



The Neuroscience of Trauma

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ANS Research

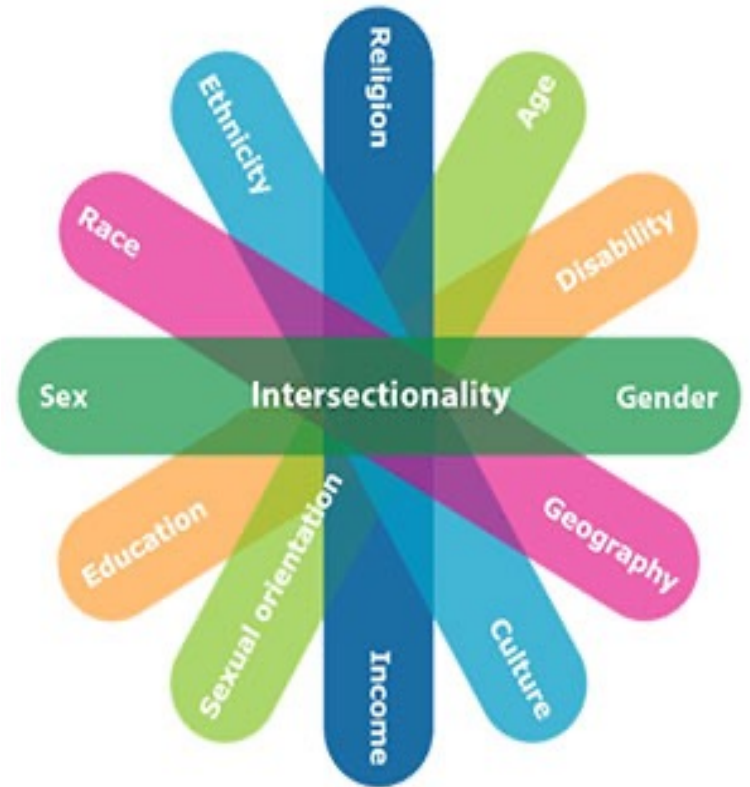
Collaborators

- PTSD Research Team: Krysta Andrews, Maria Densmore, Sherain Harricharan, Breanne Kearney, Nancy Mazza, Andrew Nicholson, Stephanie Nevill, Tracey Pocius, Daniela Rabellino, Saurabh Shaw, Suzy Southwell, Braeden Terpou
- Others: Frank Corrigan, Paul Frewen, Robyn Bluhm, Margaret McKinnon, Andrew Nicholson, Don Richardson, Tomas Ros, Patricia Vickers

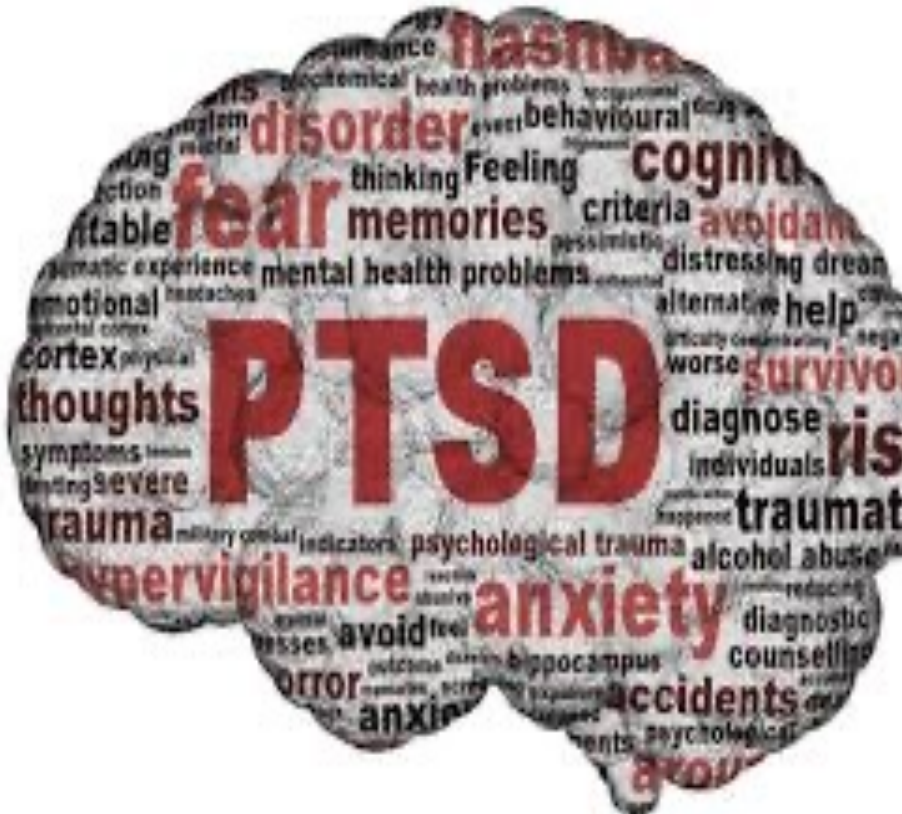
Intersectionality

“Our experiences are affected by intersecting parts of our identity, the context we are in, and our lived realities. We all have multiple identity factors that intersect that help make us who we are.”

(Government of Canada)



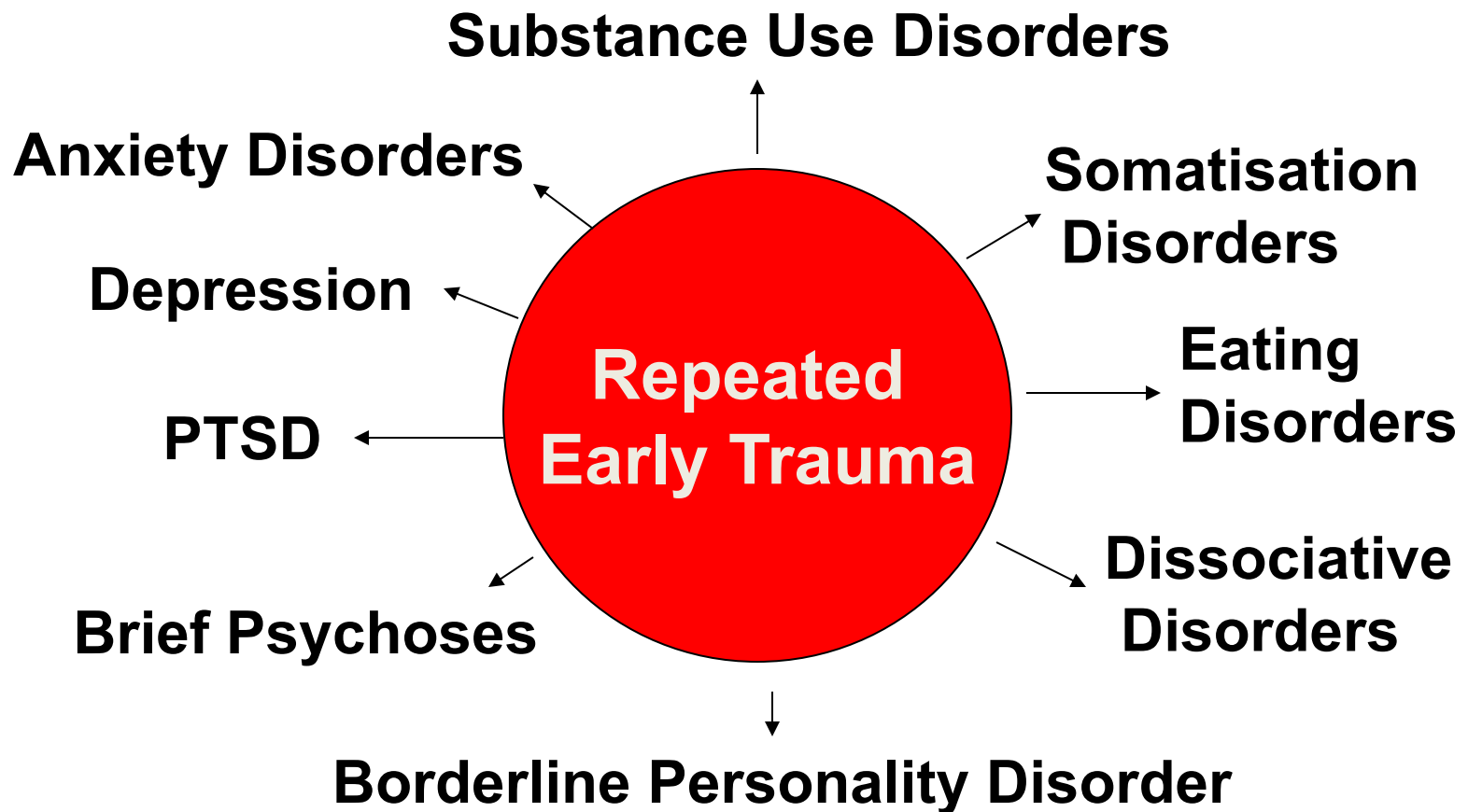
What is PTSD?



