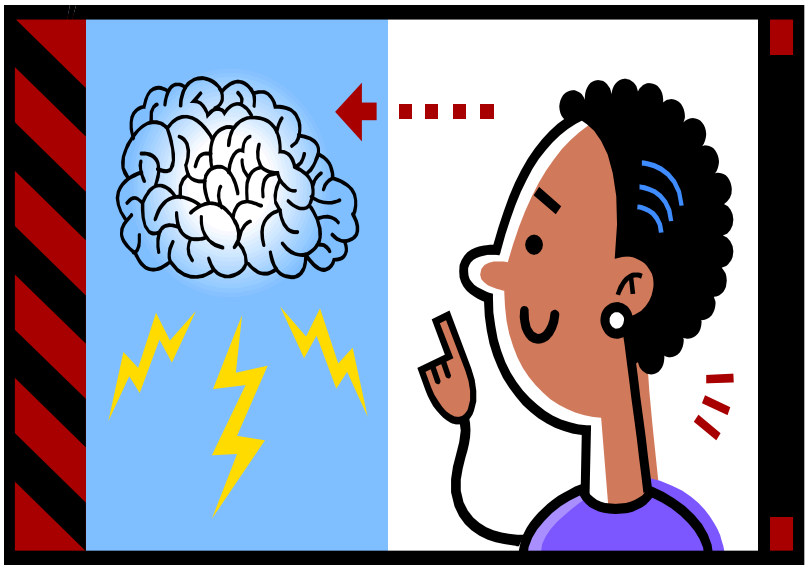
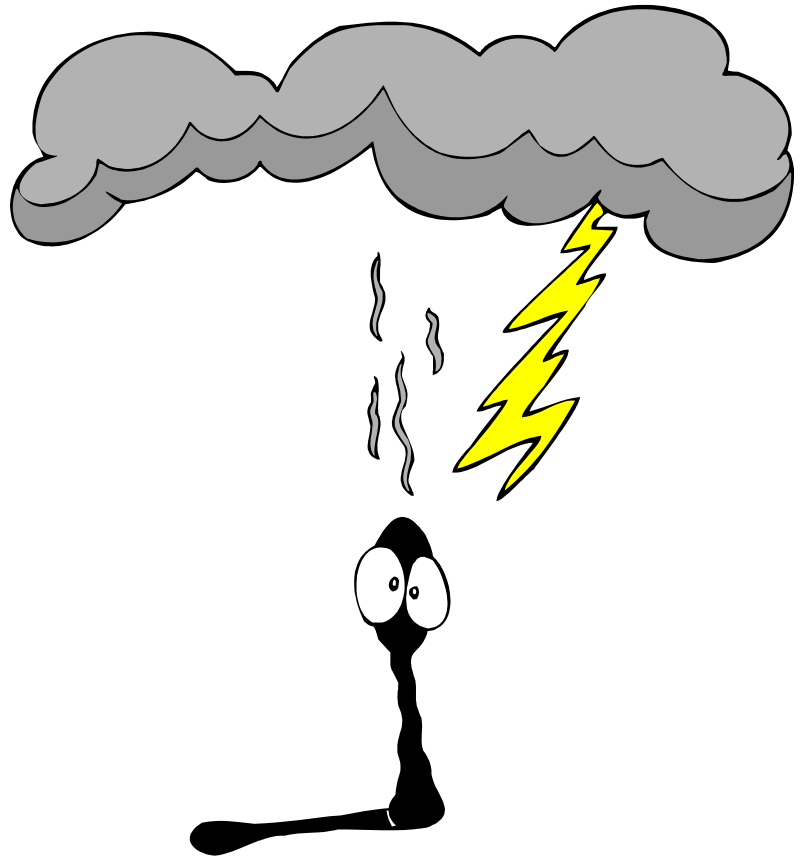
Understanding the Neurobiology of Trauma: Implications for Working Effectively with Adults and Adolescents



- Janine D'Anniballe, Ph.D.
- Licensed Psychologist; Boulder, CO

The Stress-Trauma Continuum

- Normal
- Situational
- Traumatic



What is Trauma for Adults and Adolescents?

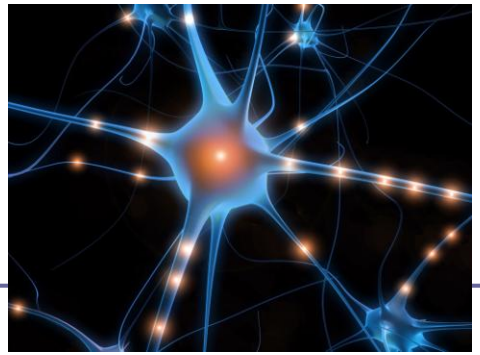
- Physical, sexual abuse, neglect
- Domestic violence
- Kidnapping
- School or gang violence
- Divorce/custody battle
- Runaways
- War
- Natural Disasters
- Severe motor vehicle accidents
- Witnessing or hearing about any of the above

Trauma and Culture

- Cultural/Gender differences in the perception and expression of trauma
- Historical trauma
- Forms of traumatic injury
  - Psychological
  - Somatic/Body
  - Spiritual

Conceptual Framework

- Psychological trauma is a neurophysiological state stemming from neurobiological injury.
- The research on the human brain has virtually exploded with new information over the past decade.
- The brain is not ridged as we once thought, but rather it is plastic/pliable, and has the ability to change its structure and function in response to experience.



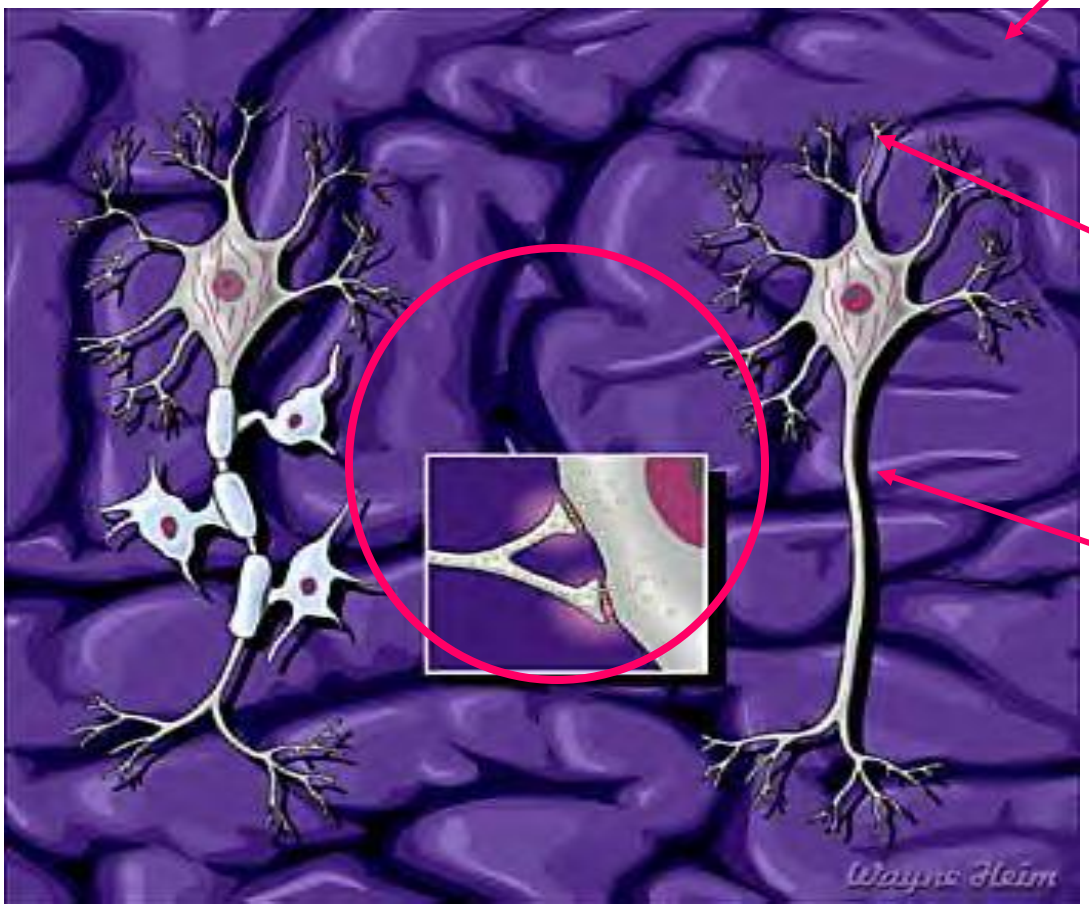
Until we understand that traumatic symptoms are physiological as well as psychological, we will be woefully inadequate in our attempts to help them heal.

