

Stress Regulation and Learning Model©: Enhancing mental health outcomes through Neurofeedback targeting the Prefrontal cortex

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The role of technology in mental health

Now is the time...

- Since the 1950's psychiatric drugs have been the technology development of "our time"
- With new emphasis on stress, trauma, and regulation, our models are changing again
- "The way medicine approaches human suffering has always been determined by the technology available at the time"

van der Kolk, Body Keeps the Score, p. 27

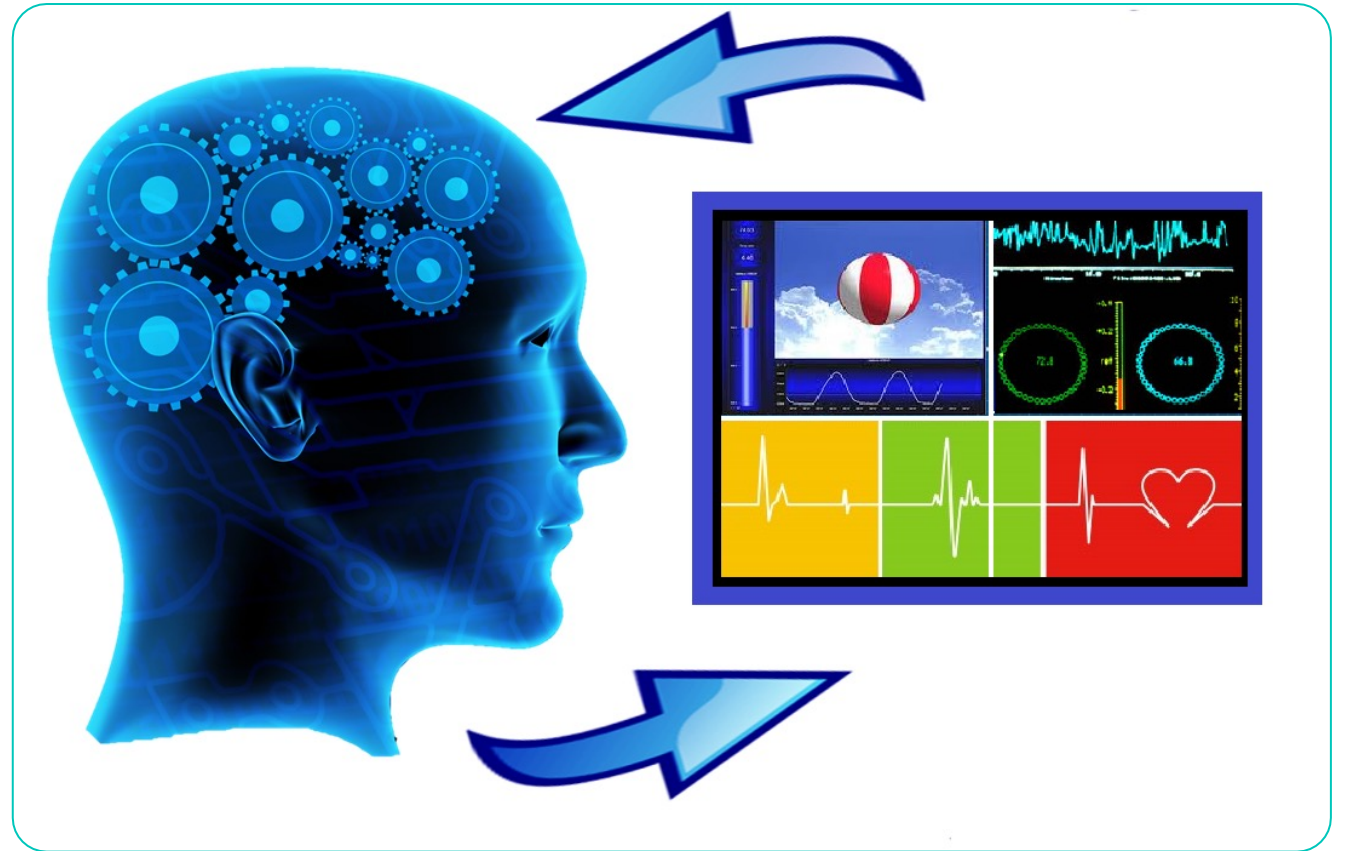
Learning Objectives

- Participants will understand what Biofeedback and Neurofeedback are and **why brain-based learning is relevant to mental health treatment** for anxiety, depression, stress, and trauma.
- Participants will be able to describe how the **brain changes under stress**, particularly the relationship between the prefrontal cortex and amygdala

Learning Objectives

- Participants will be able to describe 4 key changes unfolding from a more regulated brain and how these can enhance the process of psychotherapy.
- Participants will be able to describe the relationship between Neurofeedback targeting the prefrontal cortex, enhanced emotional tolerance, and coping self-efficacy
- Participants will be able to understand the Stress Regulation and Learning Model© framework to observe changes and to strengthen new awareness and new brain patterns in clients.

Neurofeedback is Learning Technology



Biofeedback

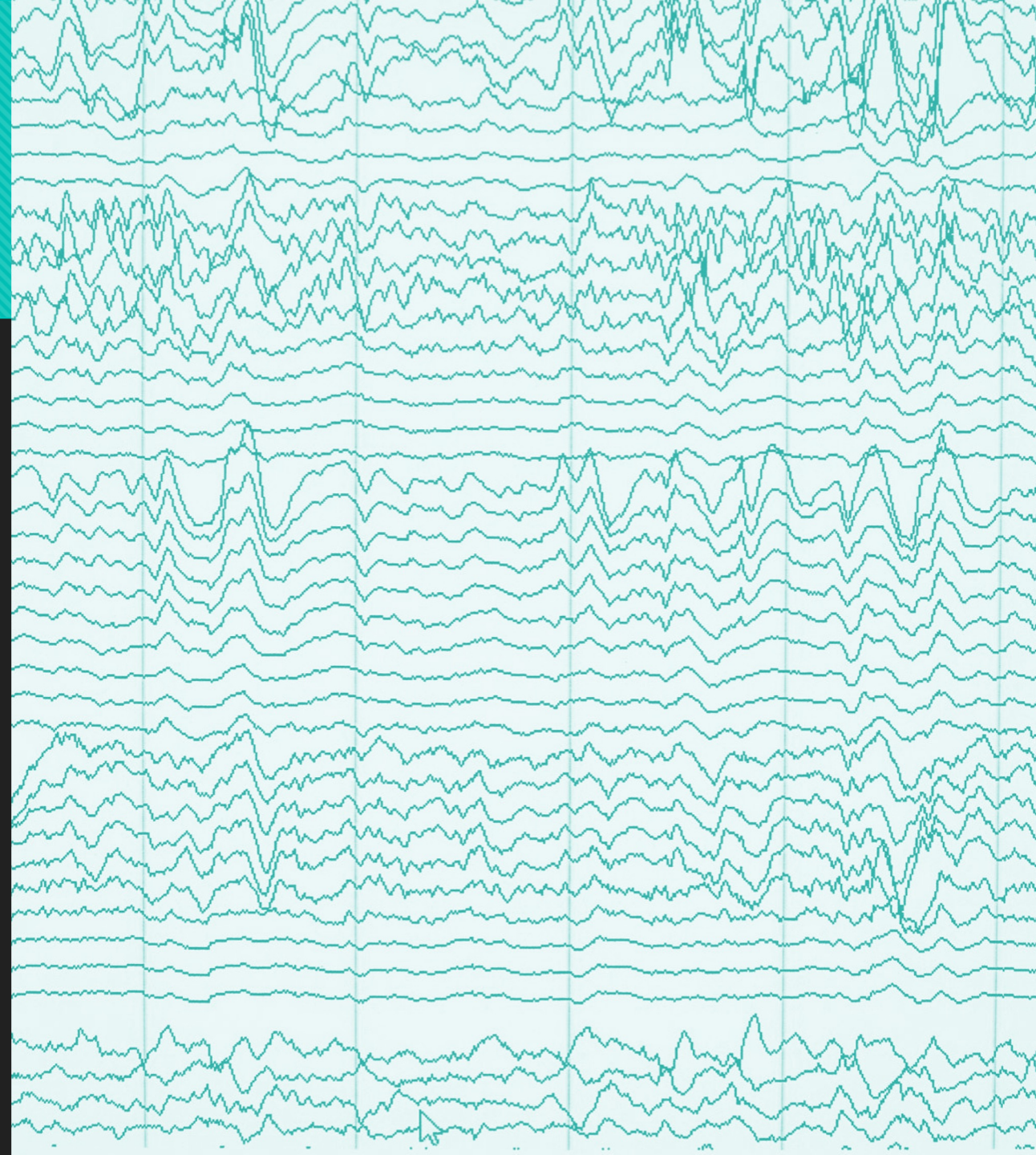
- It is non-invasive. THERE IS NO INPUT- no electrical impulses or subliminal messages
- Trainees simply receive feedback that relate to their own biological functions
- Biofeedback is a safe learning tool
- It fits into most mental health therapists and psychologists' legal scope of practice



NO HARM

Neurofeedback Methods

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



Breadth of the Neurofeedback field

- Seizures
- Brain disorders
- Cognitive rehabilitation
- Headaches/migraines
- ADHD and executive functioning
- Neurodevelopmental disorders, e.g. autism, learning disorders
- PTSD/ Developmental trauma
- Substance abuse

- Many different systems and approaches, many finding similar results

ADHD meta analysis (Van Doren et al, 2018)

- Several studies on Neurofeedback and ADHD
- Showed large effect sizes for inattention
- Showed medium effect sizes for hyperactivity-impulsivity
- Significantly different from controls at both post treatment and 6 month follow up

- Brain Futures NF evidence summary can be found at <https://www.brainfutures.org/wp-content/uploads/2021/04/brainfutures-neurofeedback-brief-final.pdf>

Neurofeedback and chronic PTSD (van der Kolk, et al, 2016)

- 52 individuals randomly assigned to Neurofeedback or Waitlist conditions
- Neuro group showed 40% decrease in PTSD symptoms
- 60% increase in executive function (capacity to plan, anticipate consequences of one's actions, to move easily from task to task, and to feel in control of emotions) *** "no other treatment has shown such MARKED improvement in executive function" (Body Keeps the Score , p.330)

Nicholson et al, 2020

- 36 Healthy Controls
- MRI revealed differences between PTSD and Healthy controls
- PTSD group that received NFB showed normalization on fMRI. These changes correlated with changes in PTSD symptoms
- At 3 month follow up:
 - 61% of the NFB group no longer met criteria for PTSD compared to 33% of the sham control



Yu et al 2020

- Impaired executive functioning results in difficulties disengaging from negative ruminative cognitions
- NFB protocol targeting peak alpha frequency (PAF) in PFC
- NFB group showed improvements in executive functioning while control group did not. As executive function improved, depression and rumination both declined.
- Possible that inhibitory properties of the PFC are at play, allowing patients to more easily disengage from depressive thinking.

Fernandez- Alvarez et al 2022

- Looked at studies on NFB and HRV biofeedback
- For depressive symptoms; $g=.303$ (small effect size)
- For Major Depressive Disorder; $g=.717$ (medium to large effect size)
- Only experimental design had a mediating effect on analysis (not type of NFB, age, # sessions, year of publication etc) with RCTs showing greater effect sizes.

Kerson et al (2009)

- 12 patients with anxiety were treated with biofeedback and alpha symmetry NFB
- Measured anxiety via the STAI (State Trait Anxiety Inventory)-administered 4 times.
- Showed modest improvement after NFB was conducted
- At 6 month follow-up results were stronger than immediately post treatment; both state and trait anxiety were significantly improved

Rance (2018)

Looked at two different studies on different populations and different types of NFB

Did analyses to look at post treatment effects and found that symptoms (OCD and Tourette's) continued to decrease post NFB

“Neurofeedback is a form of learning and it is well established that learning goes through processes of consolidation and reconsolidation over time”

CRI-Help study of substance abuse (Scott et al, 2005)

- 121 subjects with polysubstance abuse were randomly assigned to treatment as usual condition or treatment as usual + EEG Neurofeedback
- 47 of the 60 patients in the experimental group remained in treatment (only 27 of 61 controls did)
- 37 of the remaining 47 patients remained abstinent at one year follow up (compared to only 12 of the control group)

Naturalistic studies- Psychiatric populations

- Cheon et al 2015
 - 77 adult psychiatric patients
 - Received approx 17 (fmri) NF sessions
 - Showed significant decreases in depressive symptoms, anxiety, and inattention
- Fleischman 2022
 - Applied (infra low frequency) NF to complex psychiatric presentations in underserved mental health population
 - Clients received 20 NF sessions
 - Reported reductions in drug/alcohol relapse, cognitive accuracy, use of ER/Hospital, and coping measures.

EEG Neurofeedback is the gold standard

- Involves use of electrodes to pick up on EEG brain wave activity in various areas of the brain
- Patterns of brain waves are compared to normative standards and a protocol is selected to train the brain to
- Many different systems and specific types of training
- Difficult to train the PFC because of eye movements causing “noise” in the EEG readings
- Difficult to assess limbic area because deep in the brain

Hemoencephalography (HEG)

- HEG was developed in late 1990's as an alternative method of brain training
- niR HEG- near infrared HEG (Toomim)
 - 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.