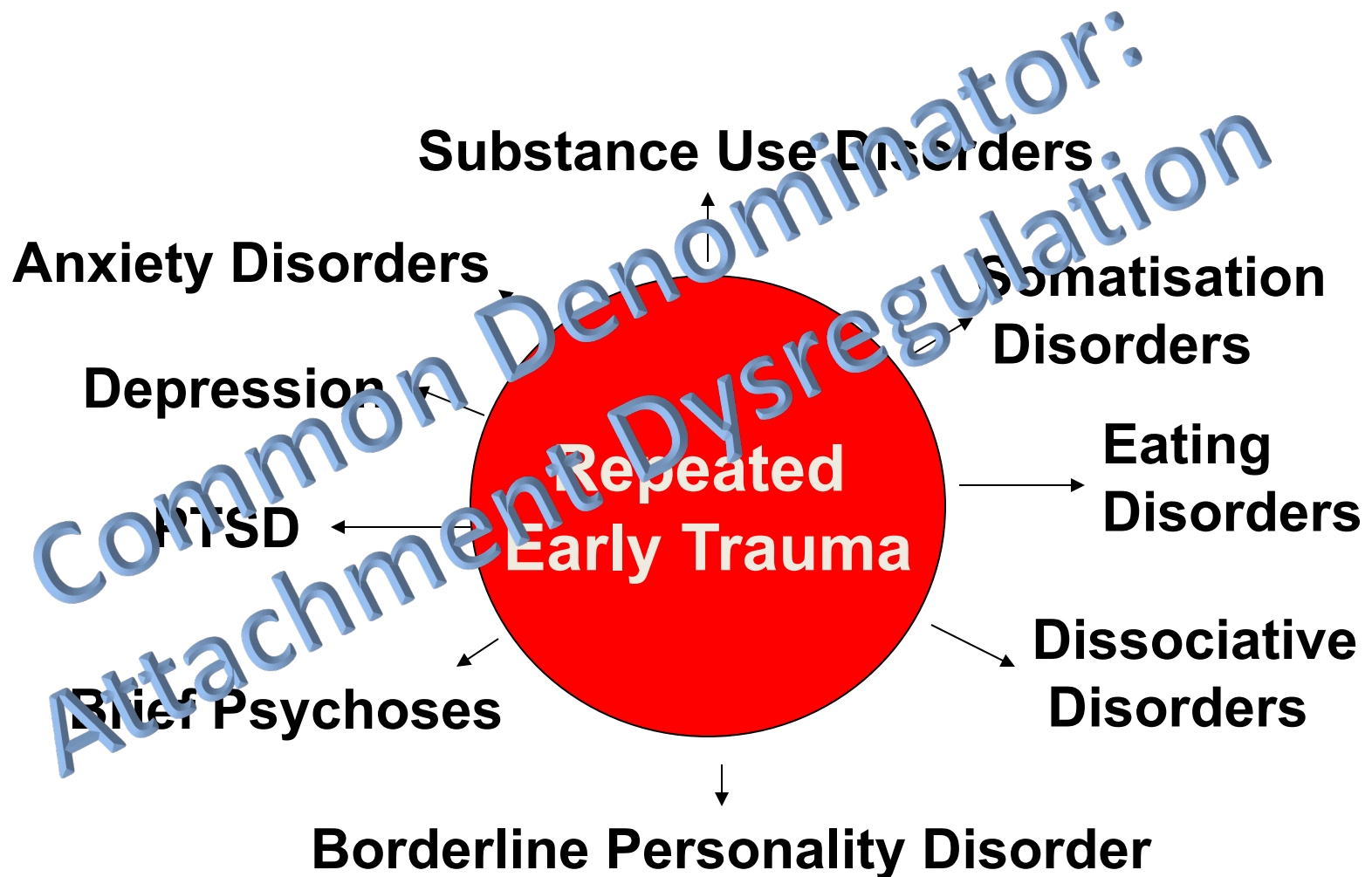
- Exposure to traumatic event
- Re-experiencing
- Avoidance
- Alterations in Cognition and Mood
- Hyperarousal
- Symptoms cause functional impairment

Dissociative Subtype:
Depersonalization/derealization

Psychiatric Comorbidity of Chronic Early Trauma



Psychiatric Comorbidity of Chronic Early Trauma



The Attachment Relationship: A Prerequisite for an Adequate Window of Emotional Arousal

Window of Tolerance/Capacity

Hyperarousal-Dissociation

Unable to think and react rationally

Unable to stand back and reflect

Optimum social, work, and cognitive functioning

Optimum Emotional
Arousal Zone

Poor social engagement

Unable to feel

Hypoarousal-Dissociation

Not Being Seen...

Not Being Heard...

Not Validating Feelings...

Window of Tolerance/Capacity

Hyperarousal-Dissociation

Unable to think and react rationally

Unable to stand back and reflect

Optimum social, work, and cognitive functioning

Optimum Emotional
Arousal Zone

Poor social engagement

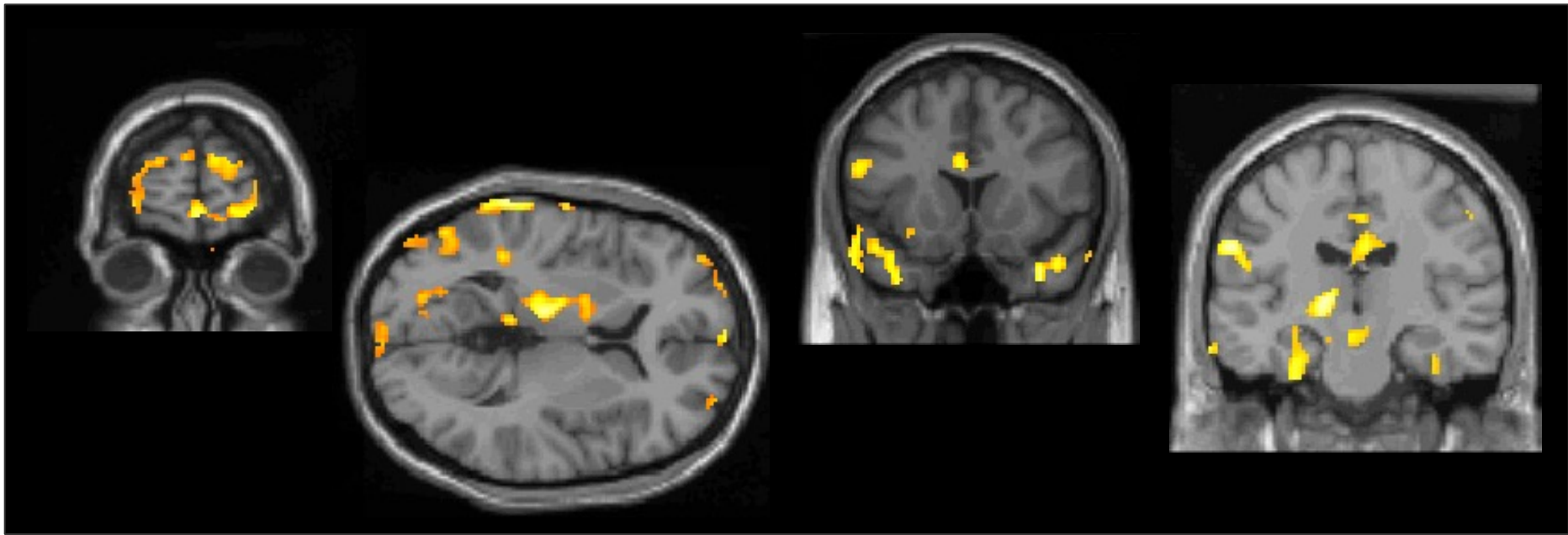
Unable to feel

Hypoarousal-Dissociation



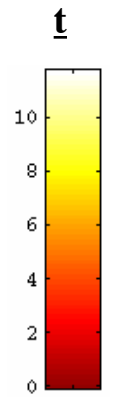
Implications for the Capacity to Trust...

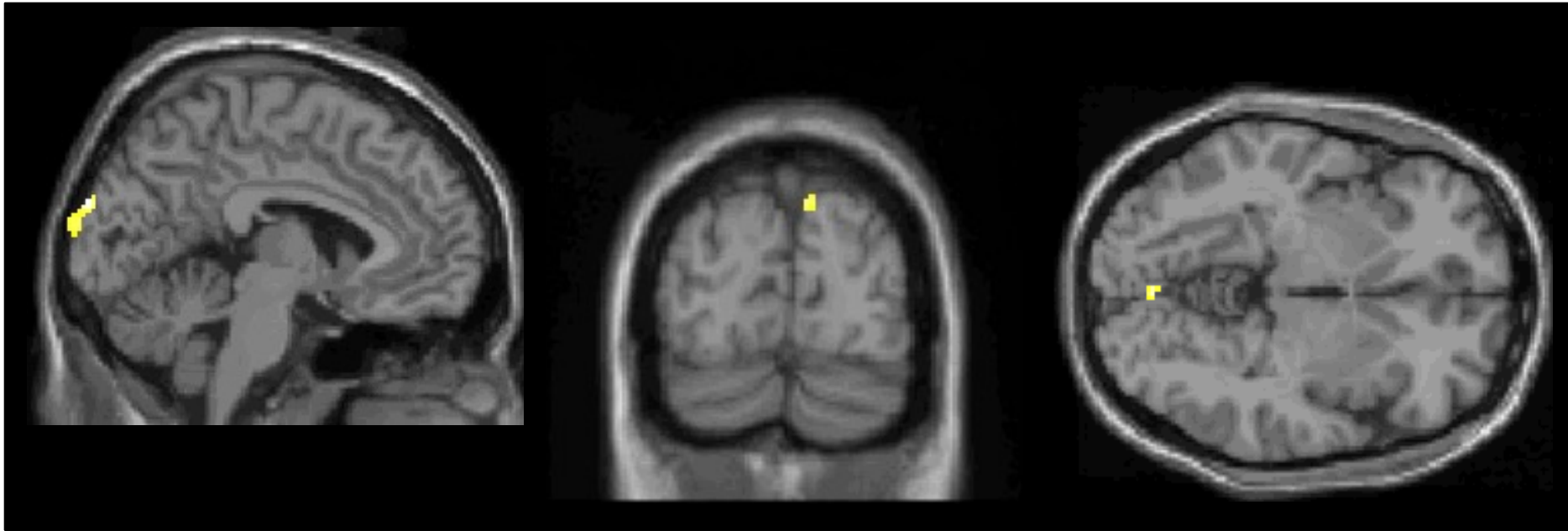
Heterogeneity of Response to
Psychological Trauma:
A Case Example



