

# TRAUMA AND THE BRAIN

---



Stephanie Sundborg  
[ssund2@pdx.edu](mailto:ssund2@pdx.edu)

# Trauma Informed Care

“A program, organization, or system that is trauma-informed:

1. *Realizes* the widespread impact of trauma and understands potential paths for recovery;
2. *Recognizes* the signs and symptoms of trauma in clients, families, staff, and other involved with the system;
3. *Responds* by fully integrating knowledge about trauma into policies, procedures, and practices; and
4. Seeks to actively *resist* re-traumatization” (SAMHSA)

# Our work is to

- Prevent re-traumatization – triggers
- Recognize early warning signs
  - Know your work/population
- Intervene – deescalate as needed

# When trauma happens....

- Individuals respond differently to fear and toxic stress - freeze, flight, fight, fright
- They may experience complex trauma from different sources. It may be chronic in nature.
- It doesn't matter what it is called, e.g., trauma, toxic stress.
- It is important to know how it “looks” in clients and in staff.

# Clients may...

- Feel unsafe
- Engage in harmful behaviors
- Tend toward anger and aggression
- Feel hopeless or helpless
- Be hyper aroused with memory and communication problems
- Have trouble managing emotions
- Feel overwhelmed, confused, or depressed
- Not be able to imagine any other future

# Negative stress (distress)

## Tolerable

Difficult and challenging  
but we react and then recover

## Toxic

Chronic or repeated circumstances or events  
Overwhelms coping skills  
Bio-chemical response  
Can change brain chemistry and function

# Traumatic events – some examples

- Physical assault
  - Sexual abuse
  - Emotional or psychological abuse
  - Neglect/abandonment
  - Domestic violence
  - Witnessing abuse/violence
  - War/Genocide
- Accidents
  - Natural or man-made disasters
  - Dangerous environment
  - Witness or experience street violence
  - Poverty
  - Homelessness
  - Historical Trauma and Current Oppression

Q. What are some examples of behaviors and emotions that represent survival response?



# INFORMATION PROCESSING

---

# Environment → Brain → Behavior

Input from the environment

- *vision, hearing, smell, taste, touch*

“In-between” stuff – mental activities

- *Perception, attention, memory, learning*



**WHY**



Output in the environment

- *Running, yelling, fighting, eating, listening, speaking,*

# INPUT AND THE “IN BETWEEN STUFF”

---

# Sensory Perception

## Touch

- First of five senses to develop and most prominent at birth
- Critical part of growth and nurturing



## Auditory

- Can be powerful triggers
- Studies show trauma victims are more aware of oddball sounds earlier



## Taste

- 2,000-5,000 taste buds
- Four types of taste:



## Olfactory (Smell)

- Can detect around 10,000 smells
- 75% of what you taste has to do with smell
- Only sensory input that is directly connected to limbic system (memory & emotion)



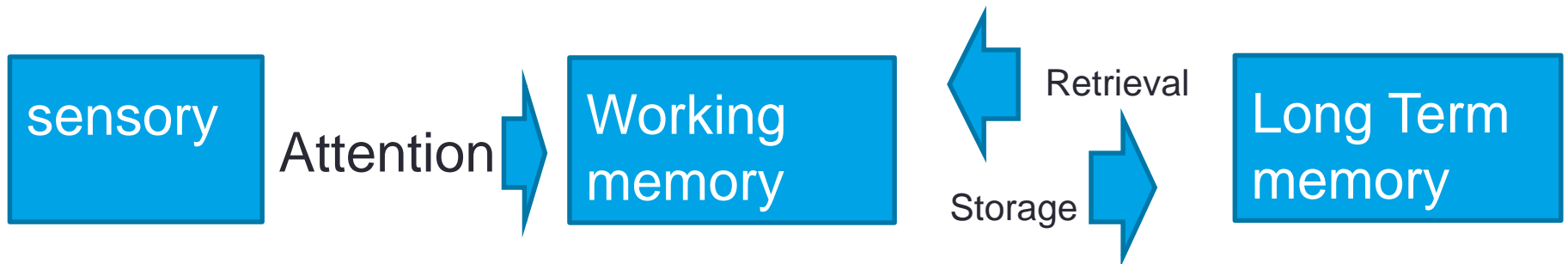
## Visual

- Least accurate of all senses
- Does not reach full adult functioning until age four



Q. What are some of the sights, smells, sounds, present in your setting?

# Perception - Attention - Memory



Influenced by expectations and prior experiences

*“We don’t see things as they are.  
We see them as we are”*

Anais Nin

# Perceptual Processing

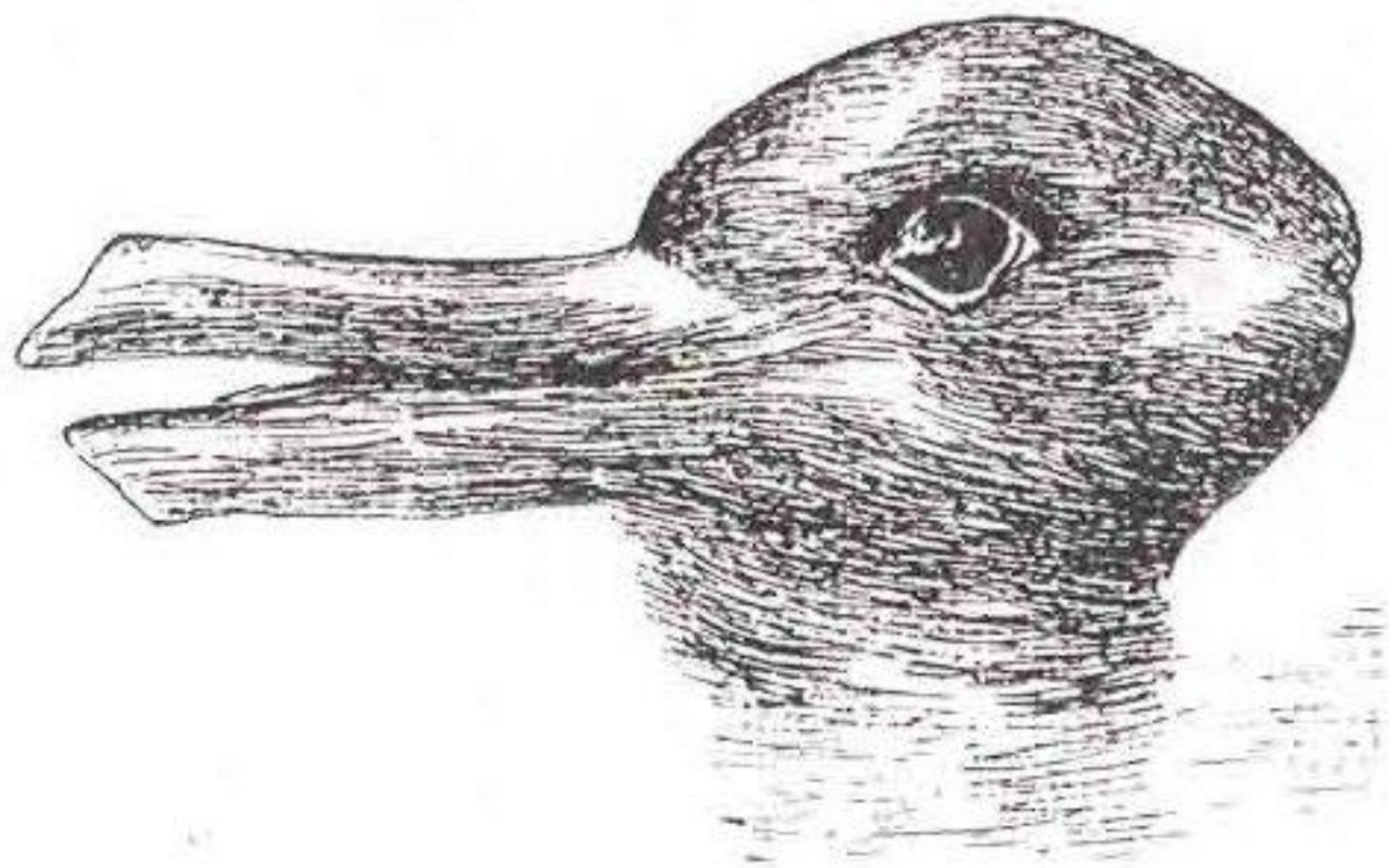
- Bottom-Up Processing: Analyzing information starting at the bottom (small units) and going upward to form a complete perception