The brain and heat (Toomim 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)

PIR HEG (Carmen)

- pIR HEG does not introduce any signal into the brain
 - “Measuring excess thermal energy generated by brain cells, vascular supply, and vascular return” (Toomim & Carmen, 2009) 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

HEG is Direct training of PFC

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

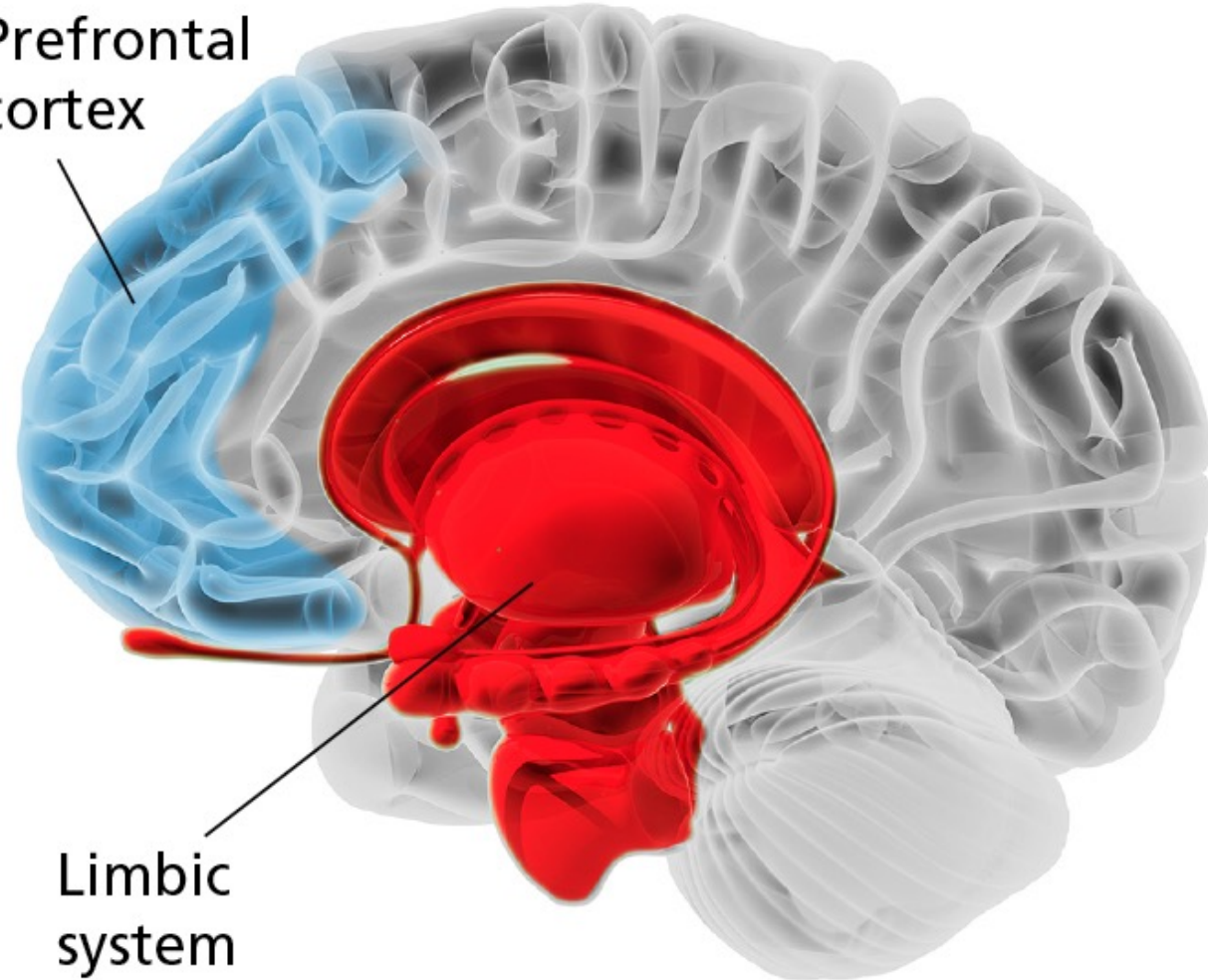


Wide applicability of PFC training

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

Prefrontal
cortex



Limbic
system

**Activity in prefrontal
area and limbic
system are inversely
related to each other**

Prefrontal changes in Neurofeedback

- Most interpretations of Neurofeedback effects are about increased activation/connectivity of Prefrontal cortex
- It seems that there are many trainable mechanisms in the brain
- When the brain gets a chance to learn and adjust functioning, neuroplastic changes almost always seem to involve the PFC.

Qualitative data on pIR HEG applied to mental health population

- More than 100 patients
- 1400 pIR HEG sessions
- Avg # sessions 15; Median 12
- Diagnoses:
 - 27% Generalized Anxiety Disorder
 - 40% PTSD
 - 10% Dysthymic Disorder
 - 11% Adjustment Disorder
 - 7% ADHD
 - 5% other
 - **13% have co-occurring alcohol/drug problem

Case Study: Jennifer (Depression)

- teacher
- History of psychological abuse, rejection by mother
- History of Major Depression (1-2 episodes every year)
- Not sure what triggers the episodes
- Self hatred- could not look at photos of herself; relentless self critical voice



After 4 sessions

- “Other people are noticing a change in my reactions. I don’t yell as much.”
- “I am letting people handle their own problems. I feel less emotional and less overwhelmed”
- “I feel less angry at school when I have to repeat directions”

After 5 sessions

- Able to feel down one day after argument with son (and not get stuck there for 5 days)

After 8 sessions

- lots of forced curriculum changes at school. Tuning into experience of loss. Feeling out of control with big emotions. “But I am not acting out of control”

After 9

-wrote letter to BOE to express concerns, was “calm and confident” in meeting with principal

-fearing depression but no signs of depression

After 12

-“I am being nicer to myself.” “I am taking care of and nurturing my soul”

-“The critical voices are no longer there. It is a relief”

After 14

-“I have not had a depressive episode all winter....this has never happened in my adult life”

Effect of Neurofeedback is brain learning

- It is the (unnatural) focused effort, repetition of the task, with time for rest and formation of neural connections that seems to result in sustainable adaptive brain learning

Case study: Sam (Stress)

- Angry reactions to family members
- Angry outbursts would be followed by retreating/ isolating
- Stuck on people doing the “right thing”
- Overwhelmed at work

After 2 sessions

-son botched the garbage take out. Sam fixed it without yelling and did not let it ruin his day

After 6

-“I know I am over-reacting”

-asked boss if he could work 1 day/week from home for less distraction

After 8

- Had one anger escalation. Apologizing came easier. Situation did not linger, guilt did not last
- Put alarms on his phone to remind him to breathe and notice tension in his body

After 10

- "I feel better"
- "I connect to my wife and kids more often which helps my mood"
- My son noticed- "Dad is not miserable!"
- interviewing for a new position. Realized that he does not like the manager role. Choosing something that will work better for him

Documenting the Effects of Noninvasive Prefrontal pIR HEG Neurofeedback in the Treatment of Common Mental Health Problems

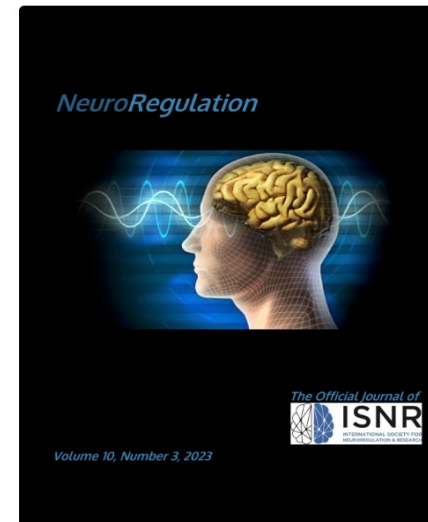
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DOI: <https://doi.org/10.15540/nr.10.3.207>

Keywords: neurofeedback, pIR HEG, limbic overload, self-efficacy, data-driven practice, Prefrontal cortex

ABSTRACT



Data Collection

- Quantitative Measures are collected after 5 sessions, 10 sessions, 15 sessions, and 20 sessions



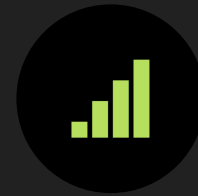
Sample



N=66 T1 and
T2 (after 5)



N=46 T1 and
T3 (after 10)



N=21 T1 and
T4 (after 15)

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

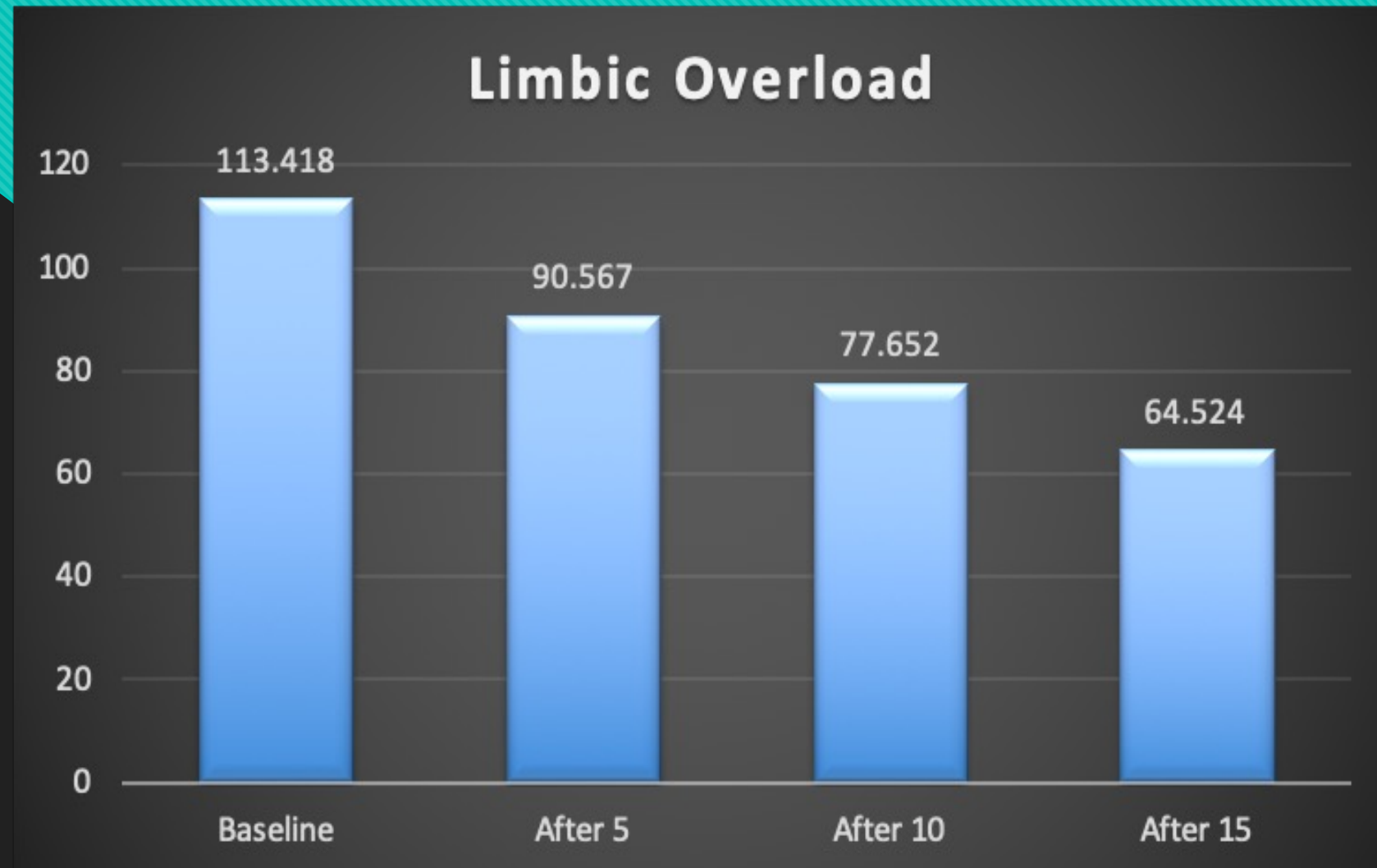
1. I have trouble controlling my anger/irritability.
2. I feel stuck, unable to change.
3. I feel panicky and anxious in my body.
4. I feel helpless.
5. I feel on edge/hypervigilant.
6. I am scattered in my mind and can't focus.
7. I find myself overreacting emotionally.
8. I procrastinate.
9. I numb, distract, and/or avoid things.
10. I ruminate about my problems.
11. I can't make decisions.
12. I am stressed.
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.
17. I have pain in my body.

Note. 17 items are rated on a 10-pt scale from 0 = *Never* to 10 = *All the time*. Item scores were summed to create a total score. Please contact author for use of this scale.

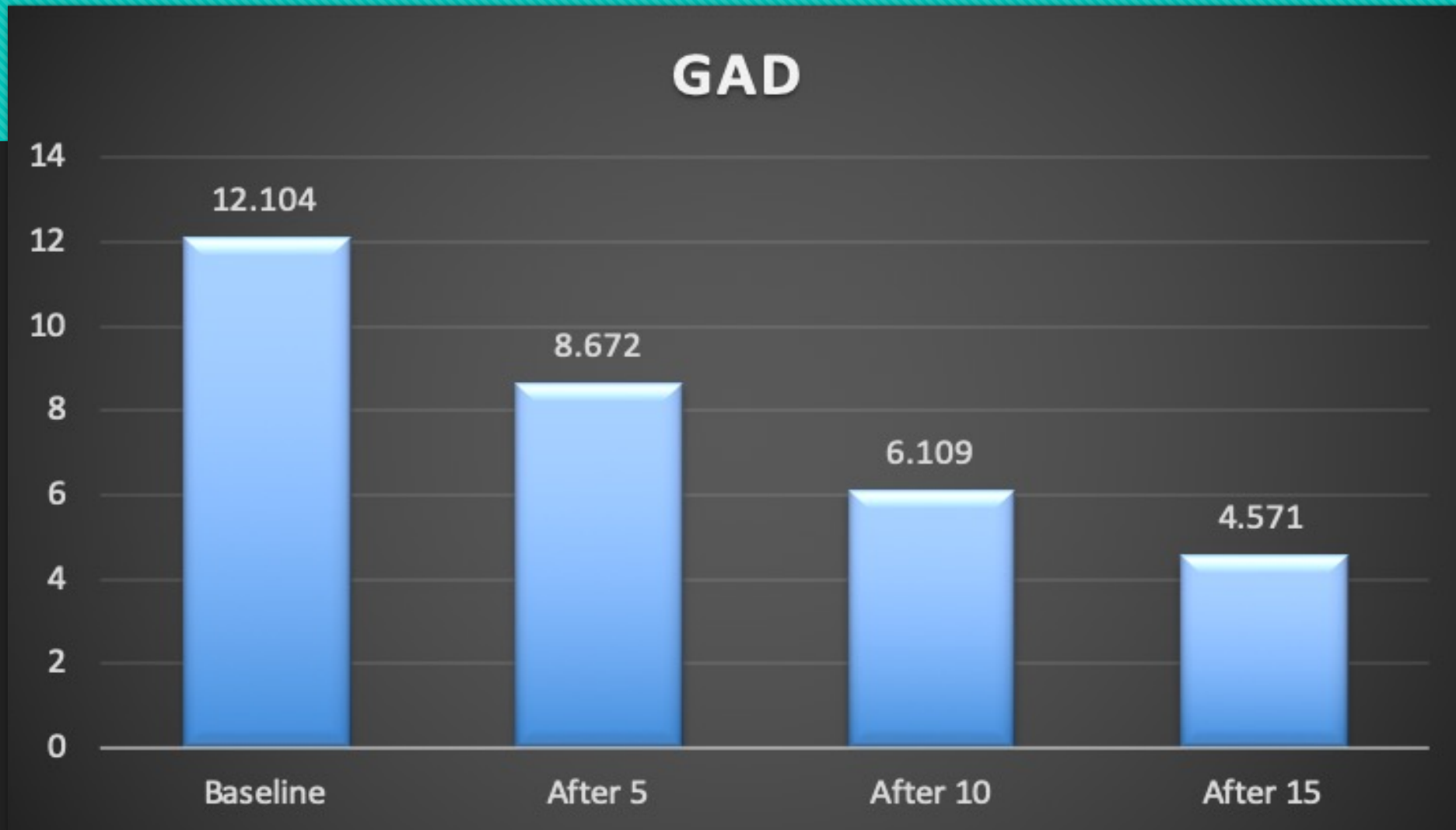
Limbic overload

- Capturing experiences that can stem from lack of self regulation
- Related to emotional reactivity
- Related to system overwhelm on emotional and physiological level