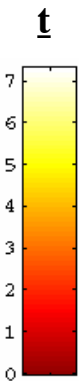
Degrees of Freedom = 82.39, Cluster Size > 10voxels

| Talairach | R/L | Effect Lobe | Effect Gyrus | Brodmann's Area |
|------------------|------|-------------|-------------------------|-----------------|
| - 14, - 18, 2 | L | Sub- lobar | Thalamus | |
| - 4, 12, 24 | L | Limbic | Anterior Cingulate | 24 |
| 6, - 16, 32 | R | Limbic | Cingulate | 24 |
| - 28, - 18, - 12 | L | Limbic | Parahippocampal | Hippocampus |
| 38, - 20, - 28 | R | Limbic | Parahippocampal | 36 |
| 32, 64, 4 | R | Frontal | Superior Frontal | 10 |
| - 18, 66, 20 | L | Frontal | Superior Frontal | 10 |
| 12, 64, 22 | R | Frontal | Superior Frontal | 10 |
| - 38, 56, 3 | L | Frontal | Middle Frontal | 10 |
| 0, 65, 3 | R, L | Frontal | Medial Frontal | 10 |
| - 54, 12, 4 | L | Frontal | Inferior Frontal | 44 |
| - 58, - 16, 30 | L | Frontal | Postcentral, Precentral | 4, 2, 3 |
| 38, 12, - 32 | R | Temporal | Superior Temporal | 38 |
| - 46, 18, - 20 | L | Temporal | Superior Temporal | 38 |
| - 66, - 38, 0 | L | Temporal | Middle Temporal | 21 |
| 0, - 96, 18 | R, L | Occipital | Cuneus | 18 |





| Degrees of Freedom = 82.39, Cluster Size > 10voxels | | | | |
|---|------|-------------|--------------|-----------------|
| Talairach | R/L | Effect Lobe | Effect Gyrus | Brodmann's Area |
| 12, - 81, 43 | R | Parietal | Precuneus | 19 |
| - 4 - 94, 29 | L | Occipital | Cuneus | 19 |
| 2, - 80, - 4 | R, L | Occipital | Lingual | 18 |
| 10, - 104, 4 | R | Occipital | Cuneus | 18 |



Too Much Emotion

Too Little Emotion

Active Defense

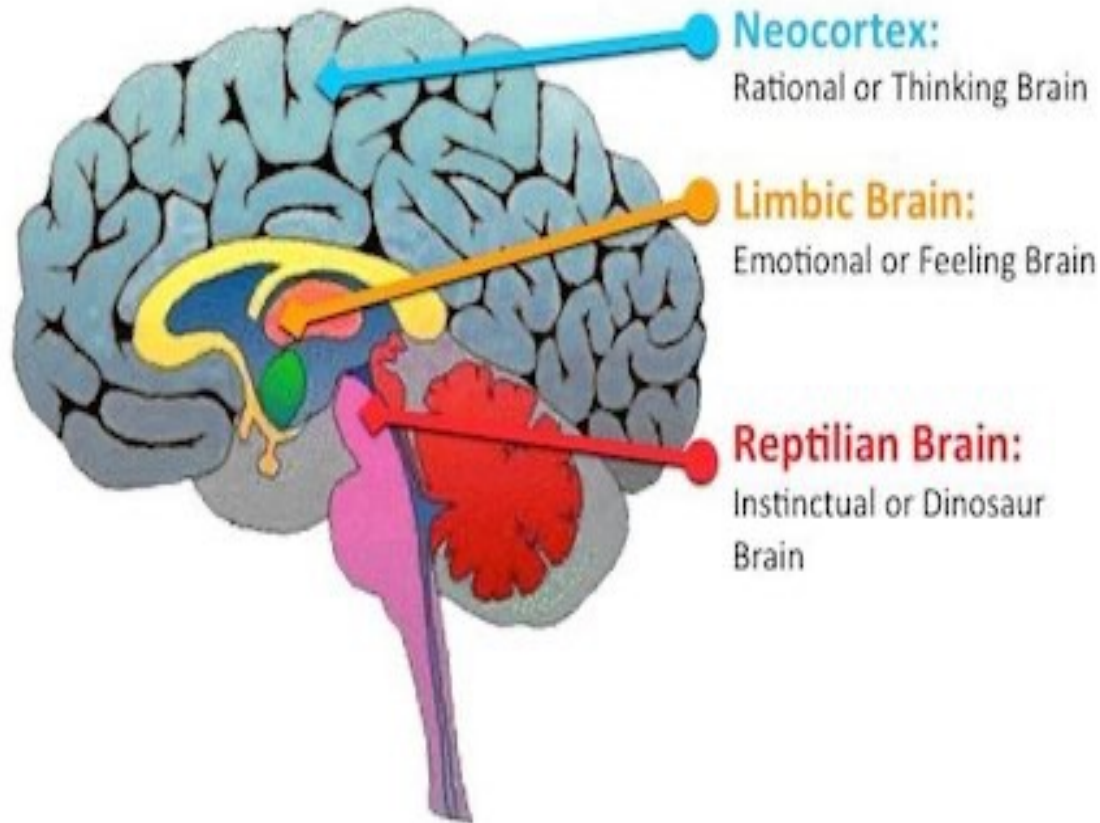
Passive Defense

Stress Response and the Reptilian/Survival Brain...

The Reptilian/Survival Brain



The Reptilian/Survival Brain



MacLean, 1990

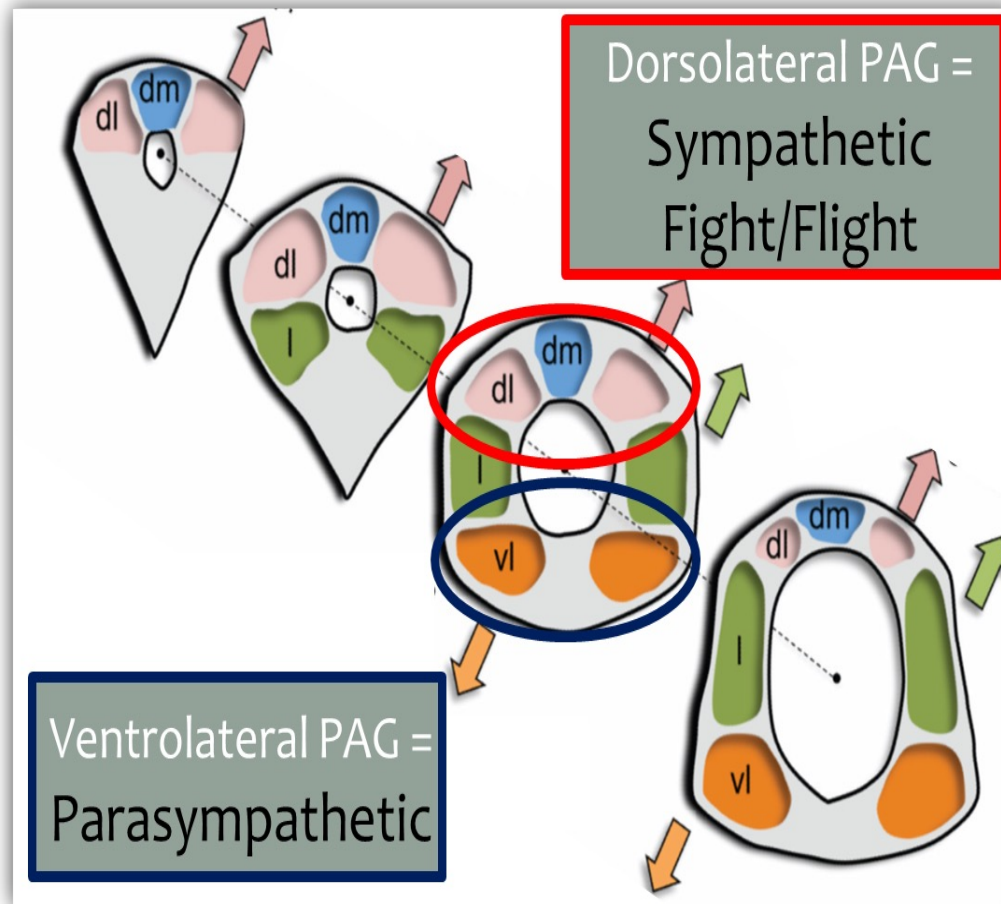
Periaqueductal Gray (PAG)



- Critical for autonomic regulation and for defensive responses
- Comprised of multiple subdivisions that vary in function
- Important role in all basic emotional systems (fear, rage, seeking, panic)

Bandler et al. 2000; Bandler & Shipley, 1994; Mobbs et al., 2007; Panksepp, 2008; 2014