# Perceptual Processing

- Top-Down Processing: Pre-existing knowledge that is used to rapidly organize features into a meaningful whole
- Perceptual Expectancy: Past experiences, motives, contexts, or suggestions that prepare us to perceive in a certain way











# Sensory / Perception... and the Trauma brain

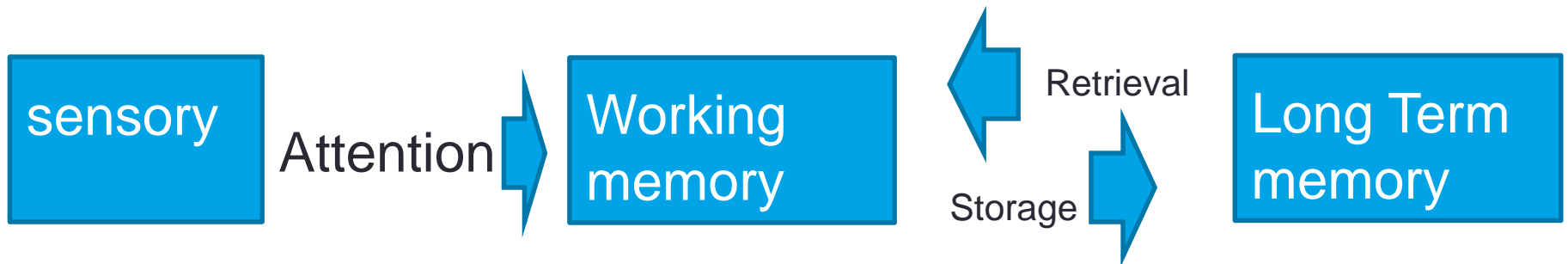
- More sensitive to incoming sensory information – sounds are louder, smells are stronger.
- Sensory information act as triggers
- Top down input may be distorted – not available

# ATTENTION

---



# Perception - Attention - Memory



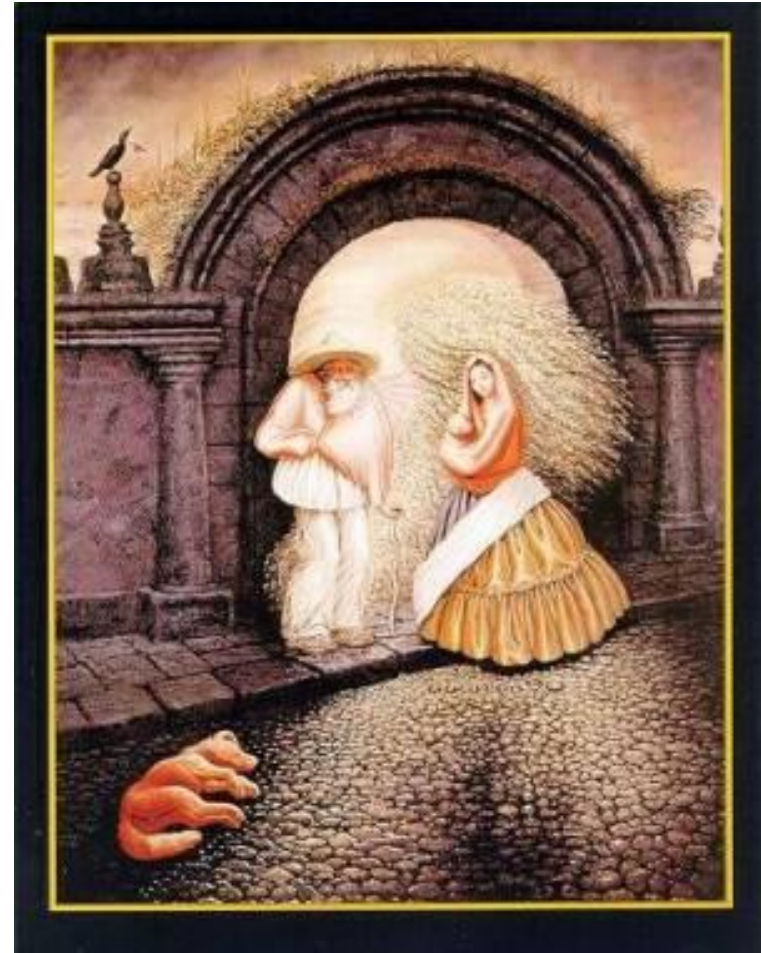
# What is attention?

- **Selective Attention** – only aware of a subset of stimuli – able to focus on something while inhibiting distractions
- **Divided Attention** - Capacity Limitations – limited ability to handle different tasks or stimuli at once
- **Sustained Attention** - Sustained mental effort: Limited ability to engage in protracted thought, especially on the same subject

# Attention - and the trauma brain

- Selective attention is worse in general but better for threatening stimuli
- Divided attention is better –hyper vigilance and the ability to pay attention to a lot of stimuli at once
- Sustained attention worse

Connecting to behavior: Do you notice survivors have a harder time focusing attention? Are they easily distracted?

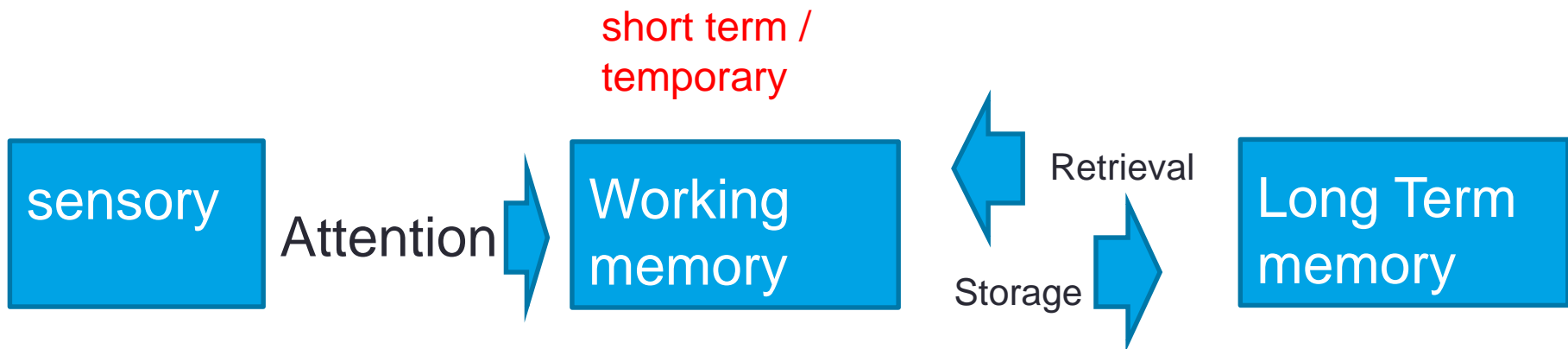


Q. What are some examples of attention issues you see with yourself or others?

# MEMORY

---

# Perception – Attention - Memory



# Characteristics of temporary memory

## Sensory Memory

- sensory based
- rapid decay
- not available to awareness

## Working Memory

- Capacity Limitations (7 +/- 2 items)
- rapid decay (seconds to mins)
- processes by sound or sight



# Characteristics of long-term memory

## Declarative (explicit)

- Consciously aware (can be stated explicitly)
- Memory for facts (Semantic)
- Memory of events (Episodic)
- Unlimited capacity
- Longterm storage (days - years)

## Non Declarative (implicit)

- Not consciously aware
- Associative and non associative
- Unlimited capacity
- LT storage (days - years)

# Fear conditioning

Like classical conditioning - events paired in time tend to become **associated.**

Fear conditioning – associations are made between traumatizing event and other sensory input

# Components of fear conditioning

- **Unconditioned Stimulus (US):** a stimulus that an organism biologically reacts to, e.g. an electric shock.
- **Unconditioned Response (UR):** reflexive reaction to US, e.g. fear.
- **Conditioned Stimulus (CS):** neutral stimulus that organism has no response to ordinarily, e.g. an electrical outlet
  - Fear conditioning related to trauma – this neutral stimulus can be the source of triggering a trauma memory
- **Conditioned Response (CR):** learned response.