- Peter Levine, Author of Waking the Tiger, and Healing Trauma

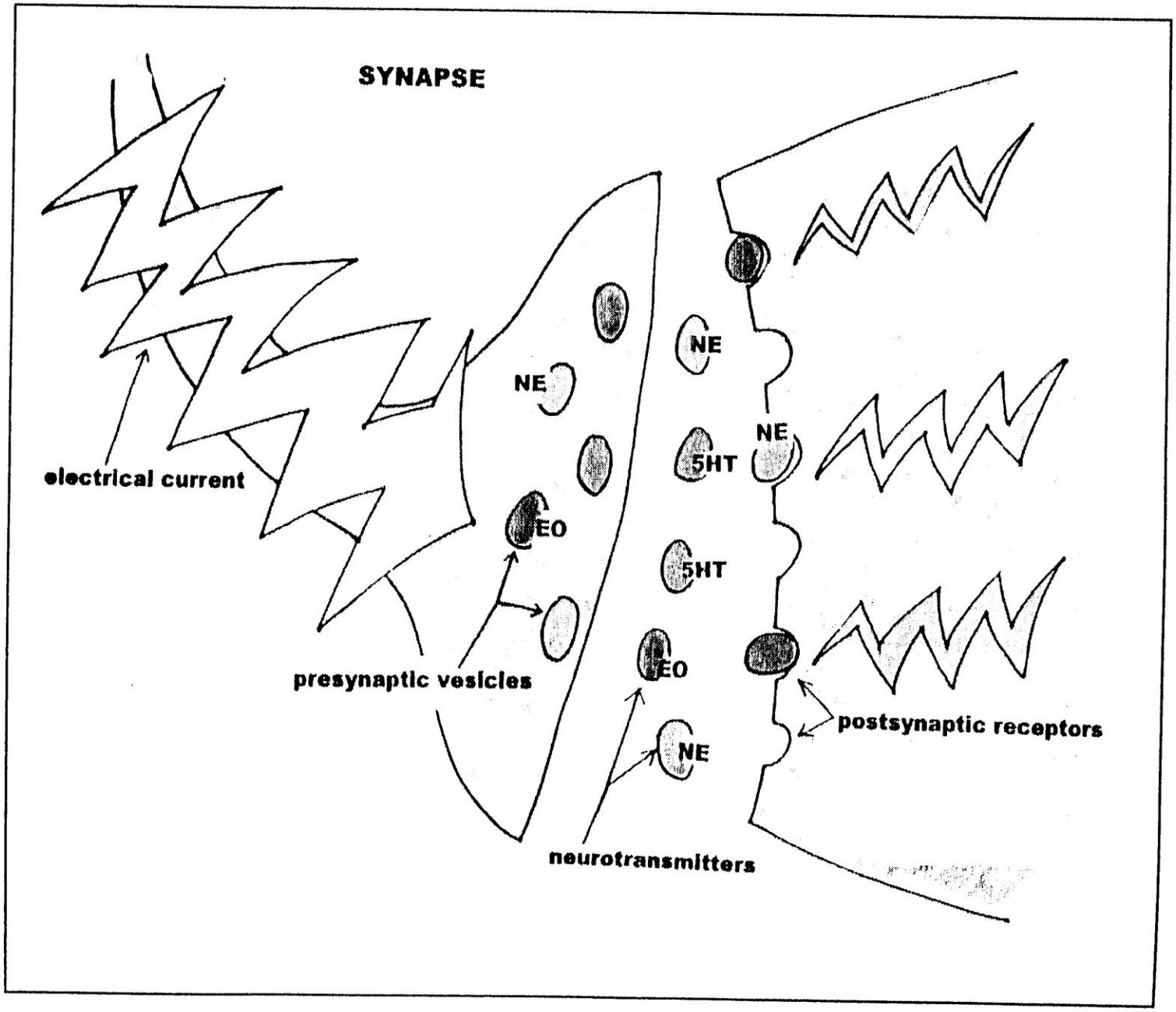
Trauma-Related Behaviors in Adults and Adolescents with links to Neurobiology

