The Impact of Domestic Violence on Children's Brain Development

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Objectives

- Define the types of abuse
- Review background information on the effects of abuse, including domestic violence, to better understand short- and long-term consequences
- Describe the different brain regions that are directly, and indirectly, impacted by domestic violence
- Discuss how this knowledge can shape diagnostic and treatment recommendations

The challenges

Definitions

Definitions

- Child Maltreatment
  - Physical abuse
  - Physical neglect
  - Emotional abuse
  - Emotional neglect
  - Sexual abuse

1. Torchalla, I et al. The association between childhood maltreatment subtypes and current suicide risk among homeless men and women.
2. Egeland, B. Taking stock: Childhood emotional maltreatment and developmental psychopathology

Neglect and Abuse

- Neglect: parent/guardian has
  - Harmed the child
  - Failed to properly care for the child by providing inadequate education or medical care
  - Abandoned the child
- Abuse: parent/guardian injured the child
  - Physically
  - Sexually
  - Mentally
  - Emotionally

Background

(Not at all) Fun Facts about Abuse

- Annually
  - 702,000 children in US maltreated in 2009 (reported)[1]
  - ~900,000 child victims of abuse/neglect (12/1,000 children)[2]
- CPS evaluations[2]: 30% substantiated → youngest children at highest risk
  - 60% neglect (2% medical neglect)
  - 16% physical
  - 8% psychological[3]

1. Klika, JB & Herrenkohl, TI. A review of developmental research on resilience in maltreated children.
2. Hayes, JP. Parenting Assessment in Abuse, Neglect and Permanent Wardship Cases.
3. Keyes KM et al. Childhood maltreatment and the structure of common psychiatric disorders.

(Not at all) Fun Facts about Abuse

- Costs: lifetime exceed $210,000 per victim (law enforcement, child welfare, medical treatment/hospitalizations, loss of productivity)
  - Helps justify why financially you would want to prevent/fund prevention programs
    - Such as The Nurse Family Partnership, Positive Parenting Program (Triple P)

Klika, JB & Herrenkohl, TI. A review of developmental research on resilience in maltreated children.

Background

- Children's brains primed to learn new experiences, but also makes them more susceptible to environmental stresses

Odgers, CL & Jaffee, SR. Routine versus catastrophic influences on the developing child.

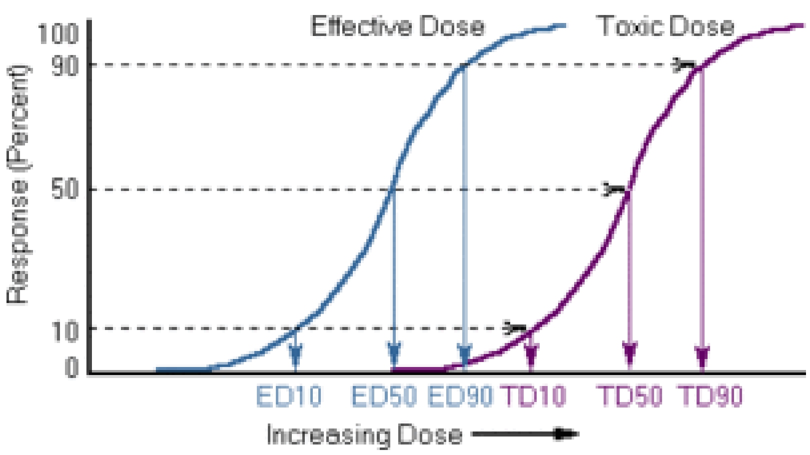
Biological

- Early Years Study 2: poor caregiver-infant interactions compromised formation of neural circuits and pathways[1]
- Cortisol and catecholamines: ↑ with stress from abuse → destruction of brain cells, disrupts neuronal connections[2]

1. McCain NM, Mustard F, & Shanker S. Early Years Study 2. Putting science into action.
2. Odhayani, AA, Watson, WJ & Watson, L. Behavioral consequences of child abuse.

Background

- Clear dose–response relationship between severity of exposure and magnitude of the neurobiological findings



1. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.
2. Dannlowski, U et al. Limbic scars: Long-term consequences of childhood maltreatment revealed by functional and structural magnetic resonance imaging.
3. Edmiston, EE et a. Corticostriatal-limbic gray matter morphology in adolescents with self-reported exposure to childhood maltreatment.
4. Teicher, MH, Anderson, CM, & Polcari, A. Childhood maltreatment is associated with reduced volume in the hippocampal subfields CA3, dentate gyrus, and subiculum.
5. Treadway, MT et al. Early adverse events, HPA activity and rostral anterior cingulate volume in MDD.

Background

- Survivors of childhood maltreatment have a higher prevalence of mental health/cognitive effects:[1-7]
  - Depression
  - Anxiety
  - Substance abuse
  - Eating disorders
  - Suicidal symptomatology
  - Psychosis
  - Personality disorder
  - Diminished cognitive functioning
  - Poorer treatment response
- Maltreatment accounted for **45%** of the population attributable risk for childhood onset psychiatric disorders[8]

1. Ball, JS & Links, PS. Borderline personality disorder and childhood trauma: Evidence for a causal relationship.
2. de Bellis, MD et al. Neuropsychological findings in childhood neglect and their relationships to pediatric PTSD.
3. Bendall, S et al. Childhood trauma and psychotic disorders: A systematic, critical review of the evidence.
4. Gould, F et al. The effects of child abuse and neglect on cognitive functioning in adulthood.
5. Nanni, V, Uher, R & Danese, A. Childhood maltreatment predicts unfavorable course of illness and treatment outcome in depression: A meta-analysis.
6. Norman, RE et al. The long-term health consequences of child physical abuse, emotional abuse, and neglect: A systematic review and meta-analysis.
7. Teicher, MH & Samson, JA. Childhood maltreatment and psychopathology: A case for ecophenotypic variants as clinically and neurobiologically distinct subtypes.
8. Green, JG et al. Childhood adversities and adult psychiatric disorders in the national comorbidity survey replication I: Associations with first onset of DSM-IV disorders.

Background

- Survivors of childhood maltreatment have increased prevalence of physical health disorders:
  - Inflammation[1]
  - Metabolic syndrome[2]
  - Arthritis[3]
  - Ischemic heart disease[4]
  - Cancer[5]
  - Shortened telomeres associated with reduced life expectancy[6,7]

1. Danese, A et al. Childhood maltreatment predicts adult inflammation in a life-course study.
2. Danese, A et al. Adverse childhood experiences and adult risk factors for age-related disease: Depression, inflammation, and clustering of metabolic risk markers.
3. Spitzer, C et al. Gender-specific association between childhood trauma and rheumatoid arthritis: A case-control study.
4. Dong, M et al. Insights into causal pathways for ischemic heart disease: Adverse childhood experiences study.
5. Brown, DW et al. Adverse childhood experiences are associated with the risk of lung cancer: A prospective cohort study.
6. Price, LH et al. Telomeres and early-life stress: An overview.
7. Brown, DW et al. Adverse childhood experiences and the risk of premature mortality.