# FORGETTING

---

# Interference

- Tendency for new memories to impair retrieval of older memories, and the reverse
- **Retroactive Interference:** Tendency for new memories to interfere with retrieval of old memories
- **Proactive Interference:** Prior learning inhibits (interferes with) recall of later learning

# Repression and Suppression

- **Repression:** Unconsciously pushing painful, embarrassing, or threatening memories out of awareness/consciousness
  - Motivated forgetting, according to some theories
- **Suppression:** Consciously putting something painful or threatening out of mind or trying to keep it from entering awareness

# Other memory phenomenon

- **Flashbulb Memories: Where were you on 9-11?**
  - Vivid memories, but not completely accurate
  - Individual's confidence increases for event

# Flashbulb Memory

Neisser & Harsch (1992)

- Studied people's recollection about where they were / what they were doing following the Challenger explosion.
- 24 hours after accident
- 2 ½ years after accident



# One person's response - 2 1/2 years after the explosion

“When I first heard about the explosion, I was sitting in my freshman dorm room with my roommate and we were watching tv. It came on a news flash and we were both totally shocked. I was really upset and I went upstairs to talk to a friend of mine and then I called my parents.”

*This subject gave his recollection the highest score for confidence about the accuracy.*

# The same person - 24 hours after the explosion

“I was in religion class and people walked in and started talking about it. I didn't know any details except that it had exploded and the schoolteacher's students had all been watching, which I thought was so sad. Then after class I went to my room and watched a tv program about it and I got all the details.”

# False memory

## **Elizabeth Loftus**

- Memory is malleable!
  - memory is constructed!!
  - When we do not have the full picture--we fill in gaps!
  - Our experiences shape our memory!

# Memory - and the trauma brain

- Declarative memory is usually impaired – damage to hippocampus
- Working memory is usually not great – frontal lobe activation is decreased
- HOWEVER - Implicit memory is strong for threatening stimuli

Connecting to behavior: Do survivors forget appointments, treatment plans, what was discussed last time? But, is their memory for threat situations or details good?

Q. What are some examples of memory issues you see with clients?

# EXECUTIVE FUNCTION

---

# Executive Function

- Impulse control
- Planning
- Decision making
- Reasoning

# Executive function- and the trauma brain

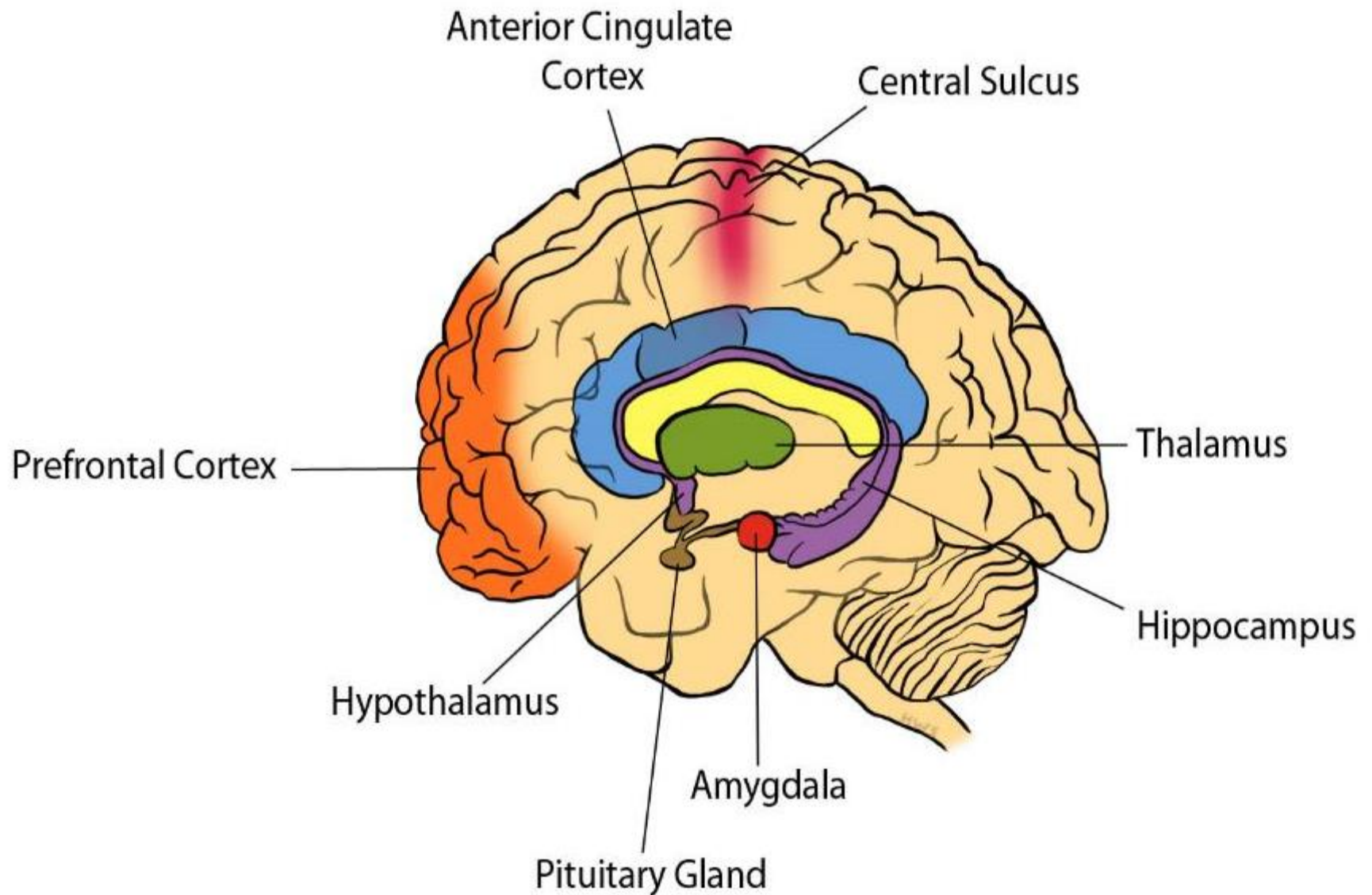
- Frontal lobe function is impaired – affecting judgment, decision making, planning, reasoning
- Poorer attention and impulse control
  - performance on stroop test with trauma related words
  - Anxiety related, perseverative loops

Connecting to behavior: Do survivors perseverate, fixate? Do they show problems with impulse control? Struggle with making decisions or planning



