

Round 22: Trauma

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Trauma and the Developing Brain

- The brain is an active system that self-organizes dynamically based on the information that it receives.
- In the first two years of life, a synaptic overproduction occurs, followed by remodeling through synaptic pruning
- Pruning is highly sensitive to experience, including stress -> effect of inflammation mechanisms on glial cells.
 - Specific “critical periods,” where the presence or absence of certain factors have large impacts on the development of various brain structures.
- When remodeling and differential pruning is associated with stressful childhood events or a lack of proper parenting it often results in maladaptive brain remodeling

- When a baby babbles, gestures, or cries it should elicit reliable, appropriate reactions for caregivers
 - Brain develops in a healthy manner, they learn how to interact with the world and how to get their needs met
- If they grow up in a chaotic, threatening or negligent world it could lead the brain to becoming hyperalert or not fully develop



Trauma and the Developing Brain

- Affects of childhood maltreatment depend on
 - Age of child
 - Duration -> One-time occurrence or chronic
 - Length of maltreatment
 - Identify of abuser (parent vs other adult)
 - Whether there is a dependable nurturing individual in their life
 - Type & severity of maltreatment
- Childhood abuse could lead to
 - Being constantly alert, unable to relax
 - Feeling fearful most of the time
 - Finding social situations challenging
 - Learning deficits
 - Tendency to develop depression or anxiety
 - Weakened ability to process positive feedback

ORIGINAL PAPER

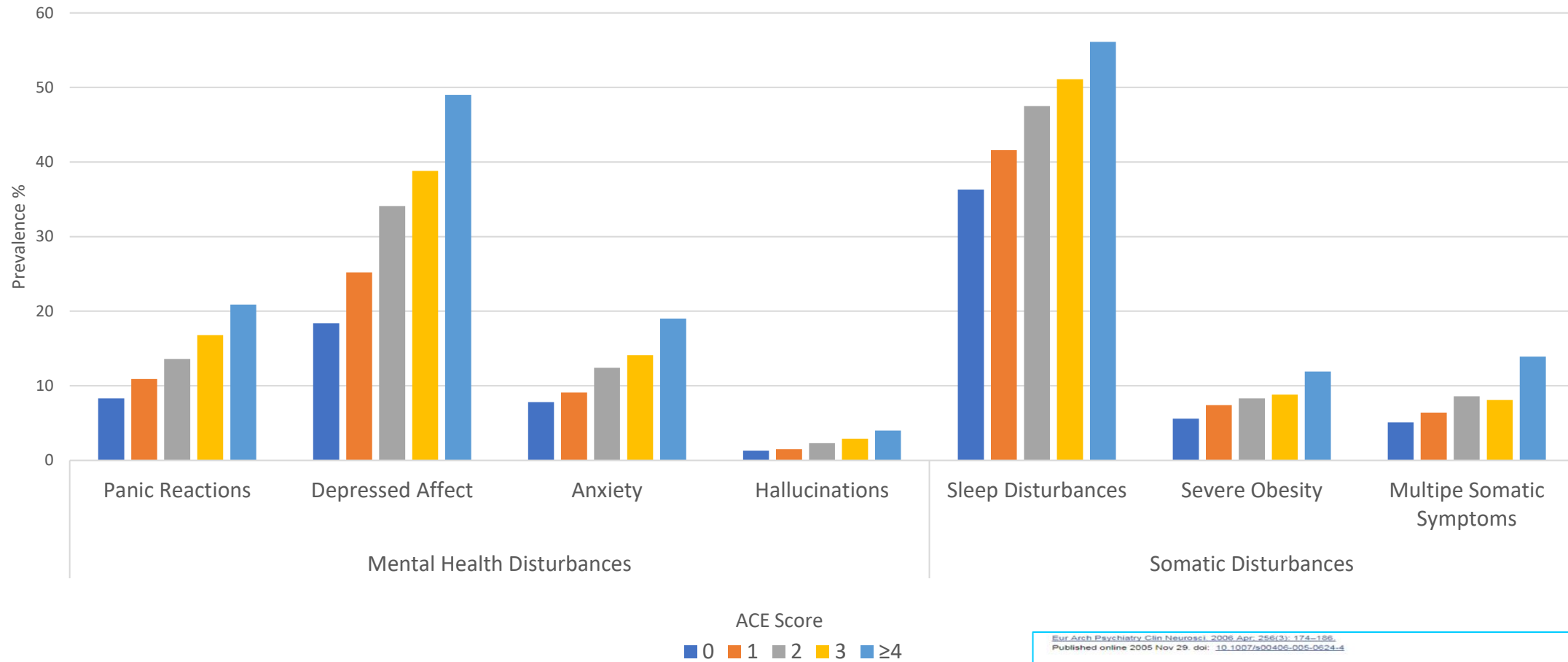
Robert F. Anda · Vincent J. Felitti · J. Douglas Bremner · John D. Walker · Charles Whitfield · Bruce D. Perry · Shanta R. Dube · Wayne H. Giles