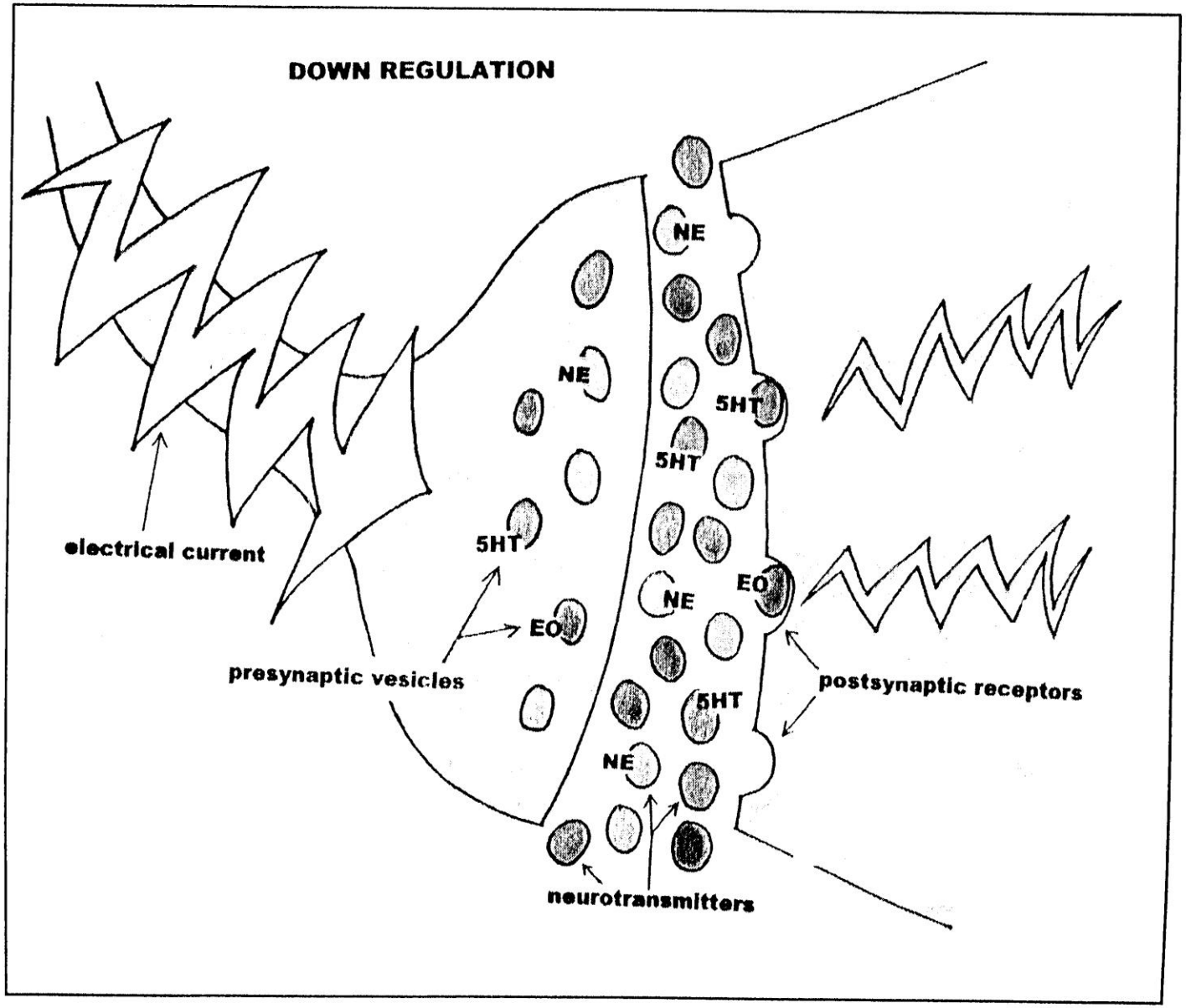
- Substance abuse to cope with hyperarousal, numbness, and reexperiencing
- Indiscriminant sexual behavior
- Cutting and suicidal gestures
- Continued contact with the abuser
- The freeze response
- Engaging in high risk behaviors

Neurobiology of Trauma



Synaptic Activity


SYNAPSE
electrical current
NE
EO
presynaptic vesicles
NE
5HT
NE
5HT
EO
NE
postsynaptic receptors
neurotransmitters


DOWN REGULATION
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electrical current
presynaptic vesicles
postsynaptic receptors
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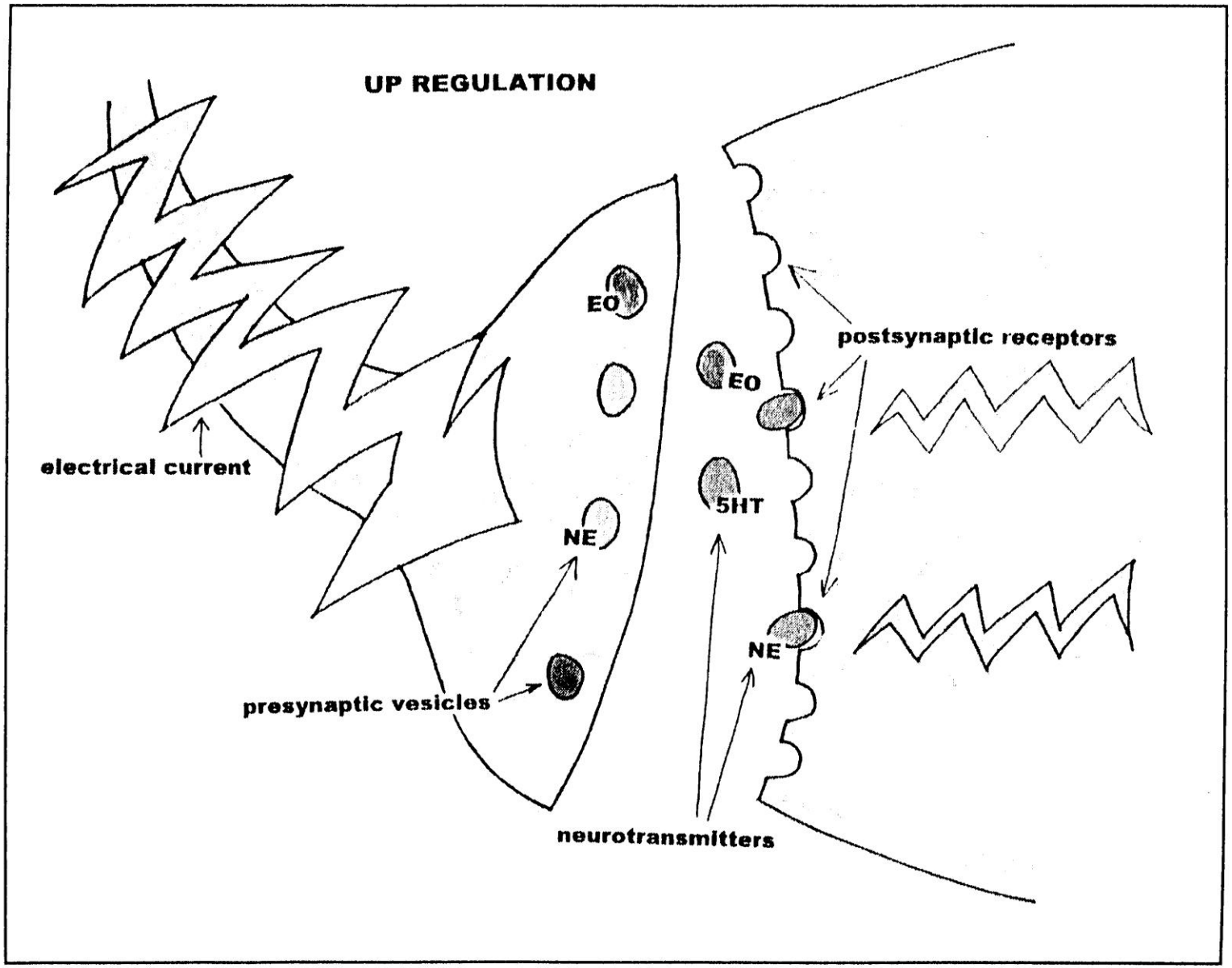
UP REGULATION
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presynaptic vesicles
EO
5HT
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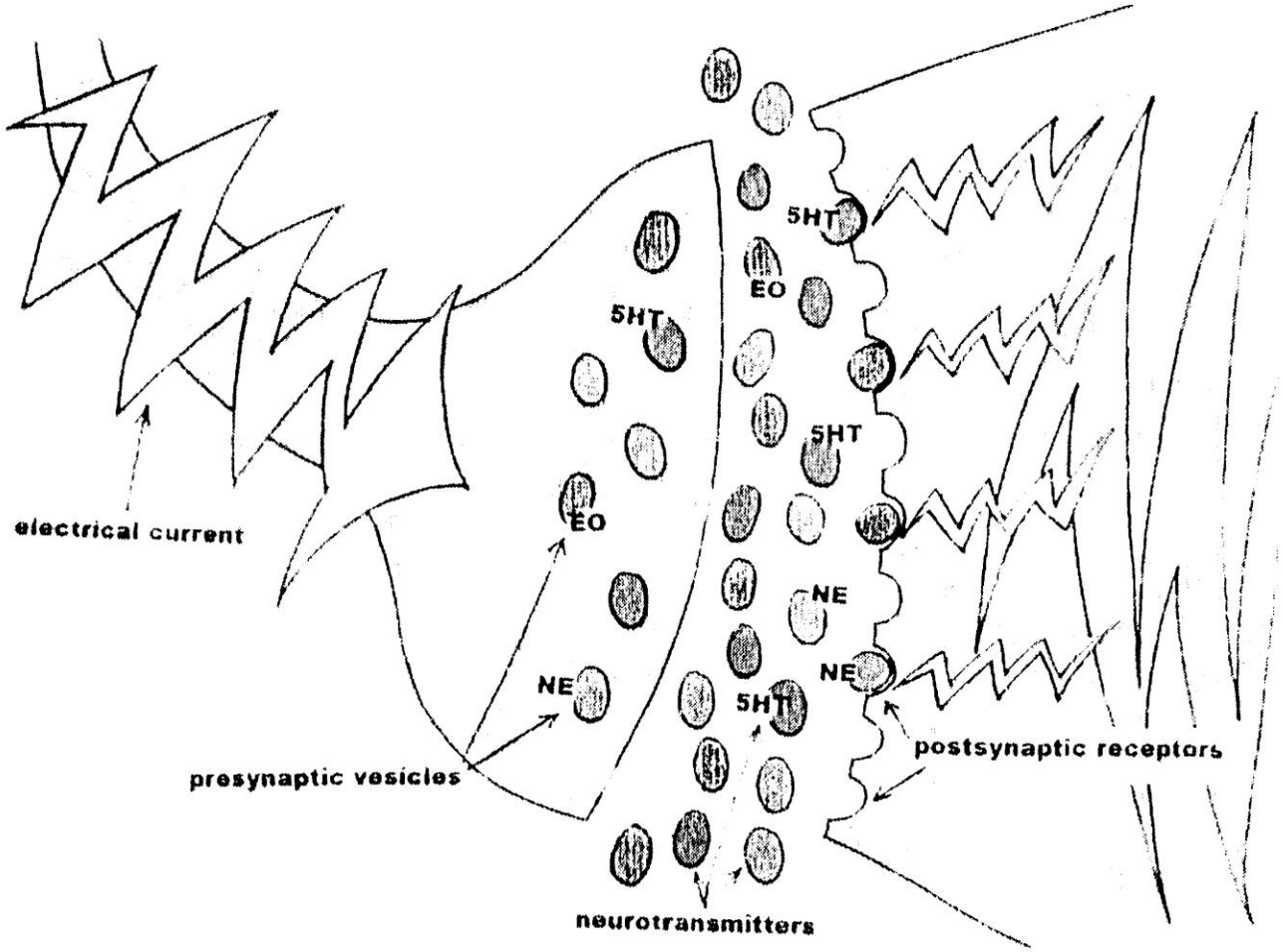
postsynaptic receptors
neurotransmitters