# STRESS / TRAUMA AND THE BRAIN

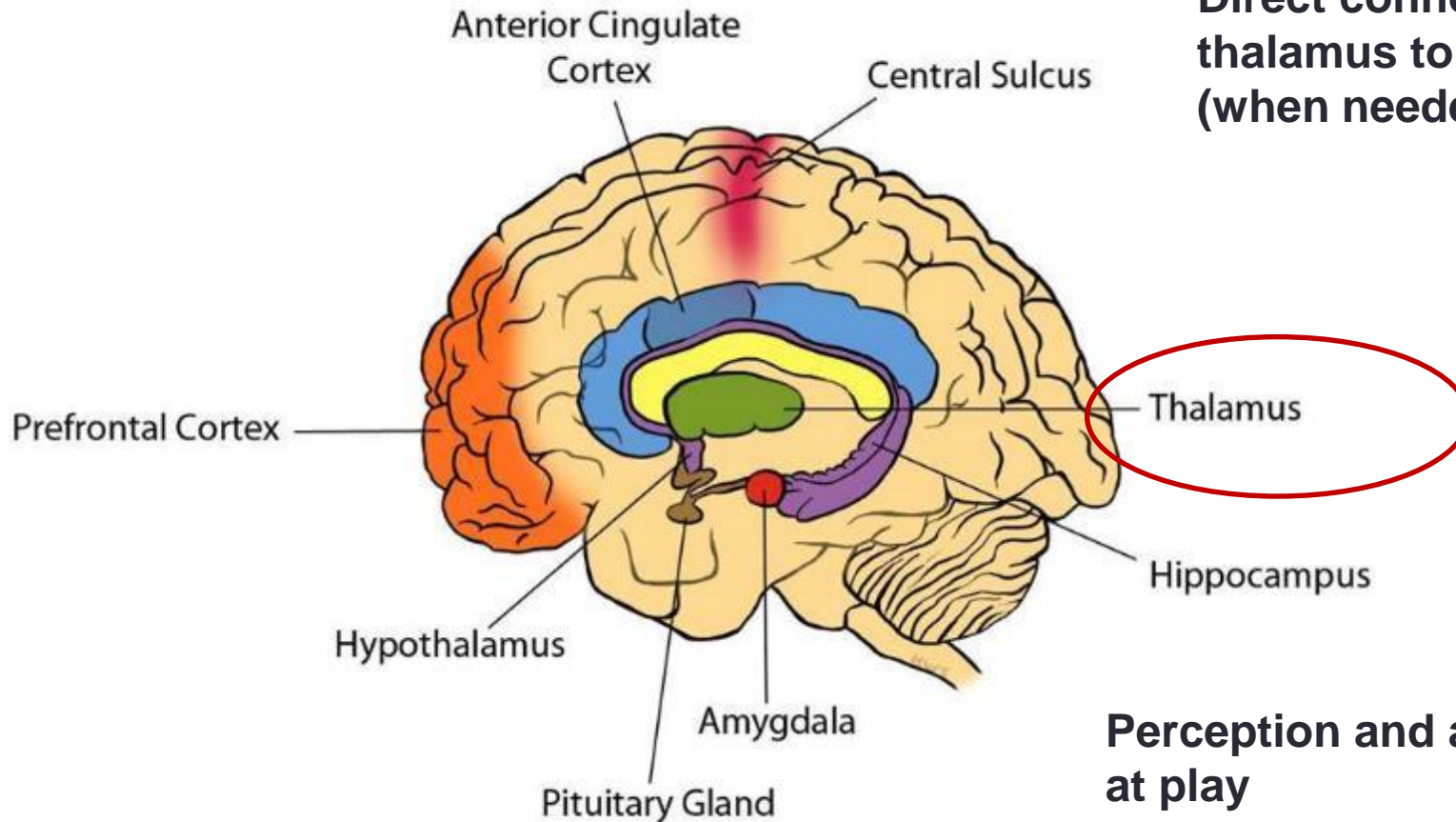
---



# Thalamus

**Sensory info travels through thalamus – except smell**

**Direct connection from thalamus to amygdala (when needed)**



**Perception and attention at play**

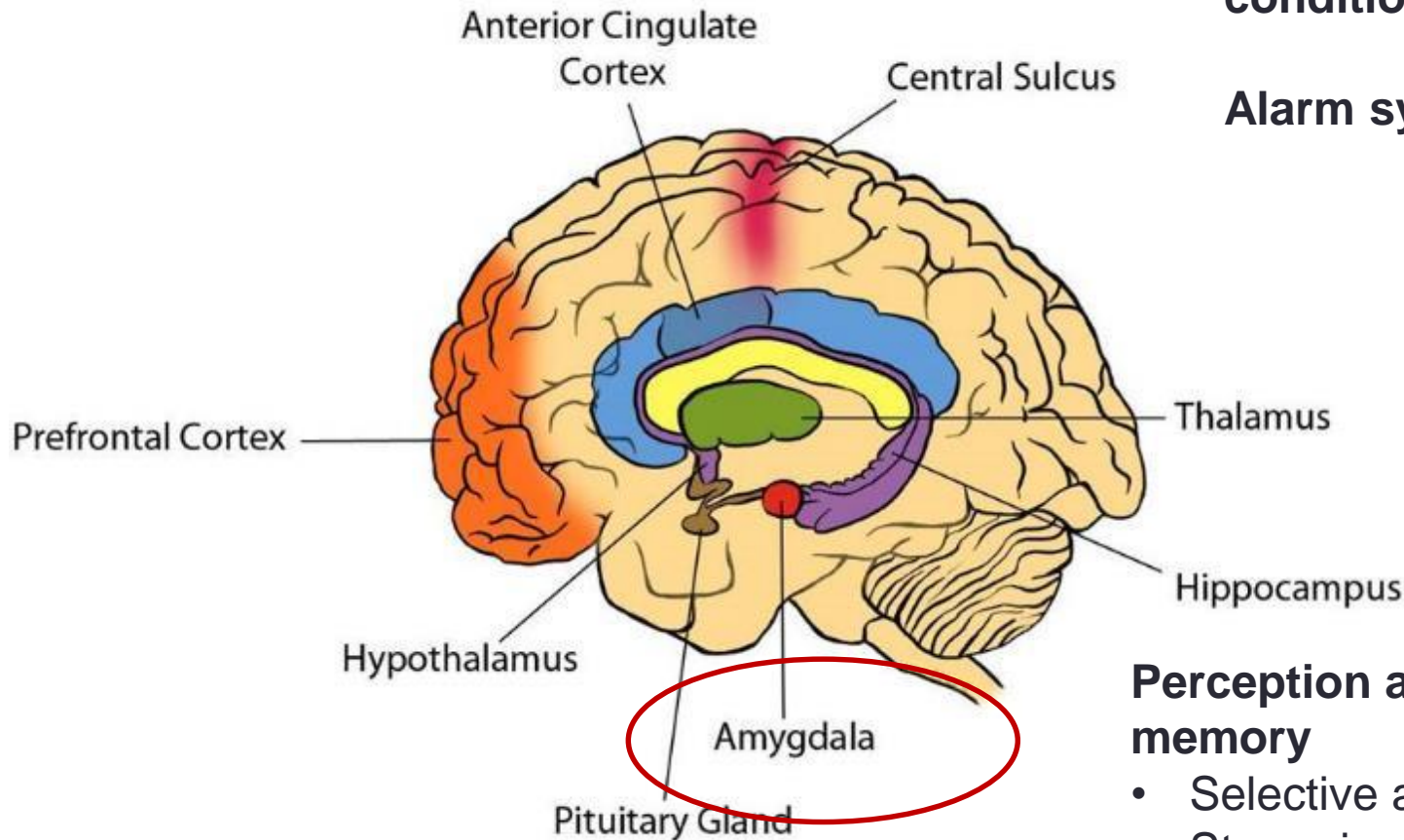
- Is sensory info distorted?
- Selective attention / arousal (NE input)

# Amygdala

**Considers info for real or perceived danger**

**Area involved in fear conditioning**

**Alarm system**



**Perception and attention and memory**

- Selective attention to threat
- Strong implicit memory formation
- Fear conditioning