The enduring effects of abuse and related adverse experiences in childhood

A convergence of evidence from neurobiology and epidemiology

Childhood abuse	Total N = 17,337
Emotional abuse (Did a parent or other adult in the household . . .)	10.6
1) Often or very often swear at you, insult you, or put you down?	
2) Sometimes, often, or very often act in a way that made you fear that you might be physically hurt?	
Physical (Did a parent or other adult in the household . . .)	28.3
1) Often or very often push, grab, slap, or throw something at you?	
2) Often or very often hit you so hard that you had marks or were injured?	
Sexual (Did an adult or person at least 5 years older ever . . .)	20.7
1) Touch or fondle you in a sexual way?	
2) Have you touch their body in a sexual way?	
3) Attempt oral, anal, or vaginal intercourse with you?	
4) Actually have oral, anal, or vaginal intercourse with you?	
Household dysfunction	
Substance abuse	26.9
1) Live with anyone who was a problem drinker or alcoholic?	
2) Live with anyone who used street drugs?	
Mental illness	19.4
1) Was a household member depressed or mentally ill?	
2) Did a household member attempt suicide?	
Mother treated violently (Was your mother (or stepmother)):	12.7
1) Sometimes, often, or very often pushed, grabbed, slapped, or had something thrown at her?	
2) Sometimes, often, or very often kicked, bitten, hit with a fist, or hit with something hard?	
3) Ever repeatedly hit over at least a few minutes?	
4) Ever threatened with or hurt by a knife or gun?	
Incarcerated household member	4.7
1) Did a household member go to prison?	
Parental separation or divorce	23.3
1) Were your parents ever separated or divorced?	

Relationship of ACE Score to the Prevalence of Mental Health Disturbances and Somatic Health Disturbances