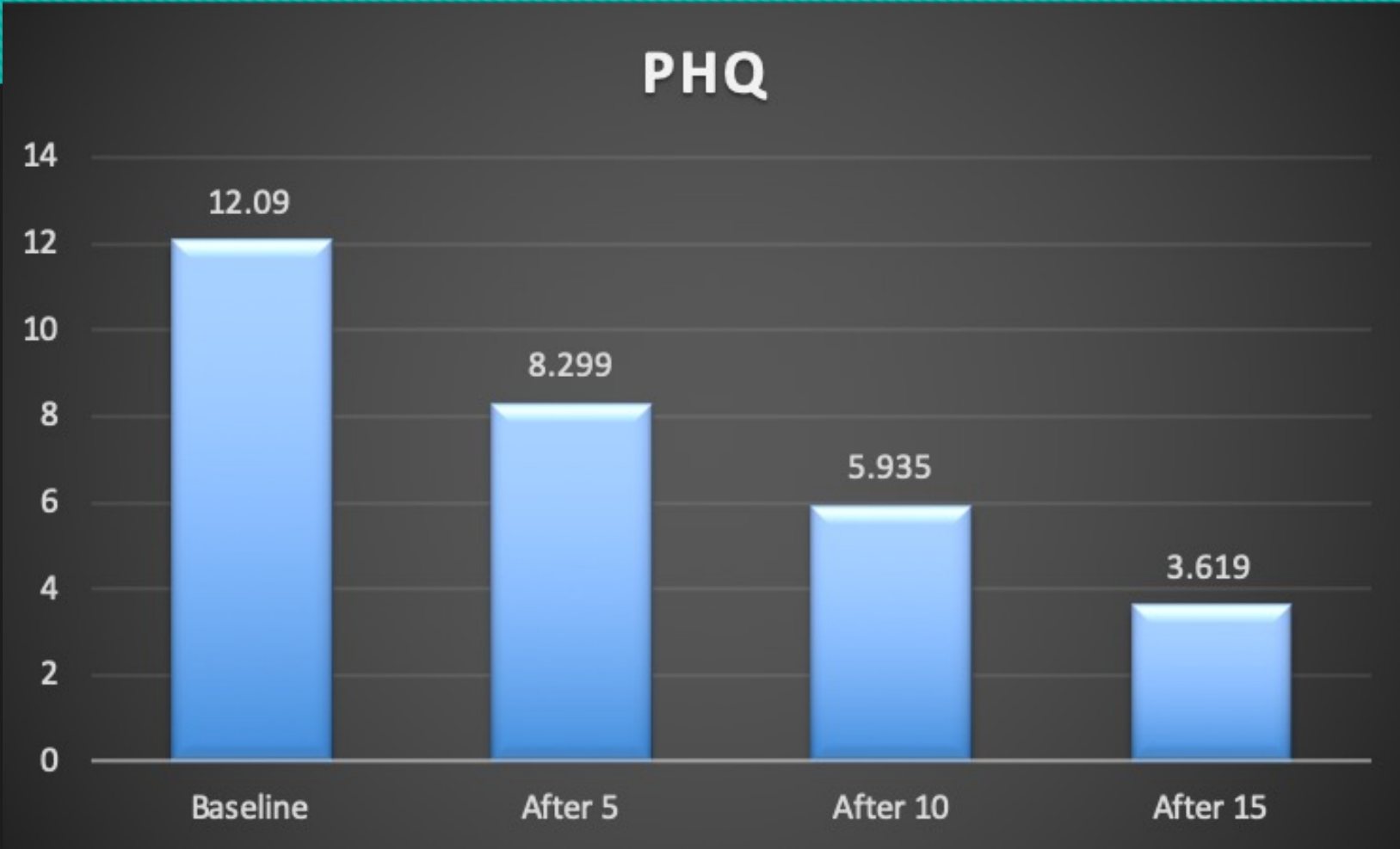
Limbic Overload©



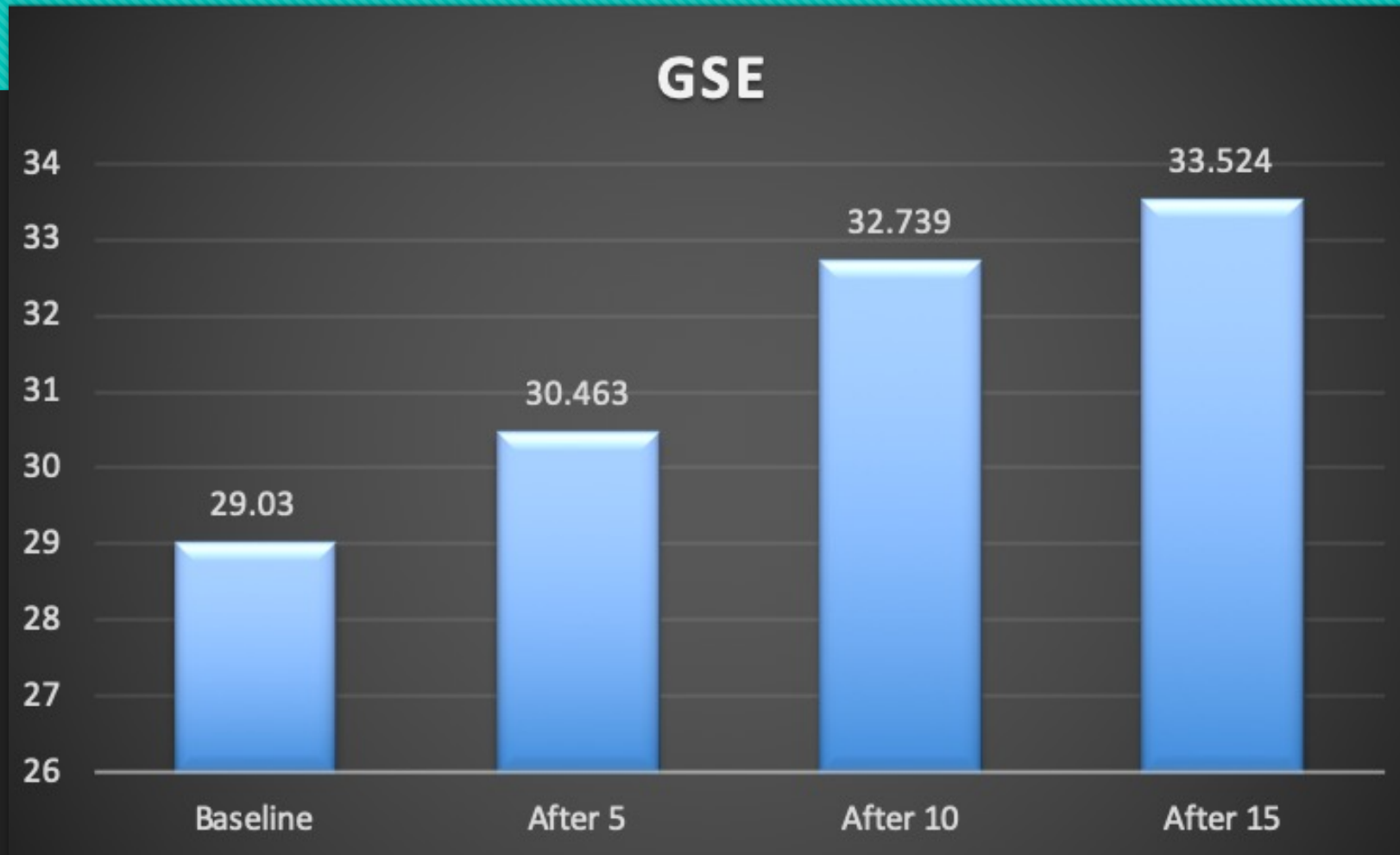
Anxiety



Depression



General Self Efficacy



Coping Self-efficacy



Number of clients scoring in various ranges of Depression and Anxiety

		Baseline n=66	after 5 n=66	after 10 n=46	after 15 n=21
	Score on PHQ				
Depression	Mild 0-9	25	46	37	21
	Moderate 10-14	15	13	6	0
	Severe 15+	26	7	3	0
	Score on GAD-7				
Anxiety	Mild 0-9	21	38	36	19
	Moderate 10-14	19	18	8	2
	Severe 15 +	26	10	2	0

Analysis of Findings

- Means markedly show clinical improvement at each data collection point
- 5 sessions of pIR HEG resulted in statistically significant changes in anxiety, depression, and coping self efficacy
- 10 sessions of pIR HEG resulted in statistically significant changes in anxiety, depression, coping self efficacy, and global self efficacy.
- 15 sessions show additional improvement in comparison to 10 sessions. Large Effect sizes after 15 sessions on all measures (range $g=1.0-1.55$)

**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

Quality of the changes

Rapid

Lack of
conscious
effort- implicit
learning

Self
perpetuating

Case Study: Michelle

- Diagnosed with cancer a few days before delivering her third child
- Went through treatment
- Extreme brain fog, mindlessness
- Difficulty concentrating (had been prescribed Ritalin)
- Depressed, hopeless about living with the possibility of it coming back
- Avoidant of emotions
- A lot of tension in marriage

After 2

- Noticing sensation in chest when she lies down
- Able to cope with demand from work without yelling at the kids

After 3

- Hopelessness is much better. More present. Forgetting to take Adderall and focus is better.
- Much more aware of anxiety in her body when she lies down, started talking about experience of MRI when she was pregnant

After 4

- Less anxiety when she lies down
- More tolerant of others' emotional states without taking it personally

After 5

- Sadness is coming up for Michelle. She cried twice this week which is unheard of for her. She allows it to come up. She's not fighting it.
- She's noticing emotions. In a fight with her husband she noticed suicidal desperation - the need to escape. She could pick up on more of what she felt "This is really overwhelming." "I'm not being heard." "I'm being dismissed."
- Less mindless distractions

After 7

- Feels more neutral and less defeated with living with the possibility of cancer returning

After 8

- In fights with husband “I used to defend myself more, now I stand my ground”

After 15

- Tolerating EMDR well

After 17

- I can deal with my husband’s emotions without feeling responsible for them “I can separate my experience from his.”
- “My brain is piecing things together”

After 18

- “The process of EMDR is empowering”

After 19

- Noticed anxiety in the chest, linked to to the time of year of original diagnosis.

ZOOM BREAKOUT:

Take-aways and questions

- 2 minutes: Individually write down 1 key take away and 1 question
- 8 minutes: Join zoom breakout room and discuss with each other
- 5 minutes: Come back together and share some take-aways with large group
- Before lunch, write any pressing question in the chat

Implementation of pIR HEG is EASY

- Headband rather than electrodes
- Cost is less than most NFB systems
- Training takes place within a few hours
- SRL is a coherent clinical model to help you make sense of outcomes and enhance progress

Jeff Carmen's EZPIR system

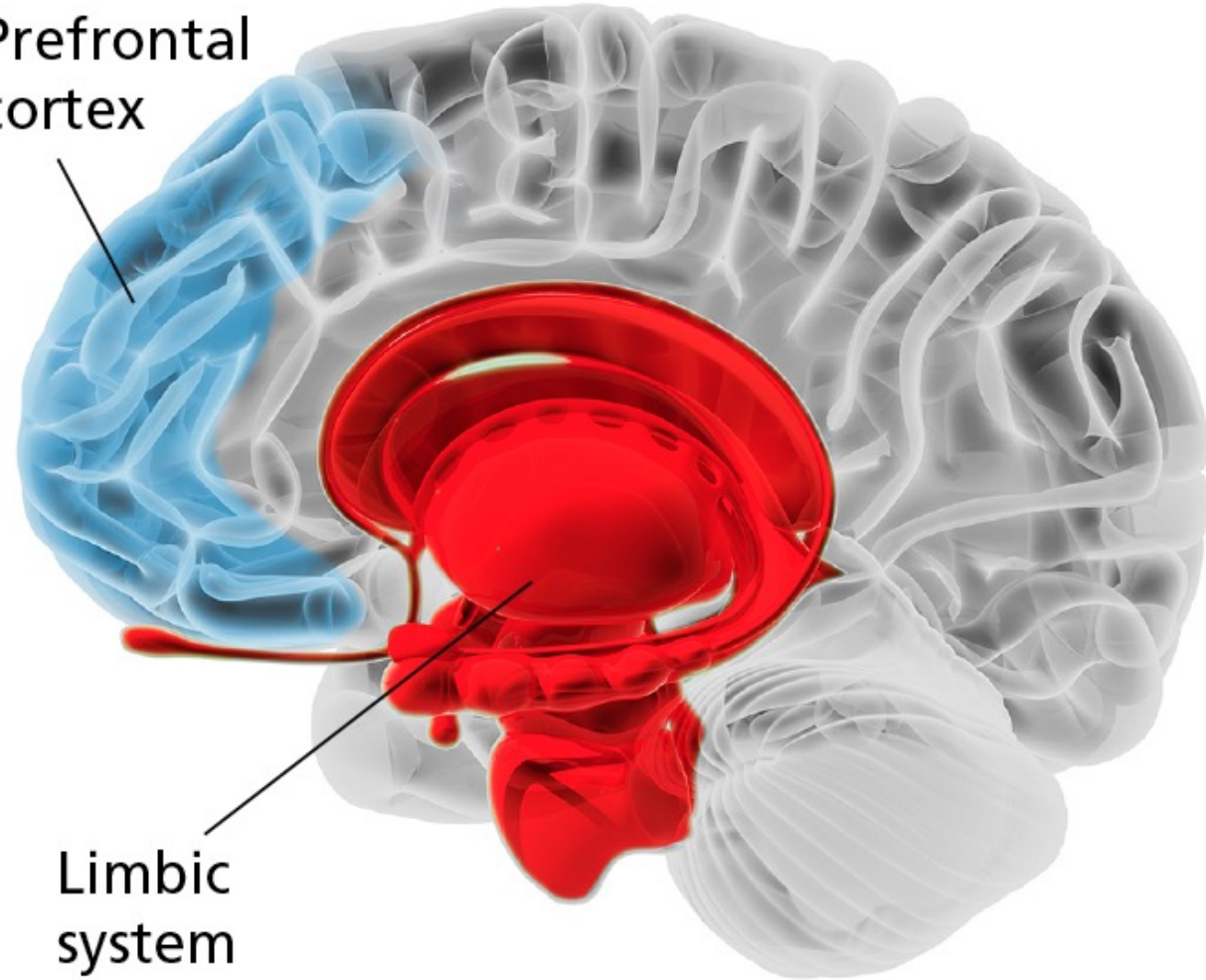
- Headband measures heat using 2 infrared sensors centered on the forehead
- It uses real emotional triggers (through movie) to elicit response
- Regular movie DVD plays
- When heat decreases in prefrontal area as detected by headband, movie stops
- Bar graph appears that provides info on activity level in prefrontal area
- Raise the bar graph (and the heat) to the top to get the movie to play again
- 4 or more pauses each session where this task is completed



Unique aspects of the EZPIR system

- Only Neurofeedback system that uses real-life emotional triggers as part of the learning process
- Takes advantage of the inverse relationship between PFC and limbic system
- By picking up on heat in the PFC and displaying it as a bar graph which rises and falls, trainees also get real time feedback about the degree to which their amygdala is activated
- Although other Neurofeedback systems provide graphic feedback when PFC is more engaged (a car moving forward), the graphic often stays static when it is not engaged.
- This system provides feedback that can easily show you increments of engagement and the brain learns rapidly with this type of immediate feedback

Prefrontal
cortex



Limbic
system

**Activity in prefrontal
area and limbic
system are inversely
related to each other**

pIR HEG Neurofeedback



Instigates the brain moving between two incompatible brain states



Through repeatedly increasing brain activity in the prefrontal cortex, this brain area becomes more dominant.



