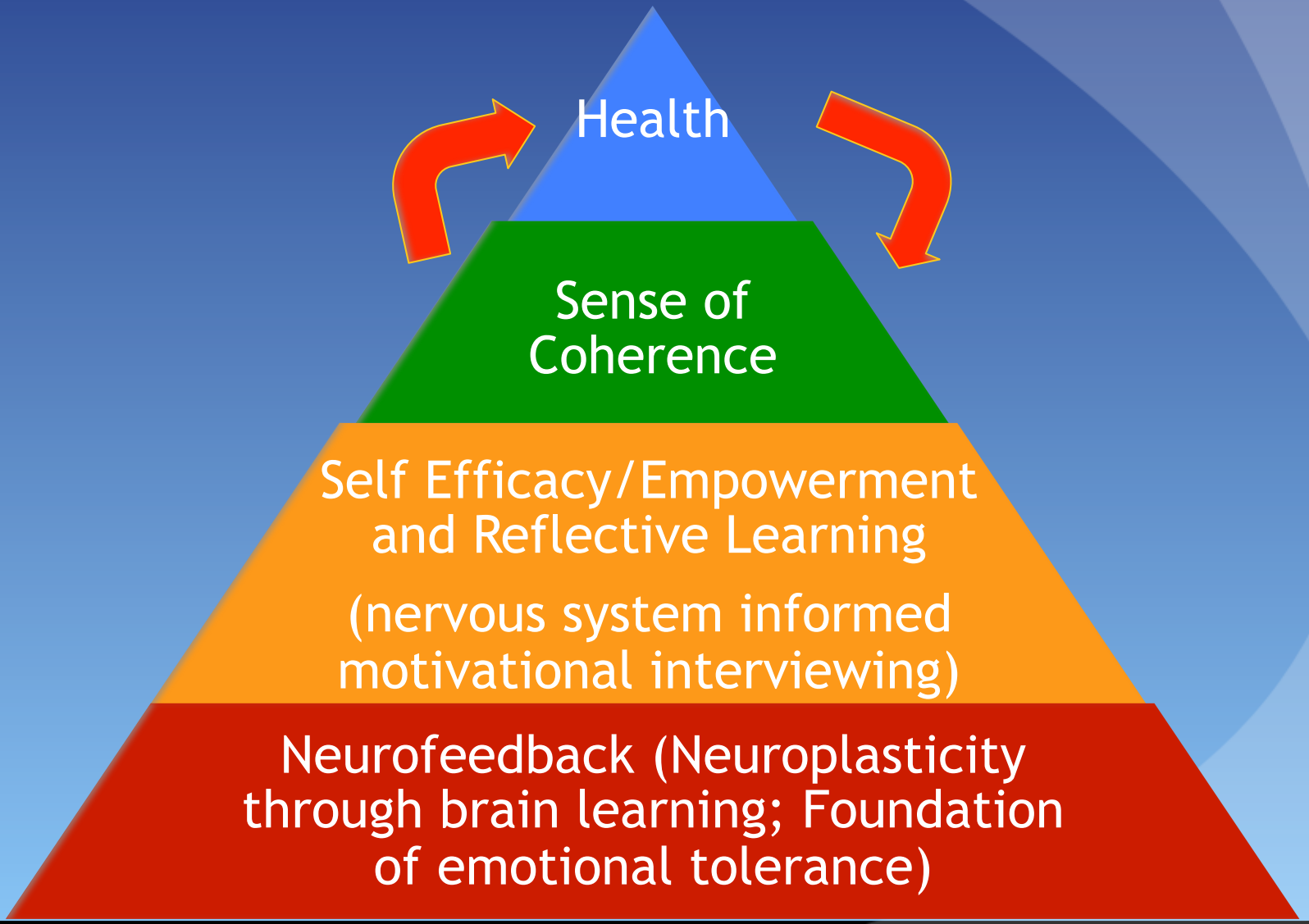
	PTSD Group (n=19)	Non-PTSD Group (n=23)
Baseline (T1)	119	103
After 5 (T2)	95.7	83.48

- 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

Christine Tyrrell Baker, PhD © 2022

Stress Regulation and Learning Model©

Christine Tyrrell Baker, PhD © 2022



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.

Christine Tyrrell Baker, PhD © 2022

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

Christine Tyrrell Baker, PhD © 2022