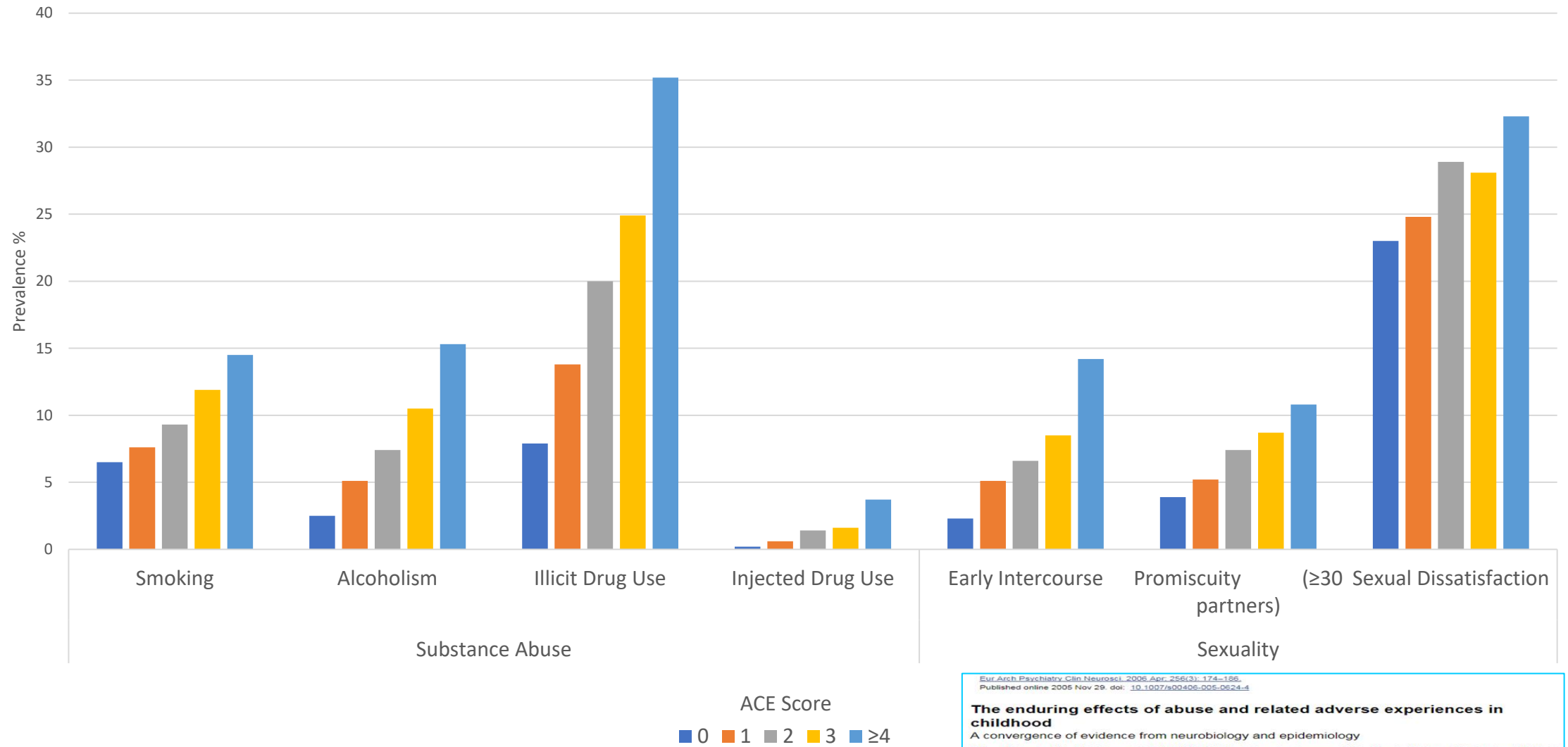


Eur Arch Psychiatry Clin Neurosci. 2006 Apr; 256(3): 174-186.
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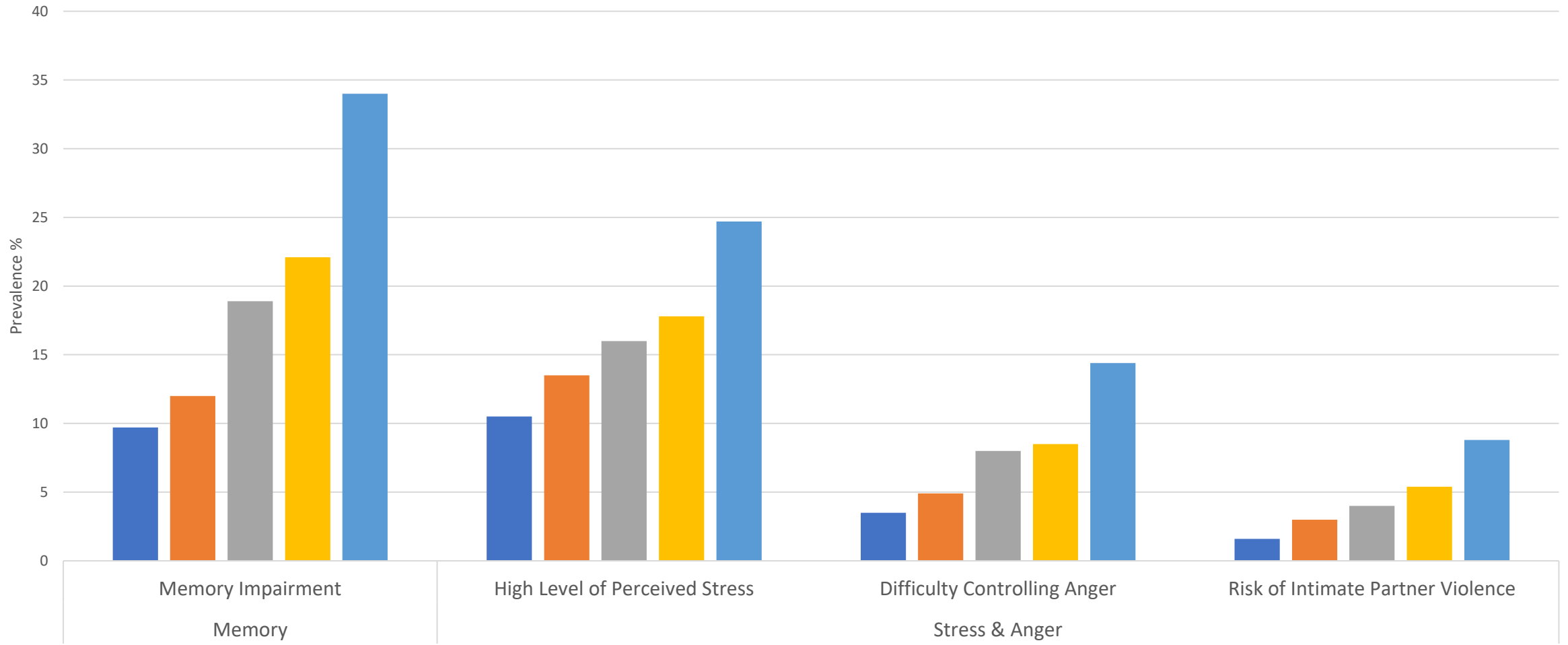
* ACE = Adverse Childhood Experiences

