Tina M. Trudel, PhD
Founder, CEO & Clinical Neuropsychologist
Northeast Evaluation Specialists, PLLC
Portland, ME | Dover, NH | Keene, NH | Manchester, NH | Burlington, VT

Trauma and the Developing Brain

Childhood Trauma Context

- USA – 2013
  - 1,520 children died from abuse & neglect (A&N)
  - 679,000 verified unique instances of A&N
  - 47 states reported 3.1 million preventative services from Child Protective Services
  - Roughly 1/3 of adult population report abuse histories, with males higher for physical abuse and females higher for sexual abuse.
  - Most abuse occurs within the family context

Childhood Trauma Context

- Canadian Data -
  - Roughly 1/3 of adult population report abuse histories, with males higher for physical abuse (31% to 21%) and females higher for sexual abuse (14% to 7%).
  - Most abuse occurs within the family context
  - Of all reported crime, over 25% is family violence related and women/girls are victims approx. 70%
  - BC- 1/3 marginalized ('street') youth are sexually abused. 60% of sexually exploited youth are Aboriginal, who also experience higher rates of abuse

Historical Context

- Freud 1896 – The Etiology of Hysteria. Retreated from this – could not accept prevalence and developed different theory of childhood fantasies and complexes instead
- Not much public attention through the post-WWII era
- C. Henry Kempe 1962 – The Battered Child Syndrome – led to reporting laws

Historical Context

- Early ideas accepted psychiatric damage from A&N. 'The Damaged Inner Child'
- Animal models demonstrate brain-based changes from A&N
- Genes provide range or structure whereas experience shapes connections and function
- Enduring negative effects of A&N on brain development is a relatively new concept now accessible via MRI, QEEG, PET and other tools
- We now know the A&N cause trauma and these experiences alter brain development.

Brain Disorders as a Model

- Genetics and Environment
- Critical Periods
- Structural Brain Development
- Cortical Cell Migration
- Myelination
- Neurotransmission
- Metabolic Maturation
- Development Continues into Early 20's

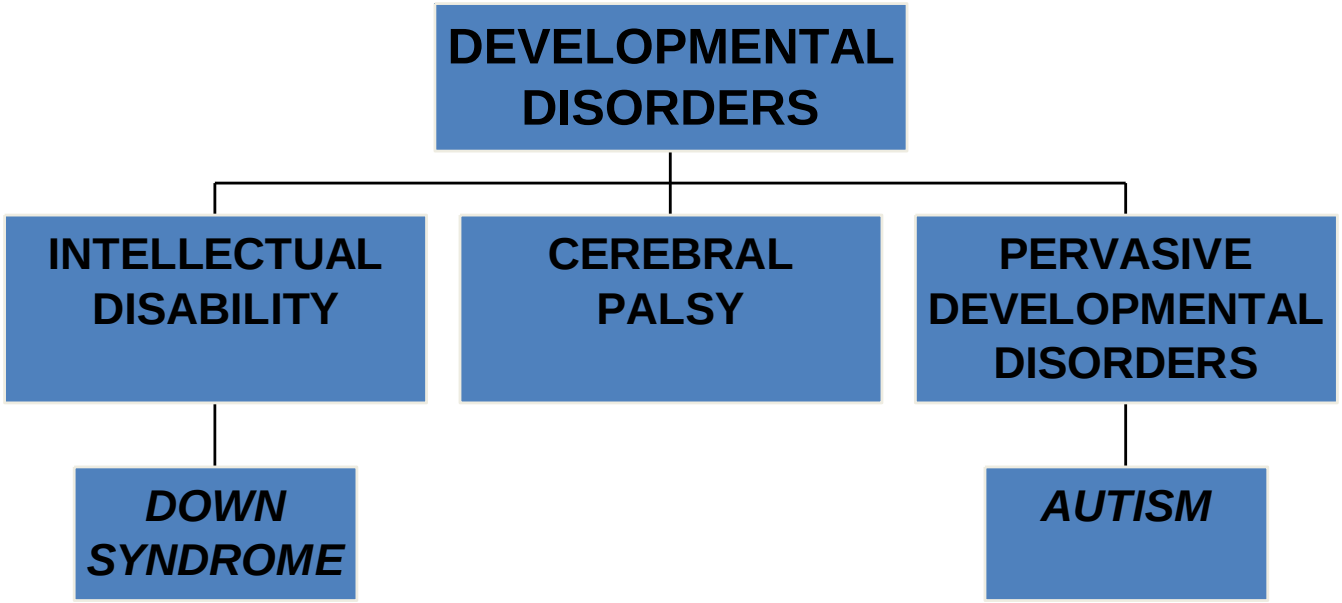
Early Brain Disorders

- Brain Development
  - 3 weeks - neural plate
  - 40 days - three swellings
    - hindbrain, midbrain, forebrain
  - In utero abuse/stress
  - Pre/post conception toxin exposure
    - Environmental/occupational
    - Drug and alcohol
  - postnatal growth spurts
    - 2-4 years
    - 6-8 years
    - 10-12 years
    - 14-16+ years

Early Brain Disorders

- **Cell Migration**
  - **chemoaffinity**
  - **blueprint hypothesis**
  - **pioneer growth cones**
  - **topographic gradients**
- **Myelination**
  - **increases brain weight**
  - **fast-signal conducting paths**
- **Neurotransmission**
  - **axon pathways**
  - **dendritic spines**
- **Cell Metabolism**

Early Brain Disorders



Early Brain Disorders

- **Intellectual Disabilities**
  - **many causes – consider range of outcomes!! – Demonstrates environment**
- **Down Syndrome**
  - **trisomy 21 (1.5% of genetic material)**
  - **reduced cerebral development (<80%)**
  - **reduced cerebellar development- 67%**
  - **relationship to Alzheimer's Disease**
    - **evidence from age 35**

Early Brain Disorders

- **Cerebral Palsy**
  - **many types – demonstrates physical versus cognitive effects**
  - **cell migration problems**
  - **pyramidal (spastic)**
    - **more global impairment**
  - **extrapyramidal (non-spastic)**
    - **basal ganglia**
    - **cranial nerves**
    - **cerebrum often not involved**

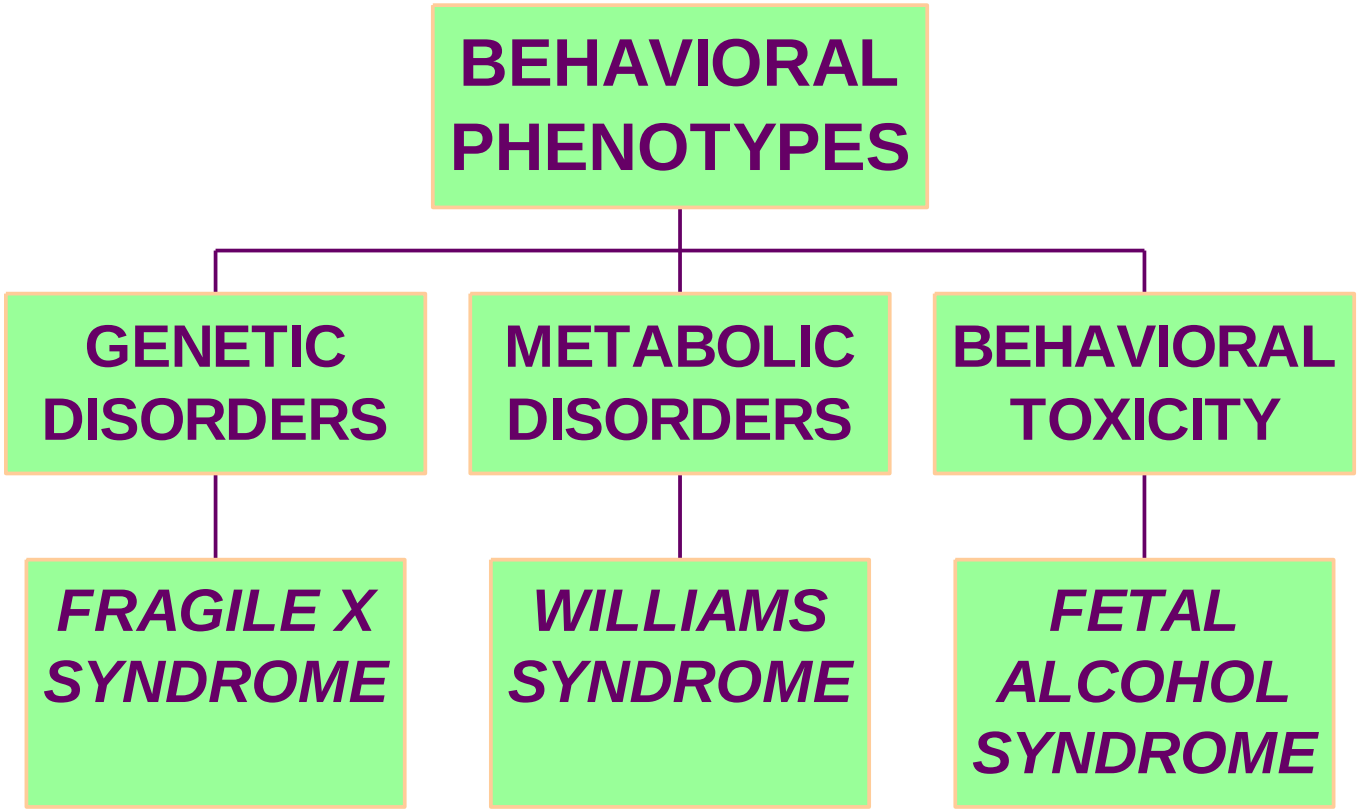
Early Brain Disorders

- **Autism**
  - **genetic basis**
  - **aberrant brain growth pattern**
    - **polymicrogyria**
    - **hemispheric symmetry/reversed asymmetry**
  - **cerebellar hypoplasia & exploration**
  - **parietal volume loss in some cases**
  - **fusiform gyrus & face perception**