PAG Subdivisions



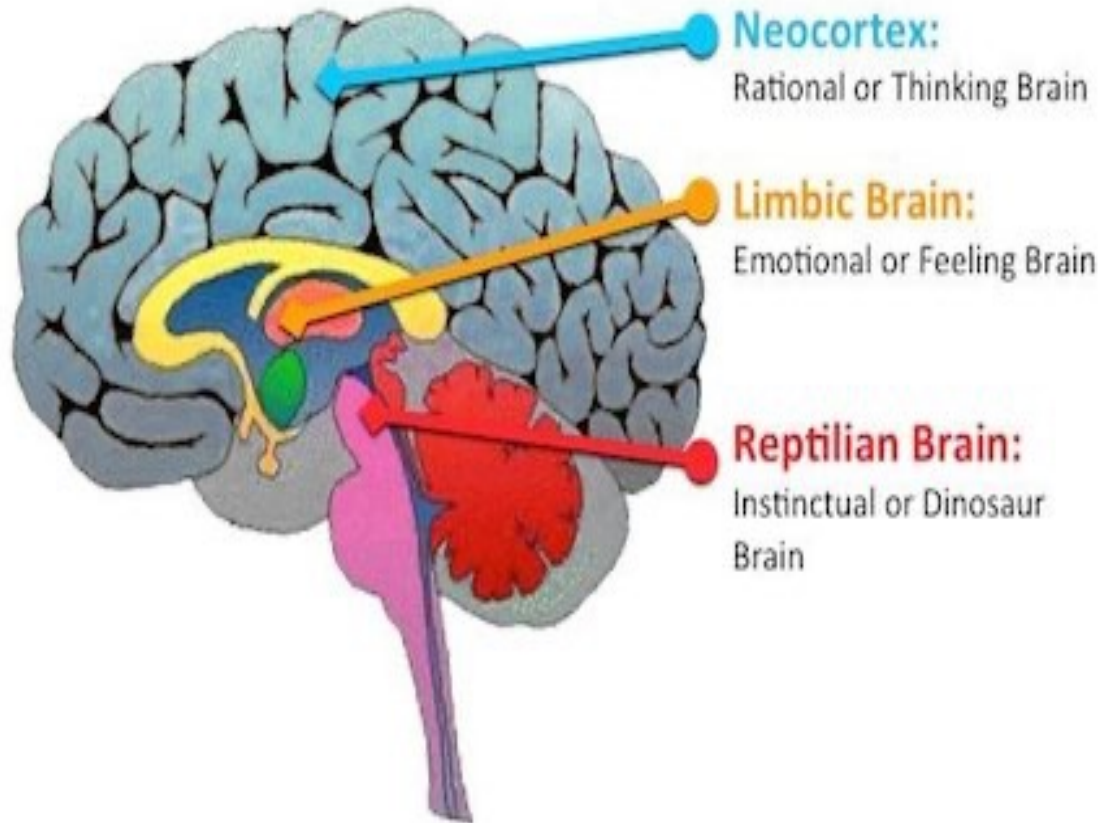
Active Defensive
Responses

Passive Defensive
Responses

Clinical Implications...

How Can the
Reptilian/
Survival Brain
Influence Our
Sense of Self?

The Reptilian/Survival Brain



MacLean, 1990

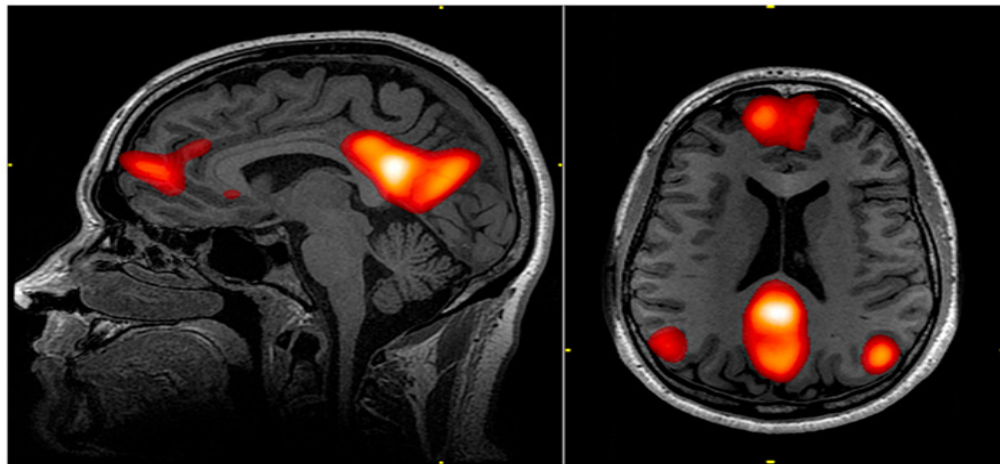
The Hijacked Self...

The Default Mode Network (DMN) as a Model for the Sense of Self

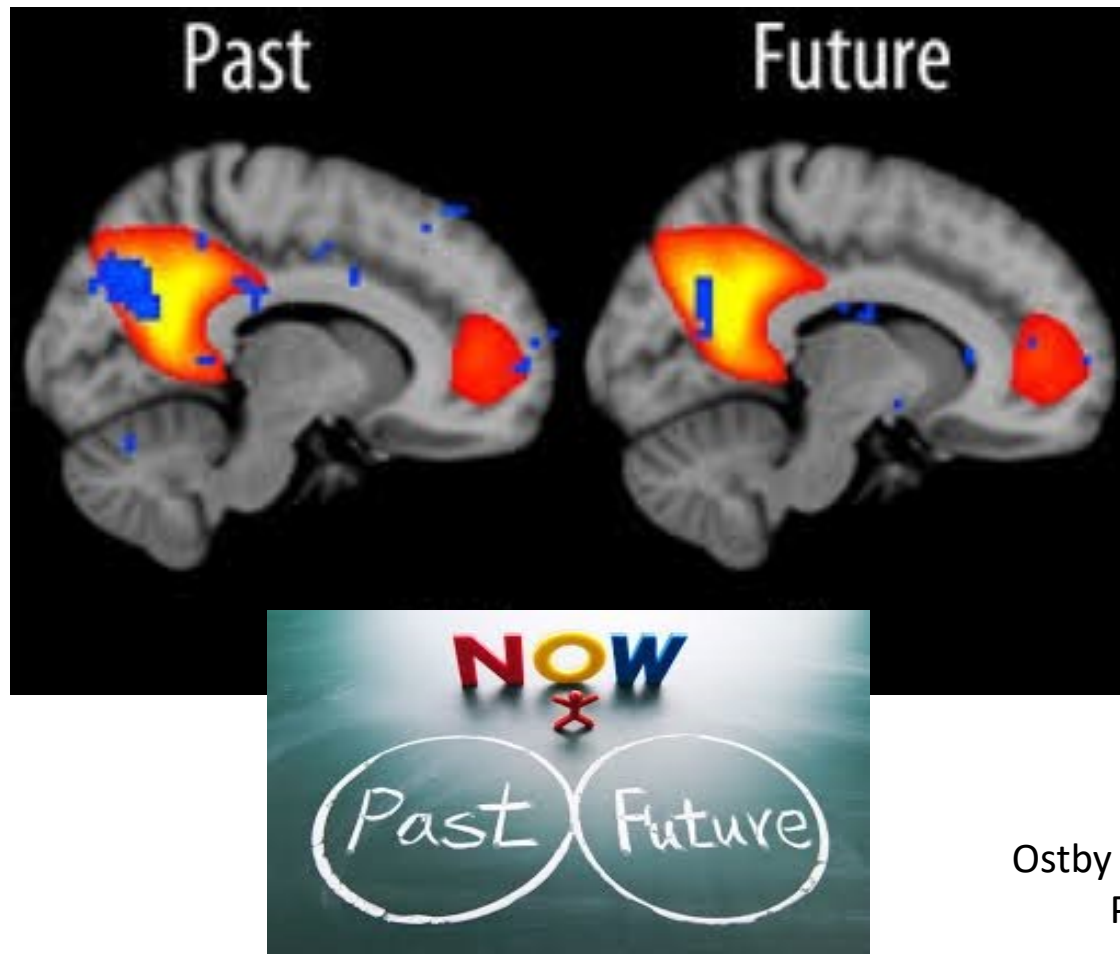


Functions of the DMN

- Self-reflection/interospection/self-awareness
- Autobiographical Memory
- Perceiving the perspectives of others/social connection
- Embodiment