Relationship of ACE Score to the Prevalence of Substance Abuse and Sexuality



* ACE = Adverse Childhood Experiences

Relationship of ACE Score to the Prevalence of Memory and Stress & Anger



ACE Score
 ■ 0 ■ 1 ■ 2 ■ 3 ■ ≥4

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Trauma-Related Disorders

Post-Traumatic Stress Disorder

- Exposure to an event that involved threat of death or serious injury causing intense fear, helplessness, horror
- Re-experience traumatic event
 - Intrusive thoughts, nightmares, flashbacks
 - Physiological reactivity to reminders of event, exaggerated startle reflex, hyperarousal, difficult sleeping, concentrating, hypervigilance

Developmental Trauma Disorder

- Exposure to multiple or chronic episodes of adverse interpersonal trauma (e.g., abandonment, betrayal, physical assault, sexual assault, threats to bodily integrity, coercive practices, emotional abuse, witnessing violence or death)
- Dysregulation in affect, somatic, behavioral (e.g., re-enactment, cutting), cognitive (e.g., thinking it is happening again, confusion, dissociation, depersonalization), Relations (e.g., clinging, oppositional, distrustful), self-attribution (e.g., self-hate, blame)
- Functional impairment in academics, family dynamics, peer relations, vocational troubles

Trauma-Related Disorders

Depersonalization-Derealization Disorder

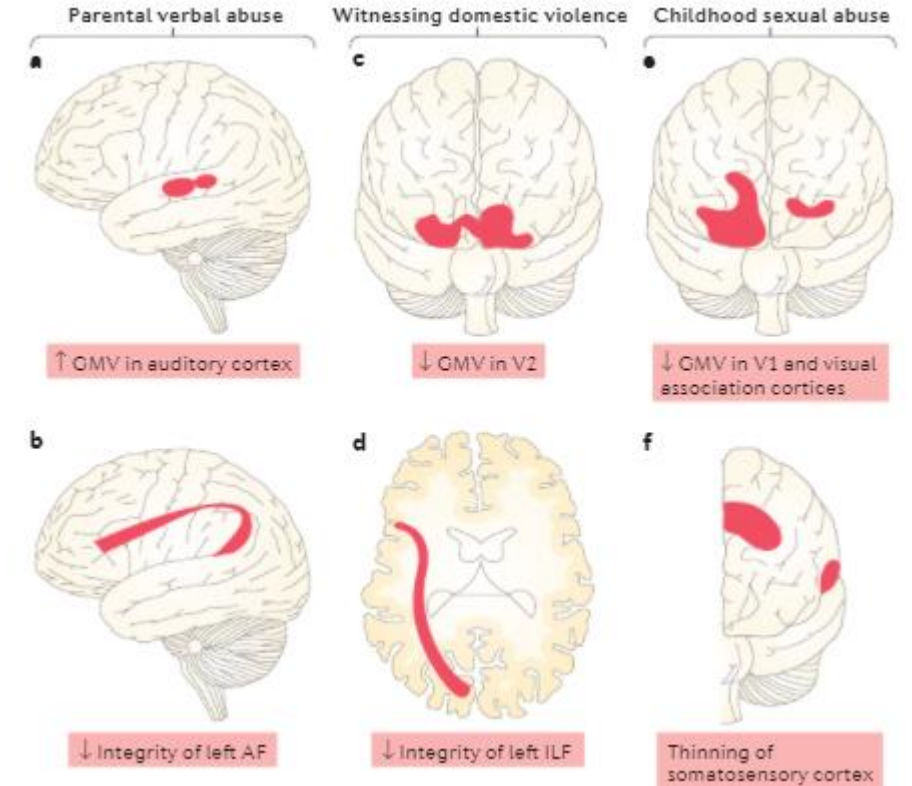
- Symptoms
 - Persistent or repeated feelings that you're observing yourself from outside your body or you have a sense that things around you aren't real, or both.
 - Emotional or physical numbness of your senses or responses to the world around you
 - Feelings of being alienated from or unfamiliar with your surroundings (e.g., like you're living in a movie or a dream)
 - Feeling emotionally disconnected from people you care about
- Causes
 - Emotional abuse or neglect during childhood
 - Physical abuse
 - Witnessing domestic violence
 - Having a severely mentally ill parent
 - Unexpected death of loved one

Trauma-general Effects

- Hippocampus
 - Smaller hippocampal volume -> decreased ability to consolidate memories
- Amygdala
 - Over-responsive to emotional stimuli (e.g., angry faces) in traumatized children, suggesting they are primed to detect threat faster -> determine reactions to potentially stressful or dangerous situations
- Prefrontal Cortex
 - Less volume of prefrontal cortex
 - Balancing emotions, perceptions, impulses
 - Reduced thickness, less developed, in ventromedial prefrontal cortex (vmPFC)
 - Responsible for emotional processing of social information
- Corpus Callosum
 - Decreased size
 - Less efficient integration of motor, sensory, and cognitive processing between the hemispheres