Early Brain Disorders

- **Autism**
  - **increased brain proteins**
    - **Hyperserotoninemia**
  - **limbic system**
    - **cellular abnormalities**
      - **densely packed**
      - **reduce dendritic branching**
  - **cerebellum**
    - **reduction in Purkinje cells**
    - **impaired olivary - Purkinje connection**

Early Brain Disorders



Early Brain Disorders

- **Fragile X**
  - **correlates with ID and autism**
  - **posterior cerebellar vermis decreased**
  - **cerebellar connection impairment**
  - **fourth ventricle increased**
  - **GABA - cerebellar neurotransmitter**
  - **cognitive performance declines relative to age peers**

Early Brain Disorders

- **Williams Syndrome**
  - **often found with hypercalcemia**
  - **smiling, social, jovial – demonstrates impact of behavior**
  - **mutation of calcitonin gene related peptide**
  - **reduced cerebral volume (80%)**
  - **cell abnormalities**
    - **horizontal neurons**
    - **dense cell packing**
    - **weak myelination**

Early Brain Disorders

- **Fetal Alcohol Syndrome**
  - **microcephaly**
  - **underdeveloped or absent corpus collosum – similar to trauma**
  - **enlarged lateral ventricles**
  - **decreased dendritic spines**
  - **abnormalities of the pyramidal cells**
  - **behavioral challenges often increase with age demonstrating developmental process**

Acquired Brain Disorders

- TBI most common
- Shaken Baby Syndrome
- However, animal and human studies have also shown that early deprivation, stress and abuse result in neurobiological abnormalities.
- Hypothesis: trauma induces a cascade of effects including hormone and neurotransmitter changes that mediate development of vulnerable brain regions.

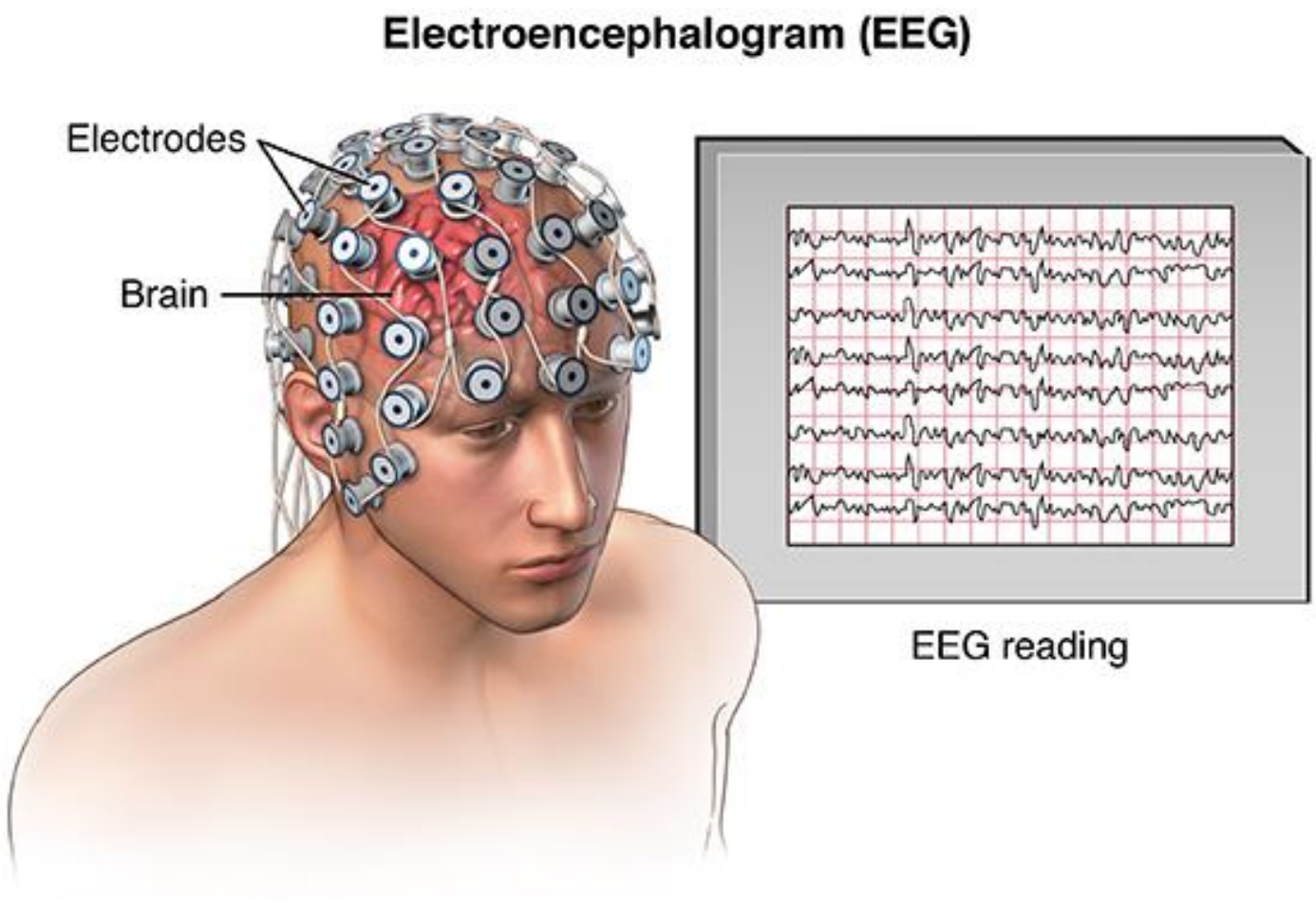
Behavior and Brain Area

Behavior	**Brain area**
Seizure/Epilepsy	Temporal lobe/Limbic
Aggression	Temporal lobe/Limbic
Explosiveness	Temporal lobe/Limbic
Anxiety	Temporal lobe
Bumping people	Parietal lobe
Lack of initiative	Frontal lobe
Adjust to changes	Frontal lobe
Self regulation	Frontal lobe
Depression	Frontal lobe esp. left
Tactile defensiveness	Thalamic or parietal

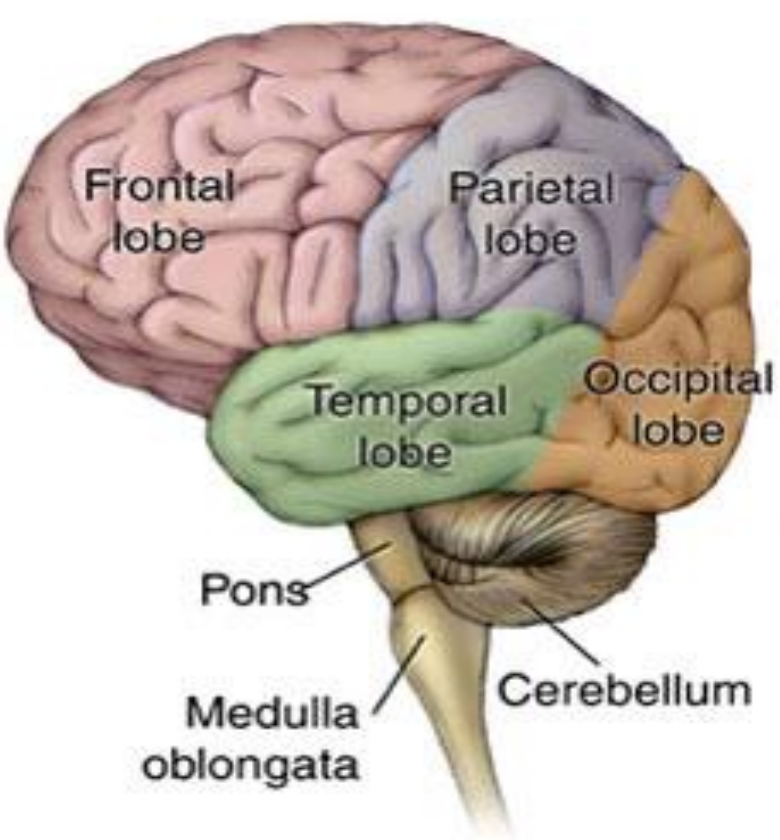
Early Findings

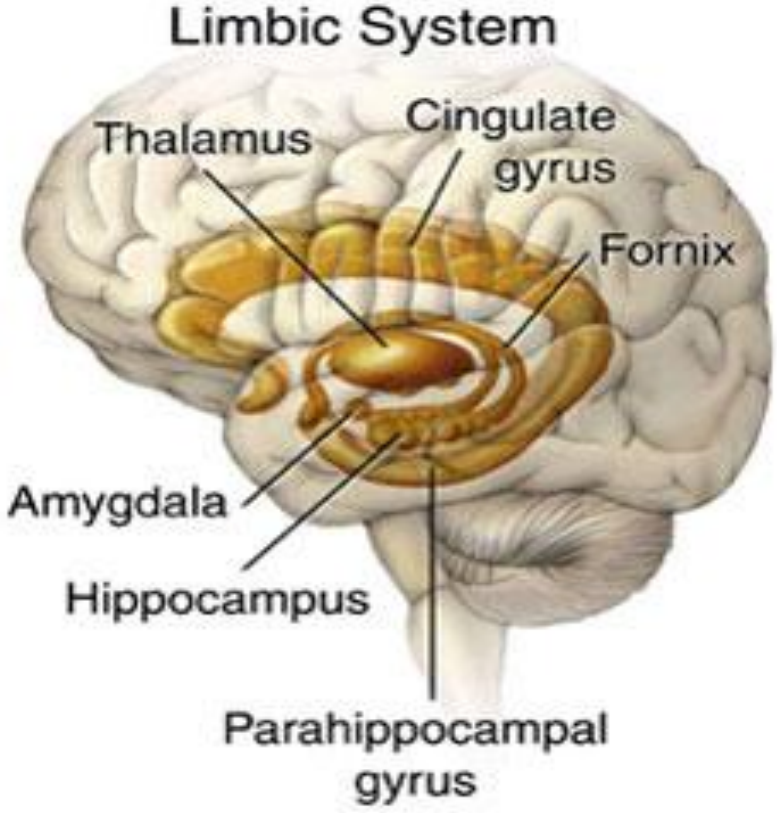
- 1983 AH Green
- Noted many abused children evidenced neurological damage without TBI
- Measured over-representation of brain wave abnormalities in A&N population
- 1979 RK Davies
- Studied 22 patients who were early incest survivors
- 77% had abnormal brain waves
- 36% had seizures
- Population base rate under 25%