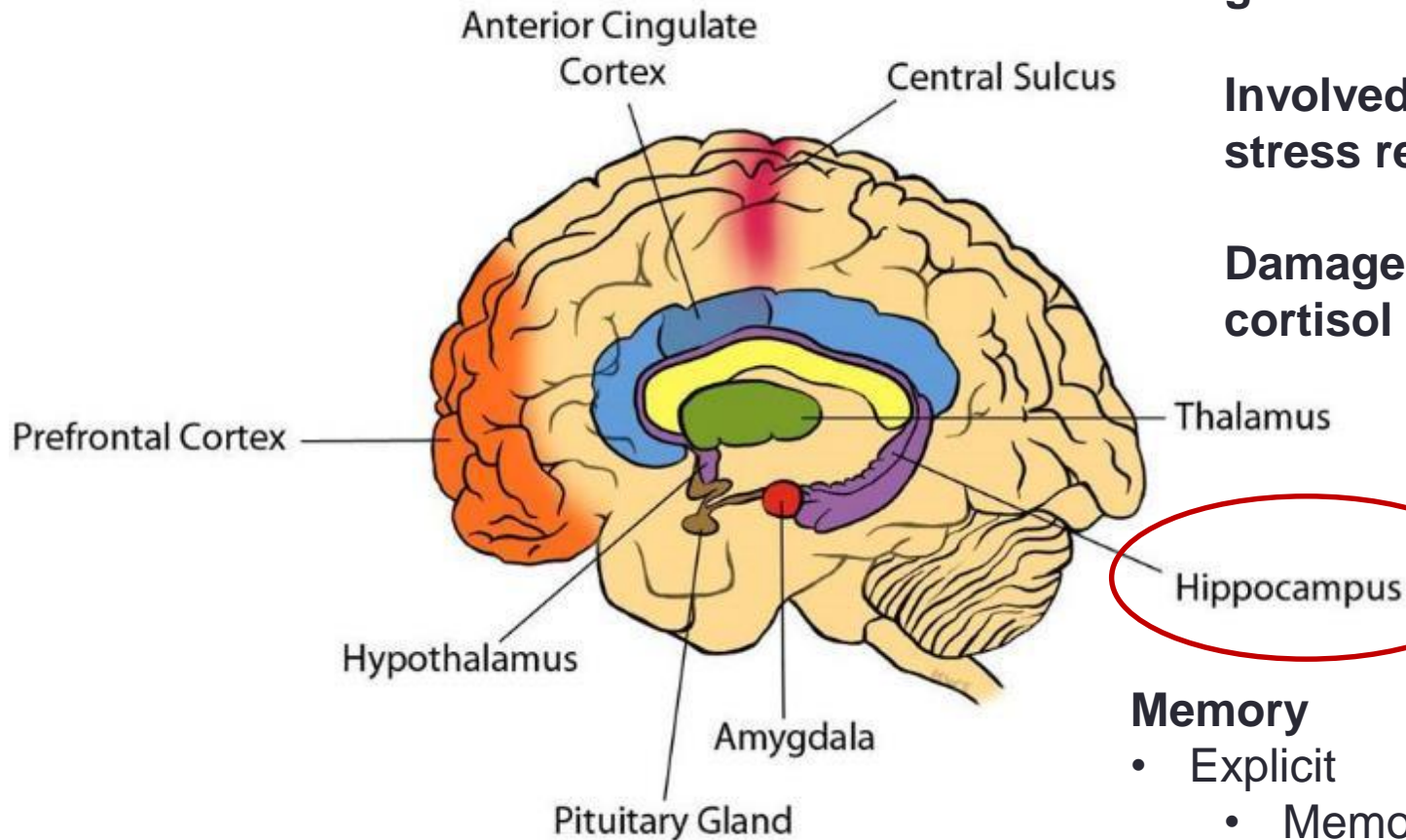
# Hippocampus

Adds context to threat response

Area prone to new growth

Involved in stopping stress response

Damaged by excess cortisol



## Memory

- Explicit
  - Memory for facts / info
  - Autobiographical
  - NE solidifies threat memory



# Prefrontal Cortex

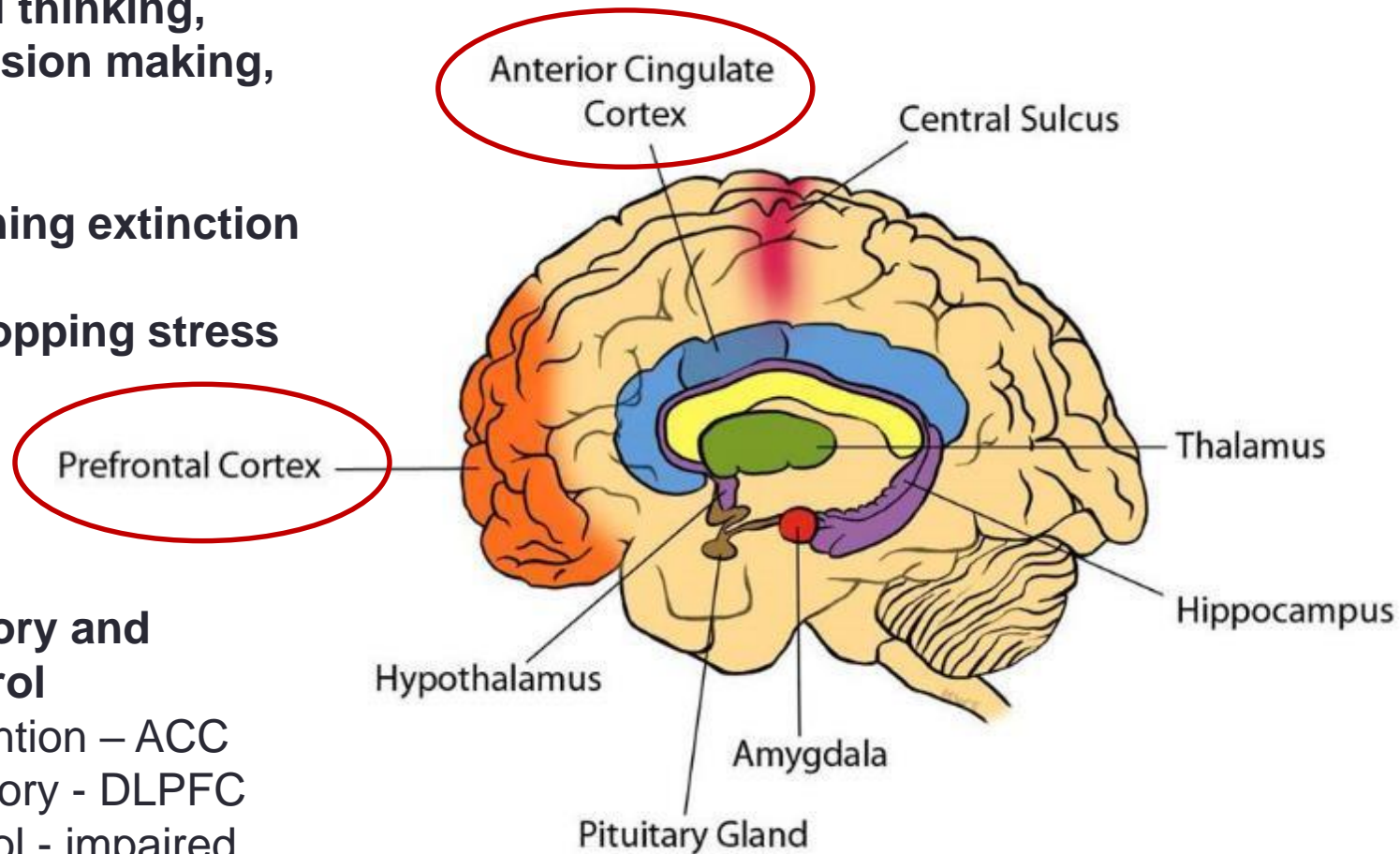
**Offers rational thinking,  
planning, decision making,  
sense making**

**Fear conditioning extinction**

**Involved in stopping stress  
response**

## **Attention, Memory and Executive Control**

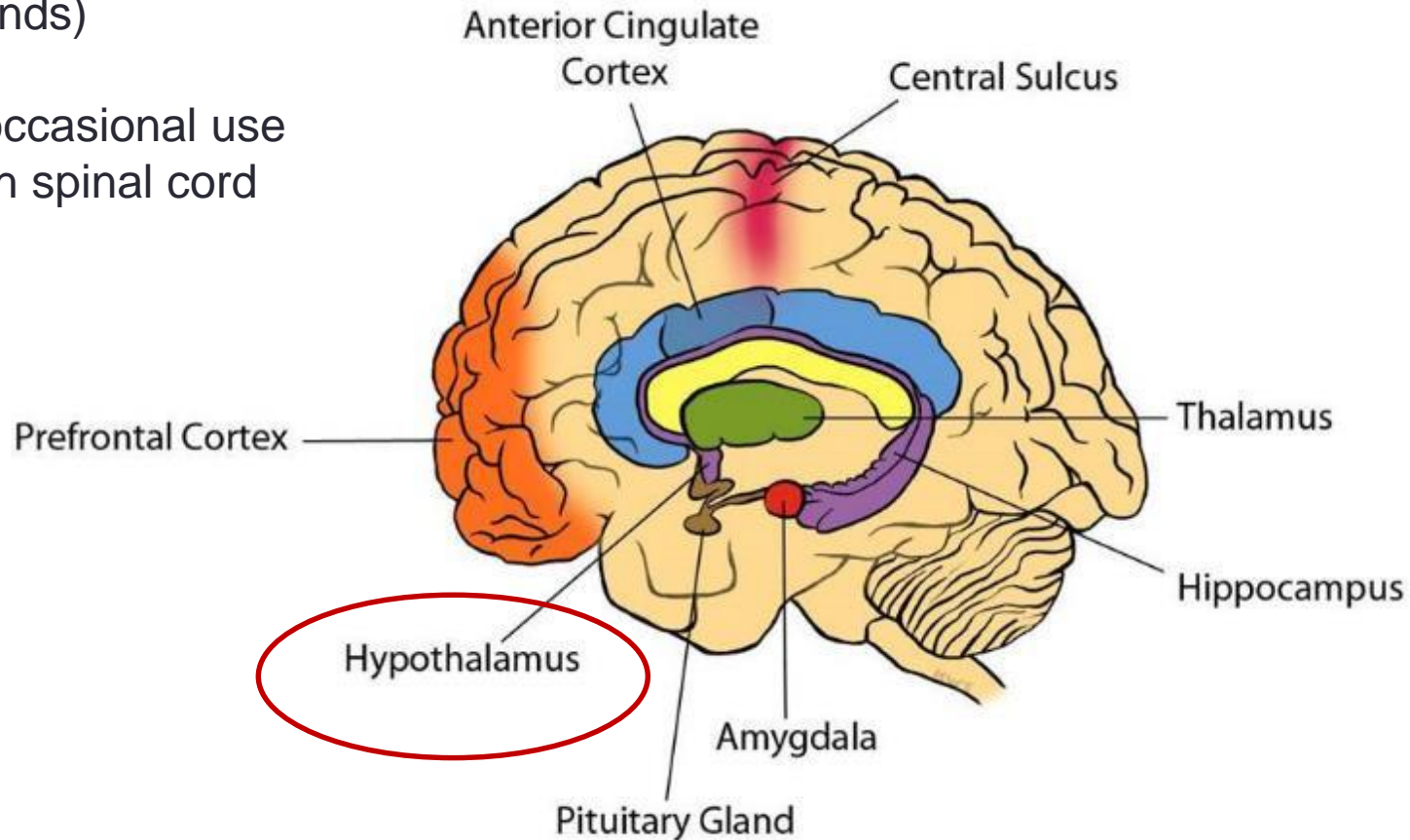
- Selective attention – ACC
- Working Memory - DLPFC
- Impulse control - impaired