The Brain

Background

- Clearly able to show: link between maltreatment, development and alterations in structure and function of stress-susceptible brain regions
  - Substantial alterations in connectivity and network architecture
- Less clear: how these changes directly link to psychopathology

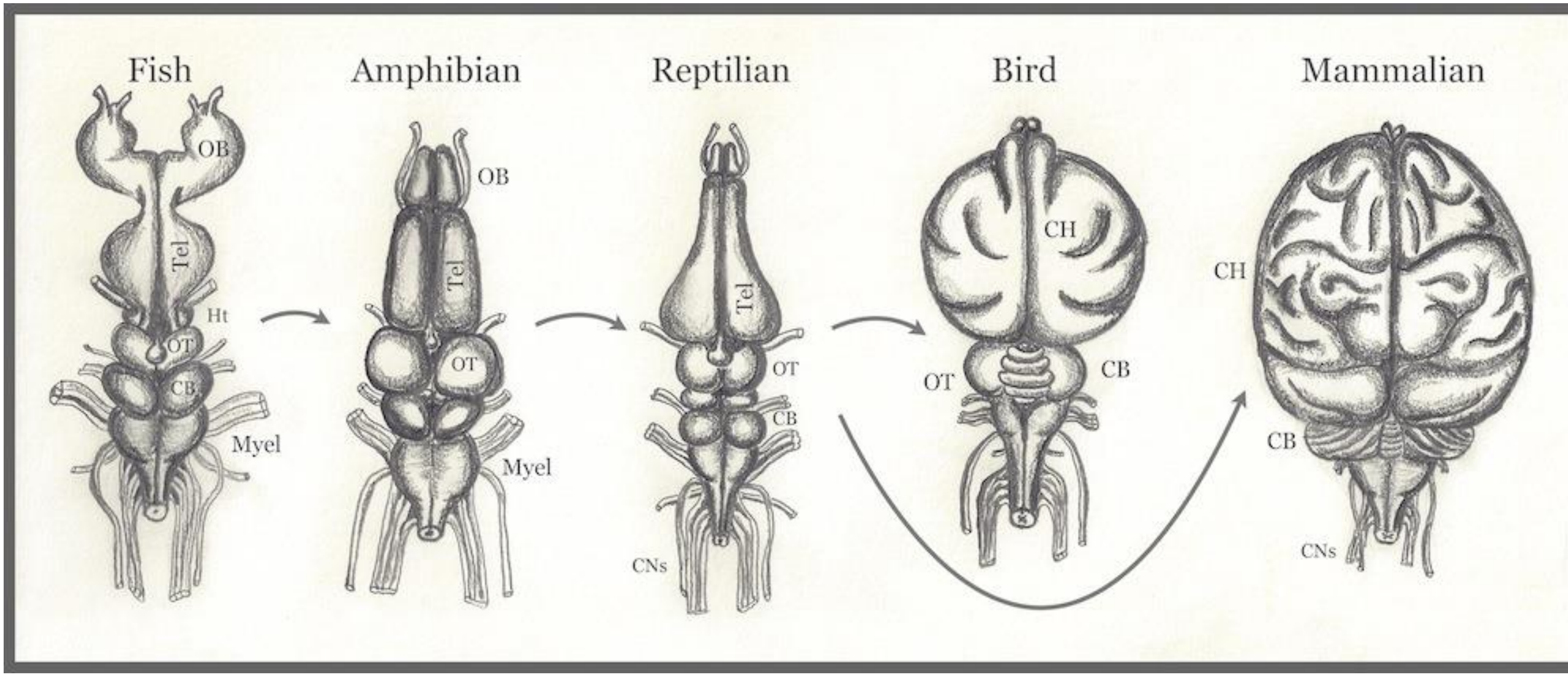
Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.

Background

- Chronic stress:
  - Potentially adaptive changes of brain → can lead to psychopathology when adaptive responses/experiences so much differ as to become maladaptive

Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.

The Brain (101)