Brain Wave via EEG



Temporal Lobe (& Limbic connections)





Teicher, et al. & McLean Hospital Boston Based Research

- 253 admits to psych clinic
- Administered Limbic System Checklist of TLE Symptoms
- Almost 50% abused test positive
- Those both physically AND sexually abused score 113% higher than non-abused controls
- 115 admits to psych hospital
- 54% of those with A&N history have abnormalities
- 27% of the non-abused
- Left sided EEG abnormalities
- Correlated with left hemisphere neuropsych deficits

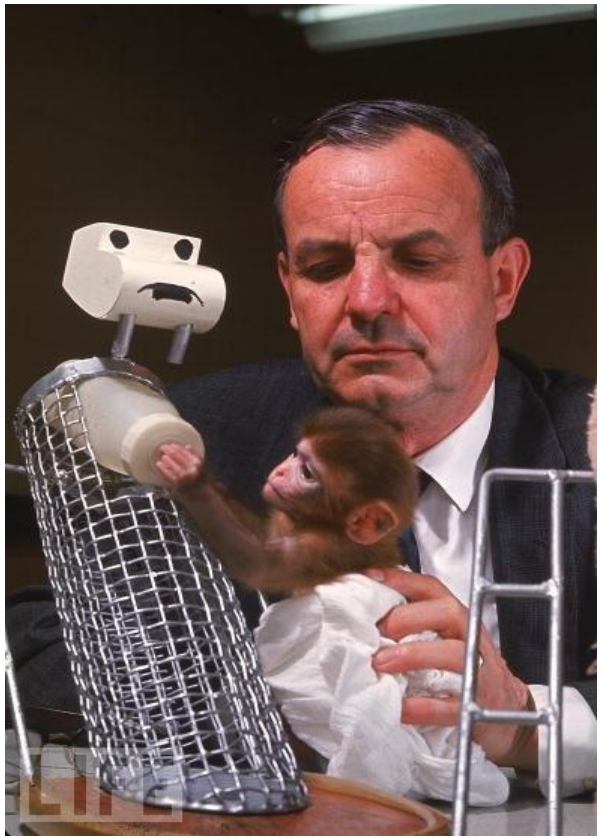
Early Research

- Cichetti and Lynch 1995
  Created framework for trauma induced changes in brain that promote atypical behavior
  Disruptions in systems that regulate coping
  Disruptions in systems that regulate comforting (endogenous opiates)

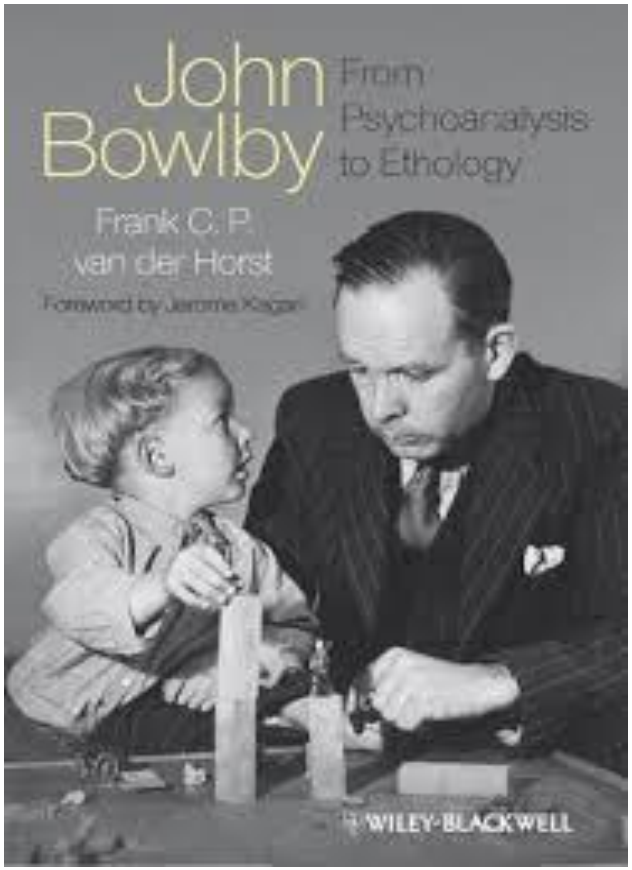
- Perry et al. 1995, 2002
  Brain injury promotes atypical ways of responding
  Neglect and trauma - similar outcomes
- Romanian orphans and development of RAD supported by work of Chugani, 2001.
- Glaser 2000 – different abuse and timeframes – different effects

Attachment – Maternal rejection at age 1 is predictor of violence at 18

- Harry Harlow



- John Bowlby



Heidi & Solomon 2006
Intl Jnl of Law and Psychiatry

- Overview of numerous studies demonstrating high correlation of organic impairment and violent crime (consistent with Lewis and Pincus studies of death row adolescents and adult inmates)
- Focus on Type III trauma survivors – severe A&N, multiple episodes, early age, perceived life threat. Also called 'Complex Trauma'.
- Multiple long term nervous system/endocrine changes limit access to higher cortical centers (frontal lobe), leading to difficulty with higher cognition, logic and decision making and reliance on limbic and brain stem responses – socially inappropriate, impulsive and dyscontrol of anger

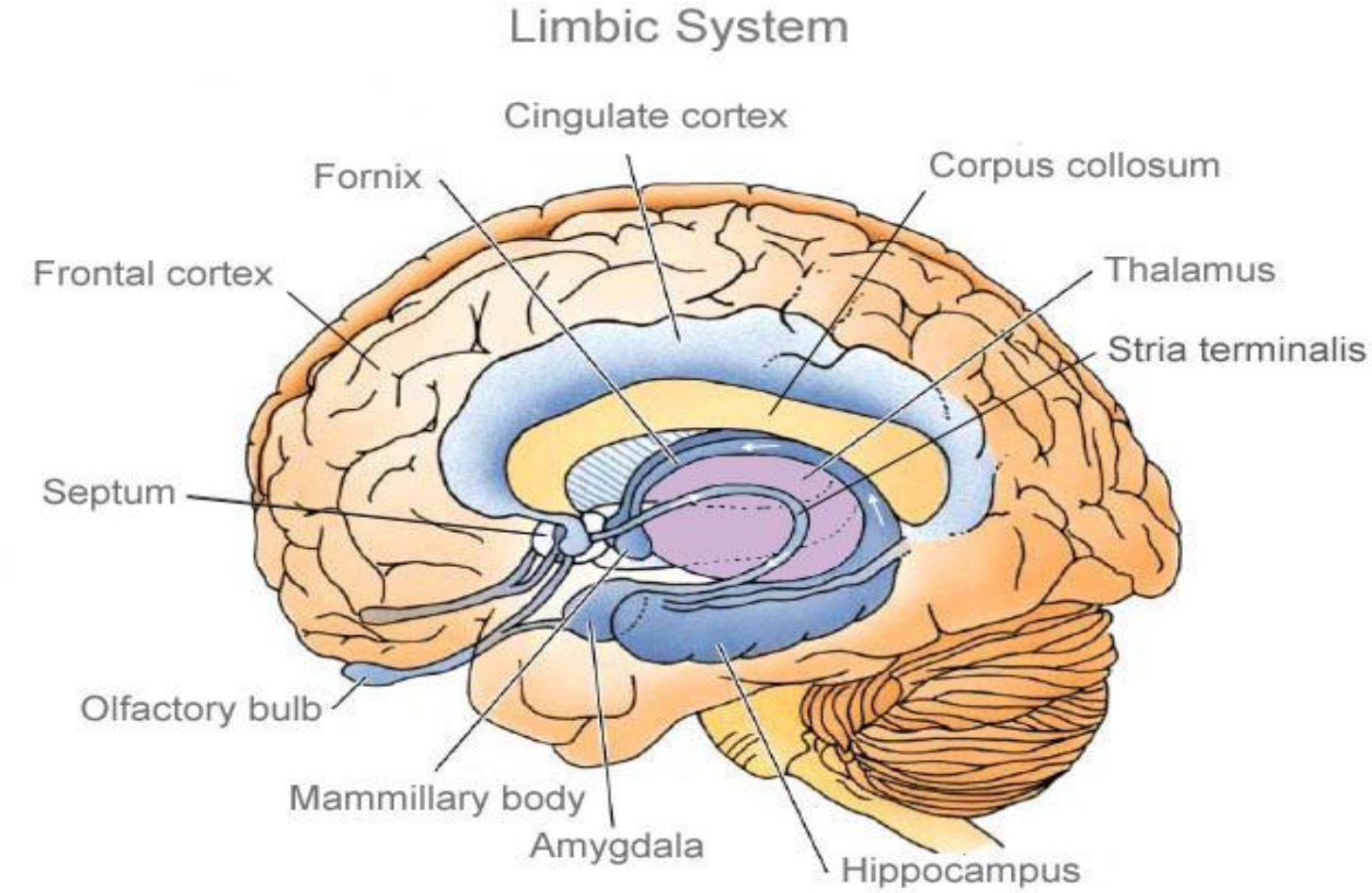
What We know – For Now

- Childhood trauma interferes with early brain development – apoptosis, pathways, pruning
- Evidence for atrophy, reduced volume, cell death
- Effects vary: age, stage and type and level A&N
- Can cause long-lasting changes into adult life
- EEG abnormalities are present (72% severe A&N)
- Corpus collosum thin (integration) is in FAS
- Limbic system is significantly affected – memories 'stuck there' & on red alert
- Neurotransmitters are affected – risk for SA
- Difficulty modulating autonomic arousal increases risk for impulsivity and aggression