E. AMPLIFICATION



L. Langhammer

More on the Sympathic Nervous System Response

- HPA axis: hypothalamic-pituitary-adrenal
  - This system is responsible for bringing the body back into balance
  - The following chemicals/hormones are released:
    - Catecholomines (ephinephrine and norepinephrine) – responsible for fight or flight
    - Corticosteriods (glucocorticoids, cortisol) – control energy and body's immune functioning
    - Opiods – prevent pain, inhibit memory consolidation
    - Oxytocin – inhibits memory consolidation, promotes good feelings
- These chemicals are POWERFUL substances ….

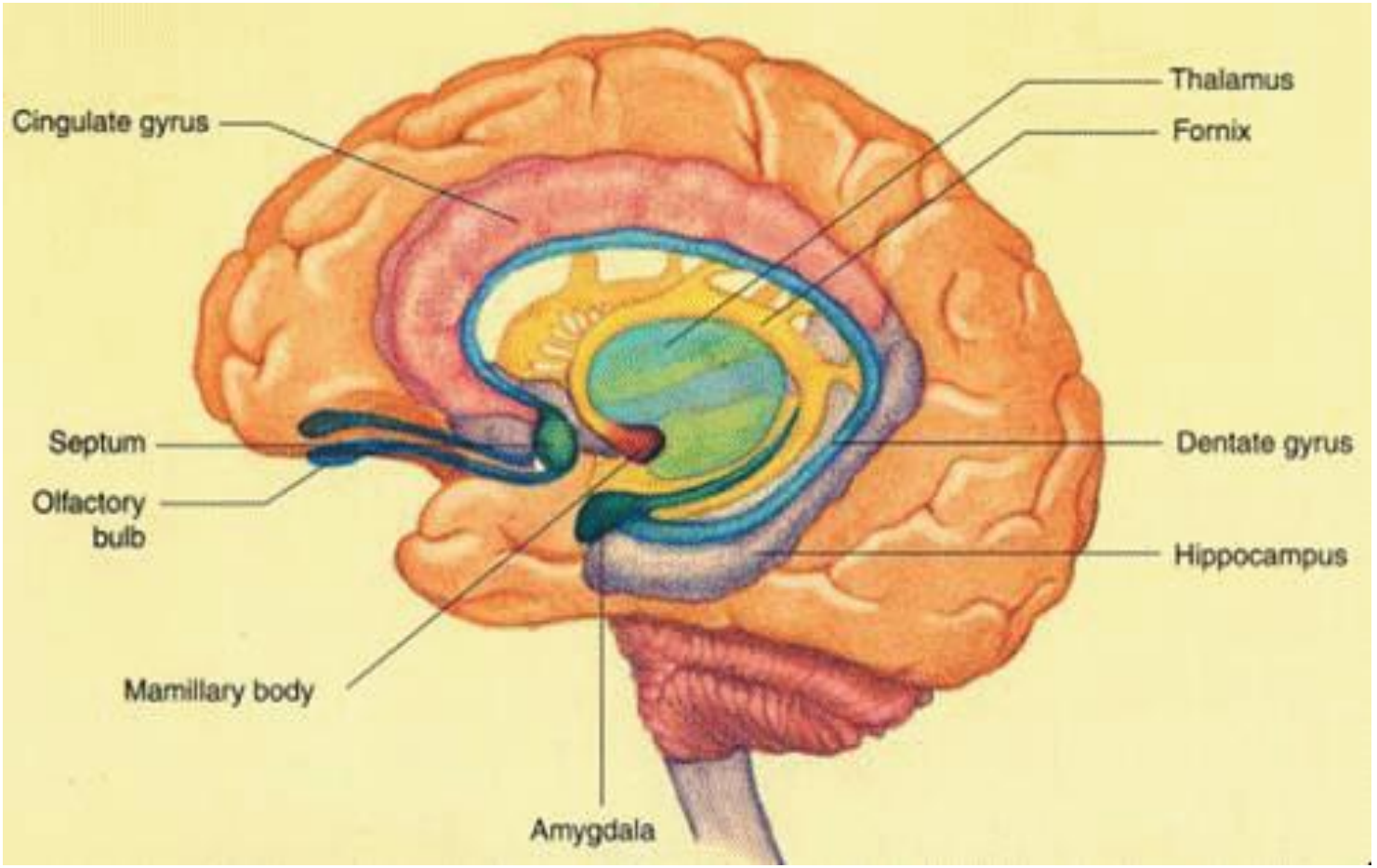
Sympathic Nervous System Response

- **If trauma is too severe, too long, triggered often … then**:
- **Catecholamines** are chronically increased; damage to memory, rational thought, hypervigilance, inability to distinguish danger signals
- **Corticosteroids** are chronically low; reduced immune functioning (lupus, Graves disease, RA, fibromyalgia), catechamines aren't regulated
- **Opiod** levels increase (equivalent to 8 mg of morphine); flat affect
- **Oxytocin** increased– memory impaired; bonding to perp

Other Neurotransmitters of Importance

- **Seratonin** – inhibitory; involved in emotion and mood. Too little serotonin has been shown to lead to depression, problems with anger control, obsessive-compulsive disorder, and suicide.
- **Dopamine** – inhibitory (meaning when it finds receptor sites, it blocks the firing of the neuron); controls arousal, alertness, attention; vital for giving motivation; Drugs like cocaine, opium, heroin, and alcohol increase the levels of dopamine, as does nicotine.
- **GABA** – inhibitory; acts like a brake to the excitatory neurotransmitters that lead to anxiety.