Fish
Amphibian
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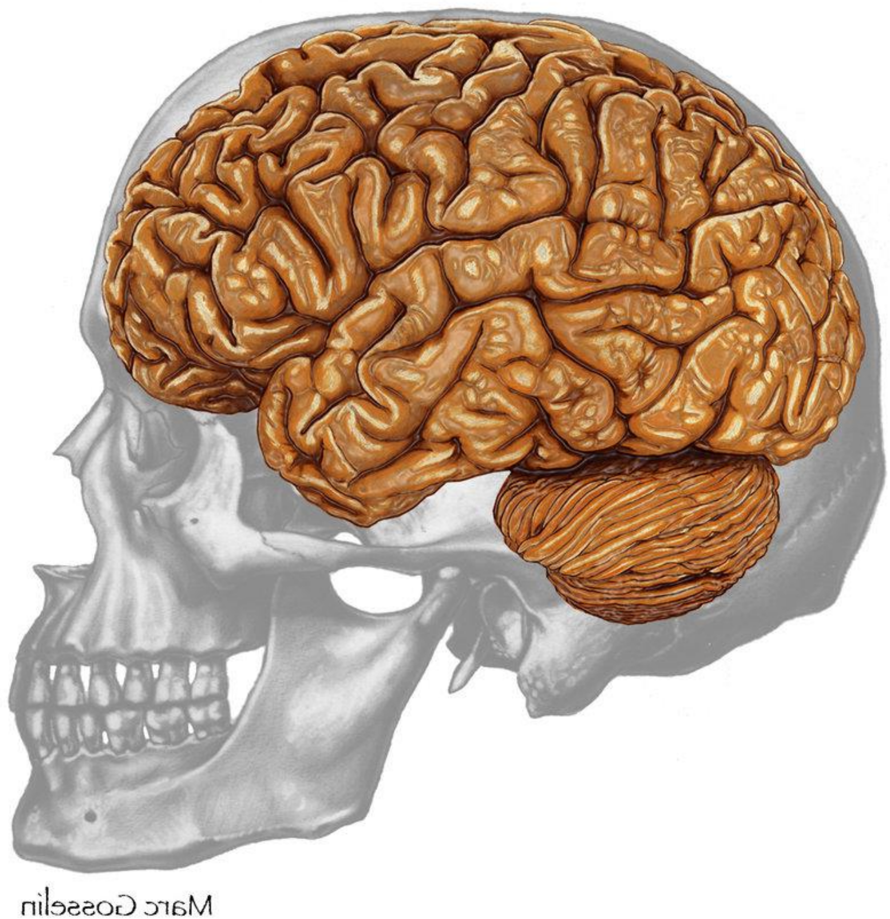
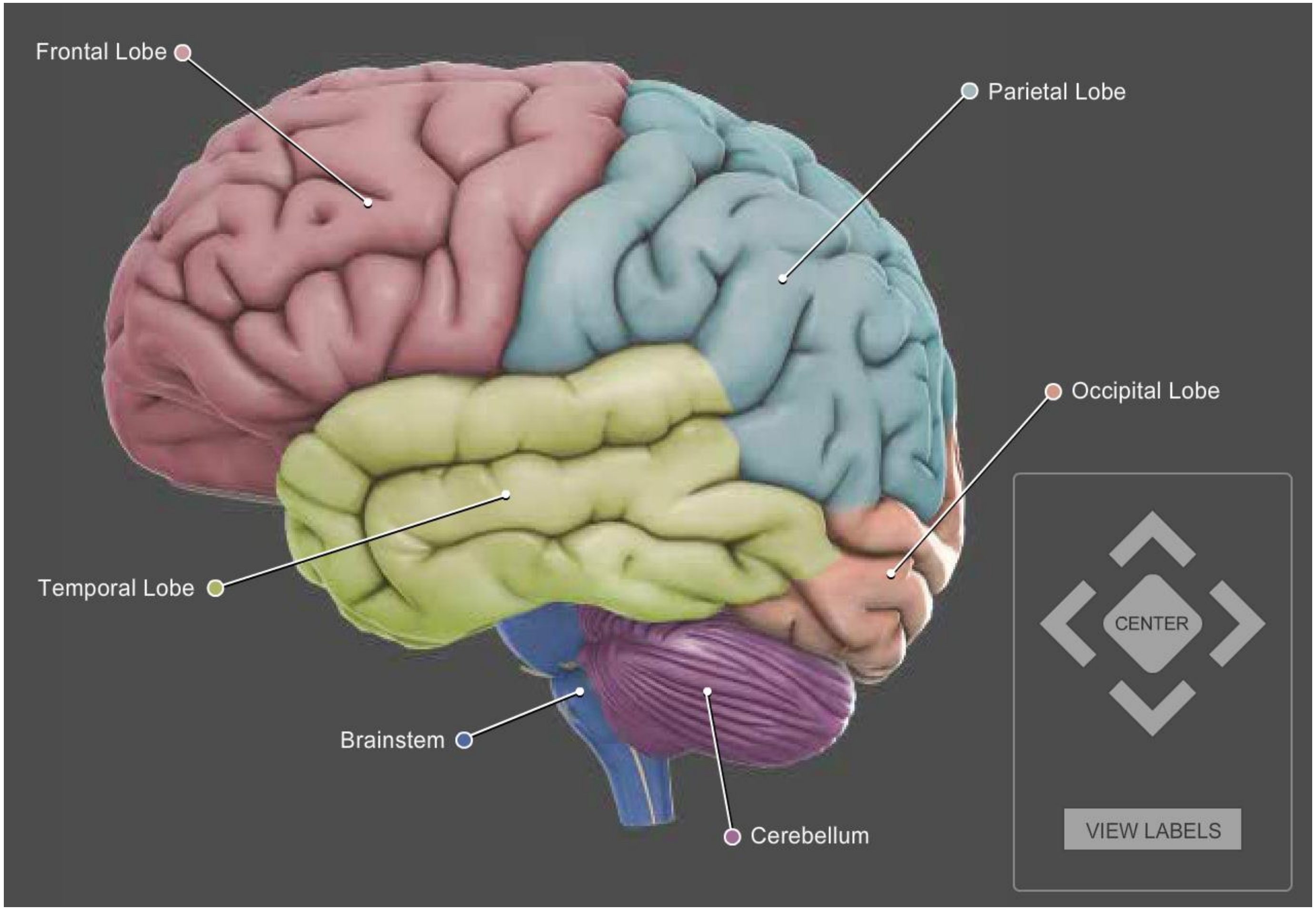

Marc Gosselin

Whole Brain



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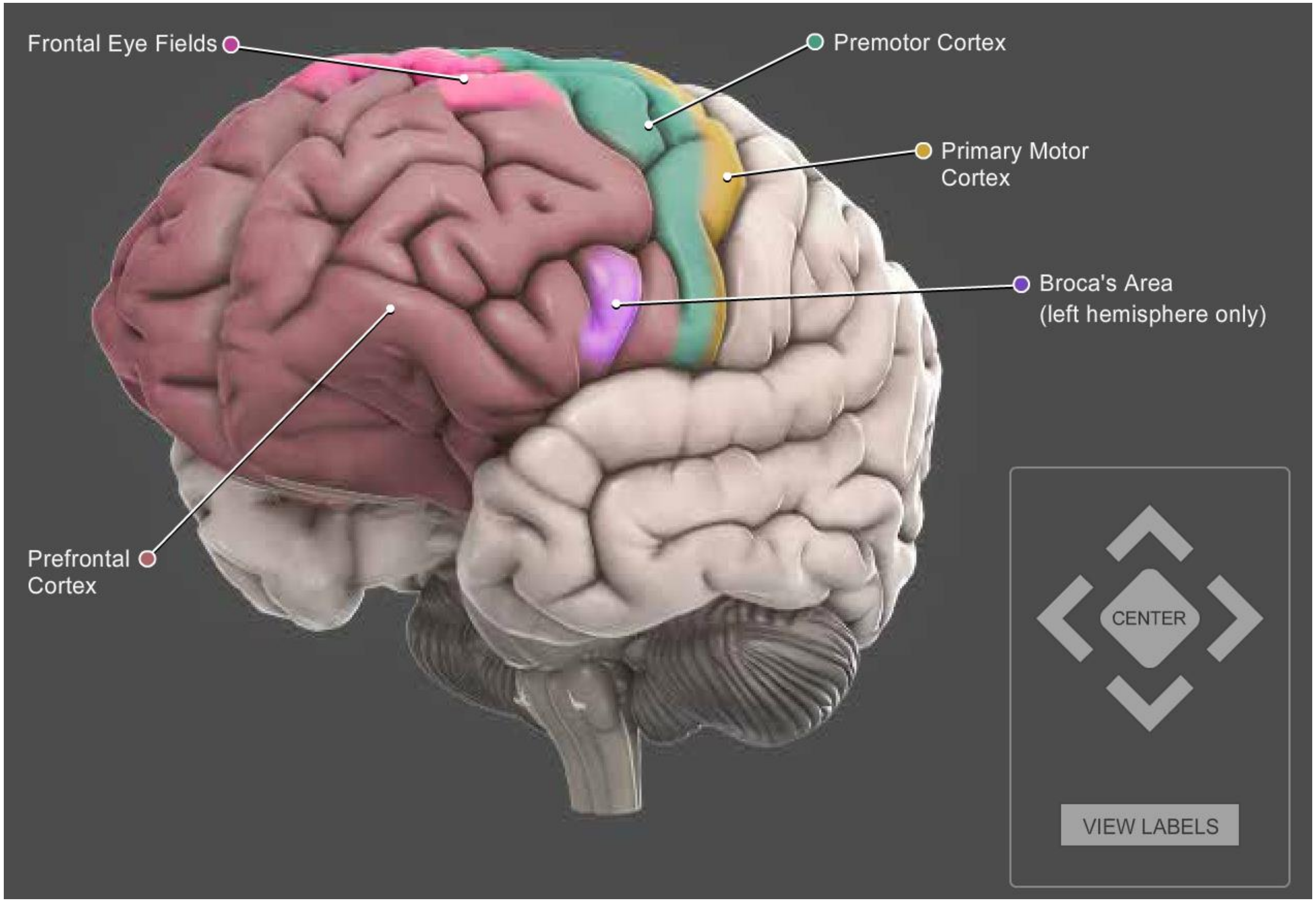
Frontal Lobe