Common Diagnoses

- Attention Deficit Hyperactivity Disorder
- Oppositional Defiant Disorder
- Conduct Disorder
- Antisocial and Borderline Personality
- Learning Disorders
- Mood Disorders/Depression
- Anxiety Disorders, Panic and Agoraphobia
- Somatoform Disorders
- Dissociative Identity Disorder
- Substance Use Disorders

Limbic System and Trauma Burden



Hippocampal Studies

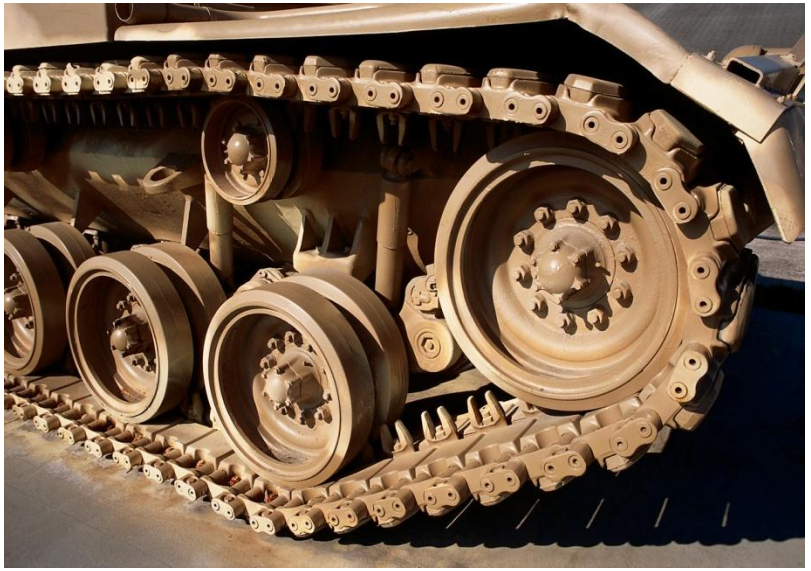
- Bremner et al. –Yale
- 17 Adult A&N survivors paired with matched controls
- Left hippocampus on average 12% smaller
- Lower verbal memory score
- Murray Stein
- 21 women abused as children
- Left hippocampal volume significantly reduced
- Reduction proportional to symptom severity of PTSD

History of PTSD

- Evolution – fight or flight and survival
- Increased pupil size
- Increased heart rate
- Rapidly contracting muscles
- Modern hard-wired stress response
- Present from birth

History of PTSD

- 19th century 'Railroad Spine'
- WWI & WWII
  - Shell shock
  - Battle fatigue
  - Traumatic neurosis
  - Concentration camp syndrome
    - Sica, 1996



History of PTSD

- 1970's – Vietnam Syndrome
- 1970's – Rape Trauma Syndrome
- 1980 – PTSD recognized as a generalized anxiety disorder in the then DSM-III
- 1980's – PTSD issues and controversy emerge in worker's compensation, disability claims and medicolegal fronts
- 1990's – PTSD becomes highly compensated psychological injury claim
- 2000's – PTSD recognized in childhood trauma and affecting development – problems with diagnosis.
- 2010's – effort to develop specific trauma and youth diagnoses and treatments

DSM-V Diagnosis

- Criterion A – Stressor

Exposed to actual/threatened death, serious injury, sexual violence

- Directly
- Witnessing
- Indirectly (close person)
- Repeated or extreme indirect as in professional duties (not via media)

DSM-V Diagnosis

- Criterion B – Intrusion

Traumatic event is persistently re-experienced

- Recurrent, involuntary and intrusive memories
- Recurrent distressing dreams of event
- Dissociative reactions (flashbacks)
- Intense, prolonged distress after exposed to reminders
- Marked physiologic reactivity after exposure to reminders

DSM-V Diagnosis

- Criterion C – Avoidance

Persistent effortful avoidance of distressing trauma-related stimuli after the event

- Trauma-related thoughts or feelings
- Trauma-related external reminders

DSM-V Diagnosis

- Criterion D

Negative alterations in cognitions and mood

- Inability to recall key features of the trauma (usually dissociative amnesia)
- Persistent (distorted) negative beliefs and expectations about one's self and the world
- Persistent distorted blame of self or others
- Persistent negative trauma-related emotions
- Markedly diminished interest in activities
- Feeling alienated from others, detached
- Constricted affect, inability to feel positive emotion

DSM-V Diagnosis

- Criterion E –Alterations in Arousal/Reactivity

Trauma-related alterations in arousal/ reactivity that began/worsened after trauma

- Irritable or aggressive behavior
- Self-destructive or reckless behavior
- Hypervigilance
- Exaggerated startle response
- Problems in concentration
- Sleep disturbance

DSM-V Diagnosis

- Criterion F – Duration

Persistent symptoms (B,C,D & E) for more than one month

- Criterion G – Functional Significance

Significant symptom-related distress or functional impairment

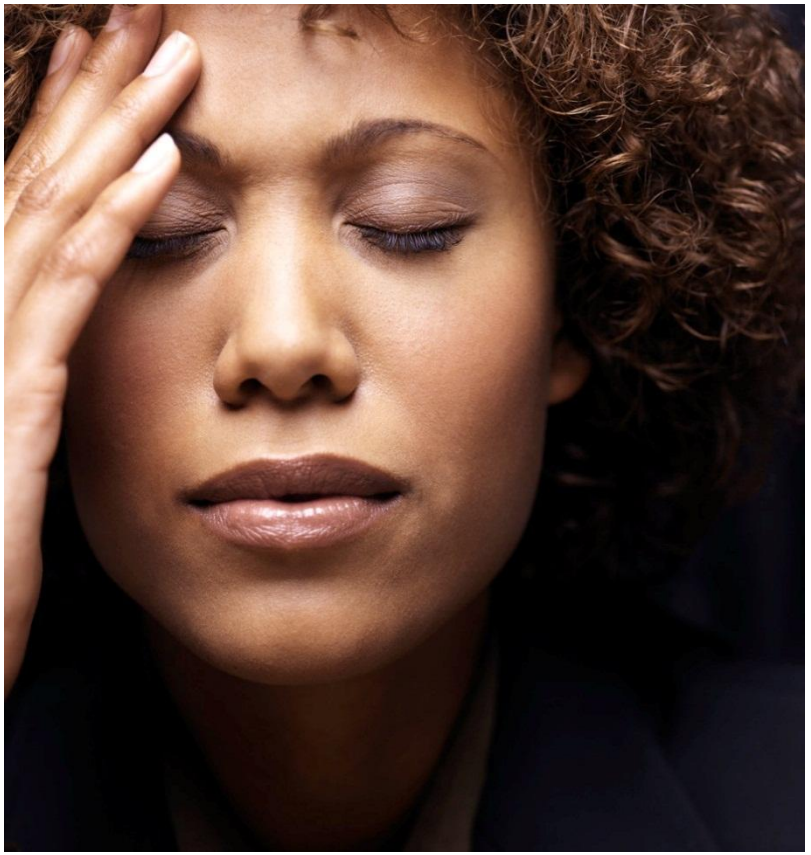
- Criterion H – Attribution

Disturbance is not due to medication, substance use or other illness

- Specify dissociative symptoms, delayed onset
- Problems re: presentation of children and not meeting DSM V criteria - proposed:
  "Developmental Trauma Disorder"

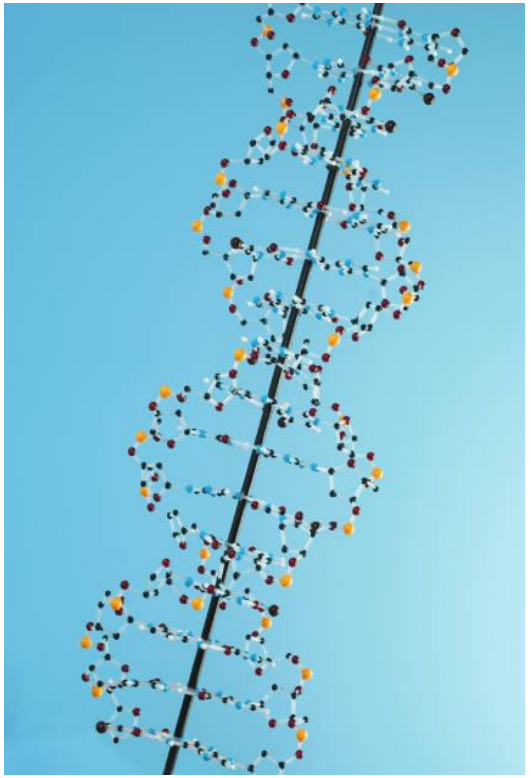
PTSD in the General Population

- 2-20% of civilians exposed to trauma
- Lifetime 5% males, 10% females
- Women 4x more likely if exposed
- PTSD beyond 3 months often chronic
- Children particularly vulnerable due to developing brain



PTSD and Genetics

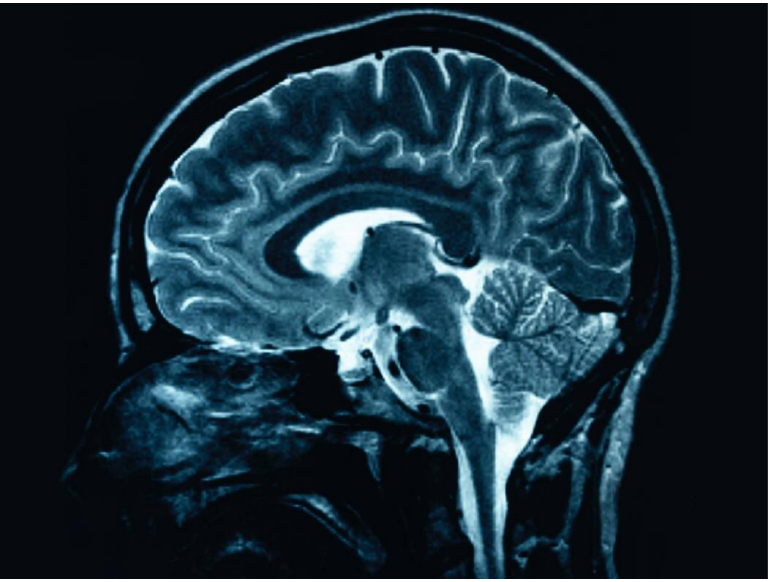
- PTSD is a polygenetic disorder
- Results of epidemiological studies have been contradictory
- Research problem for familial studies – cannot assess in relatives without trauma