Implicit learning in the PFC results in automatic changes in function

Implementation

- Sessions are no more than 1x/ week
- Pause time is no more than 10 min
- Pause time is the critical independent variable
- Monitor session for 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
 - If headache or head discomfort, stop the session
 - LESS is MORE

Free pIR HEG session tools

wellbeingcny.com/professional-learning-resources



Sample Neuro session recording sheet



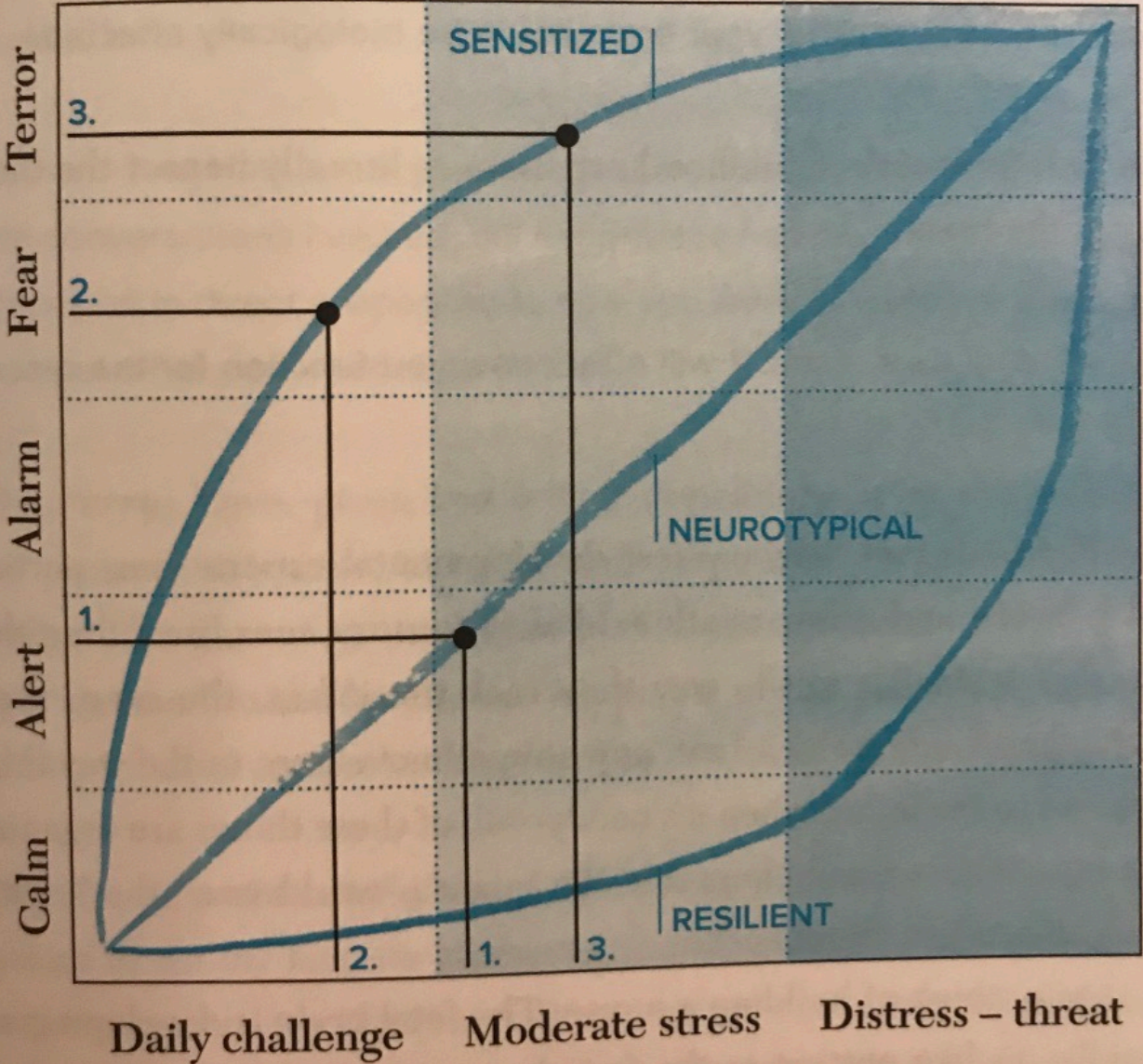
Cheat Sheet for running a session-
guidelines for using baseline and
threshold throughout the session

Key Brain Principle 1: Stress and trauma change the brain, mind, and body

- Stress produces repeated activation of human stress systems
- It also produces repetitive brain patterns that promote **stress sensitization**
- Stress sensitization and **learning impairment** affect people across diagnoses
- The activation/ mobilization of these stress systems produces **Tension in mind and body**

STATE-REACTIVITY CURVE

Stress reactivity curve (Perry, 2021, p.79)



Stress sensitization is major process mediating the development of mental health symptoms

- Resilience is built by repetitive moderate stressors
- Overwhelming stressors do not build resilience but instead sensitize us to stress
- When we are sensitized to stress, we are over-reactive to stressors, producing more cortisol.
- Early unpredictable, extreme, prolonged stressors create stress vulnerability

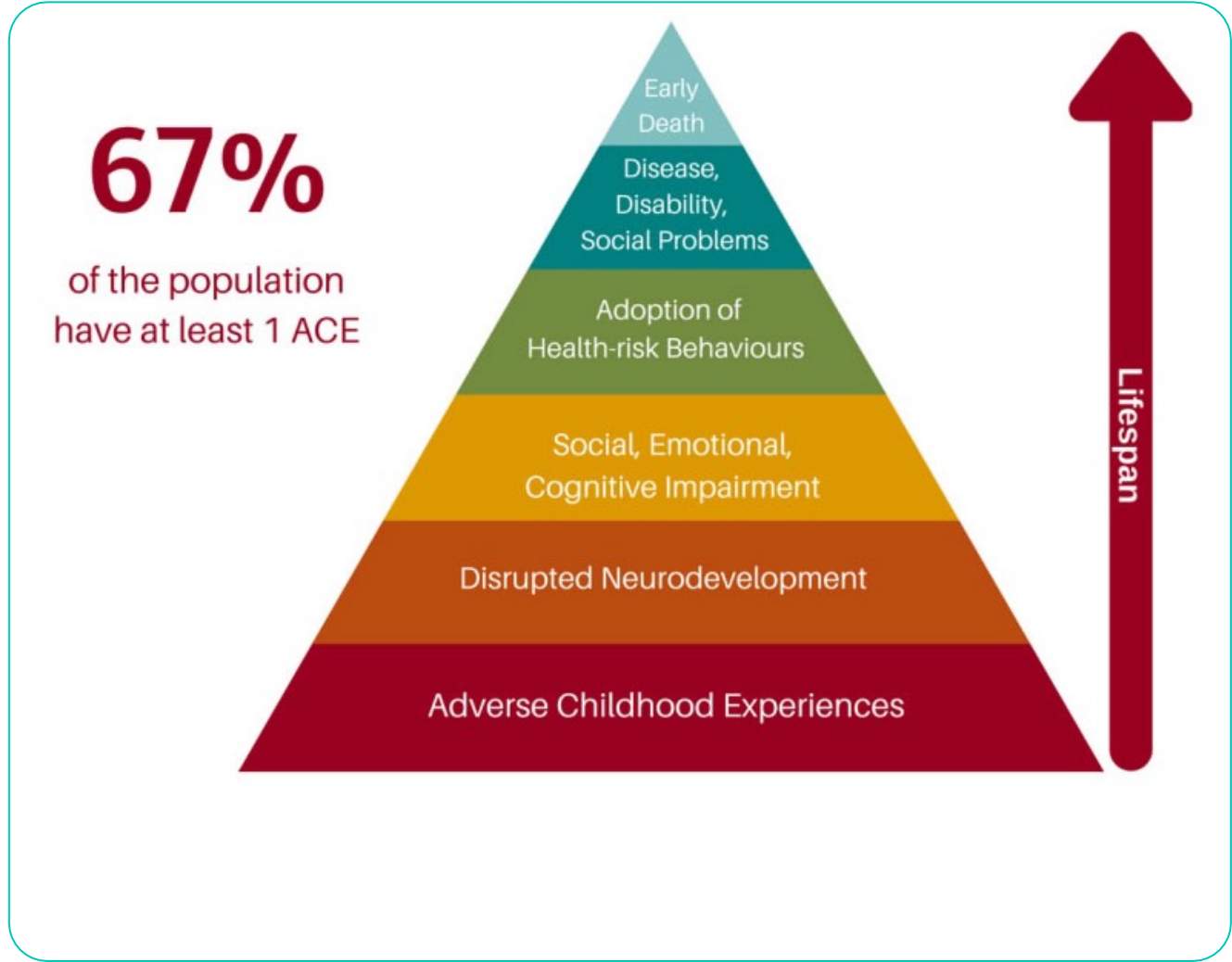
Siegel (2010)

Mental health diagnoses can be viewed as related to a hyperarousal or hypoaroused state

ACE study

- Study of Adverse Childhood Experiences (ACE Study)
- 17,000 participants
- Adverse childhood experiences are very common
- Correlated with negative mental health and physical health outcomes
- Mediated by disrupted neurodevelopment and adoption of high risk health behaviors

ACE Study



Stress and Trauma Informed applies to everyone

Stress Regulation is the most fundamental cornerstone of health

Stress Regulation at the neuron level makes mental health treatment more efficient and effective