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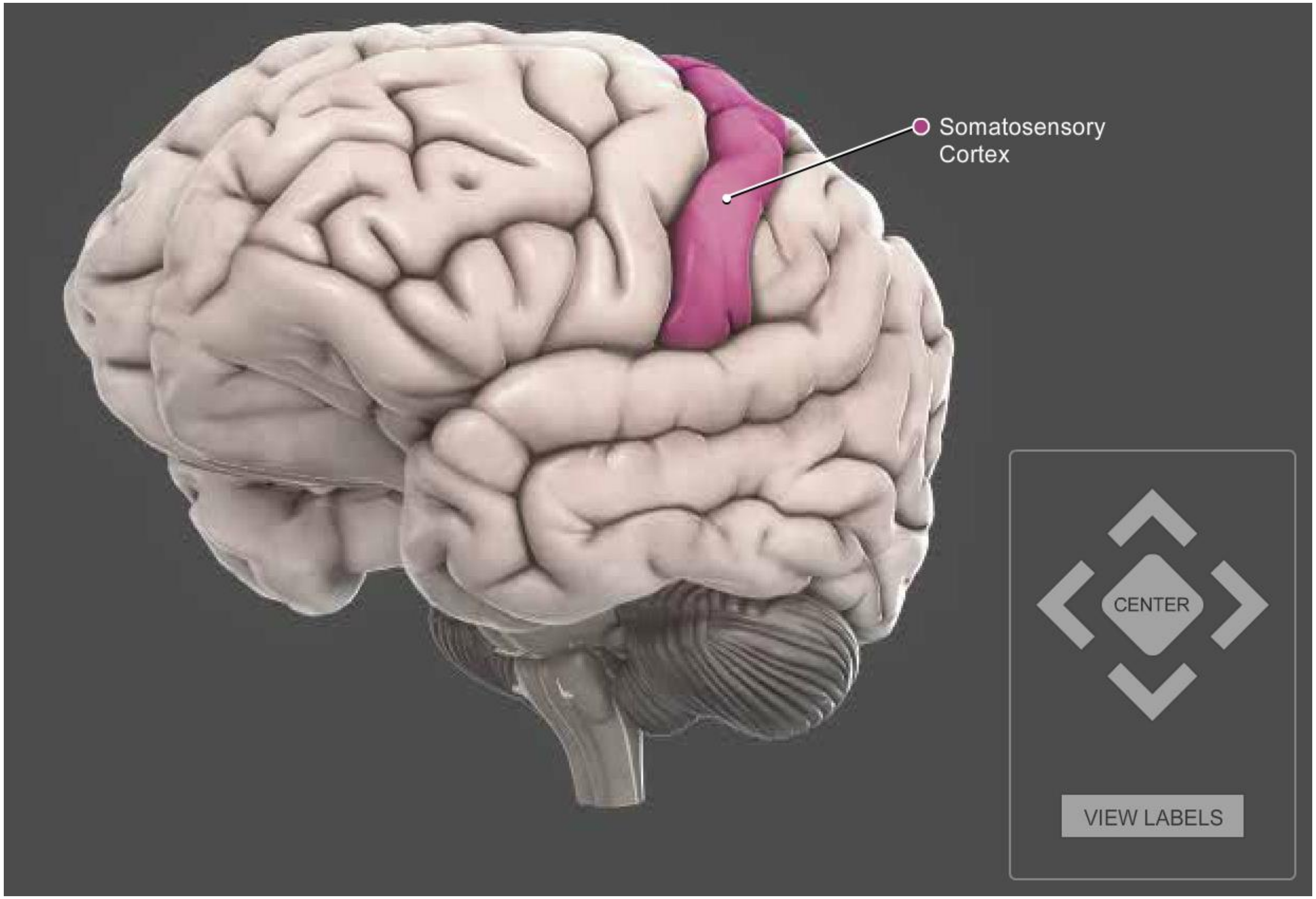
Somatosensory Cortex



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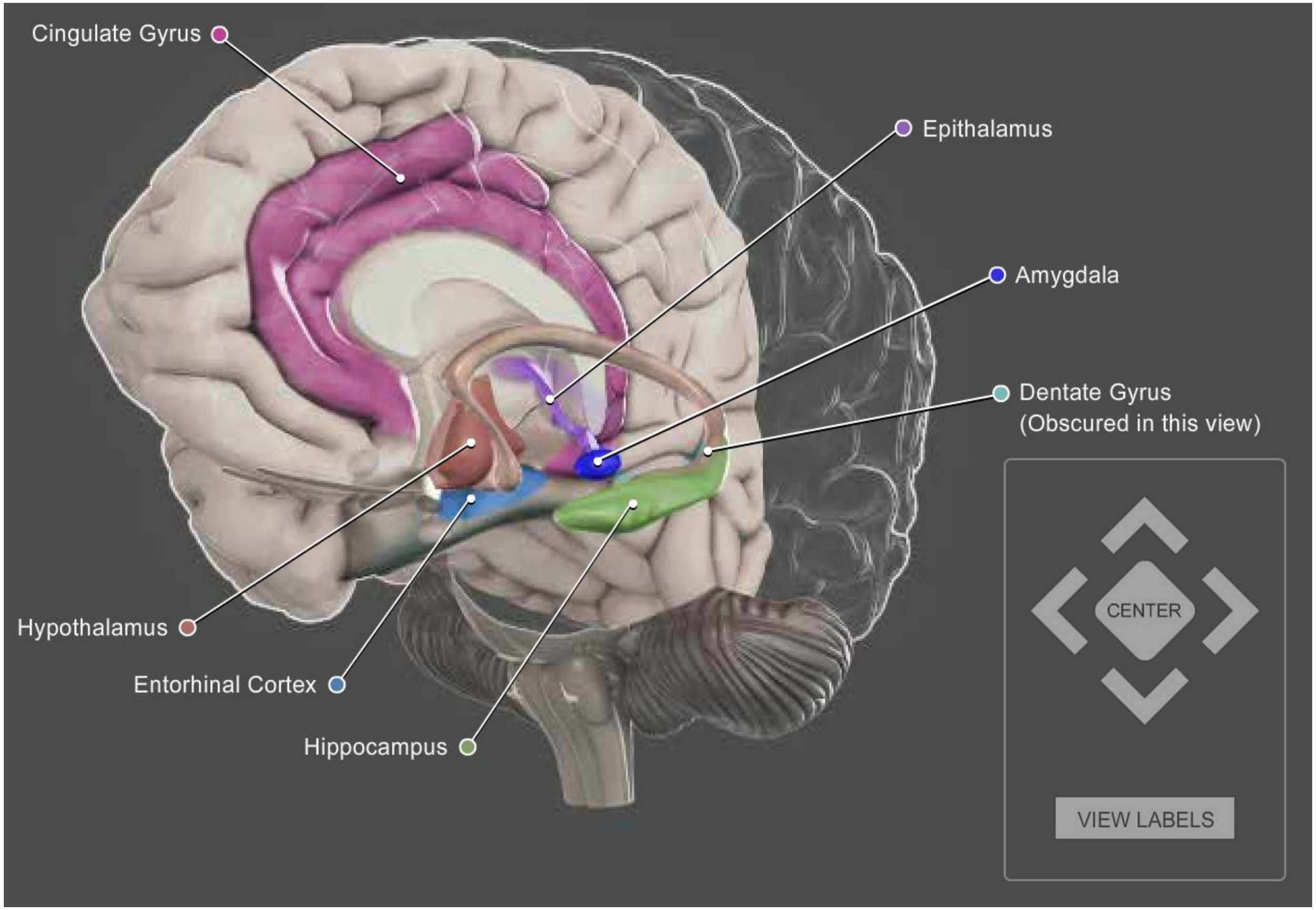
Limbic System