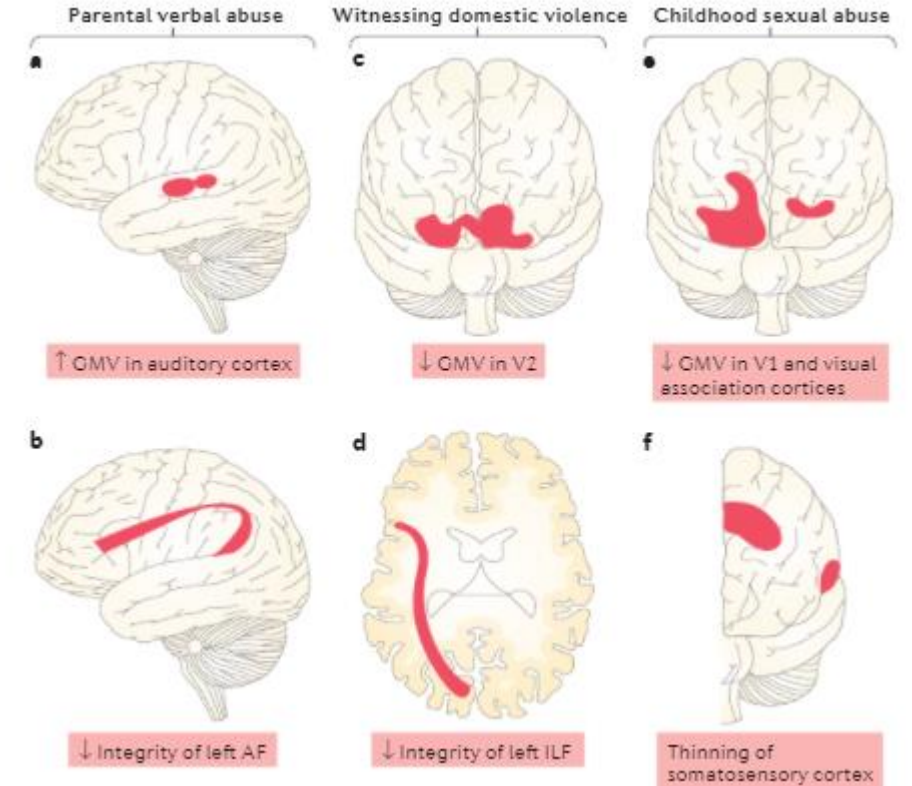
Trauma-specific Effects

- Parental Verbal Abuse
 - Reduced grey matter density in primary auditory cortex & diminished arcuate fasciculus integrity
 - Associated with lower verbal IQ and comprehension
- Visually Witnessing Domestic Violence
 - Attenuated grey matter in right lingual gyrus, reduced thickness of visual cortex
 - Observing violence between ages 11 & 13 most considerable effect
 - Witnessing between ages 7 & 13 affected myelination of visual-limbic pathway
 - Affects vision-specific emotional, memory, and learning processes



Trauma-specific Effects

- Sexual Abuse
 - Reduction in grey matter volume in primary visual cortex and visual association cortices
 - Extent correlates with duration of exposure before the age of 12
 - Graded deficit in visual memory
 - Reduced volume in genital representation in somatosensory cortex
 - Adaptive response to reduce adverse sensory input
 - This can initially help the individual cope with the abuse, but in a later stage may lead to sexual dysfunction



Sexual Abuse continued

- Structural deficits in the reward circuit
- Amygdala hyperreactivity, especially during sad autobiographic memory recall
- Reduced volume in
 - Hippocampus
 - Parahippocampal gyrus
 - Caudate nucleus
 - Corpus callosum
 - Frontal cortical grey matter
- In chronic fatigue syndrome, sexual abuse was the only childhood trauma subtype predictive of fatigue symptoms and physical functioning
- Physical trauma types (i.e., physical abuse or neglect) and sexual abuse have been associated with reduced
 - Executive functioning
 - Working memory
 - Intelligence scores in a psychiatric population
 - Reduced cognitive flexibility in healthy adults

Trauma-specific Effects

- Emotional Abuse

- Hyperactivity of amygdala (verbal abuse)
- Poor connectivity between right amygdala, ACC, vmPFC
- Thinning in left anterior and posterior cingulate and bilateral precuneus
 - Regions involved in self-awareness and self-evaluation
- Associated with Cluster C personality disorders
 - Characterized by anxious, fearful thinking or behavior; includes avoidant personality disorder, dependent personality disorder and obsessive-compulsive personality disorder