Key Brain Principle #2: The brain prioritizes survival over optimal function

Prefrontal area goes off line

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graph TD; A[Prefrontal area goes off line] --> B[Cell energy is used for arousal readiness]; B --> C[If the objective is learning, reflection, cognition, decision making, etc then the brain is clearly working against us];
```

Cell energy is used for arousal readiness

If the objective is learning, reflection, cognition, decision making, etc then the brain is clearly working against us

Sensing negative information

Neuroception is always on- this is occurring below awareness- threats are registering and we are responding

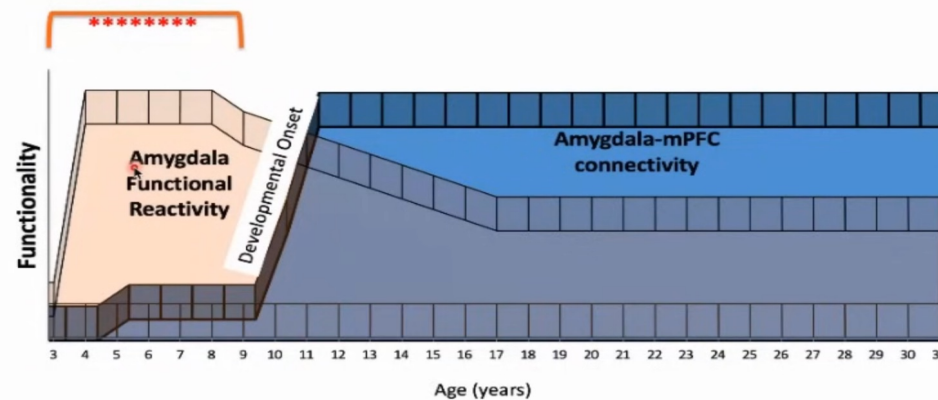
Negativity bias- we naturally register negative stimuli more strongly than positive. Our amygdala is the part of the brain which is always monitoring for this.

Developmental pathway- Amygdala and fear conditioning

- Developmental pathway is for amygdala to be very sensitive early in development when stimuli are novel.
- Amygdala reactivity is pronounced for social stimuli (faces), unpredictable, ambiguous, and salient; also biologically salient
- Amygdala is critical for Pavlovian fear conditioning, a form of classical conditioning in which animals learn relationships between aversive events and the stimuli that predict them.
- Learning “what to avoid”

Nim Tottenham, PhD Columbia University

VIRTUAL
Talks at Google



Tottenham, 2016 *Social Neuroscience*
Tottenham & Gabard-Durnam, 2017 *Curr Op in Psychology*

For the first 10 years of life or so...

- The amygdala is primarily buffered by environmental factors (rather than inhibited by PFC)
- The connectivity between the PFC and amygdala is in a very immature state
- The biggest buffer for a child's overreactive nervous system is a calm and present caregiver.
- With effective buffering, the developmental pathway is to know and understand stimuli (approach)

Developing the capacity to inhibit fear through development

- Amygdala has communication with the developing PFC, more projections to PFC than from it. Forming mental models based on amygdala information.
- Over time, PFC learns to override initial fear response and discriminate between stimuli, so that more accurate judgments are used to guide behavior

Getting stuck in Limbic overload©

The more stress and trauma experienced, the more the brain learns to be in survival mode.

- Amygdala's fear conditioning is dominant in behavioral patterns (avoidance, rigidity, and chaos) and PFC is less dominant (approach, flexibility, coordination).
 - pIR HEG Neurofeedback can help reverse this pattern, putting the PFC in a more dominant role
- The more the Amygdala's fear conditioning is dominant, the more arousal in the overall system. The tension in the system is often observable in symptoms- can't sleep, digestion problems, always on the go, hypervigilance, panic, difficulty tolerating emotional experience without running, hiding, over-reacting
 - pIR HEG Neurofeedback reduces uncomfortable tension in the system, creates greater inhibitory control over symptoms

Typical stress activation

- Interplay between Amygdala, Thalamus, and Hippocampus, and Frontal Lobes activating stress response
- Amygdala responds 80x faster than our thoughts
- Once a stress reaction is triggered, it can take up to 3 min to reverse in the body (Demos)

- When we enter alarm → fear → terror states, we do not have access to our cortex. Other parts of the brain become dominant
- Cognition moves from abstract, creative, grounded to reactive, instinctual
- Adaptive options move from reflection to avoidance, compliance, dissociation, and collapse
- Functional IQ decreases
- Digestion goes offline

**Brain
functioning is
state
dependent
(Perry)**

Key Brain Principle #3: Brains develop automatic patterns to save energy

Our evolutionary history tells us it is better to be prepared for predictable stress rather than to be open and creative when it comes to survival

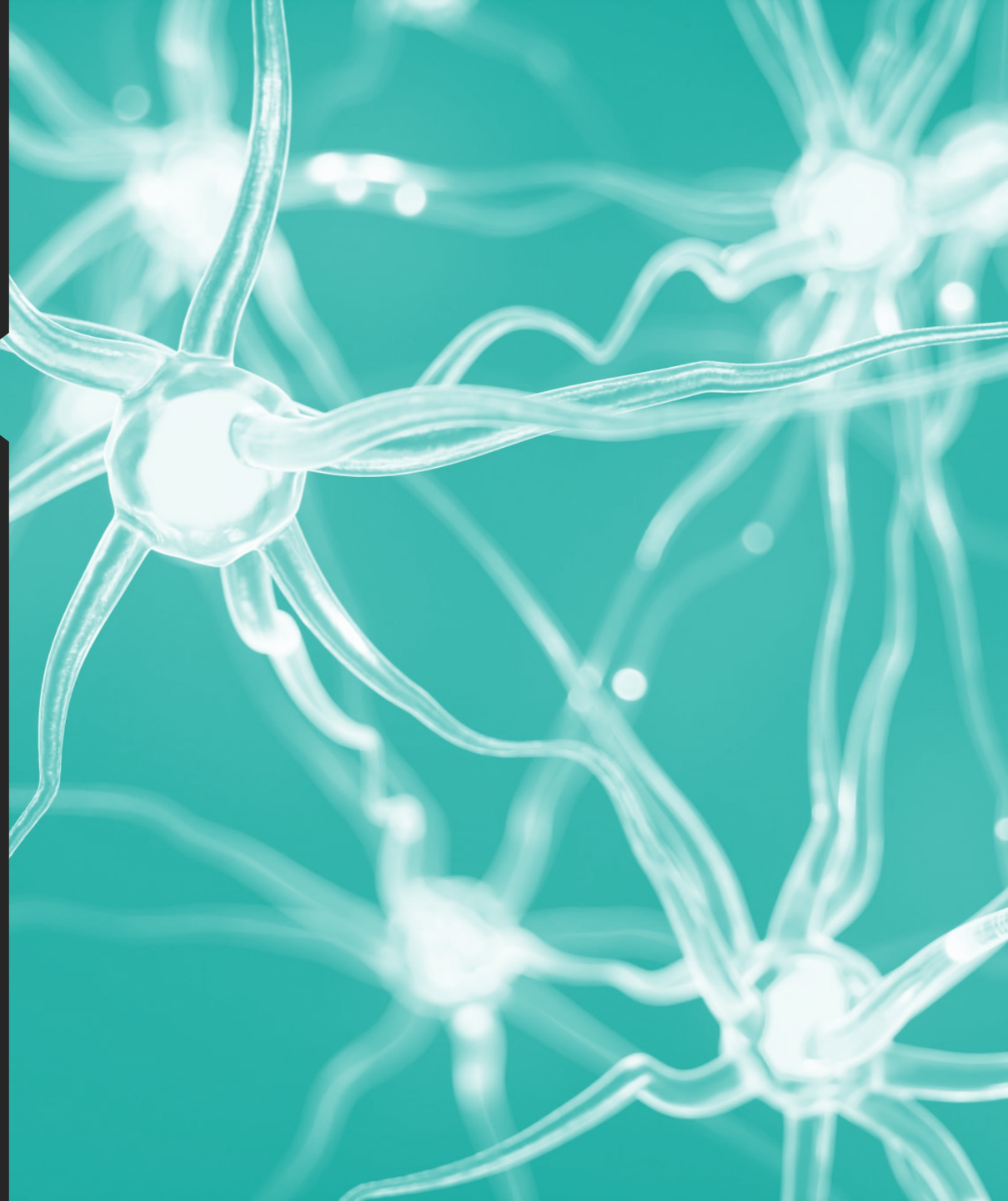
Infant Attachment

- Attachment patterns are adaptations based on stress reactions.
- For example, an avoidant strategy is designed to down regulate the nervous system to cope with a nonresponsive parent.
- First two months of life, brain development is significantly affected by inconsistent, overwhelming, or unpredictable stress. Can lead to enormous problems later in life.

“What fires together wires together”

Long Term potentiation is most widely accepted learning theory.

- The more a group of neurons in the amygdala fire together, the more apt they are to do that in a repetitive loop.
- Creates a positive feedback loop- response leads to more quicker, higher response from amygdala



What happens when a brain is dominated by the Limbic system

Inflexible

Scattered,
indecisive

Helpless, Stuck

Hopeless

On edge, tense,
irritable

Overwhelmed

Over-reactive

Anxious

Hypervigilant

Numbing,procrasti
nating

Ruminative

Avoidant

Tired

Digestive problems

Physical pain

“The brain develops in a use
dependent manner”

Perry

Key Brain Principle #4 Our brains protect us outside of our mind's awareness

- Unconscious detection of threat: Neuroception
- Unconscious mobilization of our defenses
 - Self narrative and perception of resources considerably influenced by state
 - The mind believes the information from the state
- Unconscious avoidance of overwhelm; tension relief

What is in the way is often not in the room

- Neurobiological patterns have a lot to do with how we behave but because they are operating outside of consciousness, we often can't fully assess or treat them through the mind
- “Easier to treat the mind through the brain than the brain through the mind” Fischer, p.247

Case Study- Abigail

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

After Session 4

Nightmares decreased

“It’s been all about self control lately”



After Session 5 Less panic and self doubt

“Everything is manageable”
“Everything is temporary”

“I feel odd” – neutral in
emotional conversations

Abigail

After 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

After Session 11

- got order of protection on emotional abusive father of child, prevented self from re-engaging
- 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 use decreased by at least 50%

Dissociation

- When we've had stressors where we mobilized for fight/flight but were still overwhelmed and alone, we dissociated. It was the only adaptive option.
- When we dissociate repeatedly, we get a huge opioid burst. (Perry) So, our stress reactions reinforce dissociation/avoidance of emotional pain, making it harder and harder to develop stress tolerance.
- “The brain seems to wire itself to react and to forget what it is reacting to”
Fisher, p. 65

Depersonalization (van der Kolk)

Under triggering conditions, one becomes split from self