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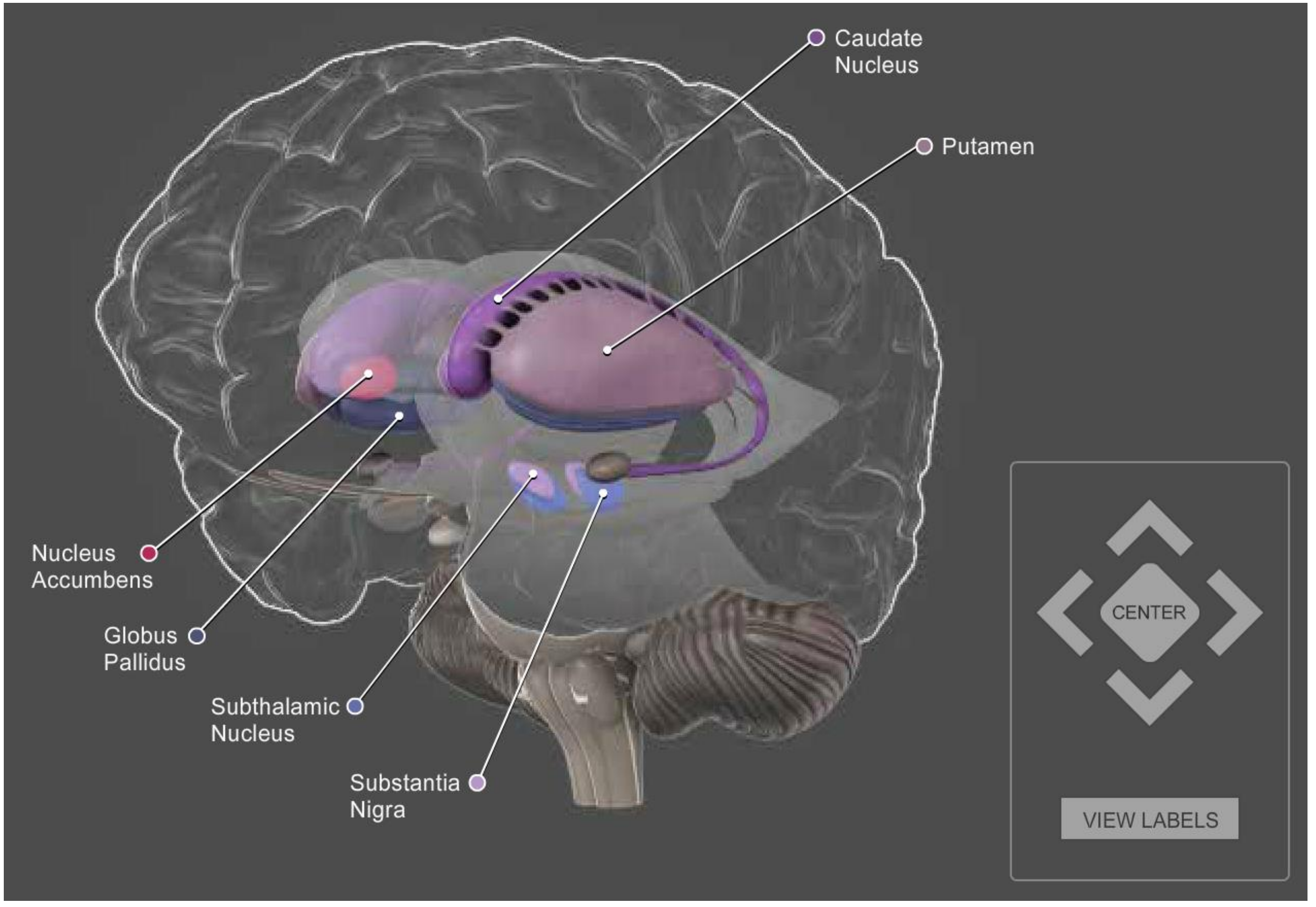
Basal Ganglia (Striatum)



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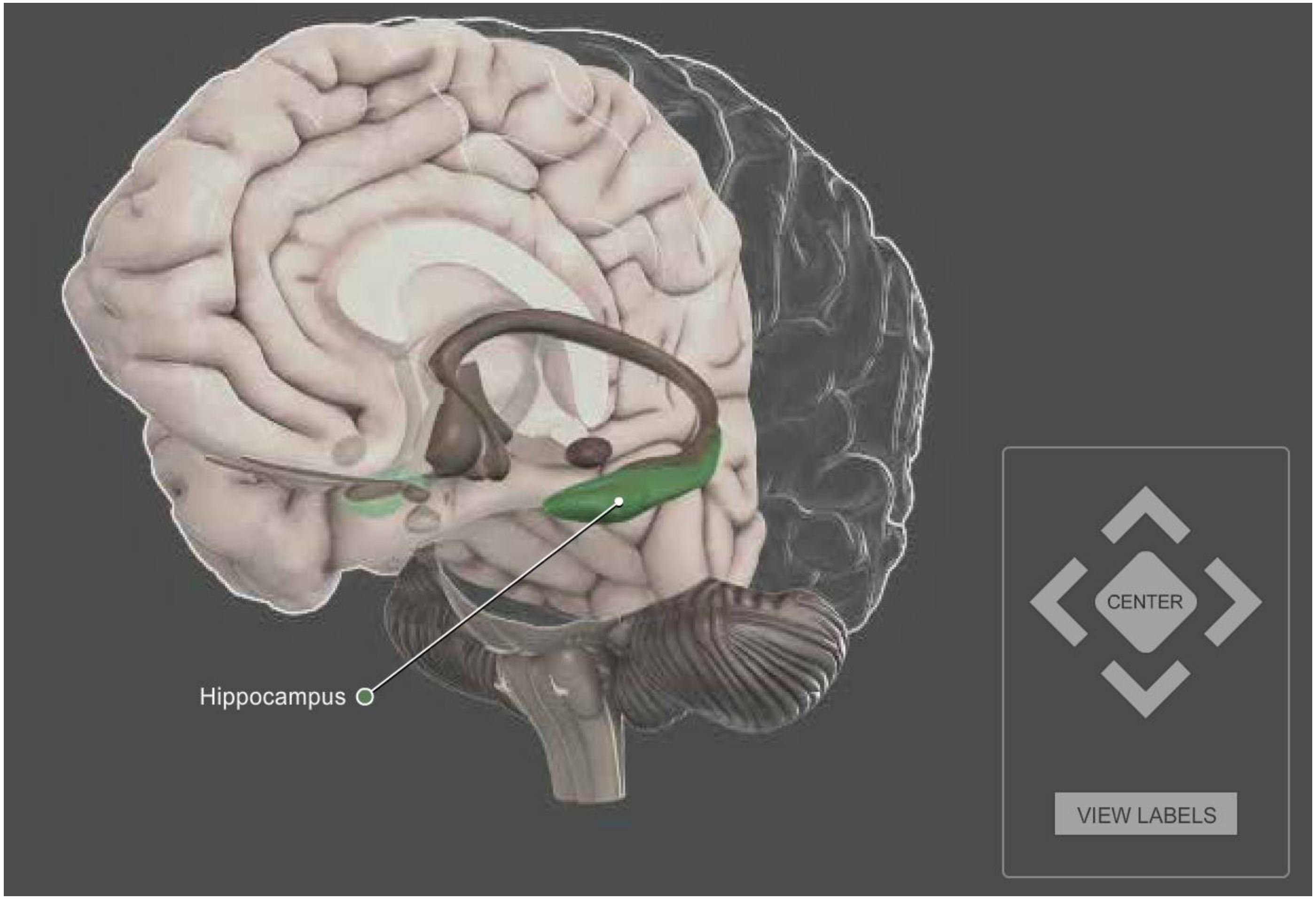
Hippocampus