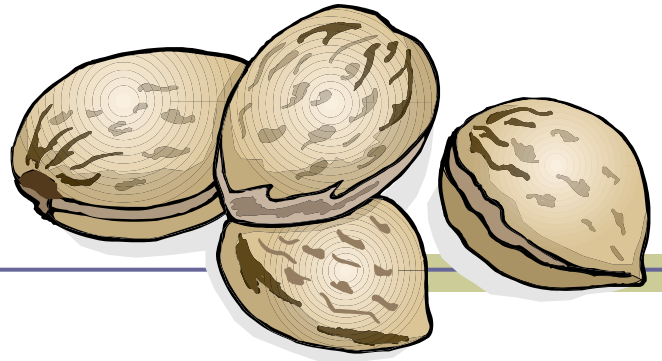
Structures of the Brain: The Limbic System



Limbic System Facts

- Old/primitive part of the brain
- Certain smells (such as lavender, flowers) can either soothe or stimulate the activity in this part of the brain.
- When the system is **less active**, there is generally a more positive more hopeful state of mind. When it is **overactive**, negativity and depression/anxiety can take over.
- When the system is less active, more activation is possible in the cortex. Current research shows a correlation between depression and increased limbic system activity and shutdown in the prefrontal cortex, especially on the left side.

The Amygdala

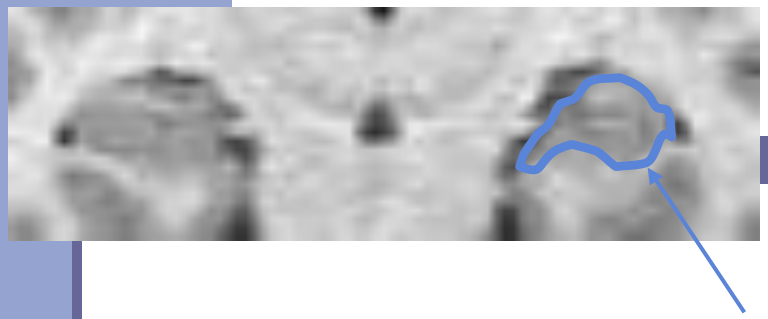


- an almond-sized structure that stores memories of fearful experiences
- responsible for regulating safety, and regulates heart rate and blood pressure, via the parasympathetic /sympathetic nervous system.
- monitors incoming stimuli for anything threatening
- activates the fight-flight-freeze stress response when “danger” is detected
- imaging studies reveal hyper-responsivity here during the presentation of traumatic scripts, cues, reminders
- increased amygdala reactivity is genetic

The Hippocampus

- a finger-sized cluster of neurons, is the hub of memory and learning because *all conscious memory* must be processed through this structure of the brain.
- functions like a memory chip in a computer. It is involved in verbal and emotional memory.
- highly sensitive to stress hormones (e.g., cortisol).

Hippocampal Volume Reduction in PTSD



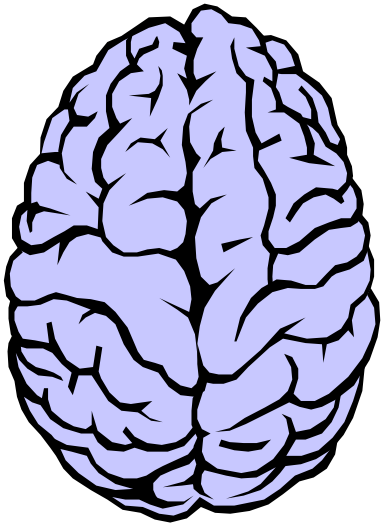
NORMAL **PTSD**

MRI scan of the hippocampus in a normal control and patient with PTSD secondary to childhood abuse. The hippocampus, outlined in red, is visibly smaller in PTSD. Overall there was a 12% reduction in volume in PTSD.

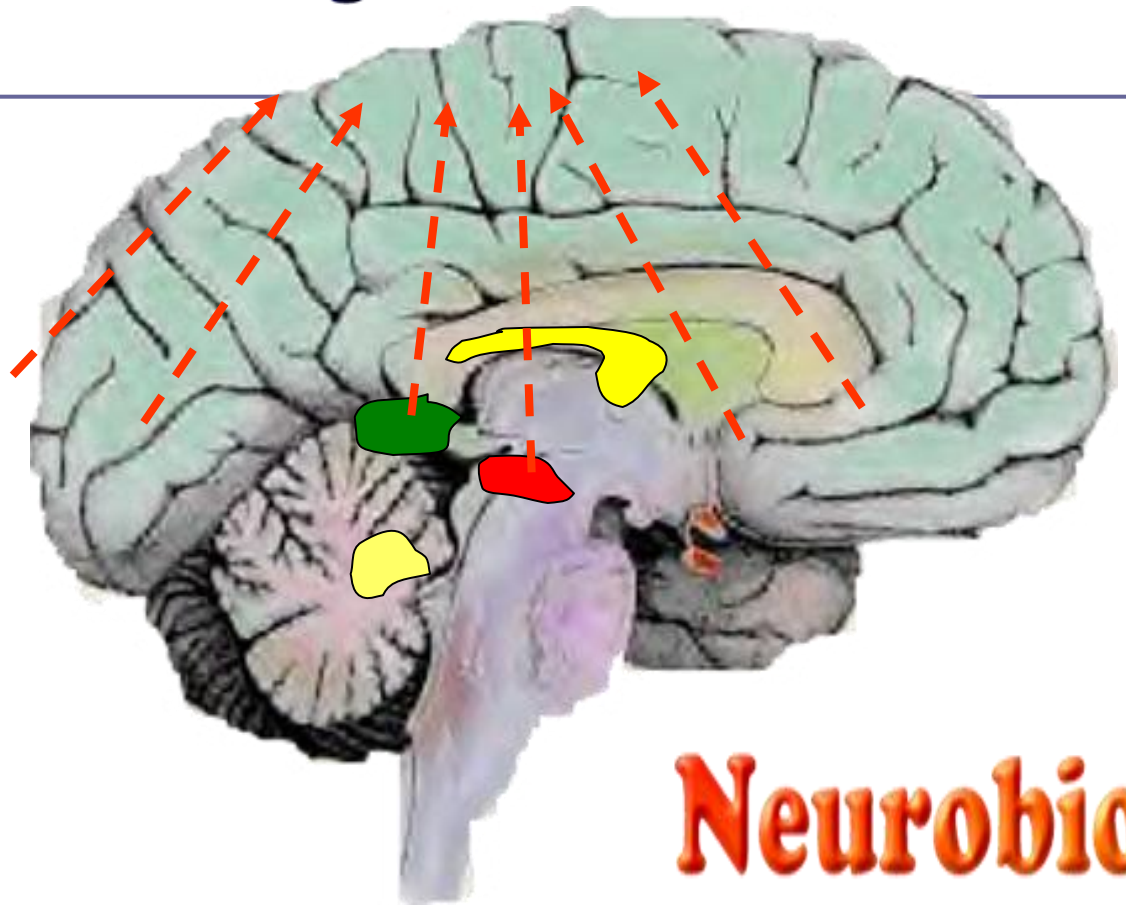
Bremner et al., Am. J. Psychiatry 1995; 152:973-981;
Bremner et al., Biol. Psychiatry 1997; 41:23-32;