```
graph TD; A[Under triggering conditions, one becomes split from self] --> B[Nearly every part of the brain tunes out]; B --> C[One cannot think, feel deeply, remember, or make sense of what is going on.];
```

Nearly every part of the brain tunes out

One cannot think, feel deeply, remember, or make sense of what is going on.

Key Brain Principle #5 Stress impairs learning

- High levels of cortisol over time inhibits neuronal growth
- Stress and anxiety impairs cell communication in brain areas including the hippocampus which is involved in memory, learning, and affect regulation.
- Increases activation in amygdala which drains glucose and oxygen needed to fuel the prefrontal cortex

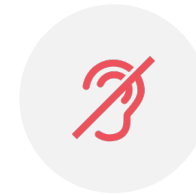
How easy is it to learn from your experience when you are:



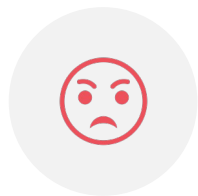
On Edge, revved up



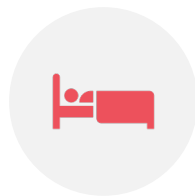
Scattered, unable to focus



Stuck, not accepting new information



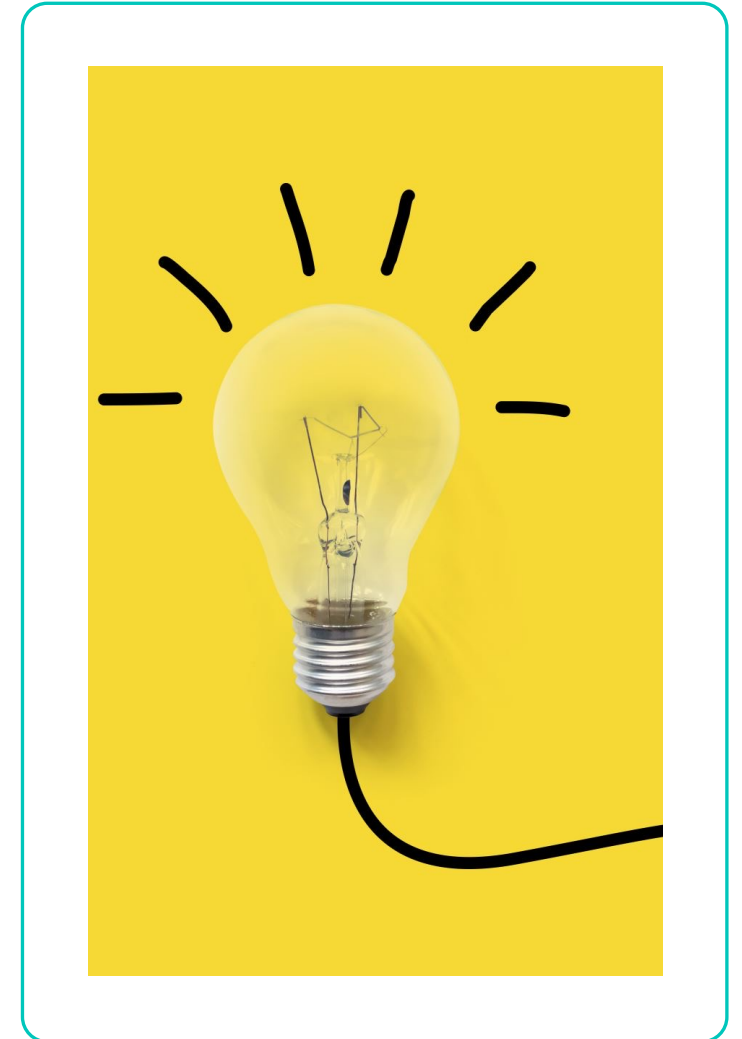
Shame and anger blind



Avoidant, tired

Stress regulation and learning

- It is biologically impossible to think, learn, reflect, and reason adequately in highly stressed states.
- It is particularly *difficult to learn from our own experiences* when our brain functioning is state dependent
- Reflective learning requires attention, ability to notice ourselves, ability to recognize what we have control over, and plan/organize an adjustment to our behavior.



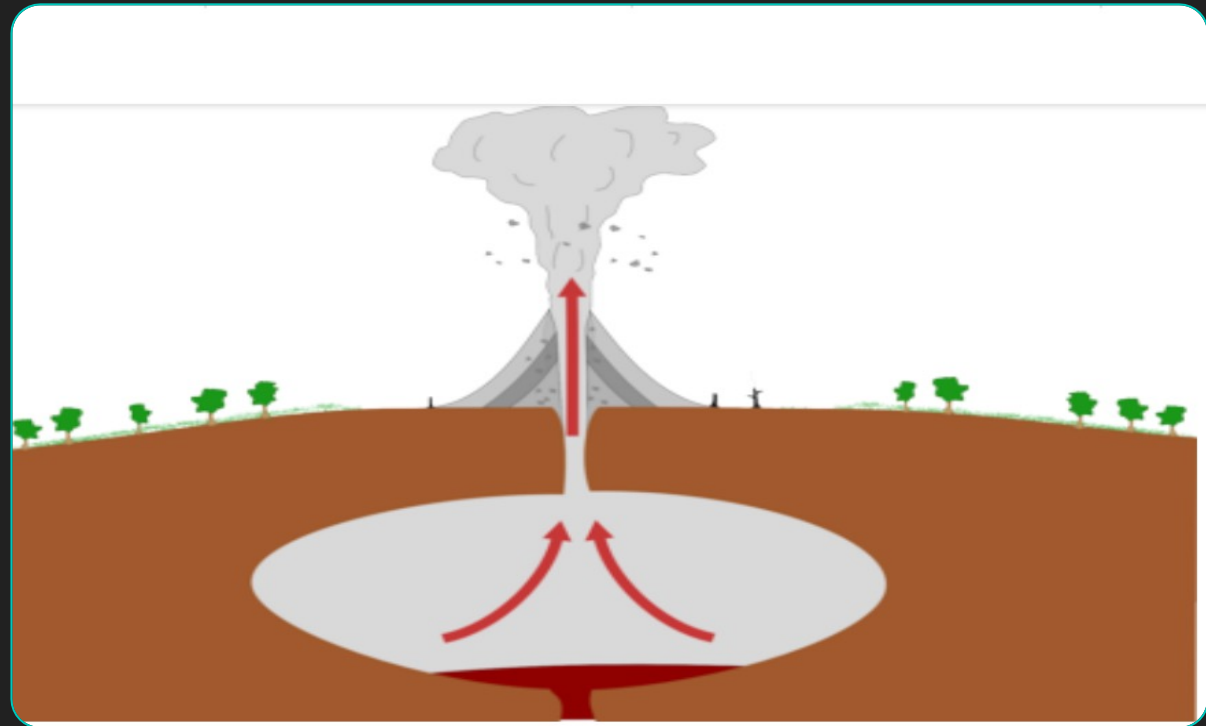
Polyvagal Theory- science of safety (Porges, Dana)

- We need our stress system but we also need the capacity for activation, inhibition, and flexibility of response
- We need inhibition of our survival response so that social engagement can happen
- Social engagement readiness requires some regulation that allows us to observe the outside world, to use resources, to connect, and to learn



Key Brain Principle #6: Tension relief is an organizing property of an aroused, sensitized, stressed brain

- Tension relief is more of a priority than learning



Tuning into brain arousal

Think of all symptoms and behaviors in relation to the tension built by stress and trauma

In this model, symptoms and behaviors are viewed as:

- **as evidence of intense fear arousal**
- **as possible tension relievers**
- **a means of psychological control in a highly overwhelmed system**
- **impairment/ shut down associated with a chronically overwhelmed system**

**Examples of
Symptoms/
Behaviors
consistent with
high fear
arousal/
inability to
regulate states**

Panic attacks; Physiological anxiety

Inattention

Hypervigilance

Irritability

Hyperactivity

Impulsivity

Disrupted sleep

Overreactions

Narratives- “I have to...”

**Examples of
Symptoms/Behaviors
that produce tension
relief**

Addictions

Anger episodes

Self harm

Avoidance of everyday activities

Avoidance of conflict/ people pleasing

Avoidance of down time, overworking,
keeping busy all the time

Examples of Symptoms/ Behaviors consistent with high fear arousal/ inability to regulate states

Self criticism

Worrying

Controlling others

Rigidity in self narratives (e.g., victor/ victim)

Creating conflict, creating predictability

Suicidal thinking

Compulsive habits, e.g., eating, exercise

**Examples of
Symptoms and
Behaviors
associated with
impairment/ shut
down in a
chronically
overwhelmed
system**

Depression

Distraction

Zoning out

Dissociation, losing time

Slow response time

Narratives (I can't; learned helplessness)

Digestive issues

Physical pain

Arousal- regulation model

There is a connection with chronic level of arousal in the fear centers of the brain and the level of regulation or dysregulation present in the person's functioning and behavior (Fisher, p.106)

Case study: Steven

- Lost 16 month old son tragically
- Addicted to Klonopin and Adderall
- A series of very serious suicide attempts over 2 years
- “Obsessed with my son’s death”
- Trauma mindset - entitled, fearless, untouchable “nothing can take me down”
- Physical assault on wife, facing serious legal charges
- Unable to deal with caring for his two young daughters “I feel paralyzed when they cry”

After 2 sessions

- Sad and grief coming up. He misses his wife. "I feel so clear and I have my emotions and it feels so good - so different from when I was numbing myself with drugs to keep from feeling the rage and pain"

After 3

- He remorseful of what he did and humbled by it. "I haven't made a formal apology to my wife yet".
- He's not suicidal anymore. Even though he rehearses worst case scenario in his mind, he's still hopeful of the future.

After 9

- A very good friend died (maybe overdose)
- This is making it more clear to him what the important things in life are : his daughters and being a good father.

After 11

- Curious and open about his urges for Adderall. Open to normal anxiety associated with a new job

After 14

- Fully connected to his daughters and invested in them
- More aware of wife's emotional reactivity and mindlessness, getting harder to live this way

After 17

- Tolerating wife's negative moods. "It doesn't affect me anymore. If she wakes up in a bad mood that is about her. I can choose to remain my happy self".

After 18

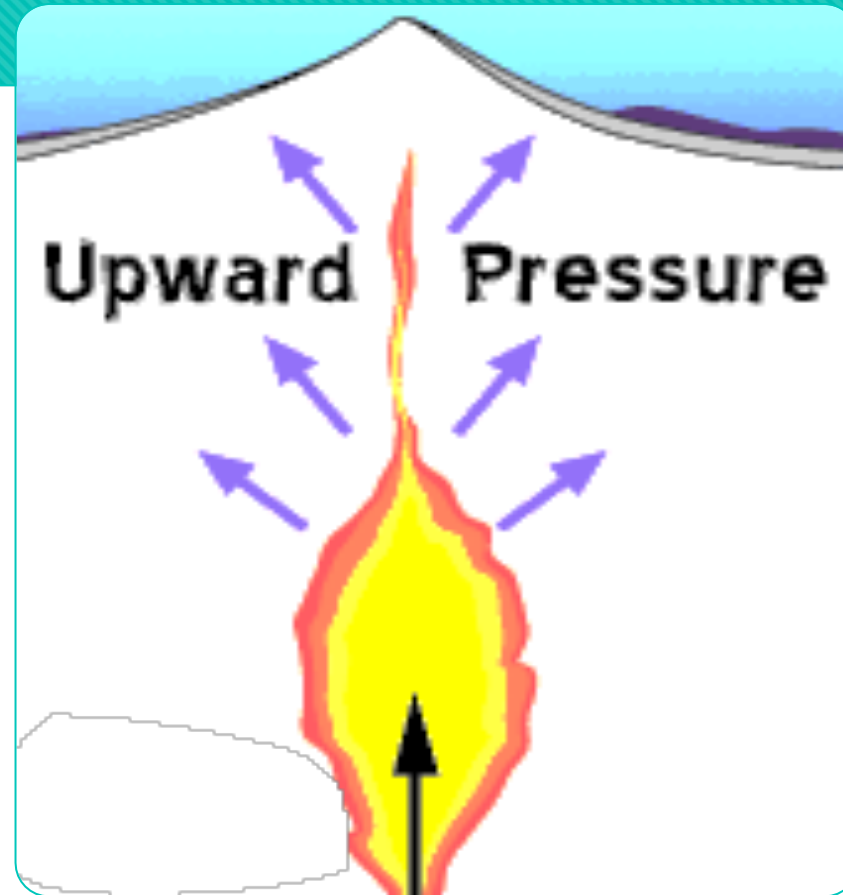
- Dealt with his son's birthday- He's sitting with stress and grieving (crying) rather than getting angry or thinking about suicide.
- Able to stay engaged with wife and family members as they got through the day

Social pain and physical pain share brain pathways (Eisenberger et al 2003)

- fMRI studies showed similar activated brain pathway for people experiencing social exclusion as for people experiencing physical pain



When in survival we don't grieve resulting in uncomfortable pressure in the system



Inhibited grief

Developmental trauma

- Childhood abuse, neglect, attachment disruptions, lack of empathy, emotional and sensory deprivation
- Brain is organized around fear
- Hyperaroused, inflexible brains
- At the mercy of “subcortical neuronal storms” that give rise to affect dysregulation
- Behavior is organized around tension relief
- Underlying aspects of chronic PTSD, Personality disorders, people in hospitals, foster care, and jail

Van der Kolk (BKS, p. 182)

- Being unable to integrate traumatic memory sets us up to lose the ability to assimilate new experiences as well.
- Without awareness of what happened in the past, their self perception is stuck, leading to a slow decline in function
- Need ways to reactivate the self sensing system without overwhelming people

The body keeps the score

- “Psychologists usually try to help people use insight and understanding to manage their behavior. However, neuroscience research shows that very few psychological problems are the result of defects in understanding; most originate in pressures from deeper regions in the brain that drive our perception and attention. When the alarm bell of the emotional brain keeps signaling that you are in danger, no amount of insight will silence it.”

○ Bessel van der Kolk, MD

Resetting the Score

- Regulation of states and reduction of tension and stress reactivity is critical
- Restoration of self-sensing system and ability to learn, change, and adapt

Key Brain Principle #7: Neuroplasticity can transform brain functioning with new learning

The PFC is particularly malleable



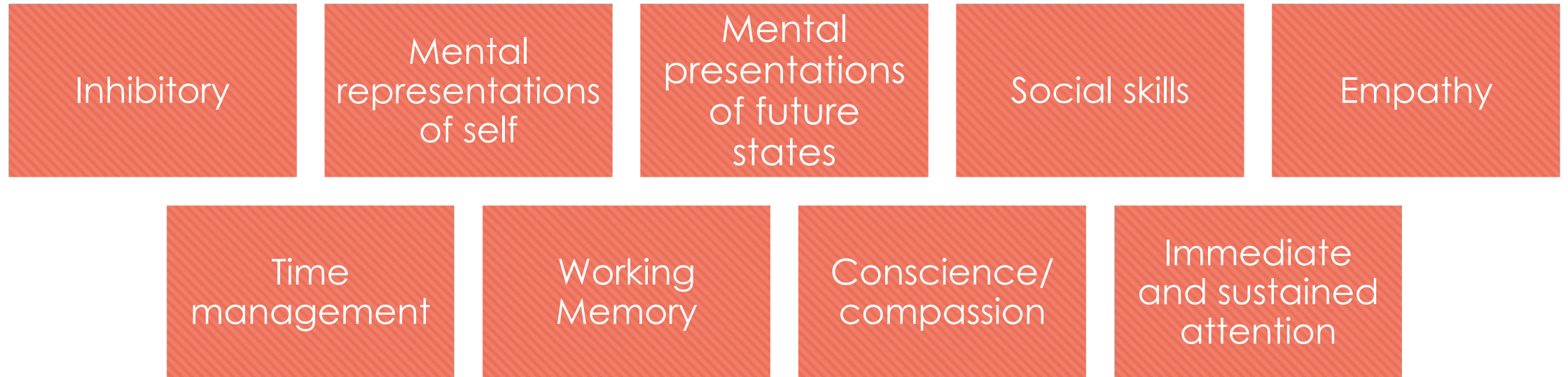
People can become:

More regulated

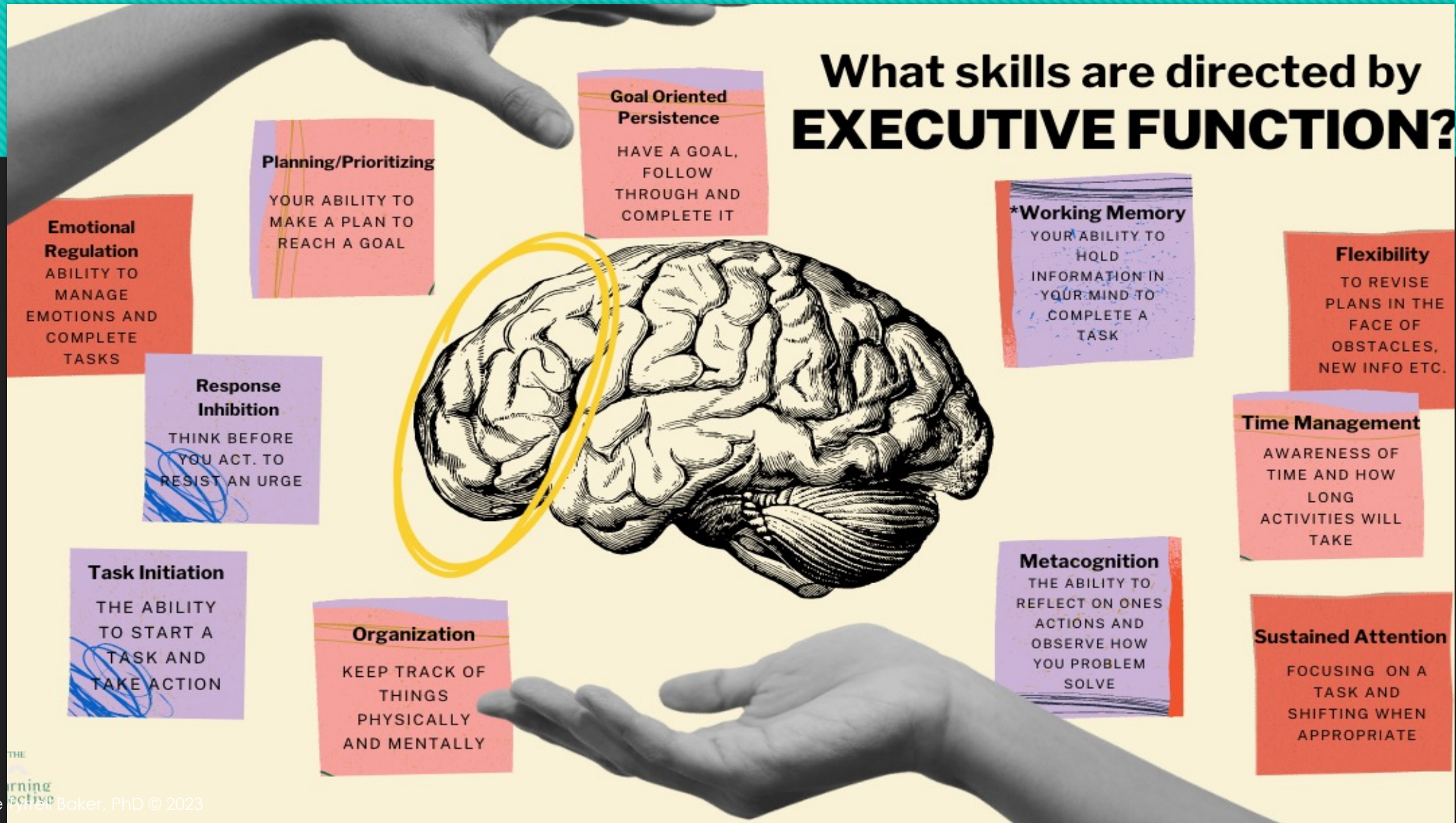
More
integrated

More self aware

Prefrontal cortex- the executive



What skills are directed by **EXECUTIVE FUNCTION?**



PFC heavily involved in learning, coping, and adapting



As evolution of the brain moved forward, the emphasis shifted from a brain with rigid, fixed functions to one that is capable of flexible adaptation



The ability to meet demands of new situations requires the brain to be able to adjust its neurological response.



“Optimal functioning can be defined as the ability to shift flexibly between states of arousal, depending on the tasks before it”
(Fisher, p. 106)

PFC integrates information