Continued Experience of Self Across Time & into Future

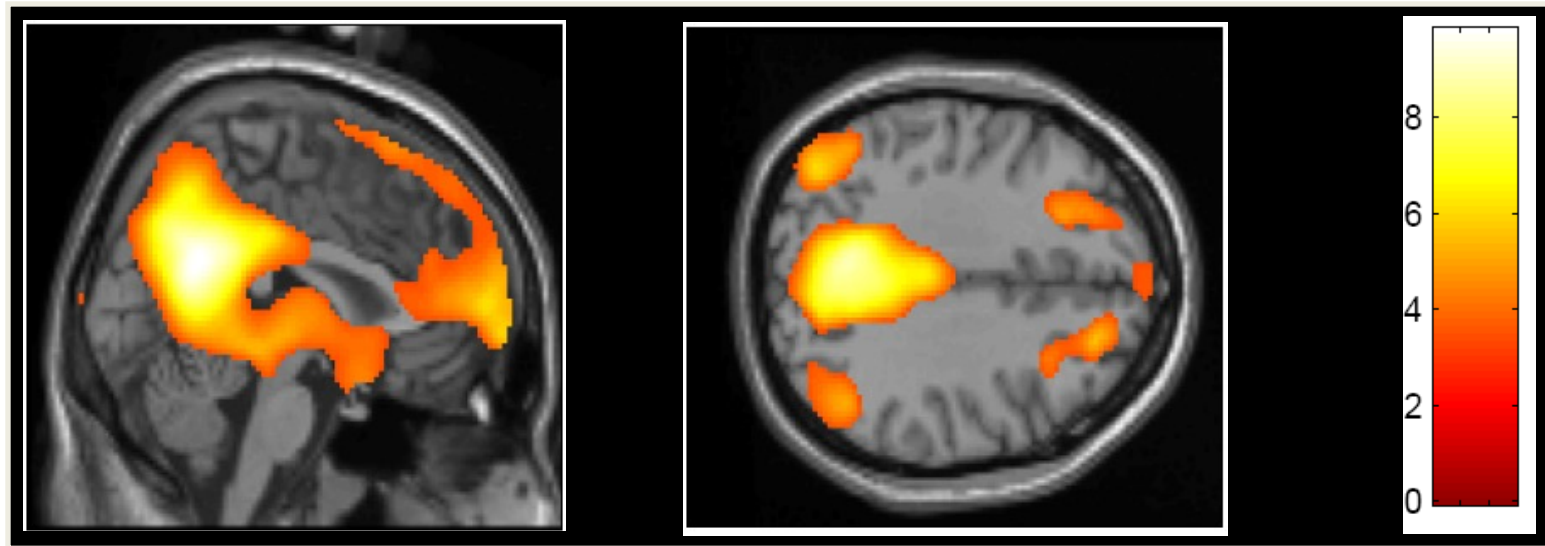


Ostby et al., PNAS, 2012;
Perkins, 2016

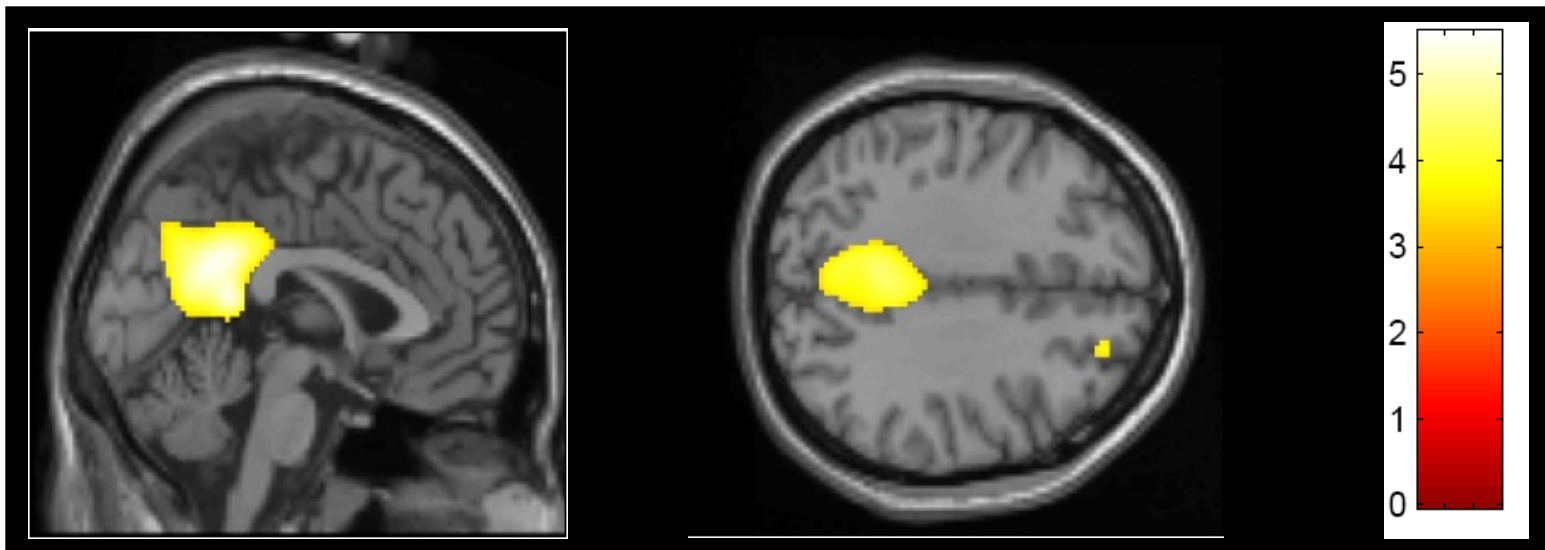
The Default Mode Network At Rest/Off Task



Controls (n=16): Positive Correlation



PTSD (n=18): Positive Correlation

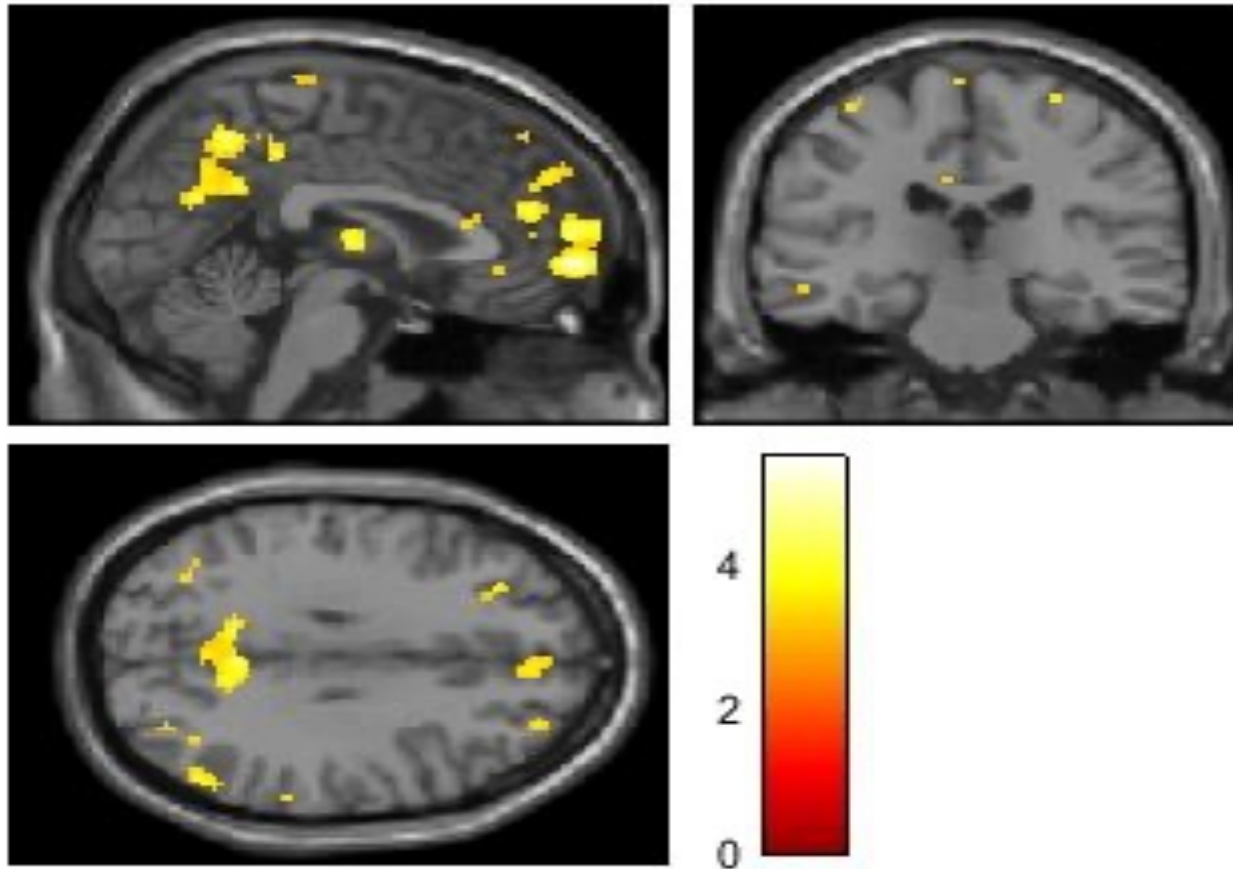




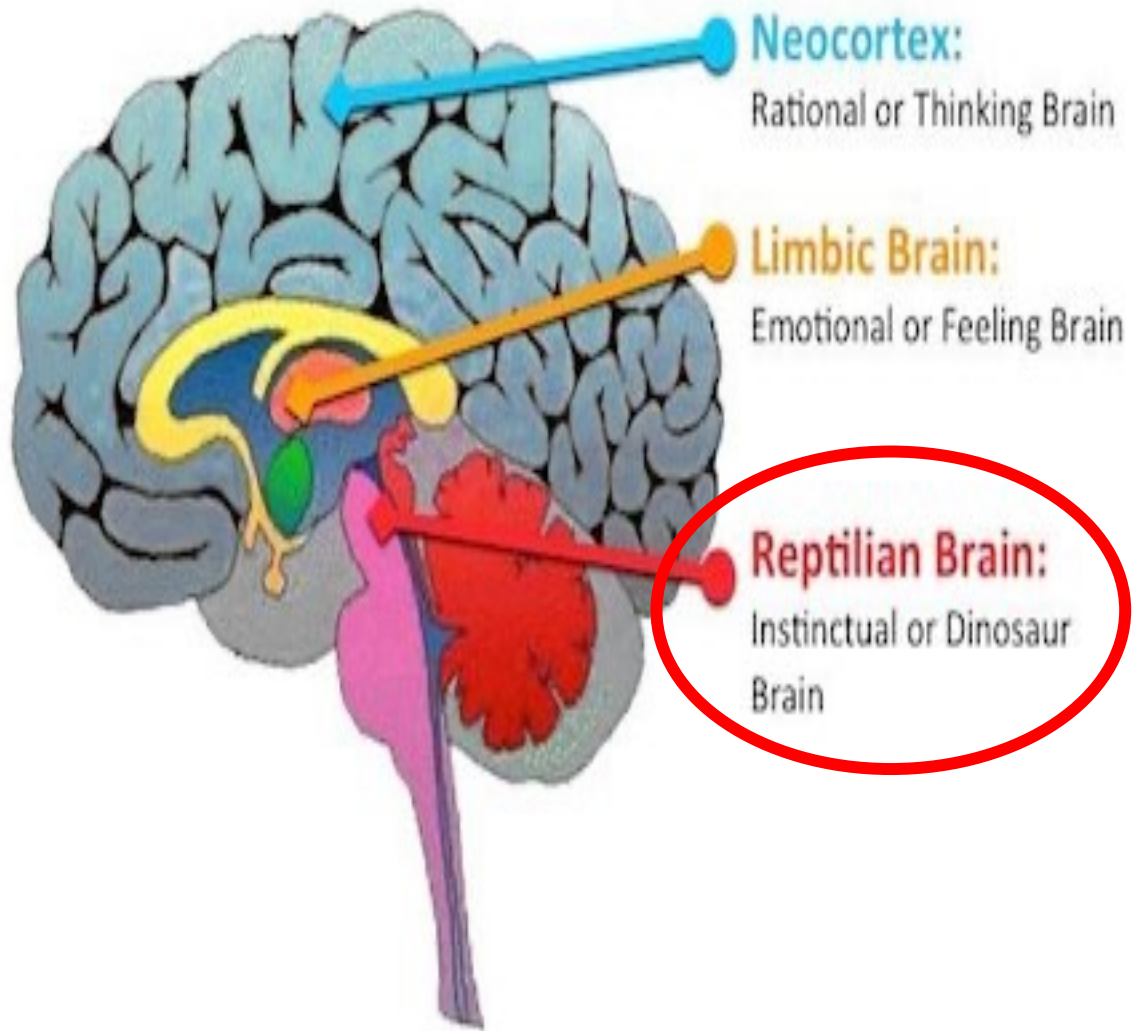
**WANDER
FIRE**

The
Default
Mode
Network
Under
Threat...