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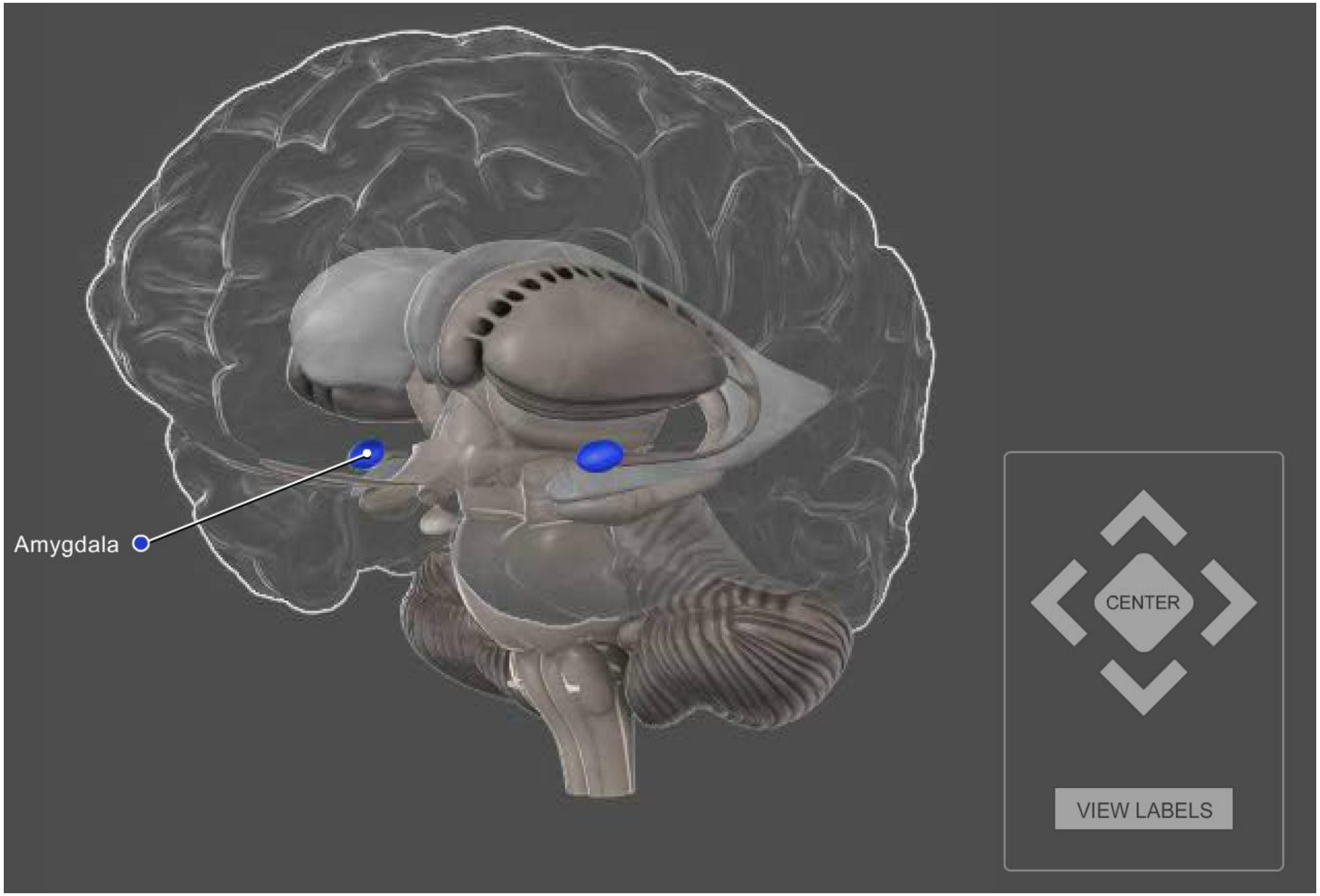
Amygdala