“PFC not linked to a single modality of function, its job is to integrate inputs coming from many modalities”

-Goldberg, p.47



Empowerment and mental models



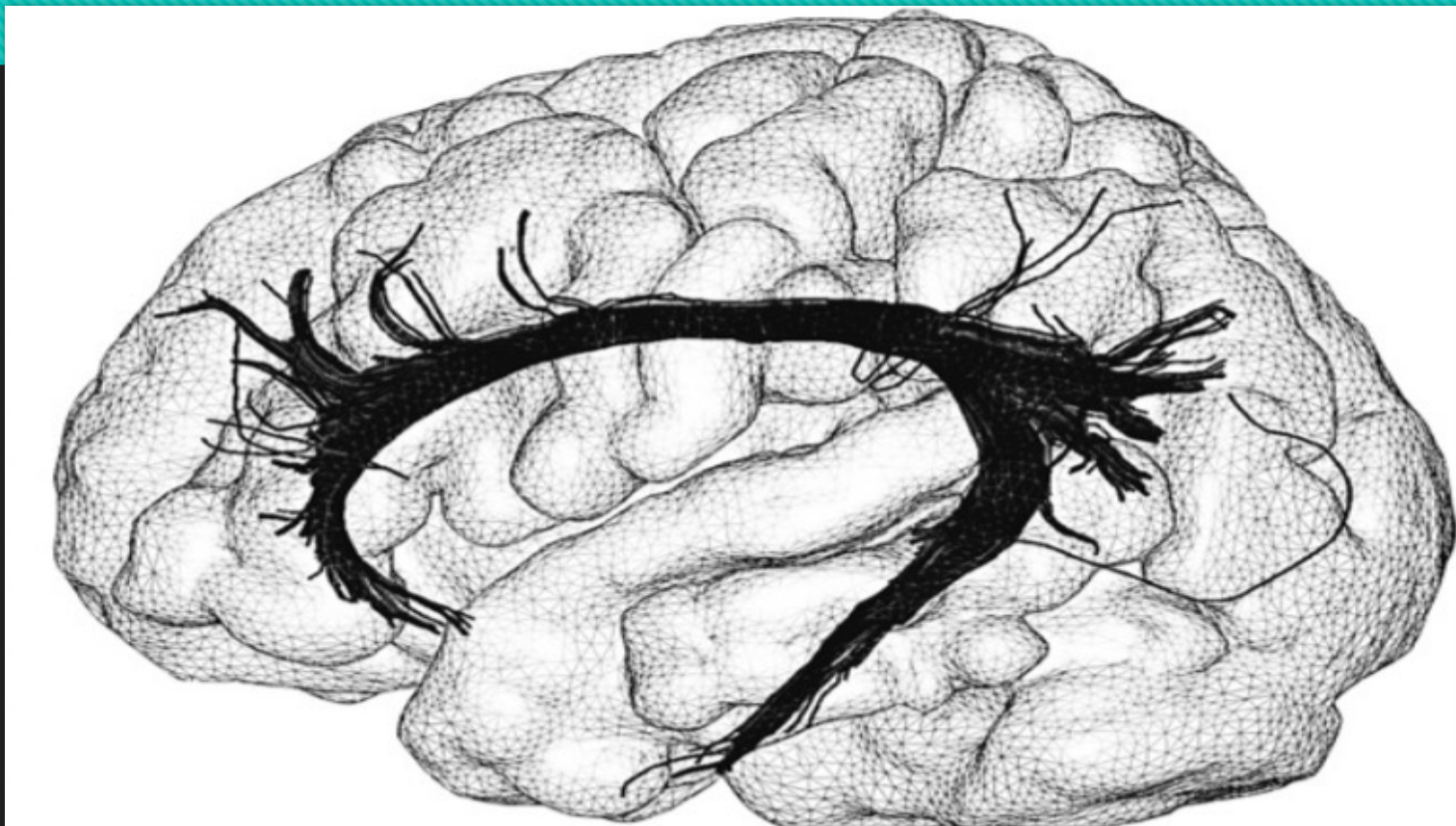
PFC allows mental models to be created, manipulated, and transformed



PFC is key to goal formation and the mental representation of self

“Ability to make mental models is a prerequisite for making things happen... models of something that does not exist yet but that one wants to bring into existence” (Goldberg, *The New executive brain*, p.24)

Increasing connectivity



Targets for Neuroplasticity

Increase

Activity in prefrontal area (decrease limbic area arousal)

Increase

Neural flexibility (ability to switch between states)

Increase

Connectivity

Qualitative data

4 key aspects of the changes unfolding from a more regulated brain

Quieting the nervous system

Window of Tolerance expands

Spontaneous self agency

Spontaneous self observations and capacity for reflective learning

Quieting the Nervous system

- “I am more present”
- “I feel better on the inside”
- “I am having fewer panic attacks and I can think my way through them. Something is different”
- “I had a conflict with my landlord and I waited two days to respond”
- “I used to yell and scream. I can see the things I used to react to. I used to feel like I had to say it and now I don’t have to say it”
- “Before Neurofeedback I used to feel a lot of dread. My hopelessness is much better. I don’t feel dark and depressive anymore”
- “My overreactivity is not controlling me anymore”
- “It feels like I can figure out stuff instead of freaking out”

Stress reactivity decrease

- Inhibition of reactivity
 - Decrease in frequency and intensity of responses (Carmen)
- Pause between stimulus and reaction/ behavior less state dependent
- Decrease in physiological arousal

Neurofeedback leads to mindfulness

- Less reactive and less overwhelmed, the mind starts to re-attune
- The pause invites reflection
- Siegel- Mindsight comes about when we experience
 - Openness
 - Observation
 - Objectivity

Limbic Overload©

	Limbic Overload	P value (compared to baseline)
Baseline (n=66)	113.418	
After 5 (n=66)	90.567	p<.001
After 10 (n=46)	77.652	p<.001
After 15 (n=21)	64.524	p<.001

Limbic Overload© Analysis Dx

	PTSD Group	Non-PTSD Group
Baseline (T1)	119	103
After 5 (T2)	95.7	83.48

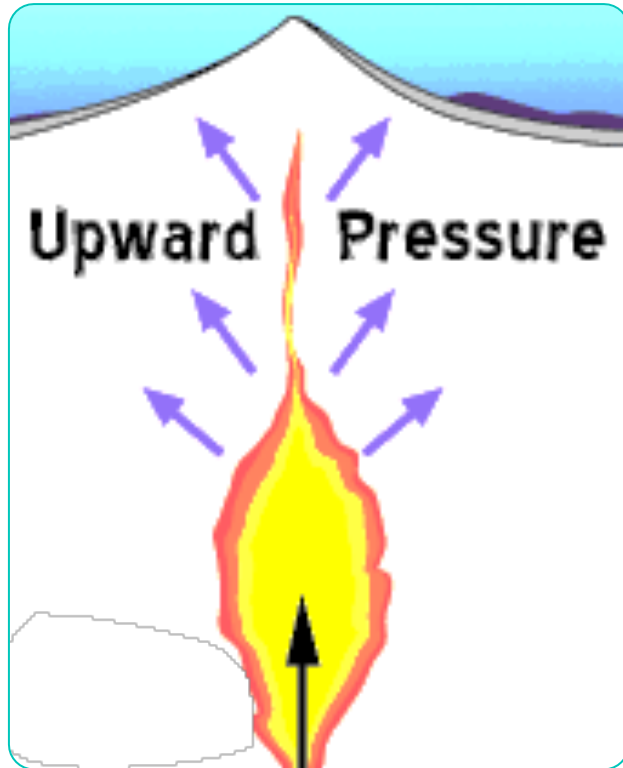
- At baseline, there is a significant difference in scores between PTSD and Non-PTSD groups
- After 5, PTSD group's mean resembles non-PTSD group
- 19 people dropped 25 points or more (half PTSD and half not PTSD)
- Change from T1 to T2 significant for both PTSD and Non-PTSD group

Window of Tolerance expands

- “I feel more irritated rather than shut down”
- “I feel more anger than panic/hopelessness”
- “I am able to allow myself to be sad”
- “I have been tearful and experiencing more emotion, not just anger/ anxiety”
- “I realize my feelings are normal. I have less doubt about being crazy”
- “Sadness, anger, disappointment, and grief are coming up. These are things I can’t change and I don’t have to”
- “I am feeling and I can tolerate the feelings. I am not numbing out”

Dissociation decreases

	DES-B	p value
Baseline n=48	10.0	
After 5 n=48	9.0	ns
After 10 n=22	7.409	p<.01
After 15 n=15	5.733	p<.01



When in survival we don't grieve resulting in uncomfortable pressure in the system

Inhibited grief

**Experiencing
more negative
emotions does
not mean
people are
getting worse!**

Unprocessed information is coming to the surface because the window of tolerance has increased and the need for avoidance/protection has naturally decreased.

Grief, sadness emerges (primary emotional experience that was buried under the sympathetic arousal).

Some people experience release of sadness/grief with some distress.

Emotional awareness and grief

- Locating self
- Awareness of personal loss
- Often, so what's here? "Sadness"
- Sadness is felt and used to make sense of the past

Grief

- Grief is a more general concept in emotional health, not just related to death and dying work
- Loss is associated with many stresses, transitions, and traumas
- **Grief is a set of primary emotions associated with a loss**
- Tension moves when we acknowledge previously unacknowledged experience and when we release perceptions that keep us stuck in or defined by that experience

CASE STUDY- DOMINIQUE

- Presenting problems- depression, stress of trying to be everything to everyone “never enough”
- After 7 sessions
- Asked about cellular memory (she gets depressed every August)
- Connected losing her brother in August when she was 12, family did not discuss
- She linked it to current symptoms of depression
- Realized coping mechanism has been to help children with trauma vs help herself
- She re-connected with her experiences of no one talking about it and how it affected her at school
- She talked to her mother and her sister about it
- It's as if she is accessed buried grief and is naming it, owning it, and using her connection with it to make sense of the past.

Self Agency

- “I am driving the chariot, it feels like I am on the ball”
- “My focus has shifted to me”
- “I said yes to something uncomfortable that led to a promotion at my job”
- “There is more of a sense of I can handle this”
- “I asked my boss to work from home 1 day per week”
- “I feel like I am standing up for myself”
- My son got Covid and I didn't worry “I can tackle this. I am doing the best I can”
- “I have more authority over what I want”

A new stronger connection to “self”

- Promoting self- one’s personal goals and priorities
- Noticing what is coming from me, from others
- Noticing what is in my control and what is not
- Decision making
- Setting boundaries

Van der kolk, BKS, p.97

Agency starts with interoception- awareness of subtle sensory body based experiences. The greater the awareness, the greater control over lives

With a decrease in physiological arousal, the person starts the process of sensing themselves again

Shifts in narrative

Spontaneous
insights occur

More "I"
statements, e.g.,
"You know what I
was thinking?"
"I realized...."
"I decided....."

Recognition of
resources,
creative solutions,
willingness to
pursue or accept
'help' of some
kind

Narrative
changes from
stressed/ trauma
narrative to
narrative with
more self agency
and more options

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

General Self efficacy (GSE) Schwarzer & Jerusalem (1995)

	GSE	P value (compared to baseline)
Baseline (n=66)	29.03	
After 5 (n=66)	30.463	ns
After 10 (n=46)	32.739	p.<01
After 15 (n=21)	33.524	P<.05

Sample items GSE

- I can always manage to solve problems if I try hard enough
- If someone opposes me, I can find the means and ways to get what I want
- It is easy for me to stick to my aims and accomplish my goals
- I can remain calm when facing difficulties because I can rely on my coping abilities

Coping Self Efficacy (CSE)

confidence in one's ability to cope effectively
(Chesney et al, 2006)

	CSE	p values (compared to baseline)
Baseline (n=62)	118.015	
After 5 (n=62)	145.149	p<.001
After 10 (n=39)	169.043	p<.001
After 15 (n=17)	187.286	p<.01

Sample items CSE

- When things aren't going well for you, or when you're having problems, how confident or certain are you that you can do the following:
 - Sort out what can be changed, and what can not be changed
 - Break an upsetting problem down into smaller parts
 - Leave options open when things get stressful
 - Try other solutions if your first solutions don't work
 - Get support from family or friends
 - Do something positive for yourself when you are feeling discouraged.

Self Awareness/ Reflective learning

- “I was aware of my heightened state.. I notice anxiety in my body when I lie down at night. It feels like an activating sensation in my chest”
- “I am more open to suggestions. I realize that many of the fights with my parents and my boyfriend are my fault”
- “This has made a huge difference coming here. My awareness of myself has increased. Noticing my own experience of working at my job, asking myself “Why am I working here?”