Default Mode Network Connectivity **Under Threat** in PTSD



What drives default mode
network connectivity under threat?



Neocortex:

Rational or Thinking Brain

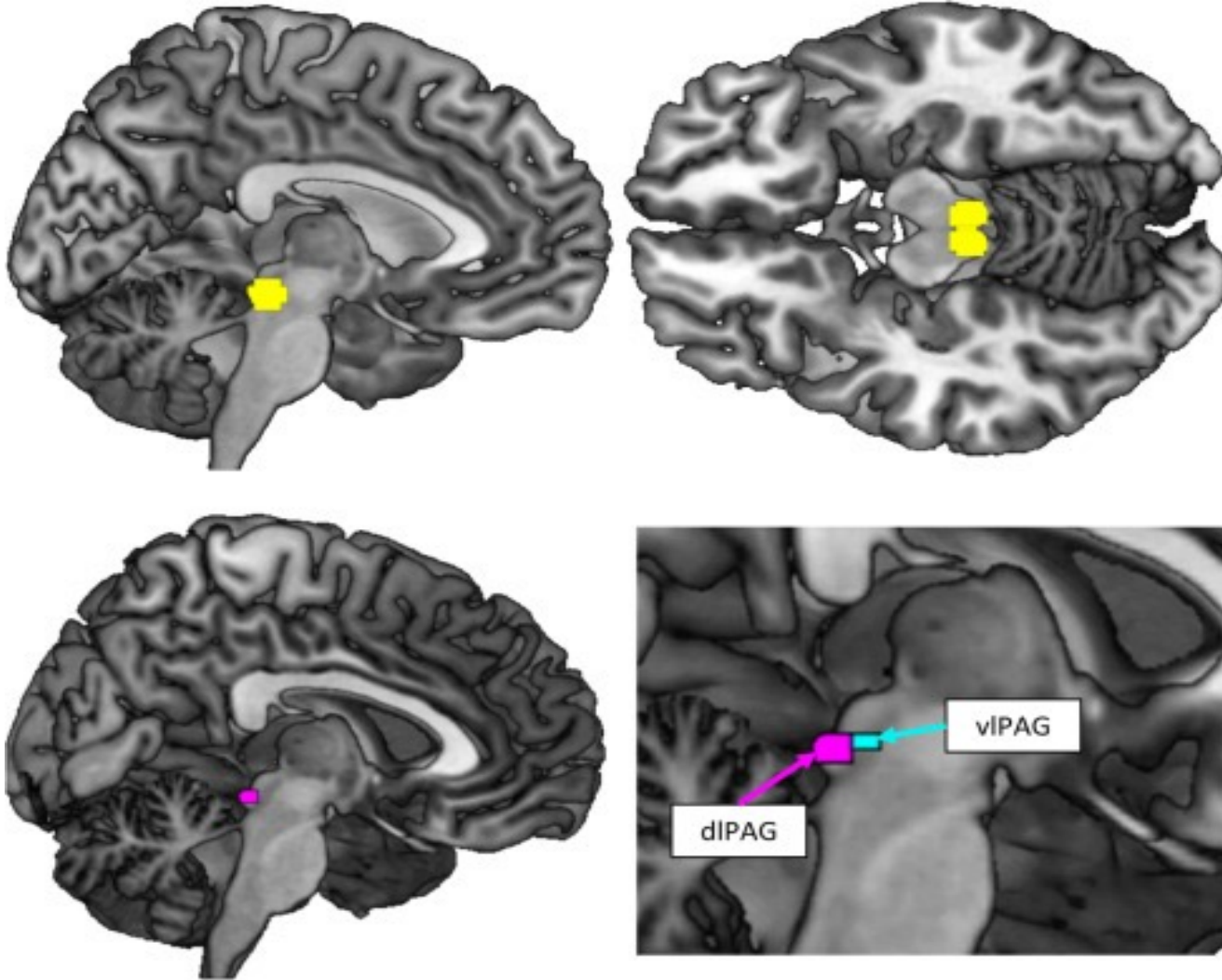
Limbic Brain:

Emotional or Feeling Brain

Reptilian Brain:

Instinctual or Dinosaur
Brain

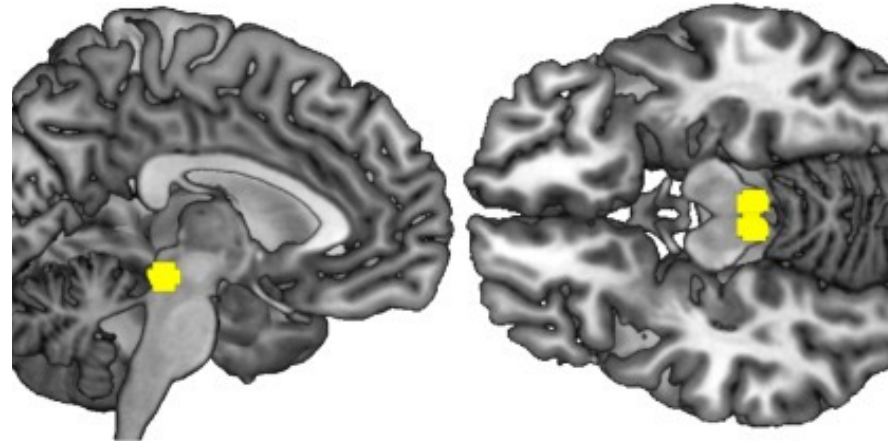
Periaqueductal Gray (PAG)



Autonomic Regulation

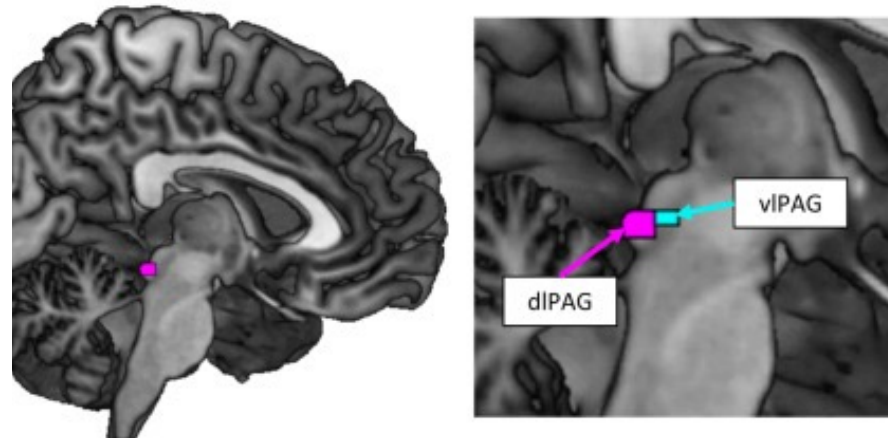
- **Dorsolateral subunit (dIPAG):**

- Mediates sympathetic nervous system
- Stimulation induces fight-or-flight in rat