The Prefrontal Cortex (PFC)

- Connected with the amygdala and exerts inhibitory control over stress responses and emotional reactivity
- Prefrontal cortex actually shrinks with PTSD
- Successful SSRI treatment restored PFC activation patterns

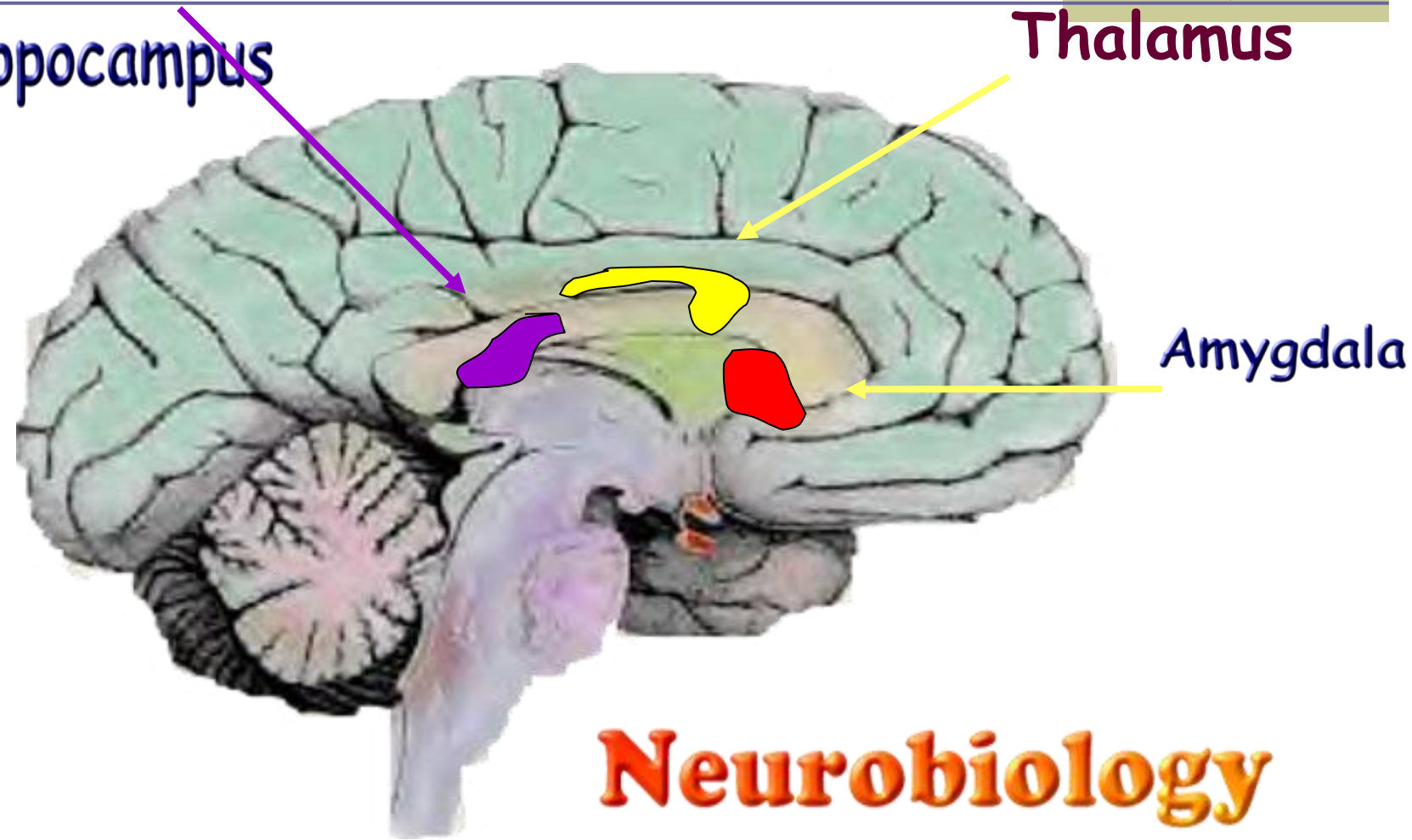


Integrated Narrative



Neurobiology of Non-Traumatic Memory

When Amygdala is highly activated, it interferes with Hippocampus functioning



Neurobiology of Traumatic Memory

Neurobiological Changes in Children with PTSD (DeBellis et al., 1999)

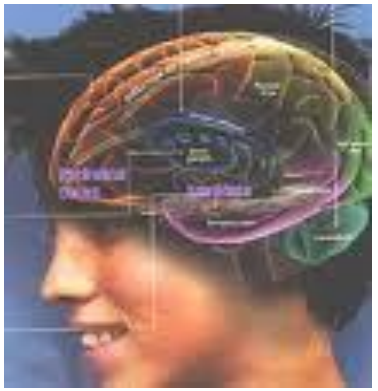
- Study: University of Pittsburgh, took MRI scans of the brains of 44 children with histories of abuse and diagnoses of PTSD and compared them with 61 healthy controls who had not experienced abuse. The average age of the subjects was 12 years

More details from DeBellis, et al:

- Abused children excreted greater amounts of cortisol and catecholamines than non-abused kids
- Abused children had 7-8% less cerebral volumes (impairing memory, dysregulating arousal)
- Neurons enlarge with age and axons thicken. Between the ages of 5 and 18 years, the process of coating the neurons in the central nervous system with a myelin sheath is most influential in determining brain size
- In the PTSD children, the corpus callosum did not grow with age compared with controls, which may be due to a failure of myelination.

The Adolescent Brain and Trauma

- Cortex still developing until mid-20's
- Not able to execute cause and effect thinking consistently – even without trauma
- Dopamine is helpful to increase judgment and impulse control; trauma disrupts dopamine
- Brain hemisphere integration (via the corpus callosum) is effected – rational thought vs. overwhelming emotion



Self-Harming Behavior

- Deliberate destruction or alteration of body tissue without suicidal intent
- Prevalence:
  - 13% to 25% in adolescents (Rodham & Hawton, 2009)
  - 11% of college-aged students
  - middle school populations have higher prevalence since that is the age at which most individuals initiate self-injury. (Whitlock, Eckenrode, et al., 2006; Gollust, Eisenberg, & Golberstein, 2008).

Self-Harming Behavior

Why do people self-injure?