PTSD and Genetics

- Refugee camp & Holocaust studies demonstrate 5x PTSD in children of parent with PTSD
- Vietnam Era Twin (VET) registry – genetic influences explained 47% of the variance re: PTSD; also supported in civilian twin studies
- Genes proposed are those influencing HPA axis dysregulation
  - (Koenen, 2003)

Brain Imaging Studies and PTSD

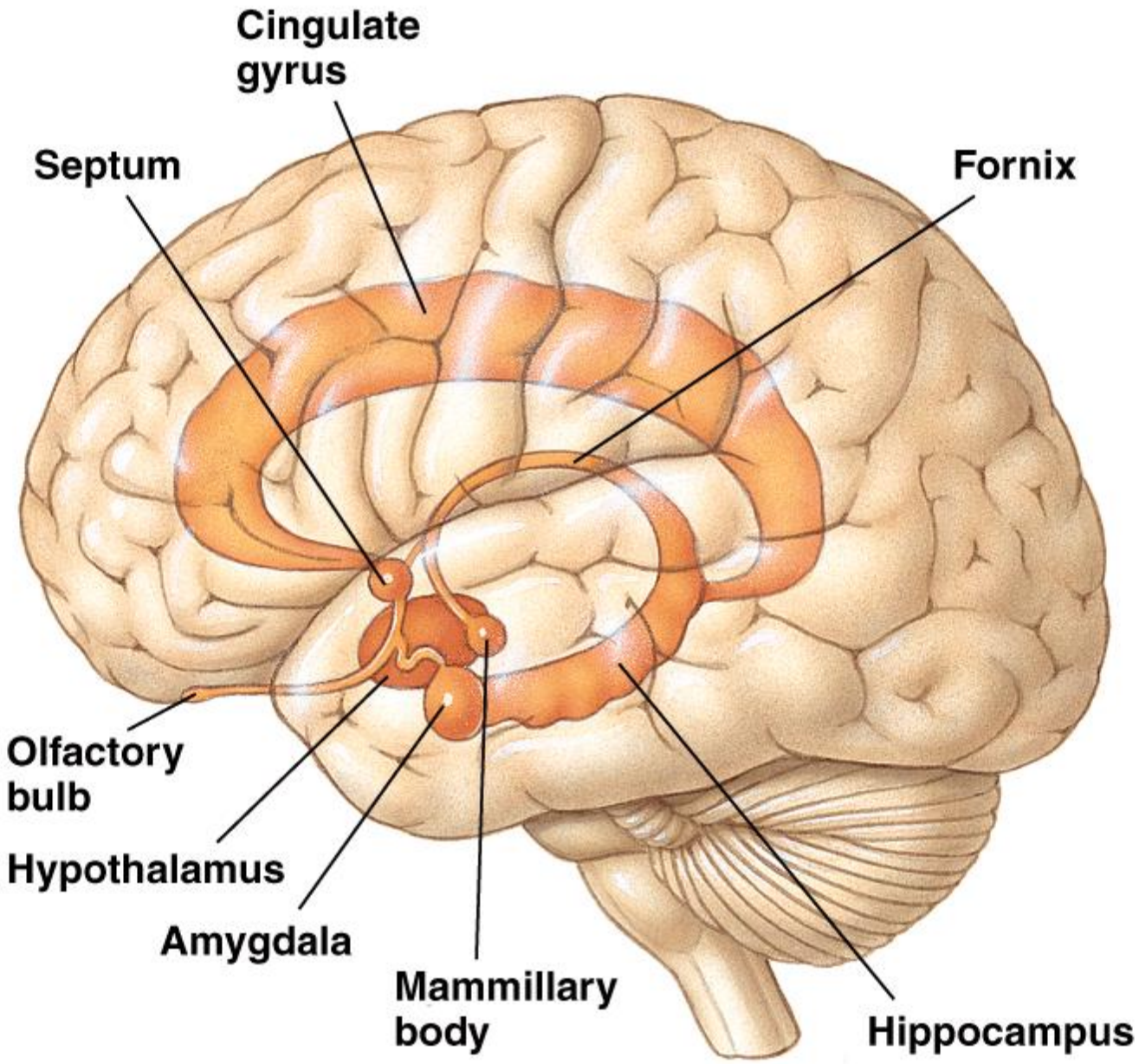


- Combat vets with PTSD – 8% reduction in hippocampal volume
- Replicated with survivors of childhood abuse with PTSD & correlated with level of abuse
- PET- low hippocampal activation
- Hippocampal reduction is specific to PTSD, not anxiety -Bremner, 2002

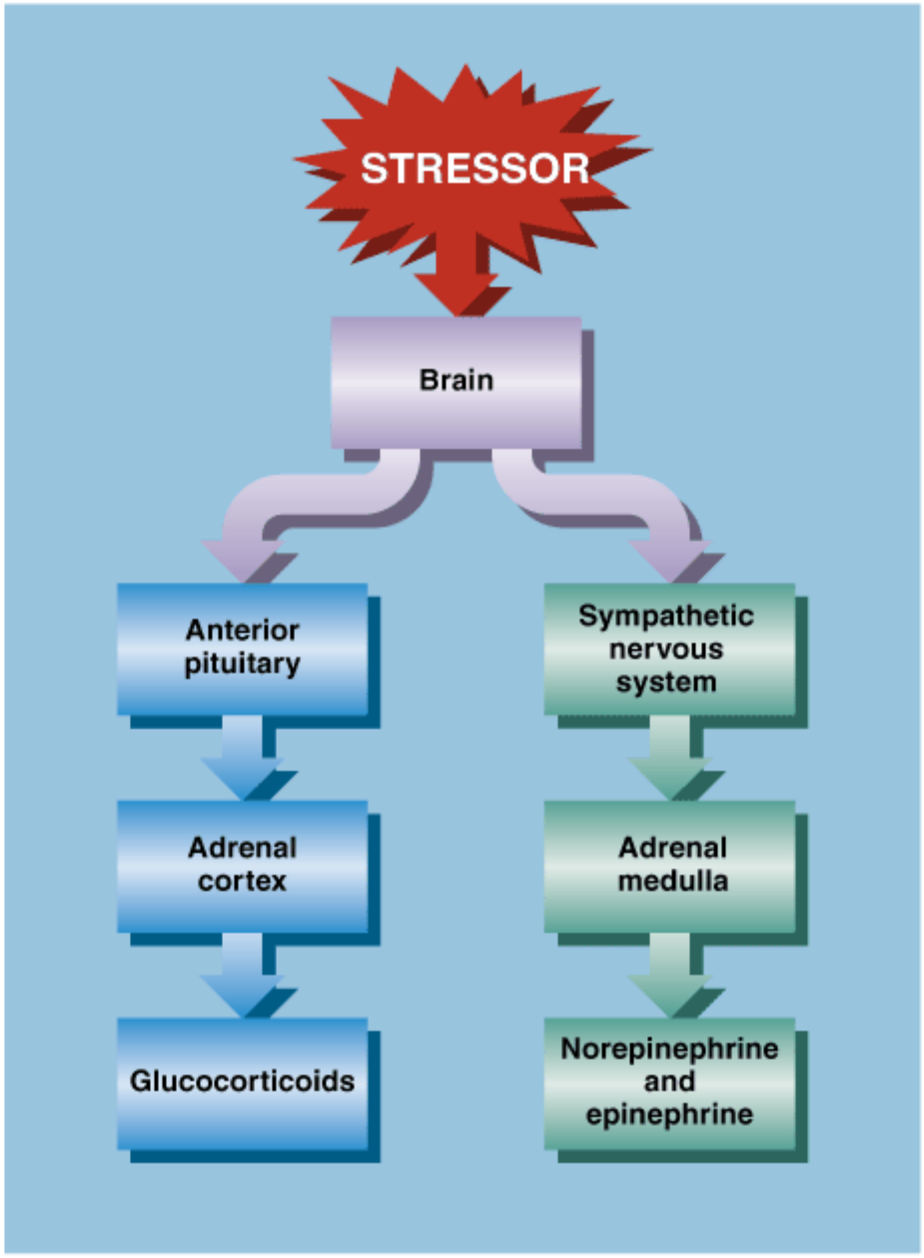
Hippocampus and PTSD

- H has inhibitory effect on release of corticotropin releasing factor (CRF)
- CRF critical in stress response, mediating HPA axis activation, mediating fear behavior/chronic stress
- Leads to chronic CRF release
- Research notes elevated CRF in CSF of persons with PTSD
  - Bremner, 2002