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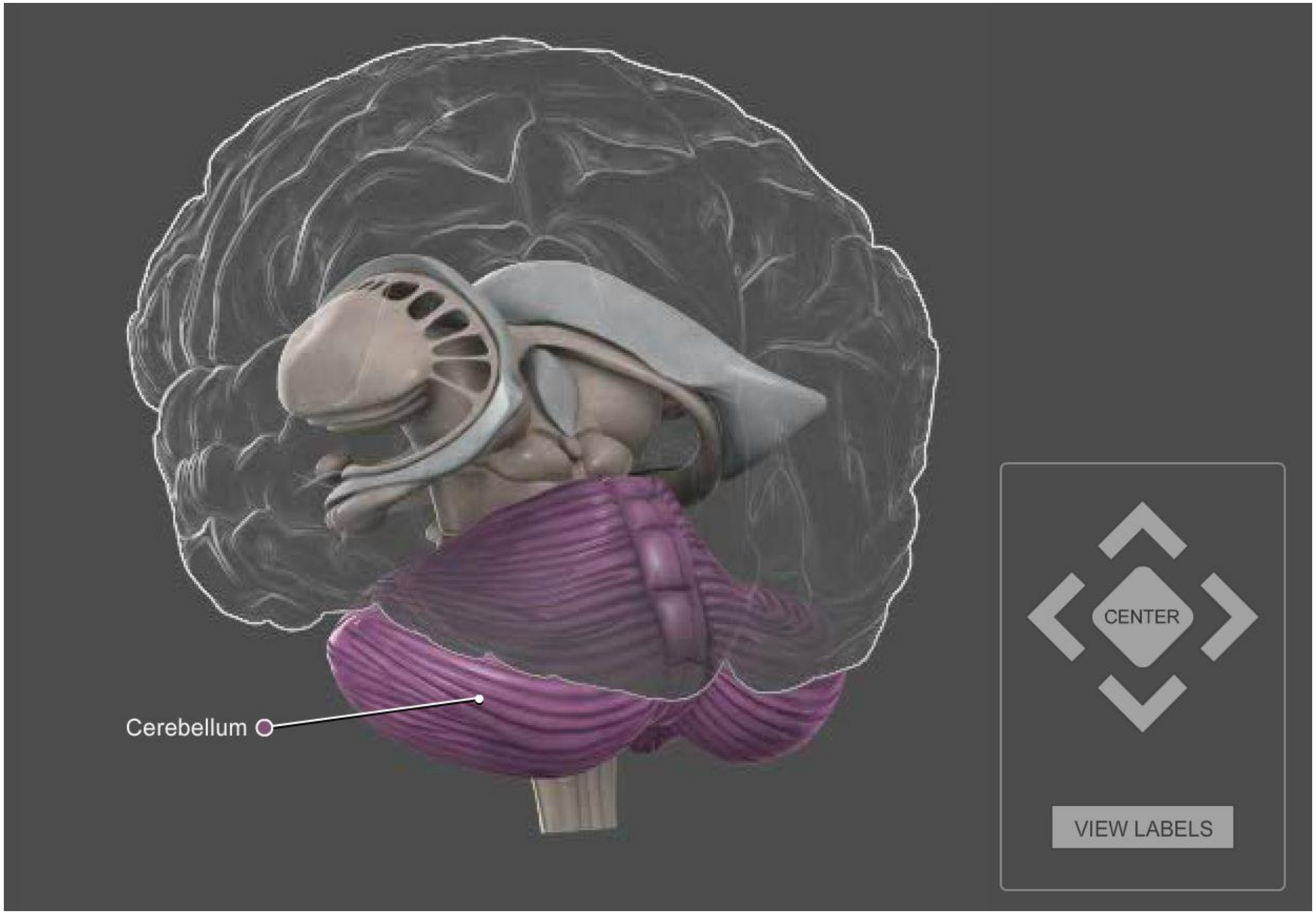
Cerebellum



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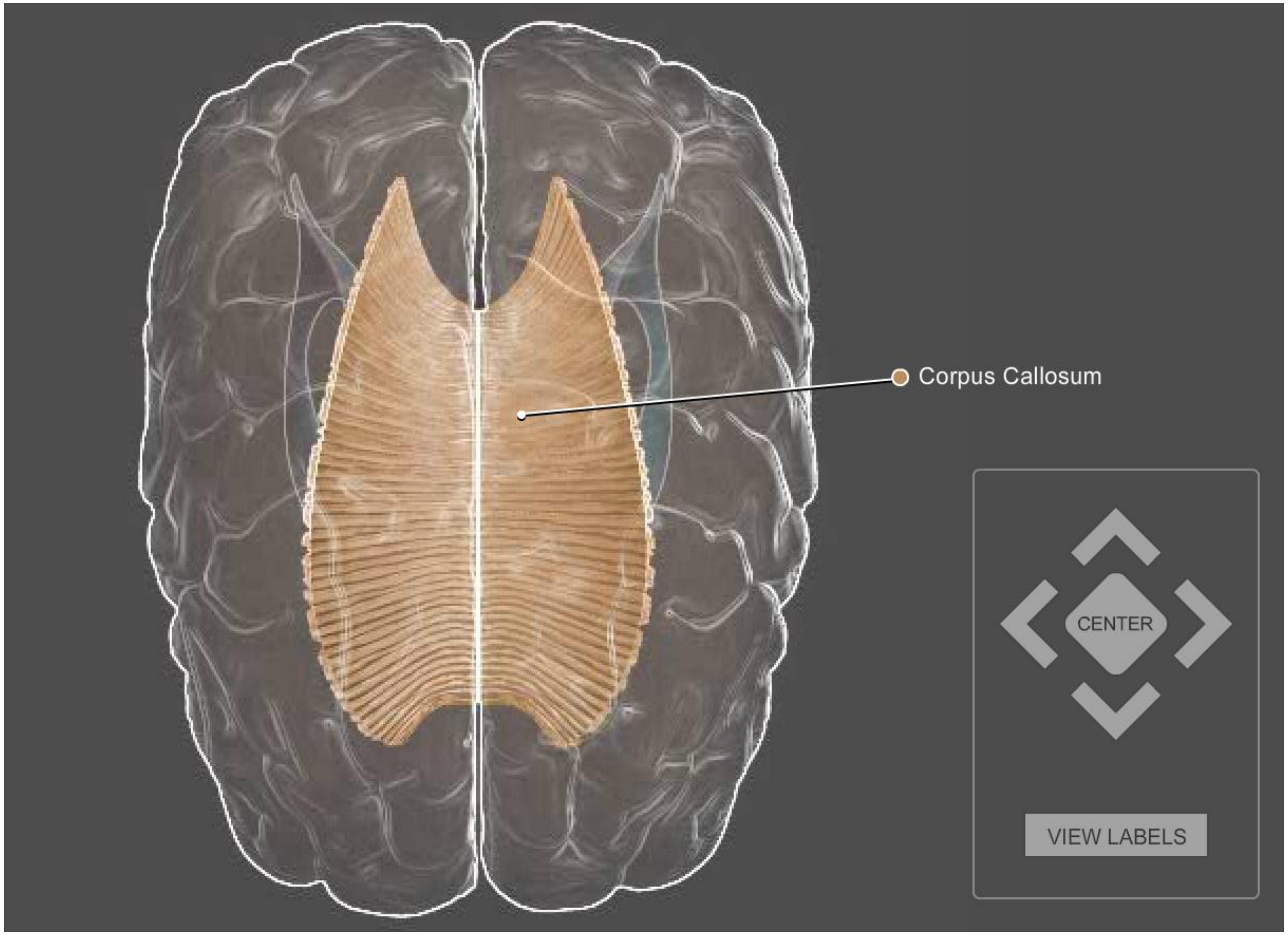
Corpus Callosum