Psychological Reasons

- to exert self-control or punishment
- as a distraction
- to get attention
- to attain group membership

Neurobiological Reasons

to unconsciously rebalance brain chemistry

to evoke emotion when feeling numb (up regulation)

imulate a high

Neurobiological explanations for Self-Harming Behavior: EOS and Serotonin

- Self-harm activates the endogenous opiod system (EOS)
- The EOS system regulates pain – releases endorphins, adrenaline and dopamine … promotes calm, well-being
- Low serotonin is correlated with suicide attempts, aggression, and impulsivity
- Impact of an adverse rearing environment: Peer-reared monkeys have lower seratonin activity in comparison to maternally raised monkey (Higley et al., 1993)

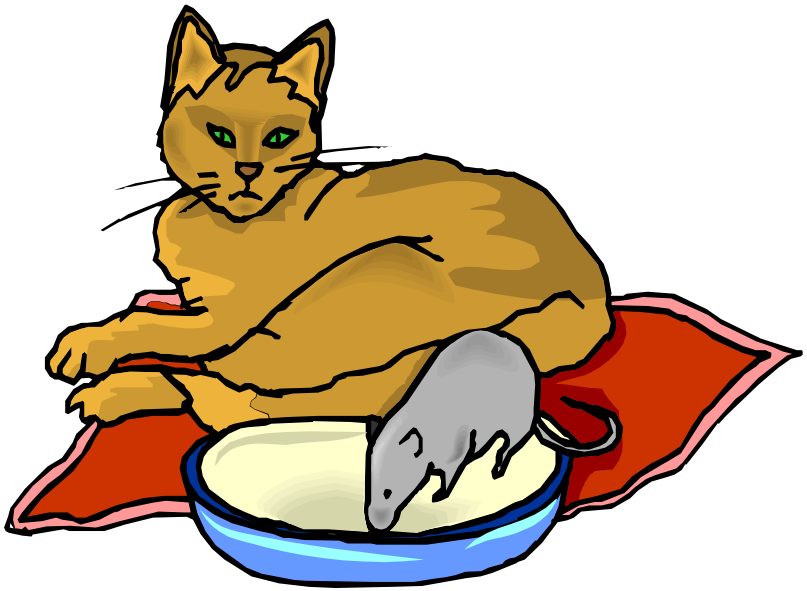
Fight, Flight, or Freeze

A lesson from Jakey Cat

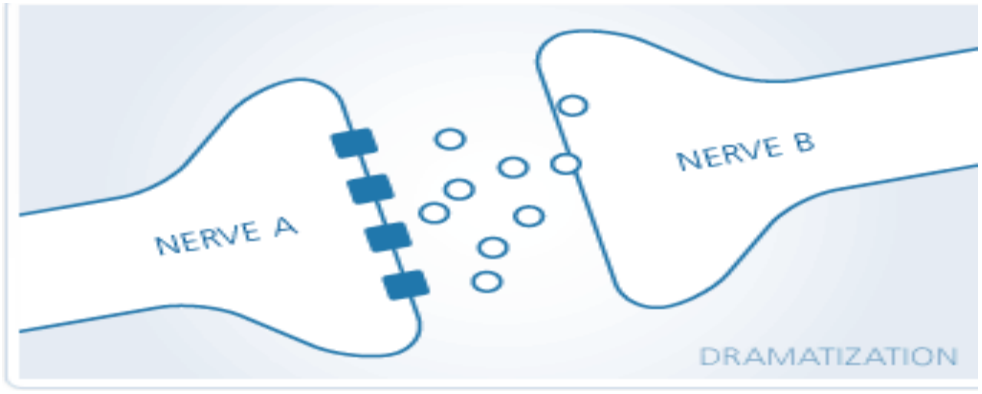
Jakey Cat (RIP)

The Freeze Response: Tonic Immobility

- Autonomic Nervous System: sympathetic and parasympathetic nervous system
- Both systems heightened simultaneously under extreme stress
- Tonic immobility as an adaptive survival response; if you move in the animal world – the predator will chase and kill



Trauma = Brain Chemistry Dysregulation



Research evidence of dysregulation

- Vietnam veterans diagnosed with PTSD
- Given yohimbine …

If you don't remember anything from this presentation, remember ….

- The more the neural system is activated, the more it will change
- Trauma leads to dysregulation of the autonomic nervous system and the limbic system
- Memory is often corrupted by trauma; recall impaired; the past is present

Neurobiological Conclusions

- Any trauma during birth to 25 has the potential to disrupt typical neurodevelopmental processes and contribute to long-term consequences
- Chronic abuse and multiple traumas have a greater neurobiological impact
- Permanence/impermanence of the damage is debatable. Teicher (2002) suggests effects are irreversible BUT some evidence suggests that neurogenesis is possible
- Prolonged stress leads to exposure to glucocorticoids (adrenal steroids) and elevated levels of catecholamines (adrenaline, seratonin, dopamine)
- **Result**: impaired cognition, emotional/behavioral regulation, potential autoimmune disorders

Strategies that Address Neurobiological Issues

- The “helping” relationship (can be therapeutic, first responder, any system response)

"There is no more effective neurobiological intervention than a safe relationship"

-- Bruce Perry

The Importance of Relationship

- Oxytocin and vasopressin are linked to bonding and relationships characterized by strong attachments.
- Positive attachments directly rewire the wiring of the orbito-frontal cortex to the Limbic system to mediate emotional response; balance sympathetic and parasympathetic systems