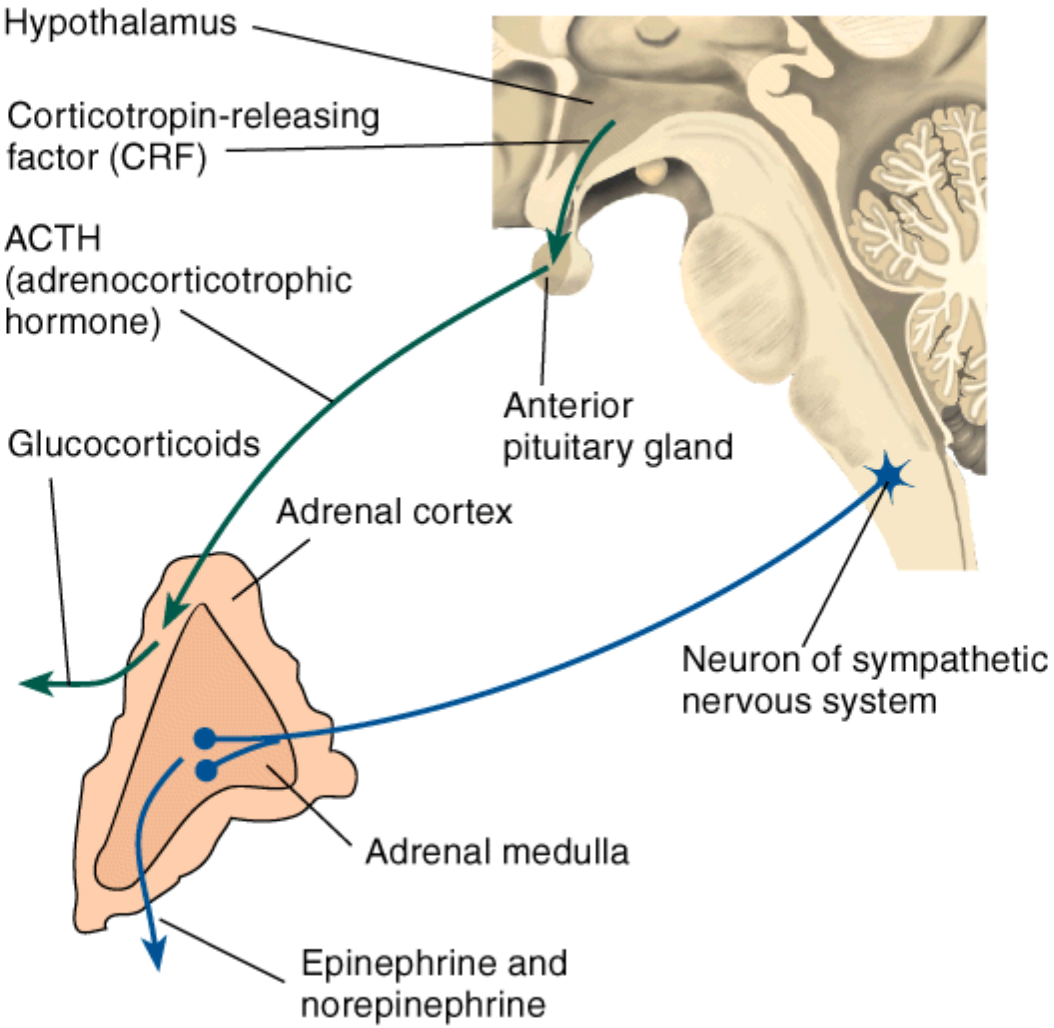
► Location of Major Limbic System Structures



► Two-System View of Stress Response



► Control of the Secretion of Glucocorticoids by the Adrenal Cortex and of Catecholamines by the Adrenal Medulla



► Structures That Mediate Responses to Auditory Conditional Stimulus

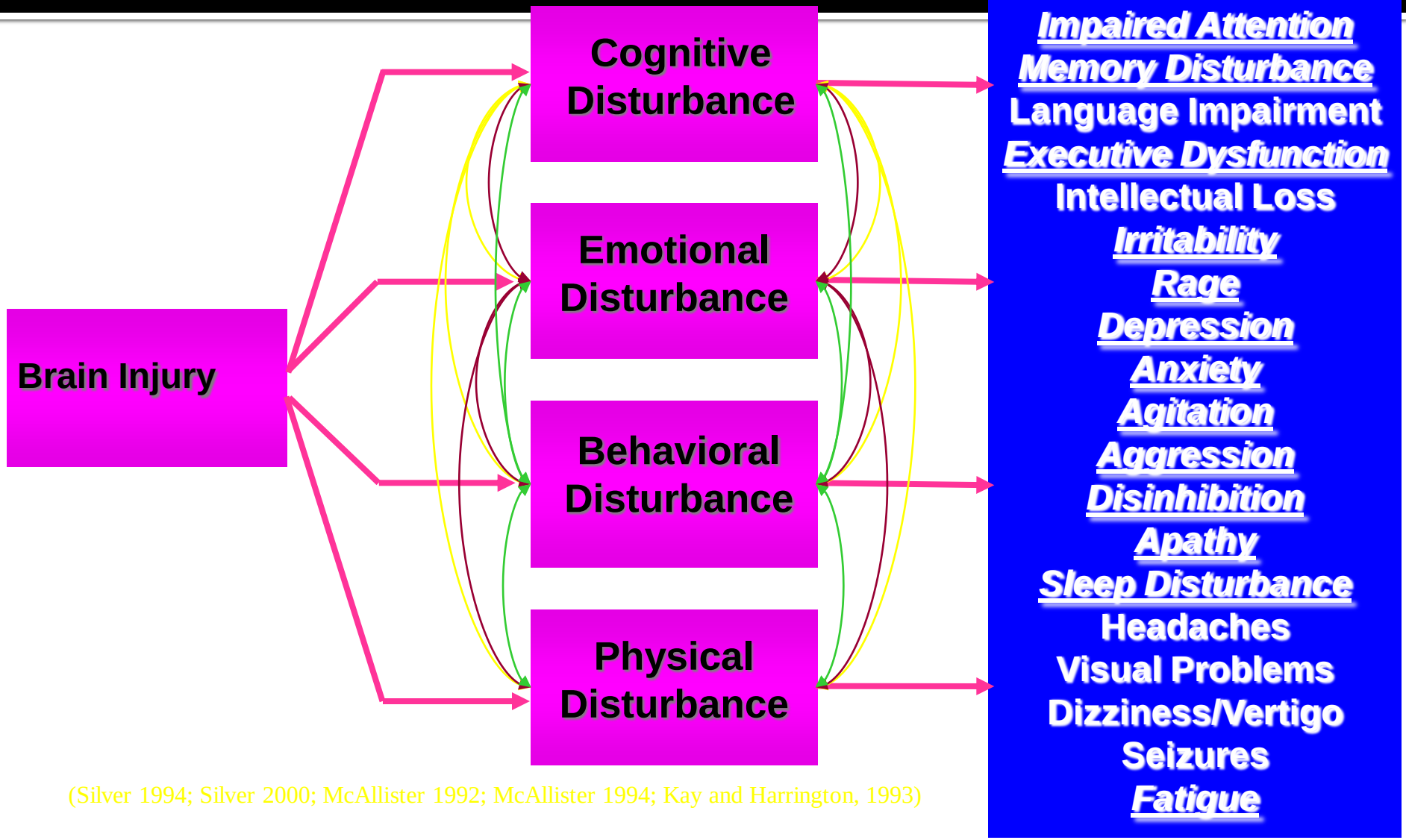
Medial Prefrontal Cortex (MPC) in PTSD – Overlaps with TBI Classic Injury Pattern

- MPC modulates emotional responsiveness/conditioned fear responses through inhibition of amygdala function
- Believed to underlie pathological emotional responses in PTSD
- Connected to hippocampus
- PET – dysfunction of both MPC and H regions during provocation of PTSD symptoms in Vets and women abused as children – also key aspect of trauma
  - Bremner, 2002

Glucocorticoids and PTSD – Hippocampus in PTSD & MTBI

- High levels of stress released glucocorticoids (cortisol) are associated with damage to hippocampal neurons (esp. CA3 region)
- Glucocorticoids disrupt cellular metabolism & increase vulnerability of H neurons to glutamate (excitatory amino acid)
- H regenerates neurons, stress inhibits this
- Animal studies support glucocorticoid-mediated hippocampal toxicity and memory dysfunction
  - Bremner, 2002

Both TBI and PTSD Produce Cognitive, Emotional, Behavioral, and Physical Disturbances with Overlap



(Silver 1994; Silver 2000; McAllister 1992; McAllister 1994; Kay and Harrington, 1993)

TBI Psychological Symptoms

- *Irritability*
- *Anxiety*
- *Depression*
- *Loss of self esteem*
- *Indifference*
- *Inflexibility/Egocentrism*
- *Emotional instability*
- *Family stress*
- *Aggression/Behavioral Dyscontrol*
- PTSD

Potential Psychological Interventions – ALL EFFECTIVE FOR BOTH

- Patient and family education
- Support group and social structures
- Development of a written person-specific development, safety, behavior and/or rehab plan
- Behavioral feedback process, coping skills
- Biofeedback / neurofeedback
- Stress management / relaxation training
- CBT (EMDR especially for PTSD)
- Medication management

Fears About Medication

- Stigma: weakness, lazy, moral issue
- 'Masks' or avoids reality
- Previous negative experience
- Sedation
- Cognitive impairment
- Interferes with "natural process"
- Interferes with rehabilitation
- Interferes with development
- Leads to substance abuse

Proper Use of Medication

- Alleviates symptoms
- Improves functioning
- Avoids sedation
- Avoids cognitive impairment
- Facilitates rehabilitation
- Facilitates development
- Reduces substance abuse risk
- Supports family and caregivers

Clinical Guidelines for PTSD & MTBI

- Intervene as soon as possible after injury to prevent dysfunctional outcomes
- Knowledgeable, thorough assessment
- Give information and education about symptoms and their resolution
- Foster resilience and coping skills

Clinical Guidelines

- Involve the family or significant other
- Provide referral or treatment when symptoms do not improve within expected timeframes
- Use appropriate specialists and services
  - Psychotherapeutic (with relevant experience)
  - Medical Management (psychiatry)
  - School/Educational/Cognitive Remediation
  - Therapeutic modalities (OT, PT, SLP, CTRS)
  - Vocational Rehabilitation

Effects of Post Traumatic Stress on Youth in Therapy

- irritability, jumpiness, anxiety
- intrusive thoughts, flashbacks
- emotional numbness, sleep problems
- compulsive play, behavioral regression
- Rx: reprocess the experience
- Rx: control stress reaction
- Rx: social reintegration
- Rx: develop resilience skills

RESILIENCE?