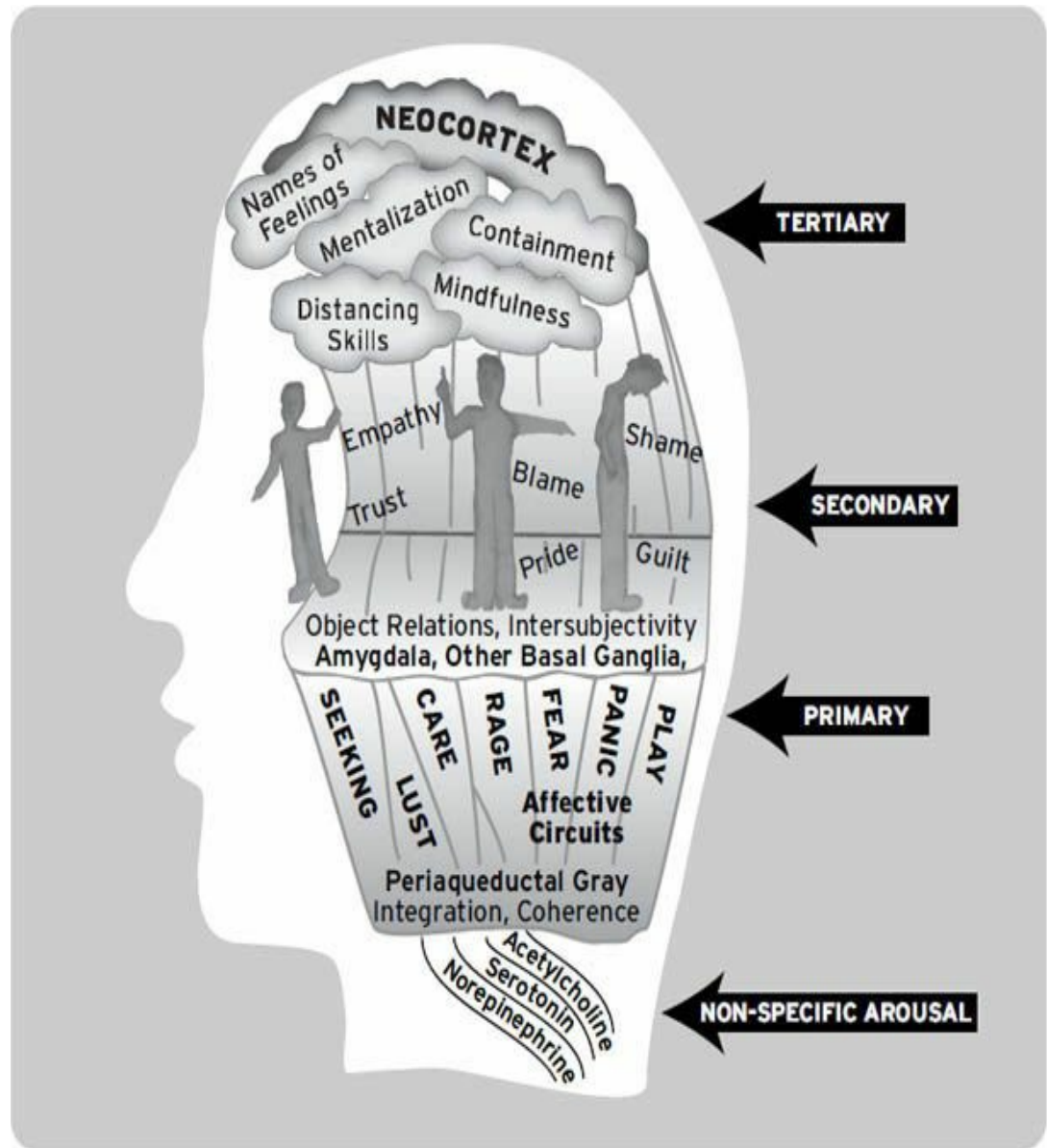


- **Ventrolateral subunit (vIPAG):**

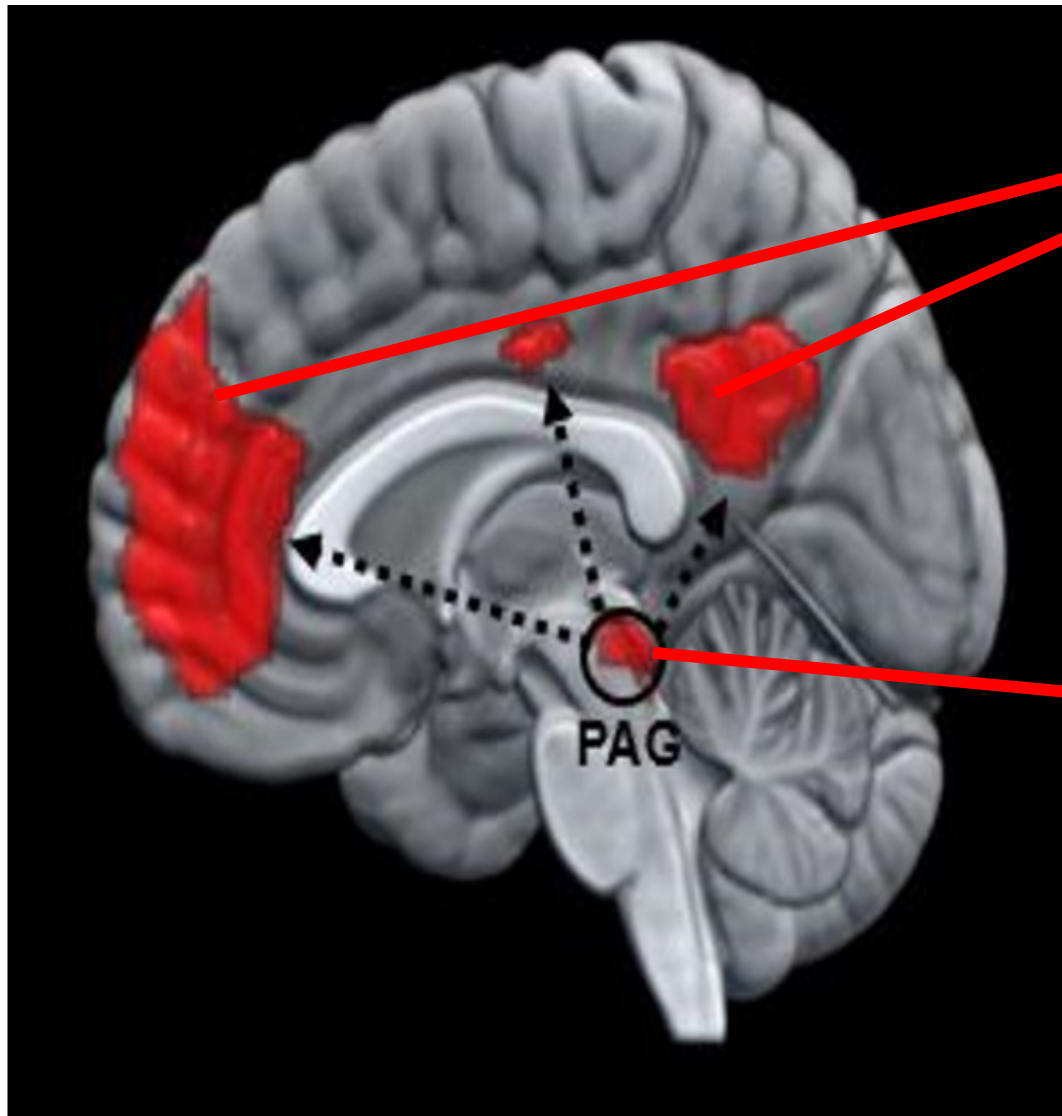
- Mediates parasympathetic nervous system
- Stimulation induces freezing/tonic immobility in rats



Primary Emotional Systems



In PTSD, the PAG Functionally
Connects to and Drives the
Default Mode Network



DMN

mediates self-related perspectives

PAG mediates physiological arousal and raw affect related to trauma

Trauma-
Related
Affect and
Arousal
Influences
Self-Related
Thoughts
and
Perspectives

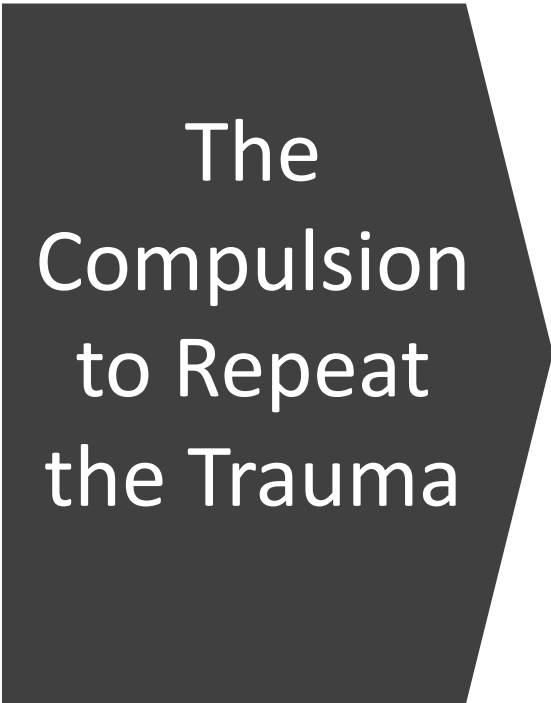
Trauma
Becomes
Central to
One's
Identity

Implications for Reckless Behaviour

A way of feeling alive?

Domestic Violence

A way of maintaining the relationship
with the perpetrator...

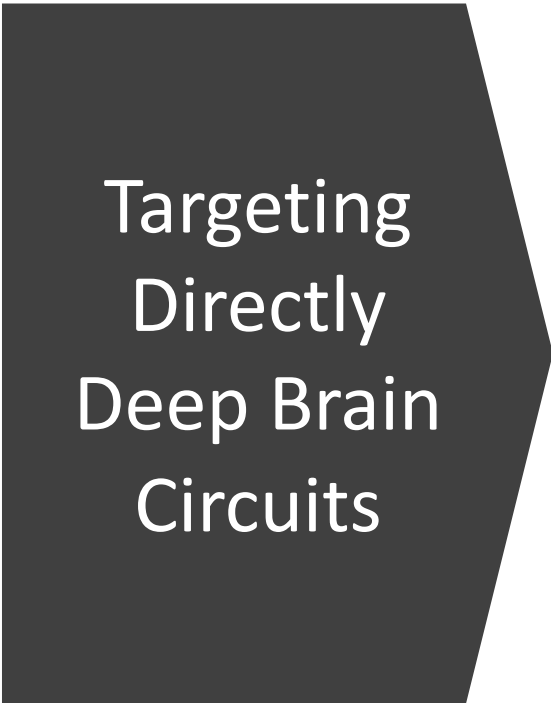


The
Compulsion
to Repeat
the Trauma

Treatment
Implications...

Uncoupling
the Default
Mode
Network
from the
Reptilian
Brain/PAG...

Toward Feeling Alive
Without Threat...