- Emotional Maltreatment

- Correlated with abnormalities in fronto-limbic, socioemotional networks
- Reduced functional connectivity between right amygdala and bilateral inferior parietal cortex, precuneus, orbitofrontal cortex, hippocampus, putamen. As well as between right dACC & precuneus
- Reduced volume in dmPFC
- Hypoactivity in mPFC

Trauma-specific Effects

- **General Neglect**
 - Reduced limbic connectivity -> prefrontal cortex (dlPFC, vlPFC, dmPFC)
 - Maternal neglect associated with Cluster A Personality disorders
 - Characterized by odd, eccentric thinking or behavior
 - Paranoid personality disorder, schizoid personality disorder, and schizotypal personality disorder
- **Physical Neglect**
 - Dysfunctional connectivity between amygdala and left anterior middle temporal gyrus
 - Reduced corpus callosum volume
 - Associated with internalizing, withdrawn behavior
- **Physical Abuse**
 - Reduced volume in right mPFC, right dorsal ACC, left dlPFC
 - Reduced volume in orbitofrontal cortex
 - Responsible for emotion & social regulation
 - Predictive of later externalizing, aggressive behavior
 - Antisocial, narcissistic, and paranoid traits

Trauma-related Anxiety

- “Fear Network”

- Amygdala, Anterior Cingulate Cortex (ACC), & Insula

- Amygdala

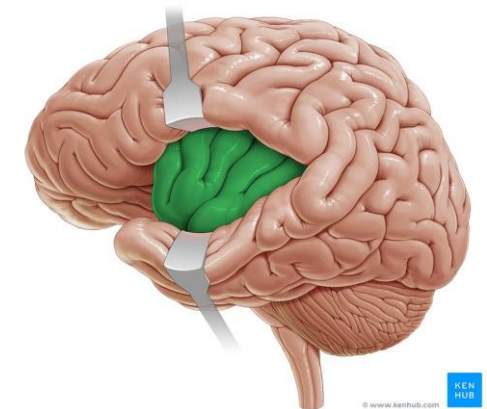
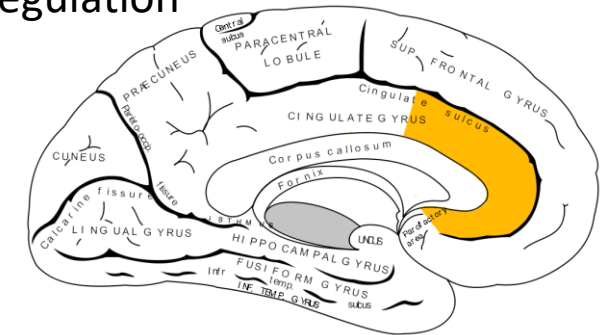
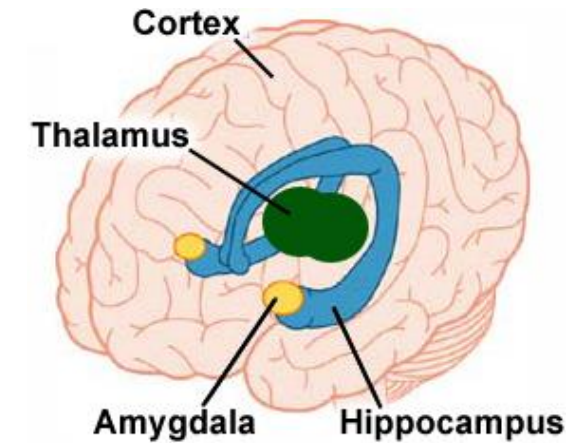
- Emotions – Fear
- Determines salience of emotional & social stimuli/ Stimulus Valuation
- Hyperactivation (right) -> inappropriate perception of threat & emotion dysregulation

- ACC

- Conflict monitoring & Fear learning
- Detection & appraisal of social situations
- Emotional awareness
- Pain perception