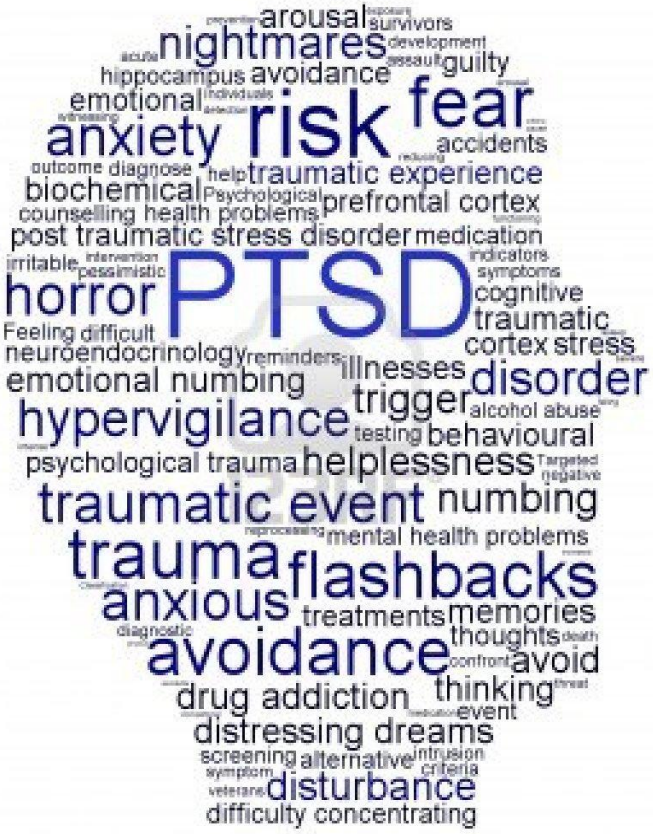
- The ability to adapt when faced with tragedy, trauma, adversity, hardship and continued significant life stressors – Newman (2005)
- A set of actions and attitudes that prepare individuals and groups for adapting to challenging situations, establishing a 'new normal' and realizing one's potential for growth'

  - (Bates et al., 2010 - DCoE Total Fitness)

EXTREME STRESS UNUSUAL?

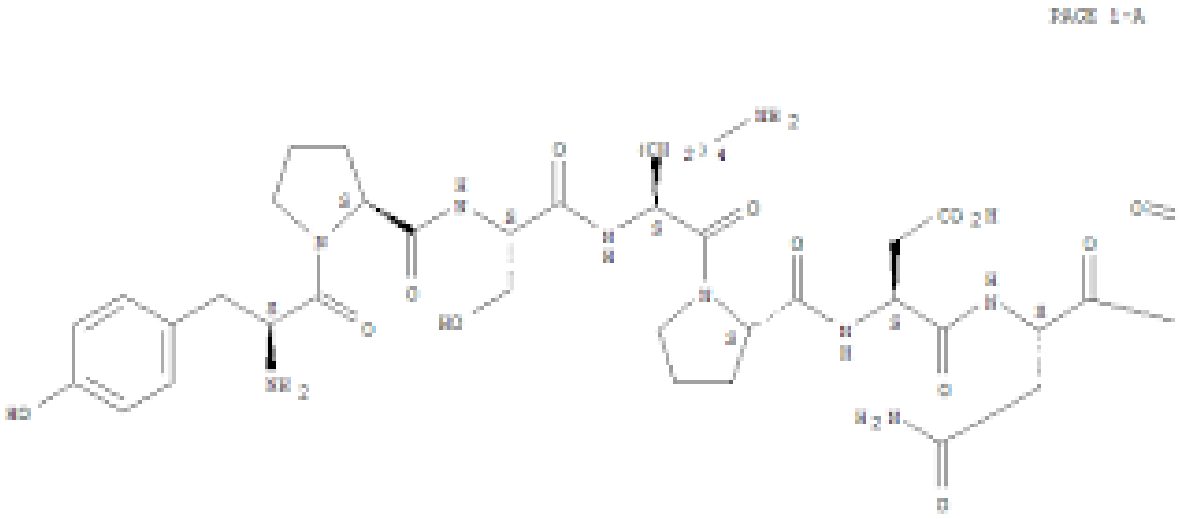
- 50-60% of Americans will experience a traumatic event
- Approximately 8% develop PTSD
- 2/3 with PTSD eventually recover
- Resilience?