# Hypothalamus – Adrenal (SAM sys)

- Fast (milliseconds)
- Electrical
- Designed for occasional use
- Routes through spinal cord

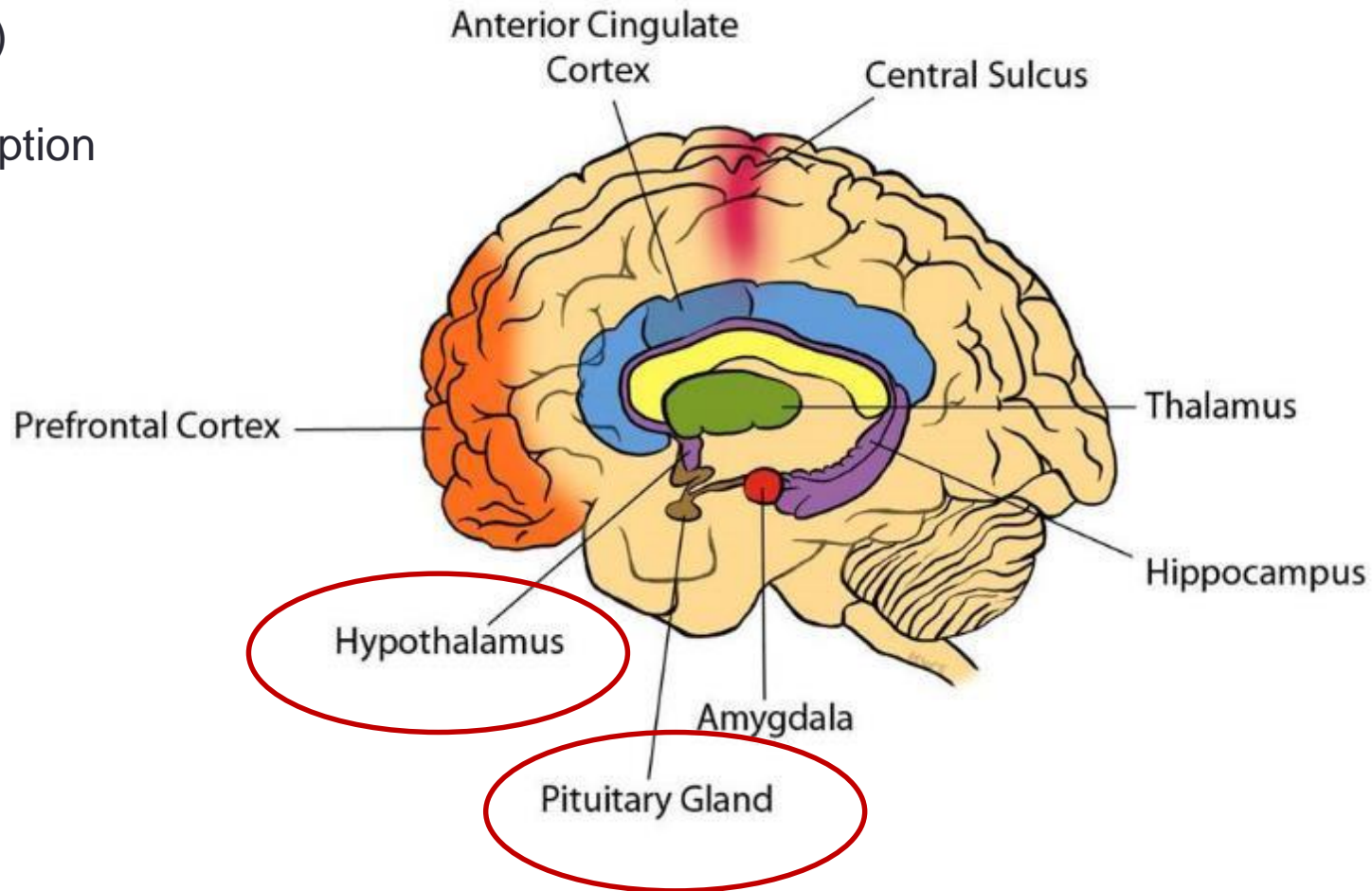
## Fight or Flight



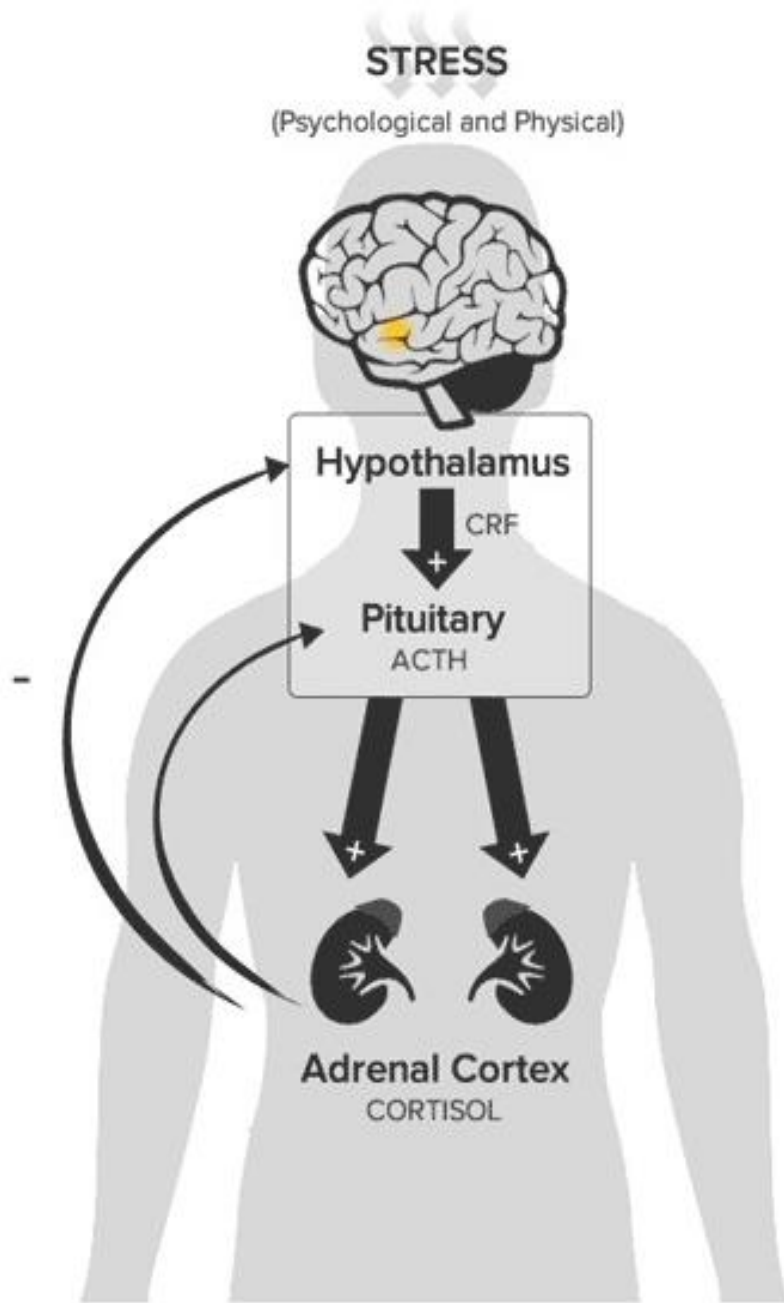
# Hypothalamus – Pituitary - Adrenal (HPA axis)