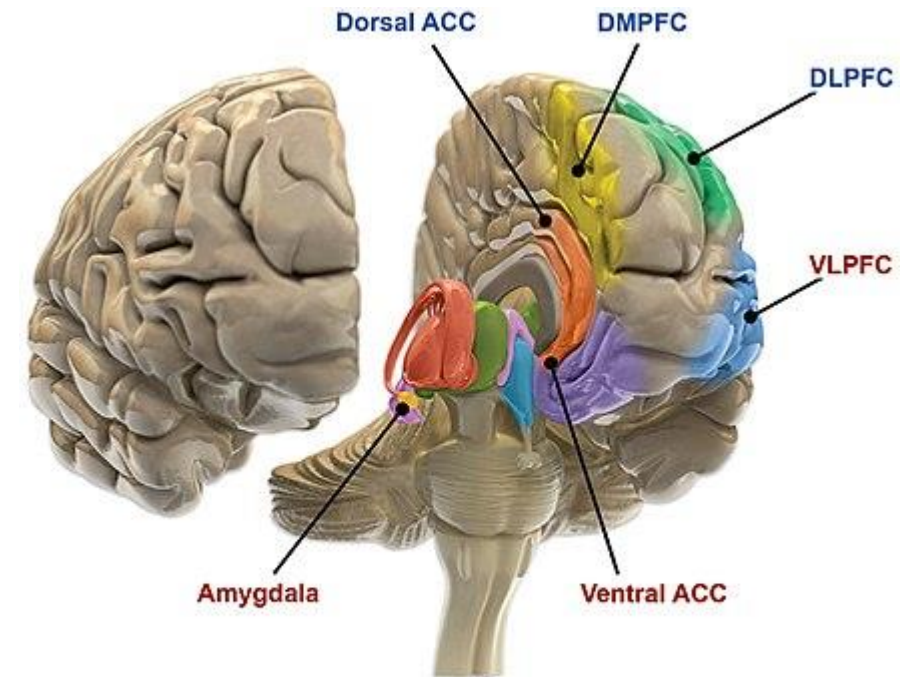
- Insula

- Self-awareness, interpersonal experience, sense of agency
- Social experience -> norm violations, emotional processing, empathy, social decision making
- Dysfunctional anticipatory processing
- Hyperactivation (right)



Anxiety Disorders

- Dorsal Prefrontal Cortex
 - (Right)
 - Associated with increased attentional bias toward threat /vigilance toward threatening stimuli
 - Decreased ability to disengage (Increased perseveration)
- Ventral Lateral Prefrontal Cortex
 - Activation inverse relationship to social avoidance behavior
 - VMPFC (underactive)
 - dampen signal from amygdala



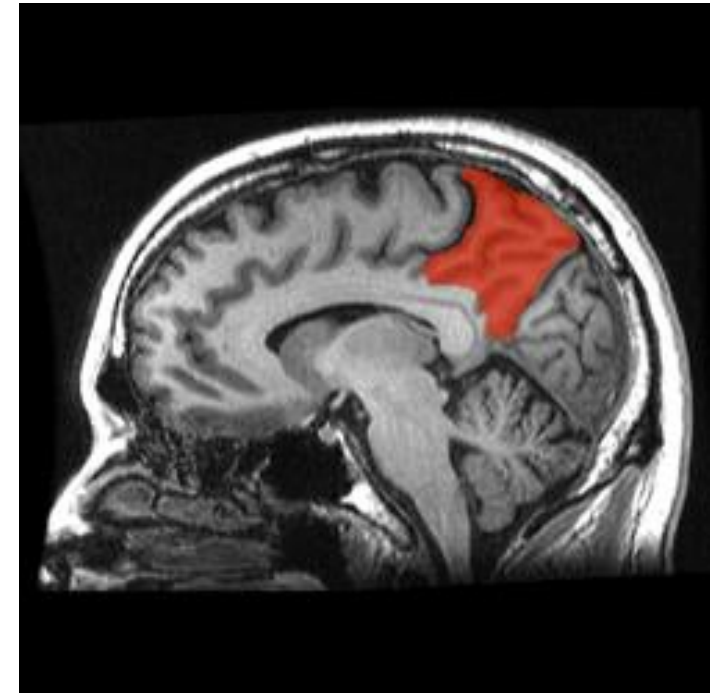
DLPFC: Dorsolateral prefrontal cortex DMPFC: Dorsomedial prefrontal cortex
VLPFC: Ventrolateral prefrontal cortex ACC: Anterior cingulate cortex

Post-Traumatic Stress Disorder

- Orbitofrontal Cortex
 - Codes information, controls impulses, regulates mood
 - Underactive
- VMPFC
 - Reward processing visceral response to emotions
 - Dysregulated, underactive
 - Abnormal structure -> failure to regulate activity related to fear expression and appraisal -> exaggerated fear response
- Networks
 - Poor connectivity in the frontal-medial temporal lobe circuit
 - Reduced connection between MTL and hippocampus
 - Correlated to increased avoidance behaviors (e.g., avoidance of thoughts and feelings associated with the trauma / inability to recall aspects of the trauma)