- Hughes, 2012

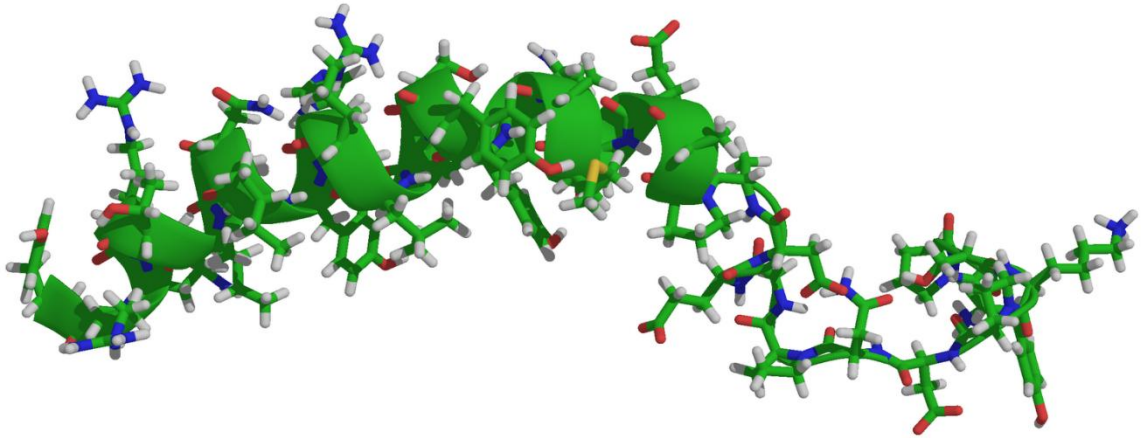


RESILIENCE & THE BRAIN

Neuro-peptide Y hormone as shut off

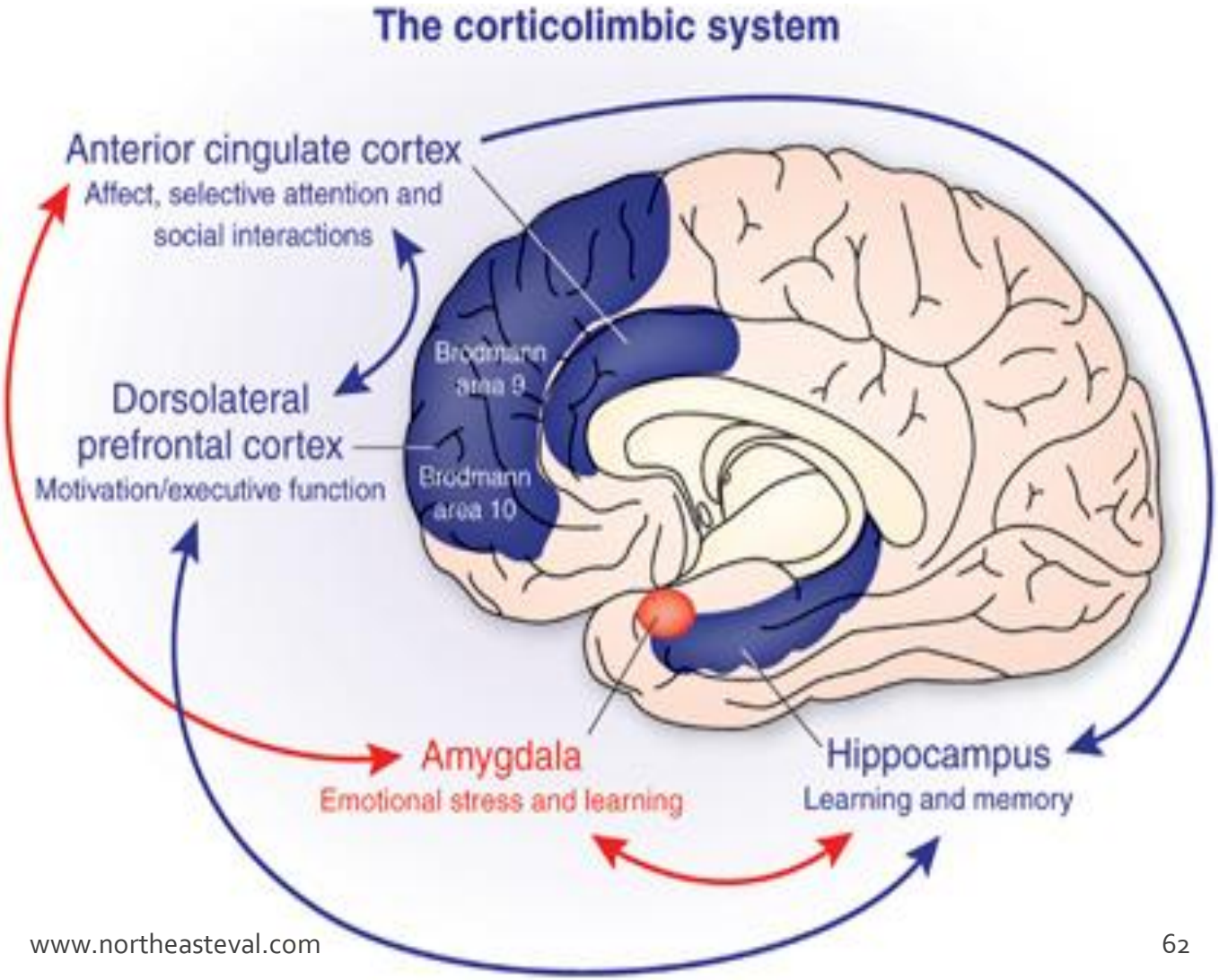


NPY

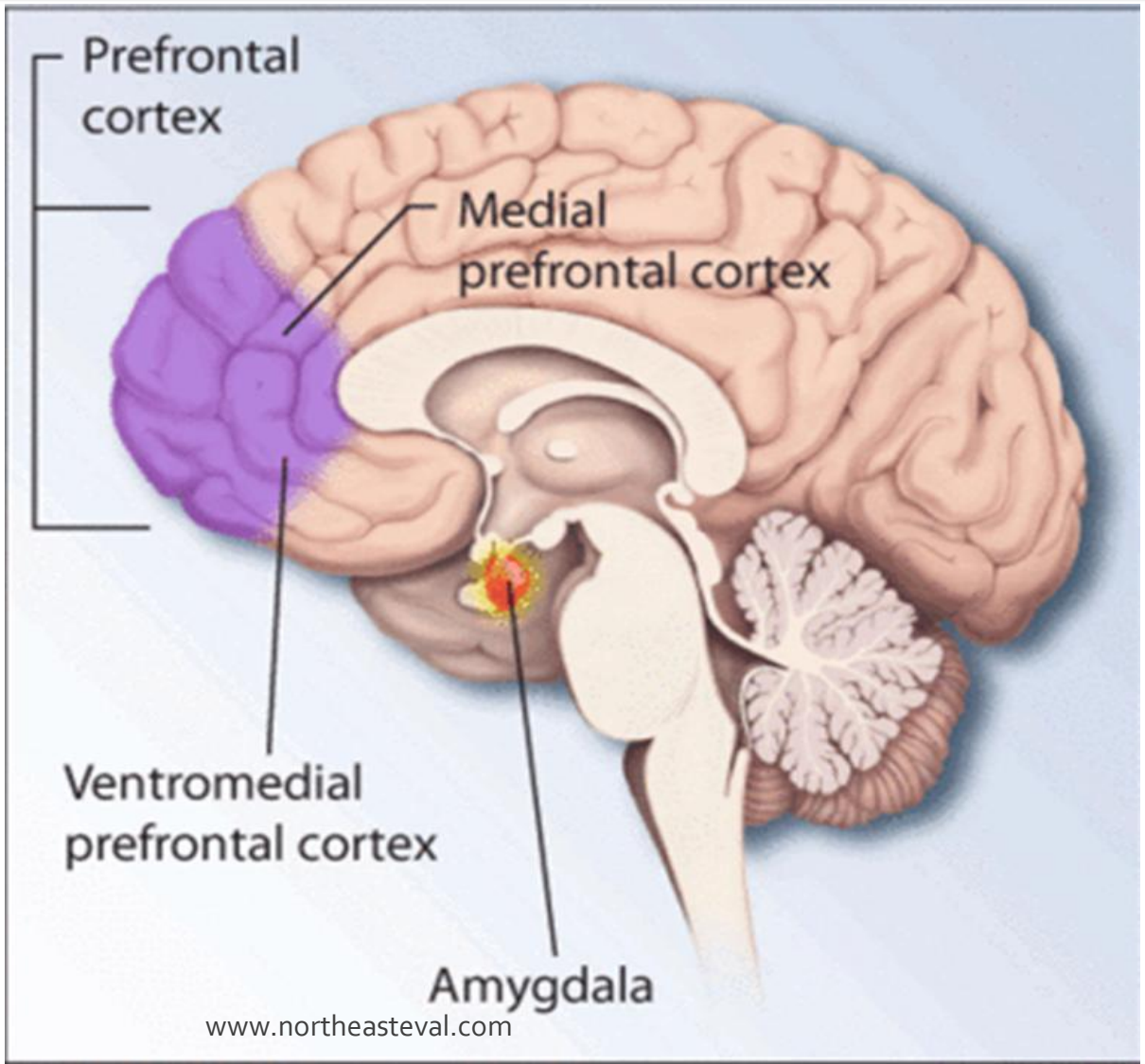


RESILIENCE & THE BRAIN

Communicatior between reasoning of cortex and emotions of limbic system – physical connections Anterior cingulate and hippocampus



KEY CORTICOLIMBIC STRUCTURES



RESILIENCE STATE OR TRAIT?

- While biologically influenced, resilience is not a trait that people either have or do not have.
- Resilience involves behaviors, thoughts and actions that can be learned and developed .
- Studies show that the primary factor in resilience is having caring and supportive relationships within and outside the family. Relationships that create love and trust, provide role models and offer encouragement and reassurance.

KEY FACTORS IN RESILIENCE

- The capacity to make realistic plans and take steps to carry them out. TEACHABLE
- A positive view of yourself and confidence in your strengths and abilities. TEACHABLE
- Skills in communication and problem solving. TEACHABLE
- The capacity to manage strong feelings and impulses. TEACHABLE

ASSESSING BASELINE RESILIENCE

- Research Scales – various out there and proliferating
- Individual, group, community, FAMILY
- CD-RISC – Connor-Davidson Resilience Scale
- The Resilience Scale
- http://www.resiliencescale.com/

The Resilience Scale [Wagnild et al.]

- 1. If something is worth starting, I'm going to finish it.
- 2. I depend on myself to find a way through anything.
- 3. I stay true to myself even when I'm afraid to do so.
- 4. I know why I'm on this earth.
- 5. My deeply held values guide my choices.
- 6. Every day I do something that is meaningful to me.
- 7. I can see most situations from different points of view.
- 8. I'm honest with myself when something is wrong for me.
- 9. In a time of trouble, I figure out what needs to be done.
- 10. Even if I don't feel like it, I do what I need to do.

The Resilience Scale [Wagnild et al.]

- 11. Looking back at my life, I feel satisfied.
- 12. I'm not upset for too long when life doesn't go my way.
- 13. I rely on myself to do what is right for me.
- 14. I am determined even if the odds are against me.
- 15. I am excited about the plans I have.
- 16. I remain calm under pressure.
- 17. I make decisions that are consistent with my beliefs.
- 18. I often tell myself "I can do this."
- 19. I can find something positive in whatever happens.
- 20. I see an obstacle as a challenge to overcome.

The Resilience Scale [Wagnild et al.]

- 21. I can say what I'm good at.
- 22. I rely on my sense of humor to improve my outlook.
- 23. I take responsibility for my decisions.
- 24. Disappointment doesn't stop me from trying again.
- 25. I know what's most important to me and this knowledge guides my life.

- I have felt depressed in the past 2 weeks (frequency)
- I rate my health as generally: EXC VG GOOD FAIR POOR
- I am at my ideal body weight: (±5 pounds):
- I exercise 30 minutes or more most days:
- I eat a healthy diet most days: (with 5 fruits/vegetables):
- I DO NOT use tobacco products: (smoke, chew, or dip):
- I have FEW/ NO alcoholic drinks: (female: 1, male: 1 or 2)

OPENING QUESTIONS

- What kinds of events have been most stressful for you?
- How have those events typically affected you?
- Have you found it helpful to think of important people in your life when you are distressed? Tell me about them.
- To whom have you reached out for support in working through a traumatic or stressful experience?
- What have you learned about yourself and your interactions with others during difficult times?
- Has it been helpful for you to assist someone else going through a similar experience?
- Have you been able to overcome obstacles? How?
- What has helped make you feel hopeful about the future?

APA Resilience Tools

- **Make connections**. Good relationships with close family members, friends or others are important. Accepting help and support from those who care about you and will listen to you strengthens resilience. Some people find that being active in civic groups, faith-based organizations, or other local groups provides social support and can help with reclaiming hope. Assisting others in their time of need also can benefit the helper.
- **Avoid seeing crises as insurmountable problems.** You can't change the fact that highly stressful events happen, but you can change how you interpret and respond to these events. Try looking beyond the present to how future circumstances may be a little better. Note any subtle ways in which you might already feel somewhat better as you deal with difficult situations.

APA Resilience Tools

- **Accept that change is a part of living.** Certain goals may no longer be attainable as a result of adverse situations. Accepting circumstances that cannot be changed can help you focus on circumstances that you can alter.
- **Move toward your goals.** Develop some realistic goals. Do something regularly — even if it seems like a small accomplishment — that enables you to move toward your goals. Instead of focusing on tasks that seem unachievable, ask yourself, "What's one thing I know I can accomplish today that helps me move in the direction I want to go?"

APA Resilience Tools

- **Take decisive actions**. Act on adverse situations as much as you can. Take decisive actions, rather than detaching completely from problems and stresses and wishing they would just go away.
- **Look for opportunities for self-discovery**. People often learn something about themselves and may find that they have grown in some respect as a result of their struggle with loss. Many people who have experienced tragedies and hardship have reported better relationships, greater sense of strength even while feeling vulnerable, increased sense of self-worth, a more developed spirituality and heightened appreciation for life.

APA Resilience Tools

- **Nurture a positive view of yourself**. Developing confidence in your ability to solve problems and trusting your instincts helps build resilience.
- **Keep things in perspective**. Even when facing very painful events, try to consider the stressful situation in a broader context and keep a long-term perspective. Avoid blowing the event out of proportion.

APA Resilience Tools

- Additional ways of strengthening resilience may be helpful. For example, some people write about their deepest thoughts and feelings related to trauma or other stressful events in their life. **Meditation, journaling and spiritual practices** help some people build connections and restore hope.
- **Mindfulness, Being Present** – concept and practice
- APA's The Road to Resilience

APA Resilience Tools

- **Maintain a hopeful outlook**. An optimistic outlook enables you to expect that good things will happen in your life. Try visualizing what you want, rather than worrying about what you fear.
- **Take care of yourself**. Pay attention to your own needs and feelings. Engage in activities that you enjoy and find relaxing. Exercise regularly. Taking care of yourself helps to keep your mind and body primed to deal with situations that require resilience.

PREVENTION IS KEY

- Child abuse awareness
- Family and community support – we must be "our brother's keeper"
- Vigilant professionals – doctors, teachers, nurses, counselors, coaches, scout leaders
- Reporting laws and practices
- Funding social services
- Parent support and training
- New baby visits at home
- Early education on boundaries, safe touch