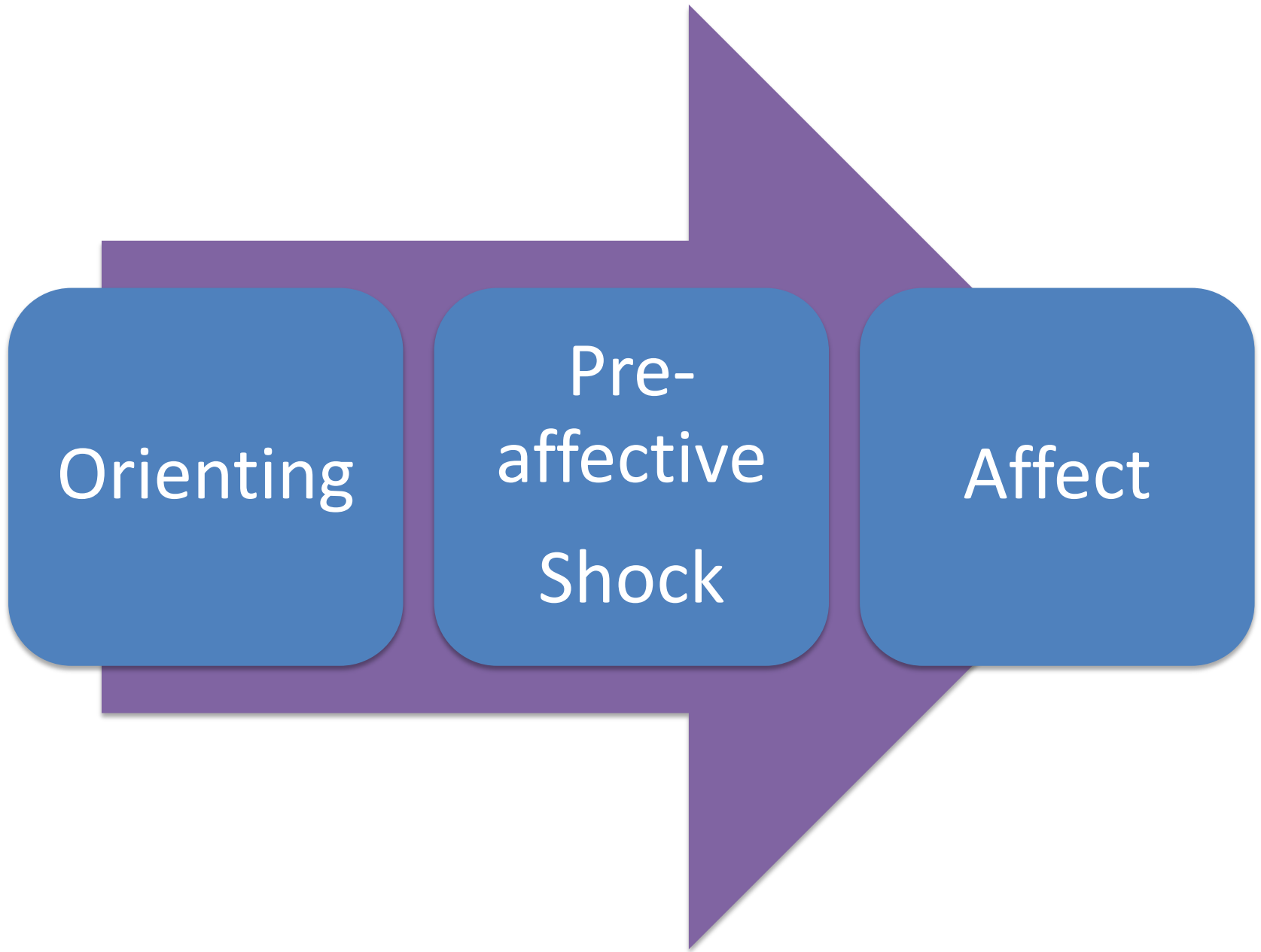


Targeting
Directly
Deep Brain
Circuits

Body Oriented Treatments; Sensorimotor Treatments; Neurofeedback

I **know** it was not my fault,
but I can't stop **feeling** it. It
keeps tearing me up inside.

Deep Brain Reorienting:
A Form of Trauma Processing Targeting
Deep Brain Circuits



Deep Brain Reorienting Sequence

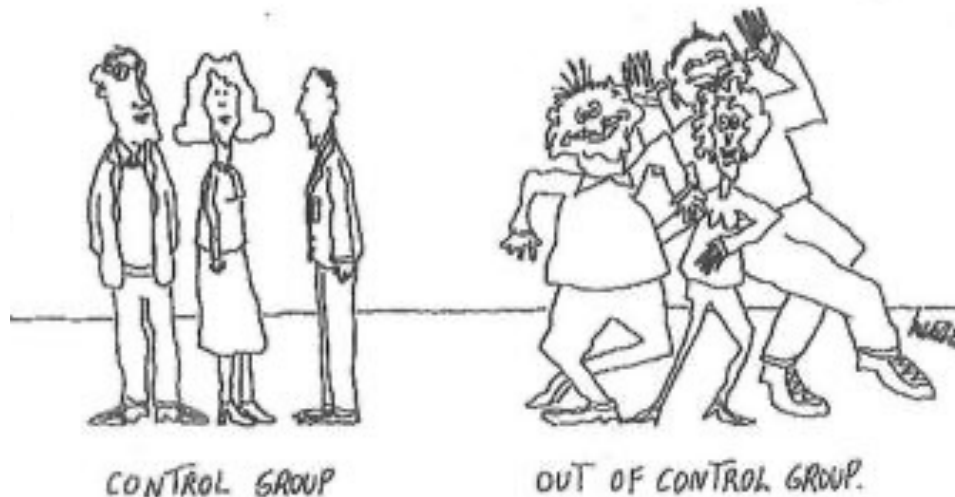
Orienting
Tension in neck
& face

Pre-affective
Shock

Affect

Focusing on the neck/face tension while processing affect
can prevent emotional overwhelm and dissociation

A RCT of DBR



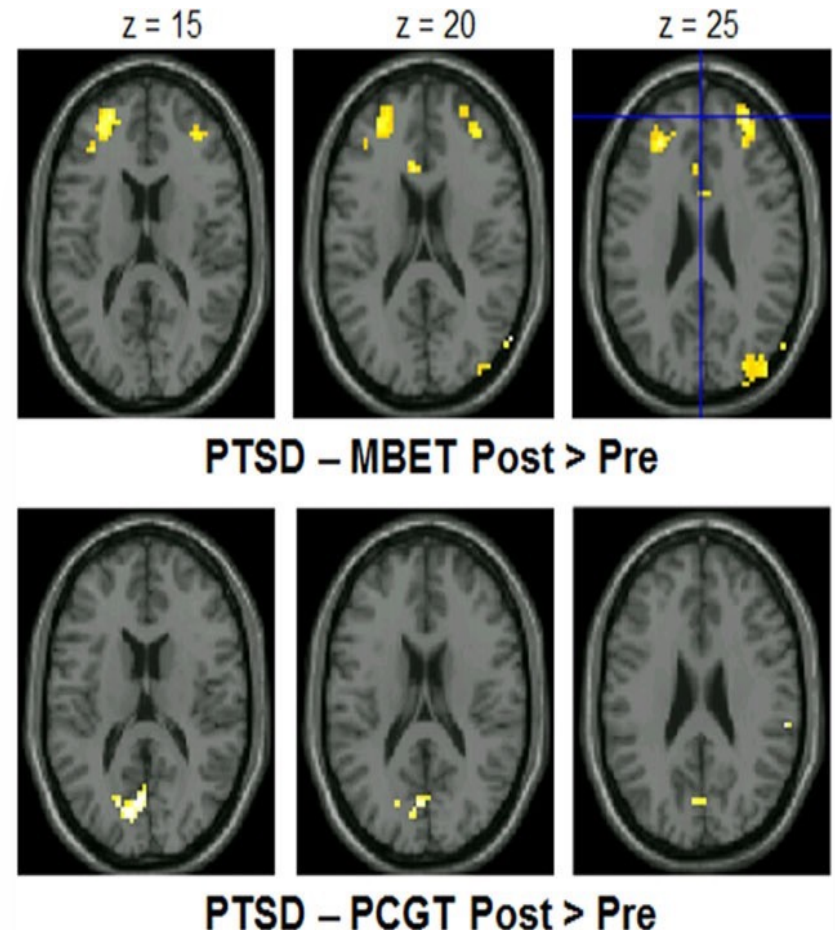
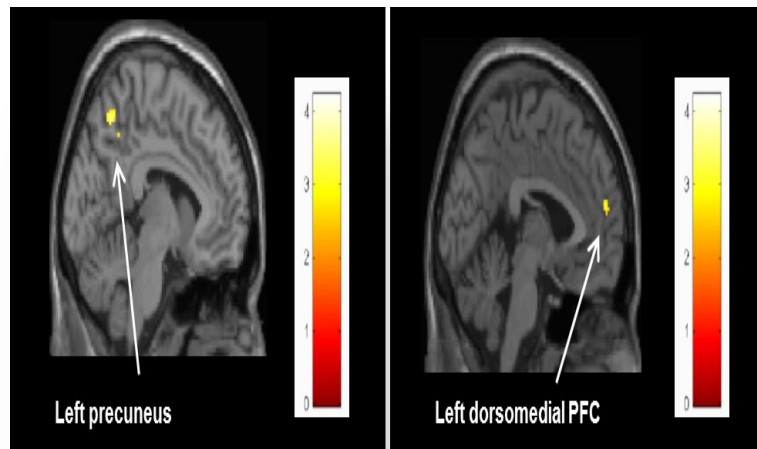
- 8 Sessions of online DBR vs. Waitlist
- Clinical assessments pre/post
- 7Tesla fMRI assessment pre/post



Interim Findings



Uncoupling
the Default
Mode
Network
from the
Reptilian
Brain/PAG...



Restoration of the Default Mode Network After Treatment

Feeling Alive Without Threat

“It’s strange.

I feel lighter all over my body.

I feel joy- real joy...

I feel alive!”



Thank You!