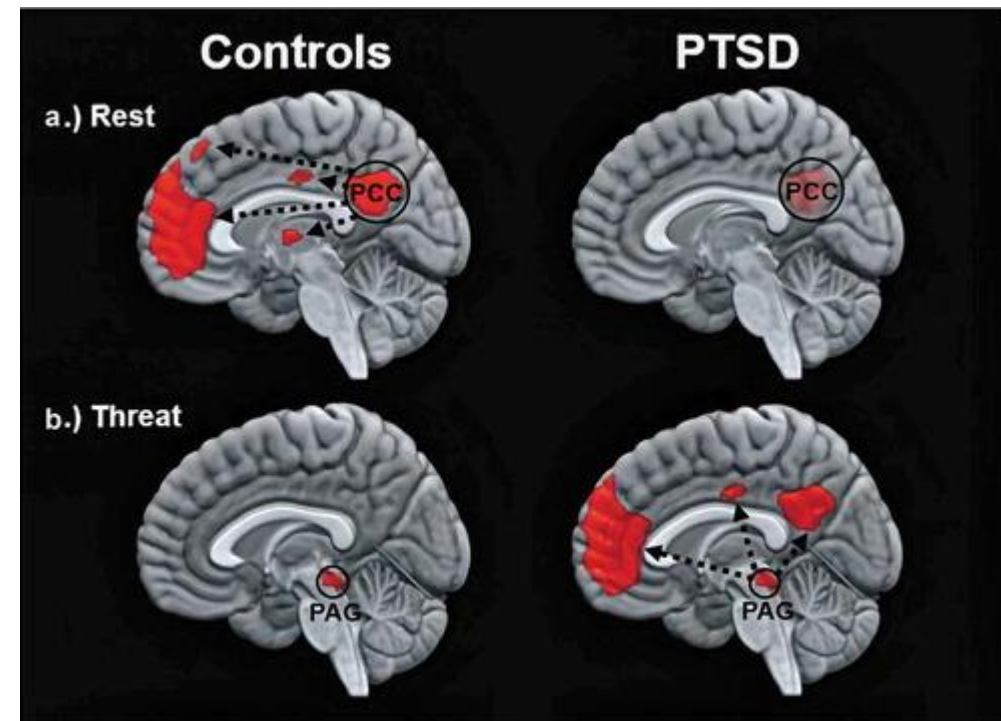
Post-Traumatic Stress Disorder

- Precuneus
 - Mental imagery concerning the self – episodic memory, self-consciousness, self-awareness, rate own personality traits relative to those judged by others
 - Works with left prefrontal in recall of episodic memories
 - Source memory
 - Contextual information to aid hippocampus in memory
 - Integration of information (gestalt) relating to perception of the environment
 - Right precuneus overactive in PTSD



Post-Traumatic Stress Disorder

- Trauma affects sense of self and how you relate to the world, mediated mostly by the default mode network
 - Midline regions such as posterior cingulate cortex, precuneus, medial prefrontal cortex
 - PTSD reduced resting-state connectivity in DMN – greater reductions -> increased symptoms
- Self-relevant information and events integrated to produce sense of self
 - PCC & precuneus -> embodied self that exists in space
 - Medial prefrontal -> awareness of thoughts and emotions related to self
 - PCC & medial prefrontal cortex -> development of self-related and social-cognitive functions



Borderline Personality Disorder

- Chronic psychiatric condition characterized by high levels of
 - Impulsivity
 - Affective instability
 - Difficulty establishing and managing interpersonal relationships
- Lower quality parental care and a history of child abuse contributing factors
- BPD patients have
 - Lower activation in areas
 - within the temporal lobe
 - the superior and medial frontal regions
 - Cingulate cortex
 - Parietal cortex
 - Hippocampus
 - Insula
 - Higher activation in
 - Bilateral amygdala
 - Left temporal pole
 - Medial frontal gyrus
 - Right middle and superior temporal gyrus
 - Left precuneus
 - Left middle occipital gyrus
 - Right insula

Borderline Personality Disorder

- Default Mode Network (DMN)
 - Hypoconnectivity in the precuneus and the right posterior cingulate
 - Hyperconnectivity in the medial prefrontal cortex, the anterior cingulate cortex, and the posterior precuneus/cingulate
- Dysfunction of frontolimbic circuitry -> emotional dysregulation and social cognition deficits
 - Gray matter volume reduction in orbitofrontal cortex and temporal regions
 - hyperactivation in response to affect-laden stimuli in the right amygdala related to childhood maltreatment

Major Depressive Disorder

- Persistent depressed mood, loss of interest, low self-esteem and energy level, weight change, insomnia or hypersomnia, and disturbance in cognitive functions such as attention and memory
- Childhood trauma, including physical, sexual, or emotional abuse, as well as physical or emotional neglect, have been found to be associated with the emergence and persistence of depressive and anxiety disorder
- Brain network studies consistently report disruptions of resting-state networks in patients with MDD
 - Hypoconnectivity in the frontoparietal network (executive control of attention and emotion)
 - Hyperconnectivity in the default mode network (internally oriented attention and self-referential processing)
 - Lower within-network connectivity in frontoparietal network, dorsal attention network, and cingulo-opercular network
 - Higher within-network connectivity in default mode network and salience network
 - Higher within-network connectivity in sensorimotor network and visual network

Thank You

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