- “I realize that I am afraid of going back to pretending that I am okay and I don’t want to do that”
- “It is amazing that I had anxiety the other day and my mind went to “isn’t that interesting?”- this is not the usual way I would relate to my anxiety

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

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"

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”

Growth mindset

Can tolerate emotional state associated with reflecting

More willing to allow some amount of “hope” for things to be different

Open to trying new things, less defensive, less resistance

Reorganization of self



Brain establishes a more regulated, less reactive pattern.




Memory becomes more stable



For some people, fundamental views of self are transformed



Effects are cascading- you see changes over time even without more training sessions



“What we see in Neurofeedback is not just the impact on targeted symptoms of the patient but on the evolving presence and dimensionality of the person. Patients widen their focus, think new thoughts about old problems, even their vocabulary changes. They escape stubborn repetitions of their narrative....”

Fisher p. 68

Discovery of true selves

- We mistake our unbalanced nervous system (and associated state-dependent behaviors, interactions, and habits) as us.
- People get to discover what is underneath all of the layers of defense and protection
- The way we know and experience ourselves stem from these complex brain patterns

Negative Feedback loop

- Carmen (2018) posits that Neurofeedback results in a sustained pattern of frontal dominance through creating a negative feedback loop
- Rather than stimuli resulting to an escalating pattern of reaction (positive feedback loop- increasing energy demands from the brain)
- With Neurofeedback, the reactions get smaller and less frequent (negative feedback loop- decreasing energy demands)
- Brain keeps the pattern because it frees energy to be used for other things

Observing the direction of effects

- Carmen posits that with greater inhibitory control, the rate and intensity of many behaviors/ symptoms decrease
- Similarly, the activation of the PFC seems to create awareness of these behaviors when they do occur
- For some people, the major change comes not in what they are doing but what they are not avoiding
- For some people, the major change comes in engaging more successfully in psychotherapy

Many things can rapidly clear up

- Suicidal ideation
- Panic attacks
- Anger outbursts
- Helplessness/ depression
- Nightmares
- Dissociation
- Recklessness

- ❖ Addictive behaviors often have automatic tension relieving components.
- ❖ Neurofeedback can help these be less automatic.
- ❖ Rational brain coming online seems to decrease most destructive consequences
- ❖ Often they can be more honest about their use and the consequences.

- **Another part of addiction is reward systems**
- **People often continue to use in some way due to their decision that it is rewarding to do so**
- **To be abstinent, that has to be the person's actual goal.**
- **Sometimes they can be more honest about what their goal is.**

Addiction

Addiction (examples)

- Ability to quit smokeless tobacco habit without difficulty after 40 years of using
- Spontaneous movement from everyday drinking to weekends only (several people)
- Willingness to go to rehab, to get more support through AA

Physical and health changes (examples)

- IBS improves
- Lupus and other autoimmune diseases- flare ups become less often, less intense
- Headaches improve
- Brain fog clears

PIR HEG Neurofeedback's poor face validity

- A Blessing and a curse
- Gym or physical therapy metaphor
- Dual Learning model

Dual learning model

#1 Brain Learning (implicit learning in PFC)



#2 Capacity for Reflective learning (explicit learning)

“Neurofeedback changes brain connectivity patterns, the mind follows by creating new patterns of engagement”

Van der kolk, Body keeps the score, p. 322

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



Sebern Fisher

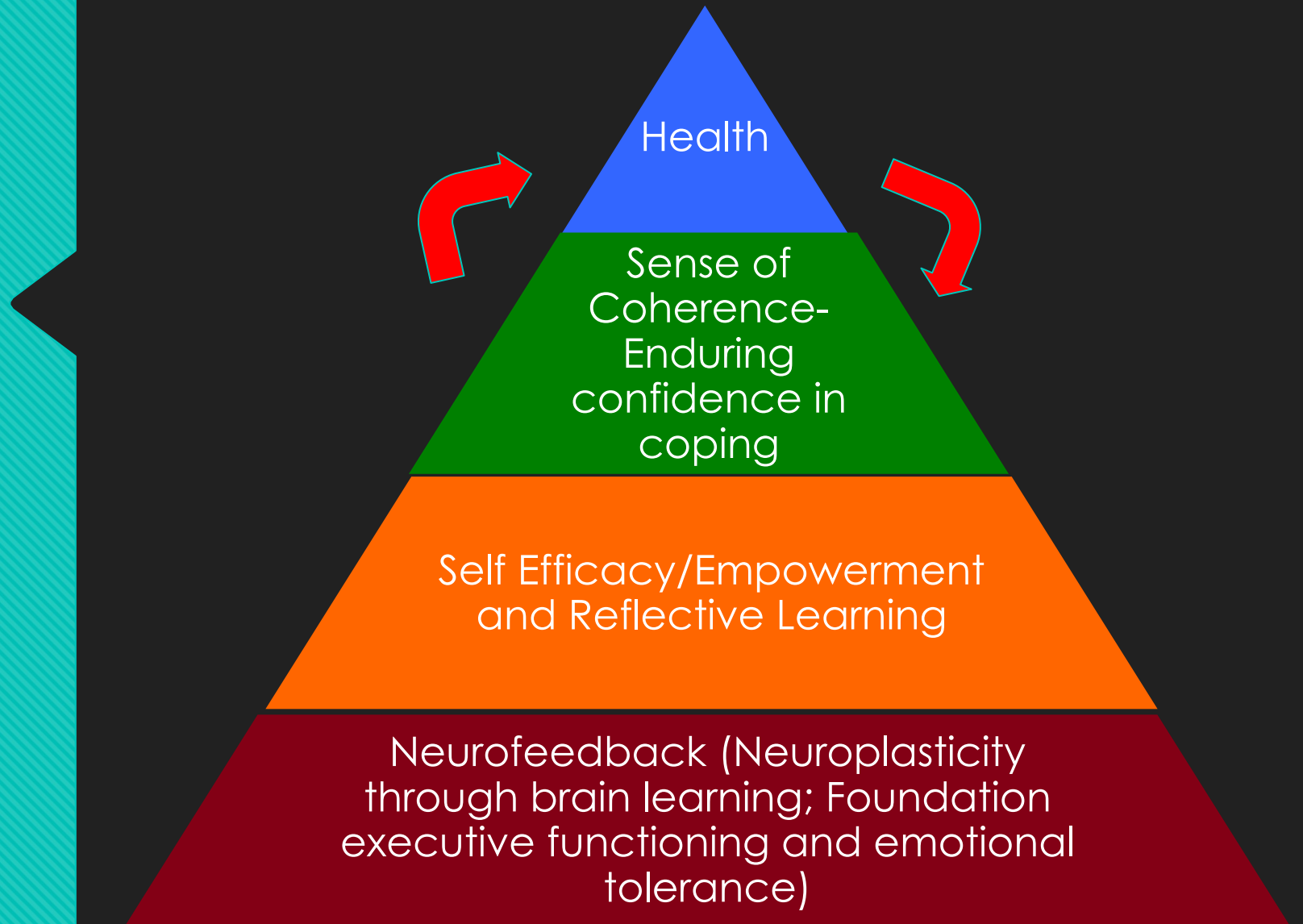
“Neurofeedback prepares the brain for new learning as it relaxes firing patterns that sustain fear” Fisher, p. 73

Hypothesis of Stress Regulation and Learning Model©:

- What we see in Neurofeedback is a global movement toward health mediated by an enduring increase in Self Efficacy and Sense of Coherence.
- Neurofeedback ignites a dynamic process of learning and adaptability that progresses toward health



Stress Regulation and Learning Model©



Salutogenic model (Antonovsky, 1987, 1996)

- Assumption: humans are under continuous stress
- If tension that arises in the body from stress is not resolved, it can lead to disease
- What leads to health? Successful reduction of tension
- Successful resolution of stress tension is predicted by Sense of Coherence

Sense of Coherence

Pervasive, enduring confidence that:

1) Stimuli deriving from one's internal and external environment are structured, predictable, and explicable (comprehensible)

2) Resources are available to meet the demands posed by these stimuli (manageable)

3) The demands are challenges, worthy of investment and engagement (meaningful)

Ability to Reflect in moments of stress increases with Neurofeedback

- Rational thinking during times of stress (Comprehensible)
- More consistent states (Manageable)
- Learning from situations where the gap between their current abilities and desired abilities is not too big; effort is likely to make a difference (Meaningful)

Empowerment increases with Neurofeedback

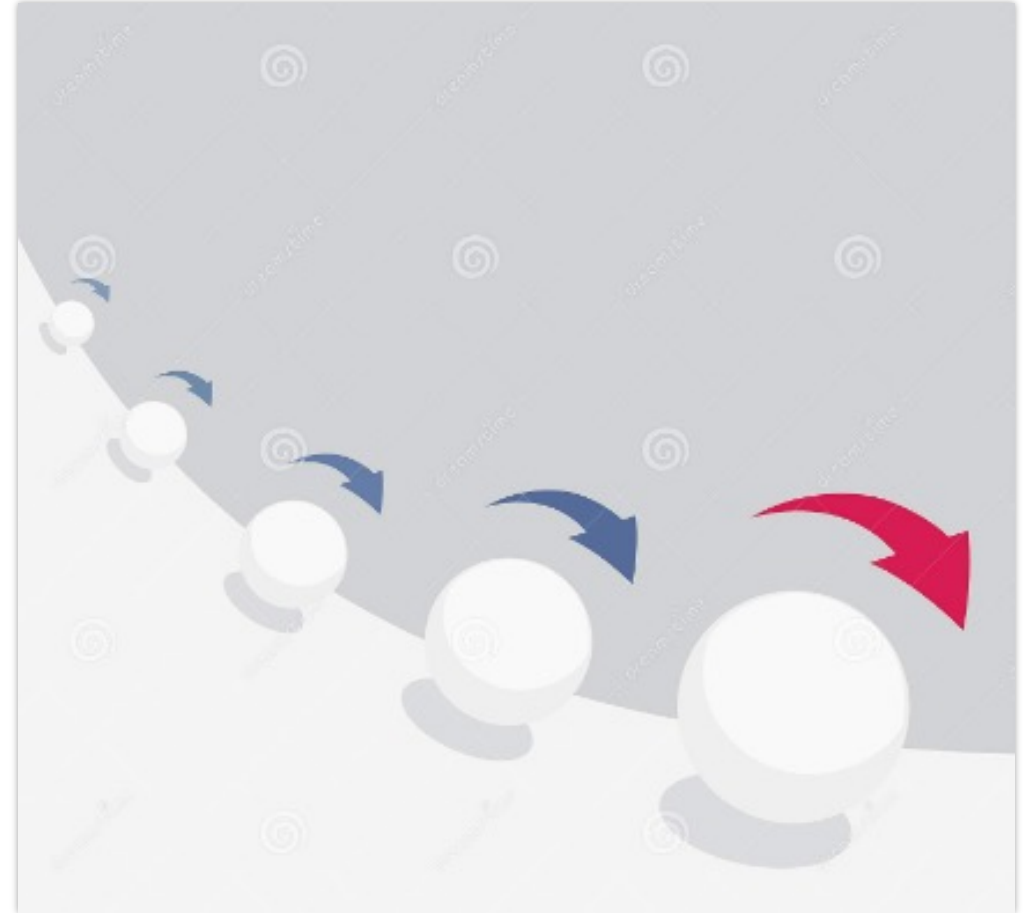
- Seeing oneself as having agency (Manageable)
- Tolerating difficult emotions “Those with high self efficacy will accept the difficult and bothersome elements of stress as part of the price of gaining mastery over problems” (Bandura) (Meaningful)

Sense of Coherence is self perpetuating

- When stressful stimuli are resolved successfully, SOC is reinforced
- “the interplay between resources, SOC, life experiences, reflection, empowerment, and health is complex and interdependent process (S. Super et al, p.874)
- Empowerment and Reflection help people accurately assess stressors, locate resources, and feel motivated and confident to use them



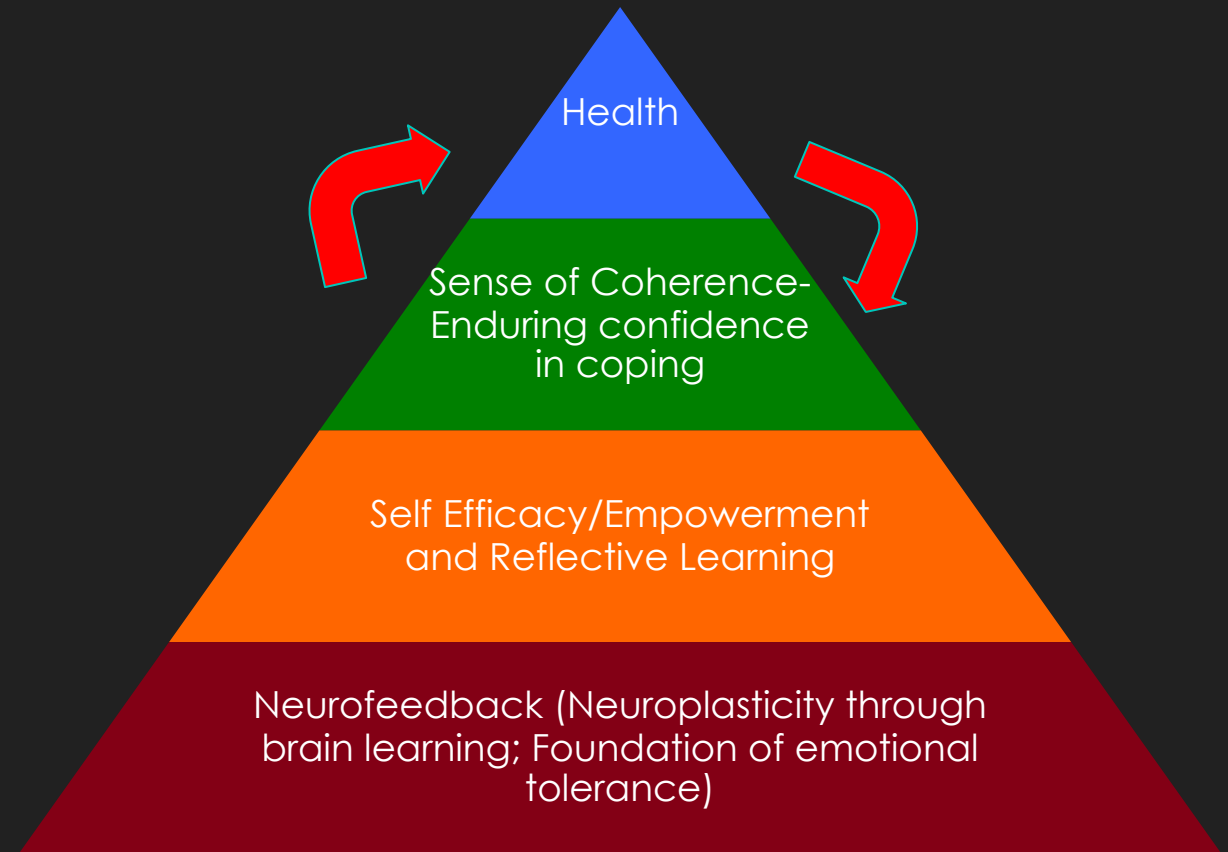
The Snowball effect – more coping successes build momentum



**Rapid growth of
perceived efficacy
can affect immune
system positively
(Wiedenfeld et al,
1990)**

- Acquisition of perceived self efficacy through performance mastery results in durable immune system changes, e.g.,
 - Total lymphocytes
 - Helper T cells
 - Suppressor T cells
 - Helper/Suppressor Ratio

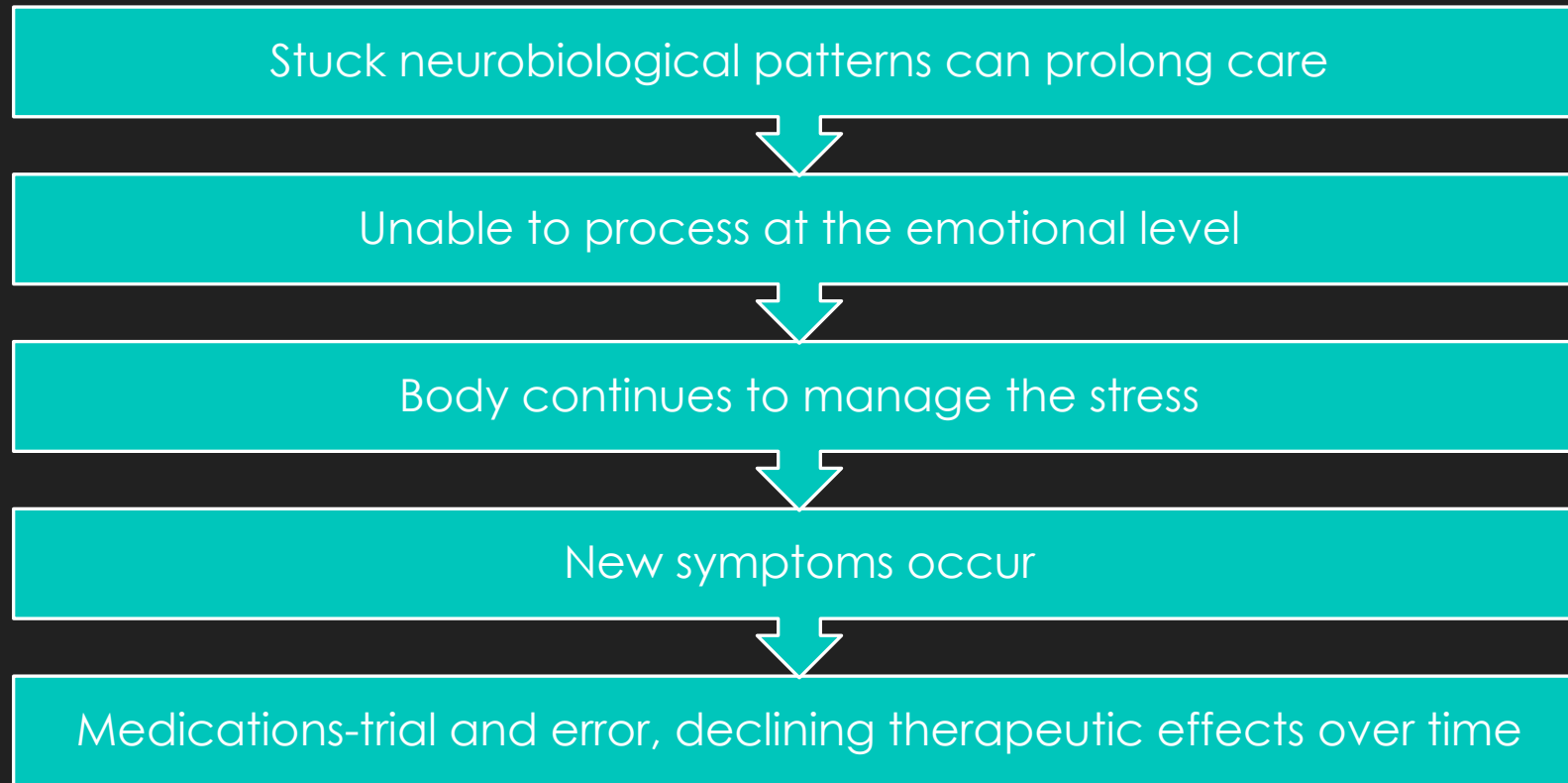
Stress Regulation and Learning Model©



5 key components of Stress Regulation and Learning Model© approach

Observe	Observe with brain arousal in mind
Expect	Expect change
Help	Help people understand the process and notice changes
Facilitate	Facilitate empowerment/ self efficacy
Enhance	Enhance reflective learning

Neurofeedback can help us provide more efficient and effective care



Therapy combination

- Neurofeedback and Mindfulness-based CBT
- Neurofeedback and Polyvagal Therapy
- Neurofeedback and EMDR
- Neurofeedback and IFS

Conclusions

- pIR HEG Neurofeedback is helpful for many clinical mental health conditions, beyond migraines
- Outcomes for PTSD, developmental trauma, etc are similar in nature to reports from EEG-based Neurofeedback
- Approx. 12-20 sessions of pIR HEG results in meaningful change
- pIR HEG has advantages in the ease of implementation
- Need for more research on pIR HEG and on the Stress Regulation and Learning Model©

Individual Mentoring, Group Mentoring, and Data Consultation

- Email me at wellbeing.cny@gmail.com
- A few individual sessions or something more ongoing
- NEW: Group Mentoring sessions Tuesdays 12-1pm EST; 6 sessions; New Round scheduled for this Fall

EZ pIR training

EZ-pIR HEG Neurofeedback system

Jeff Carmen, PhD

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