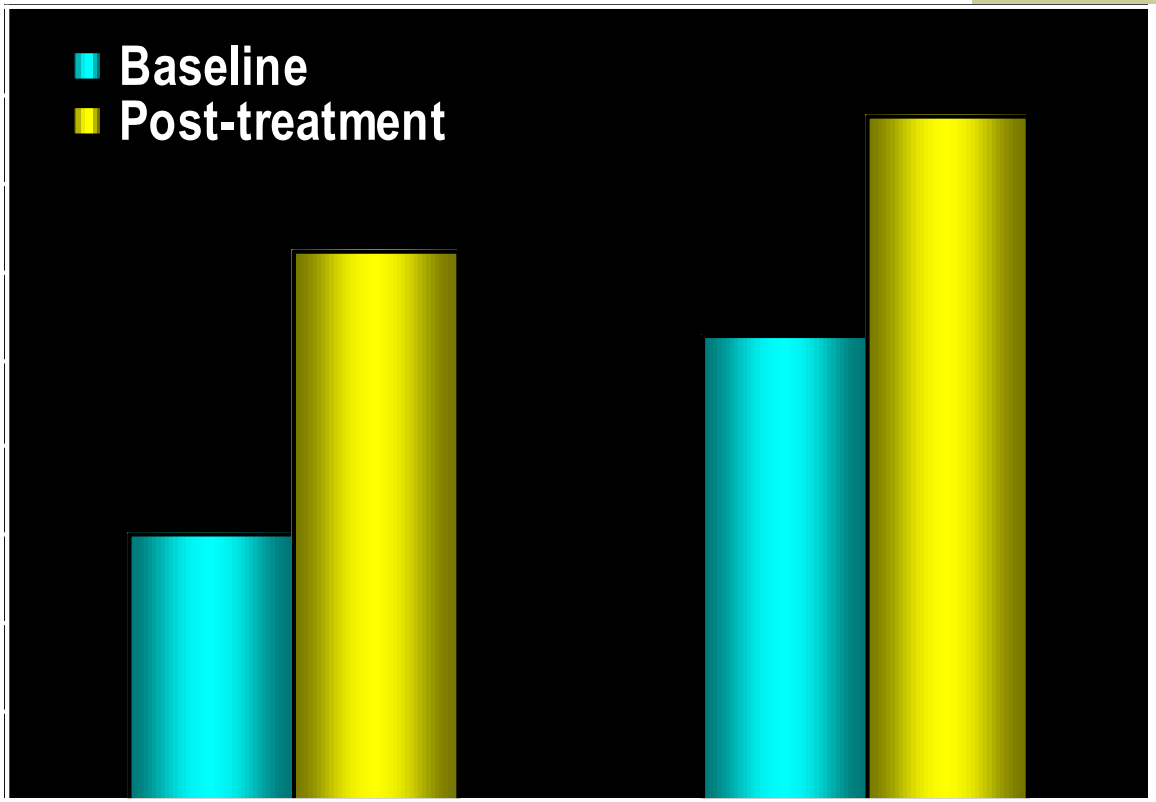
Importance of Empowerment

- Making decisions develops the cortex
- Involved clients in treatment decisions (e.g., court, child welfare)
- Avoid using relationships as consequences (e.g., restricting family visits, peer connections)
- Avoid pathologizing behaviors

Psychotropic Medication for Adolescents and Adults

- Mixed bag in the research – some argue strongly for and against
- A comprehensive review of pediatric trials conducted between 1988 and 2006 suggested that the benefits of antidepressant medications likely outweigh their risks to children and adolescents with major depression and anxiety disorders.

Increased Hippocampal Volume With Paxil in PTSD



Effects of 9-12 months of treatment with 10-40 mg paroxetine.
(Vermetten et al. *Biol Psychiatry*, 2003)

Neurobics

Engaging and Exercising the Brain: Neurobics
It is important to challenge the brain to learn new tasks

- Examples include: square-dancing, chess, tai chi, yoga, or sculpture. Working with modeling clay or playdough is an especially good way for children to grow new connections. (like controlling the computer mouse with your opposite hand).

More Neurobics:

- **Try to include one or more of your senses in an everyday task:** Get dressed with your eyes closed, wash your hair with your eyes closed, close your eyes and eat – identifying food by taste
- **Combine two senses:** Listen to music and smell flowers, listen to the rain and tap your fingers, watch clouds and play with modeling clay at the same time
- **Break routines:** Go to work on a new route, eat with your opposite hand, shop at new grocery store, switch places at the meeting table

Safe Physical Contact

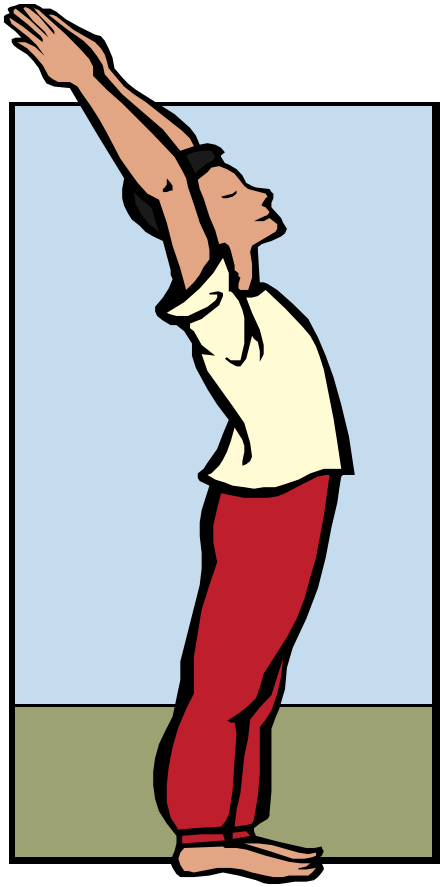
- Touch lowers cortisol, increases limbic bonding
- Massage
- Grounding with animals

Meditation/Mindfulness

- Thickens the cerebral cortex (due to trauma, age)
- Increases attention span, sharpens focus, improves memory
- Restores synapses, similar to sleep
- **Study**: Boston-area workers who meditated for 40 minutes a day had significantly thicker cortexes than controls (Lazar et al, 2005)

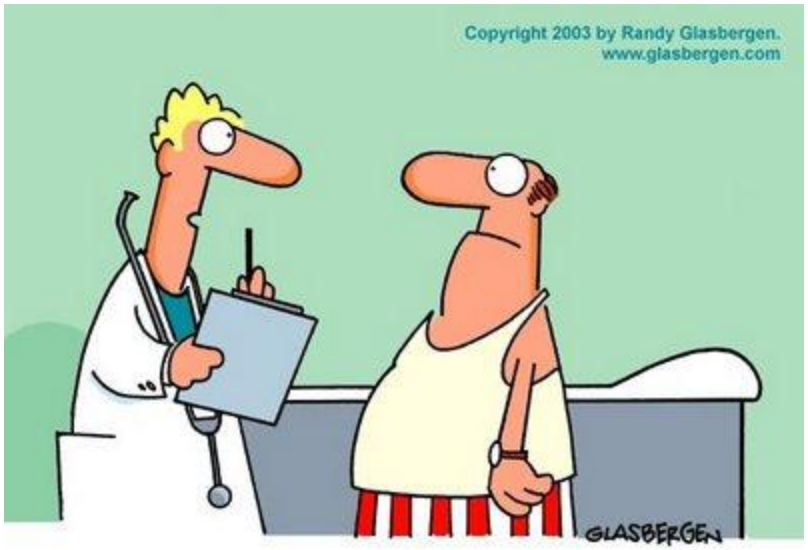
Yoga

- Yoga helps increase heart rate variability; an indicator of the body's ability to respond more flexibly to stress
- Benefits of controlled breathing similar to those receiving ECT, and taking an antidepressant
- 2010 study from Boston U. School of Medicine; yoga increasing GABA levels (GABA involved in alcohol use)



Exercise:

- Rebalances melatonin; enhances sleep cycle
- Releases endorphins (endogenous opiods)
- Promotes tryptophan which enhances mood; precursor to serotonin



"What fits your busy schedule better, exercising one hour a day or being dead 24 hours a day?"

Sleep, Rest, and Relaxation

- Sleep deprivation keeps nervous system on high-alert; cortisol is elevated
- Serotonin and dopamine rise when sleeping, resting

Diet

- The brain reads a drop in blood sugar as “danger” and begins to produce adrenaline. Adrenaline can be produced in a split second, leaving one feeling tense, jittery, weak, and dizzy. With someone who suffers from PTSD, these constant drops in blood sugar can cause mood swings into panic, anger or desperation
- Avoid stimulants (sugars, caffeine, non-herbal tea, nicotine, and simple carbohydrates such as white bread, white rice, cakes, cookies, candy bars, soda and ice cream)
- Avoid some fruit like bananas, grapefruit, melons, honey, and dates because they are high in sugar content

Eating to Manage PTSD

- Eat berries such as strawberries, raspberries, blackberries and wild blue berries. These are high in fiber, lower in sugar .
- Eat a combination of lean protein and complex carbohydrates every two to three hours, this prevents the sugar spike and crash. Good sources of proteins are eggs, white meat from chicken or turkey and fish.
- TIP: eat an egg before bed! It helps keep blood sugar even throughout the night and decreases the likelihood of waking shaky or in a panic.

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