- Slow (minutes)
- Chemical
- Reflects perception

## Fight or Flight







# Sympathetic Nervous System

## SAM sys (Sympathetic Adrenal Medullary)

- **Releases Adrenaline**
- Fast (milliseconds)
- Electrical
- Designed for occasional use
- Routes through spinal cord

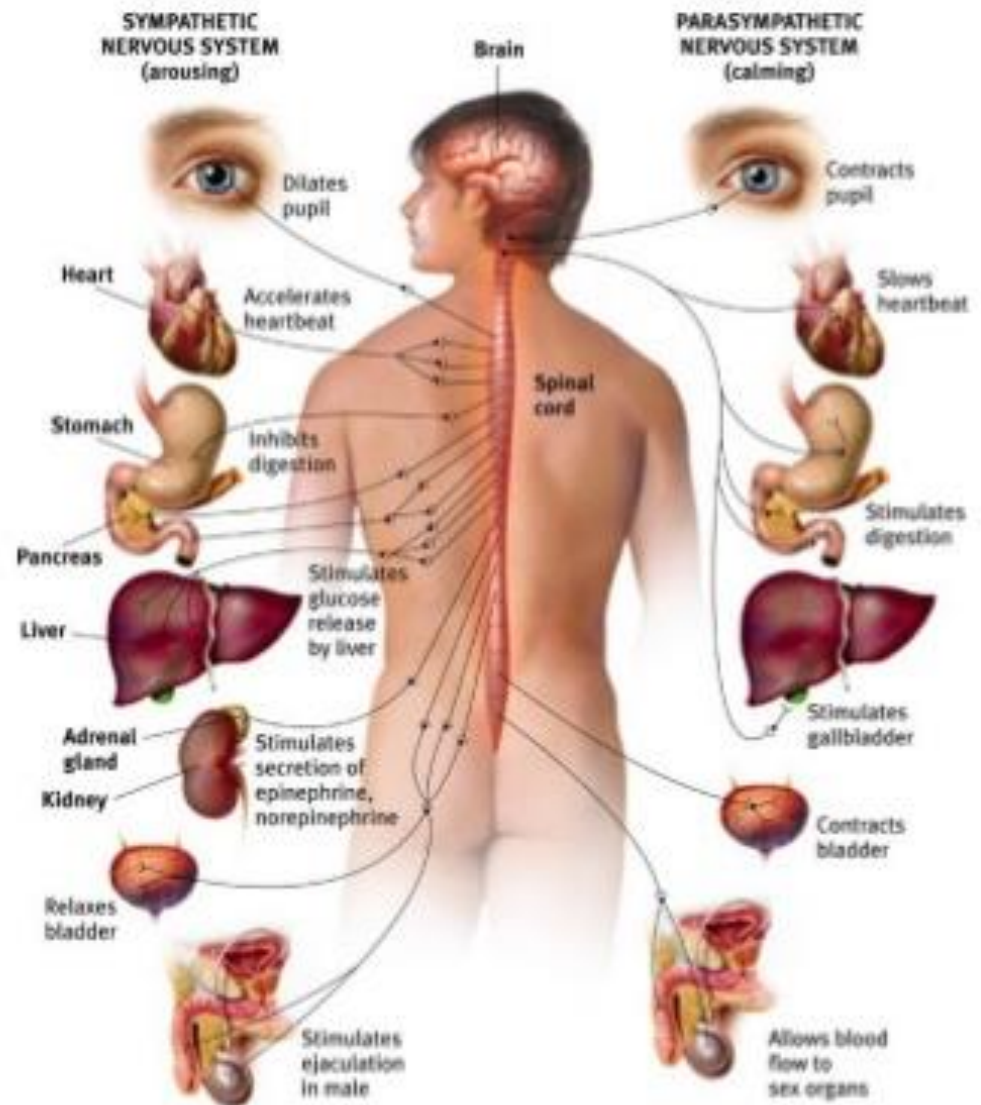
## HPA Axis (Hypothalamus – pituitary – adrenal)

- Slow (minutes)
- Chemical
- Reflects perception
- **Releases cortisol**

# Autonomic Nervous System (ANS)

Sympathetic NS  
"Arouses"  
(fight-or-flight)

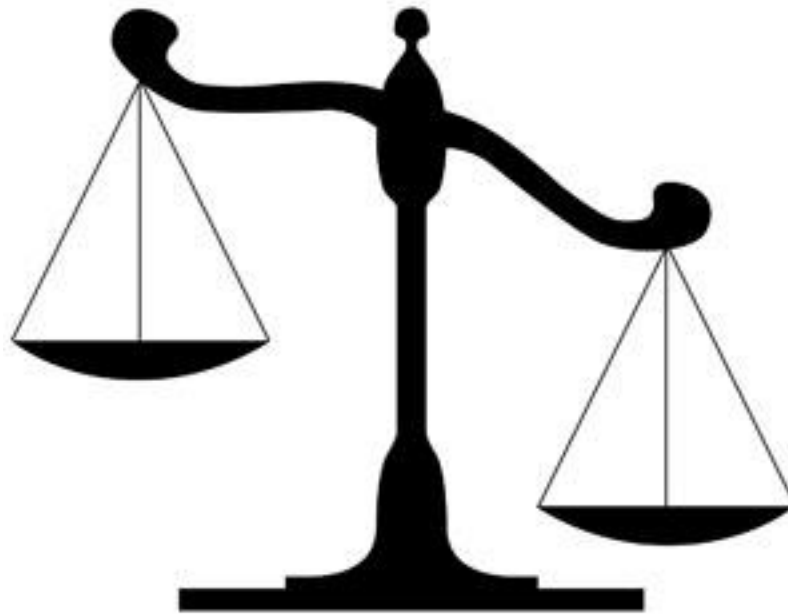
Parasympathetic NS  
"Calms"  
(rest and digest)



# When trauma happens....

- Complex, chronic trauma
  - Central Nervous system becomes unbalanced

Parasympathetic  
Nervous Sys:  
Rest and Digest



Sympathetic NS:  
Arousal system  
**Fight or Flight**



"WHICH ONE OF YOU TOLD GLURK TO STRETCH BEFORE RUNNING?"

# Brain chemicals and stress

- Too much is bad, too little is bad
- Reduced number of receptors
- Chemicals can provide protection or damage
  - Anxiogenic pathways— produces anxiety
  - Anxiolytic pathways – relieves anxiety



- Corticotropin releasing hormone (CRH) \*\*
  - Elevated levels – result from early life stress – but dependent on it
  - Has both anxiolytic pathways and anxiogenic pathways
  - Involved in HPA Axis, memory, reward, neurovegetative functions (sleep, appetite, sex)

# Cortisol and other brain chemicals

- High Levels:
  - Energy
  - Heighten memory
  - Lowers pain sensitivity
- Prolonged levels
  - Impaired cognitive performance
  - Suppressed thyroid function
  - Blood sugar imbalances
  - Decreased bone density – decrease is muscle tissue
  - Higher blood pressure, heart disease
  - Lowered immunity and inflammatory response



# Cortisol and other brain chemicals

## Norepinephrine (NE)

- Alertness / arousal / attn
- fight/flight (SAM sys chemical)
- Solidifying threat memories

## Cortisol

- fight/flight (HPA axis chemical)
- Damages hippocampus (memory)
- **Needed to shut off stress response – neg feedback loop**
- Lower levels in PTSD
- Inhibits serotonin (anxiolytic) receptor expression. \*

## Serotonin (5HT): Anxiogenic and Anxiolytic pathways

- Dampen norepinephrine firing
- **Reduces sensory stimulation into amgydala – only in presence of cortisol**
- Reduced levels in PTSD, depression
- \*Fetal and postnatal inhibition-may lead to anxiety



# Cortisol and other brain chemicals

- GABA (benzodiazepine)
  - Inhibitory NT – reduces excitatory activity
  - Reduces hyperarousal and re-experiencing /
  - Impaired in PTSD
- Endogenous Opiates
  - Analgesic
  - Related to dissociative symptoms
  - Acute stress response elevates secretion of opioids
  - Chronic stress response may lead to lower concentration of opioids

Oxytocin

decr. anxiety

incr. attachment  
and bonding



## Left and Right Brain Functions

### Left-Brain Functions

Analytic thought

Logic

Language

Science and  
math

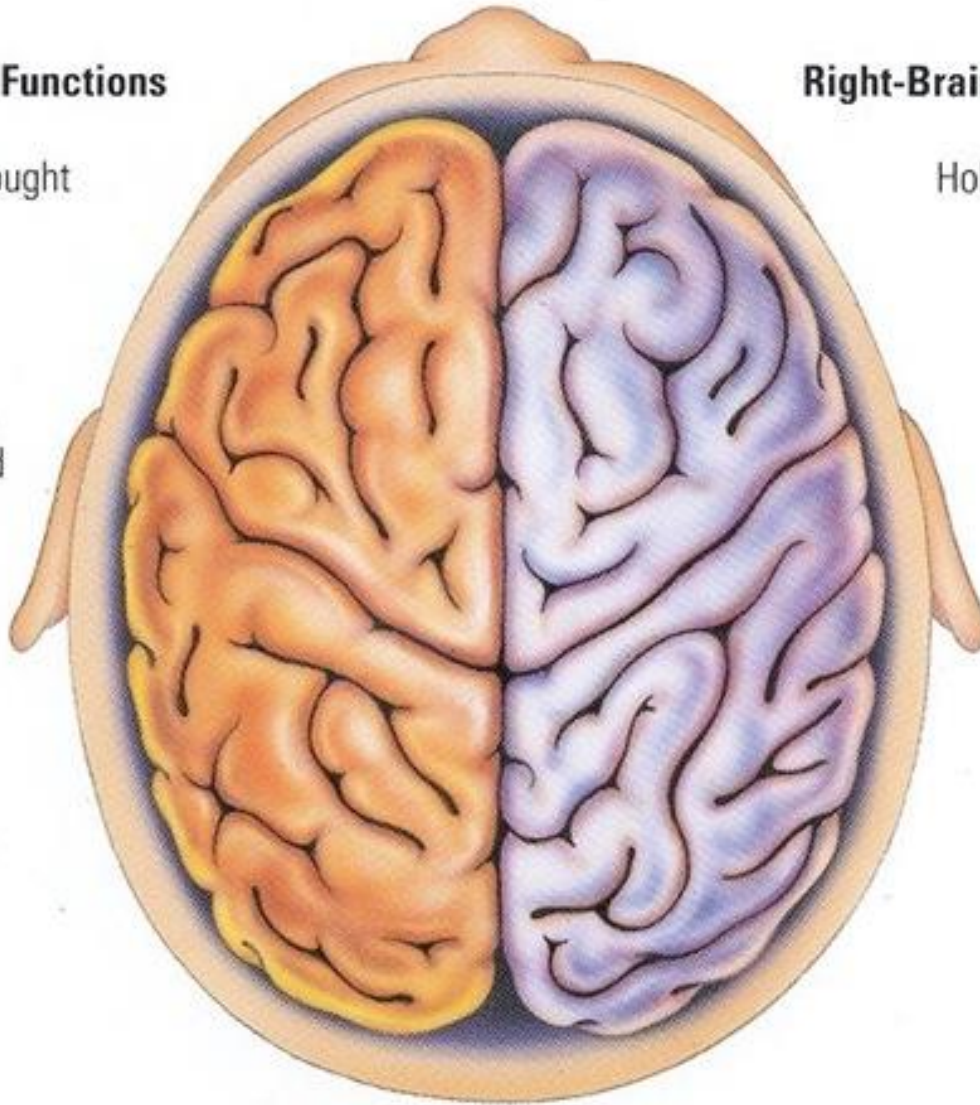
### Right-Brain Functions

Holistic thought

Intuition

Creativity

Art and  
music



# Right hemisphere

- Dominant at birth
- Sensory experiences
- Emotional regulation
  - RH plays bigger role in processing emotion
  - Left involved in emotional content of words
  - RH emotional content of words and tone of voice
  - RH production of facial expressions
- Relational hemisphere – focused on attachment

# Left hemisphere

- Developing slower ~ 18-24 months
- More logical, analytical, and sequential
- Focuses on details – construct complex theories and narratives

# Review - impact of threat response

- Emotional Reactions
  - Feelings – emotions, regulation
  - Alteration in consciousness
  - Hypervigilance
- Psychological and Cognitive Reactions
  - Concentration, slowed thinking, difficulty with decisions, blame
- Behavioral or physical
  - Pain, sleep, illness, substance abuse,
- Beliefs
  - Changes your sense of self, others, world
  - Relational disturbance

# Mirror neurons

- Your brain is active when it does the task and also in the same way when it witnesses a task.
- Empathy
- Caution – need experience
- <https://www.youtube.com/watch?v=k2YdkQ1G5QI>

# CHRONIC EFFECTS

---

“Toxic stress in early childhood is associated with persistent effects on the nervous system and stress hormone systems that can damage developing brain architecture and lead to lifelong problems in learning, behavior, and both physical and mental health.”

National Scientific Council, Center on the Developing Child at Harvard University

# Chronic effects

## Altered Brain Function:

- The under activation of some areas of the brain (e.g. pfc and hippocampus) and the over activation of other areas (e.g. amygdala) create persistent brain patterns.

## Altered Brain Chemicals:

- Brain compensates for excess chemicals by reducing numbers of receptors. Brain wants balance. This compensatory mechanism can lead to decrease in brain chemicals.
  - Chemicals involved: Adrenaline, Serotonin, Dopamine, Endogenous Opioids, Oxytocin, adrenal corticosteroids (e.g. cortisol)



# (Epi)Genetics

## Prenatal stress can affect HPA axis function

- Early care (tactile) leads to a reduction of CRH neurons in hypothalamus (Karsten & Baram, 2013) – must be recurrent
- Early and chronic abuse is associated with permanent sensitization of HPA axis

## Trans generational Transmission of Trauma

- Lower cortisol levels in mothers and babies of mothers who developed PTSD following World Trade Center attacks
- In rats, exposure to high levels cortisol prenatally (3<sup>rd</sup> trimester) associated with low birth weight, hypertension, glucose intolerance as adults

# Trauma & substance use

- System is in “active” mode – body is revved up, HR, breathing – ready to flee (or fight)
  - Drugs that calm, relax – slow sys down...e.g. depressants like alcohol, marijuana, benzodiazepines (Valium, Xanax, Ativan, Klonopin)
- Brain function is impaired - underactive
  - Drugs that stimulant those areas...e.g. nicotine, cocaine, meth
- Life is overwhelming – need to “check out”
  - Drugs that cause numbness, changes in perception, e.g. LSD, mushrooms, PCP
- Life is painful – need to numb the pain – feel pleasure
  - Drugs that numb pain like opiates; drugs that increase pleasure (increasing dopamine) – many

Drugs interact with  
natural brain chemicals

# Neurobiology take aways

- Fire-together-wire-together.
- Simple to complex – Survival mechanisms act first and faster than the thinking brain.
- When we are threatened – brain moves resources away from thinking toward survival.
- Amygdala in survivors is hyper-vigilant – scanning for danger, sensing threat, reacting to real or perceived threat

# Neurobiology take aways

- Communication: Decreased verbal (left hemisphere) – hypersensitive to nonverbal (right hemisphere) – prone to misinterpret.
- Memory:
  - Explicit memory (hippocampus) – facts, stories, pictures – impaired
  - Implicit memory (amygdala – acute trauma) often clear and sharp
- Hippocampus extremely sensitive to excess cortisol – resulting in memory problems that are long-term often permanent

# Think about information processing...

- Perception
  - Attention
    - Selective
    - Divided
  - Memory
    - Explicit
    - Implicit
  - Impulse control
  - Planning
  - Decision Making
- 
- Right hemisphere (emotions, non verbal) vs. Left (verbal, logical, sequential)