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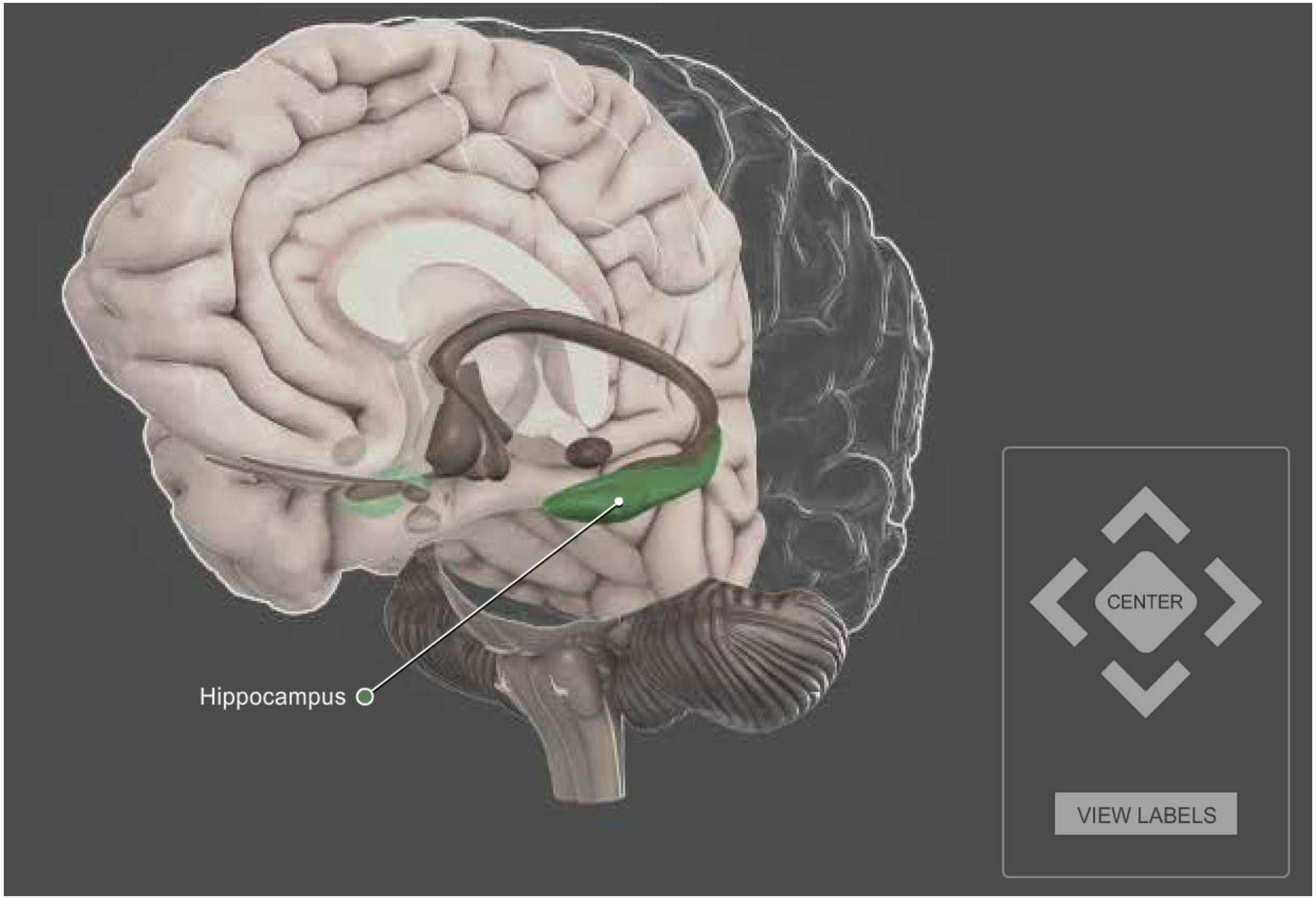
Specific Brain Regions

Hippocampus



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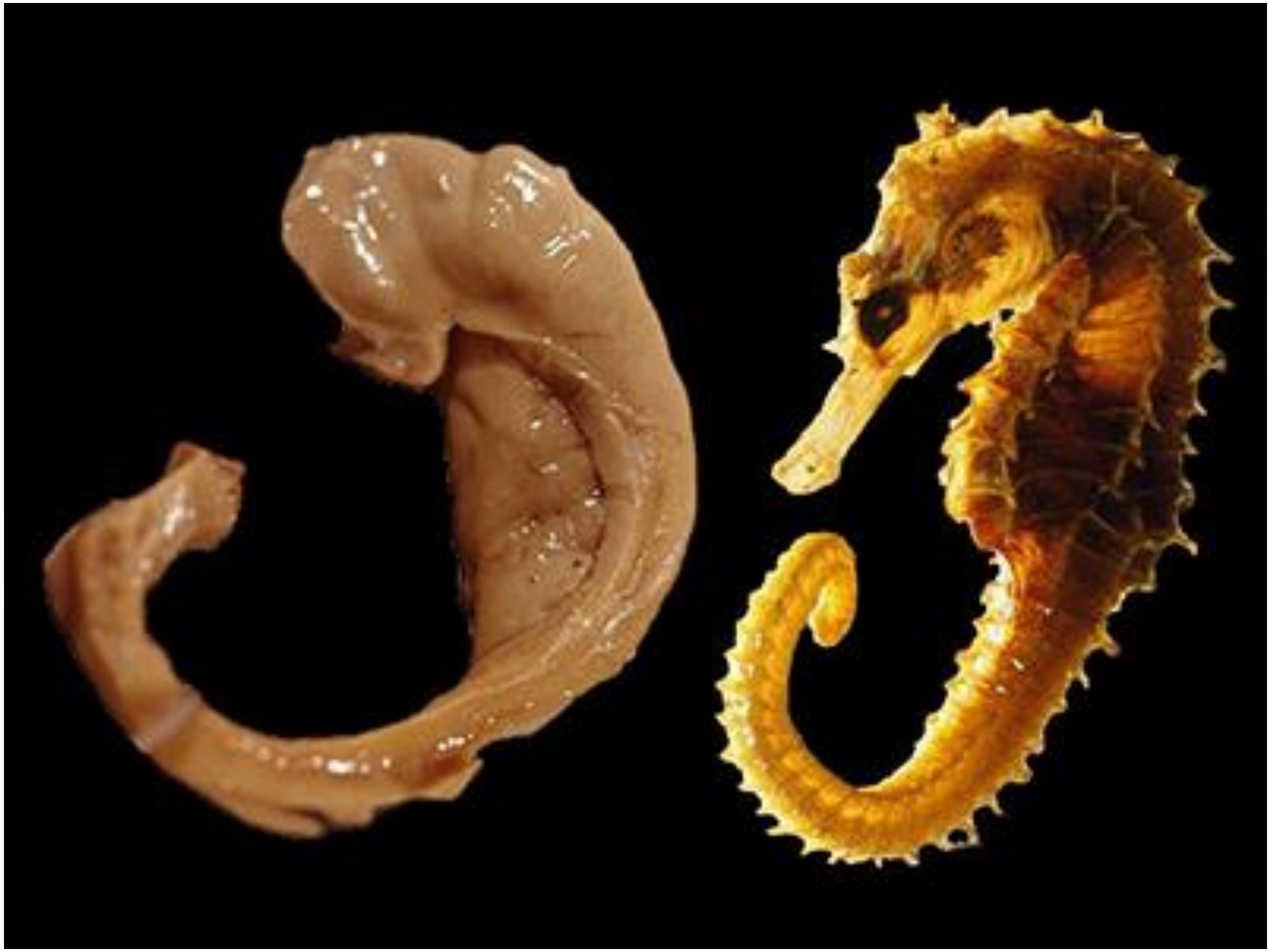


Hippocampus

- Involved in the formation and retrieval of **memories**, including **autobiographical** memories[1]
  - *Place cells* provide an internal positioning system for the spatiotemporal representation of places, routes and associated experiences[2]
- Most obvious target for potential effects of childhood maltreatment[3]

1. Nadel, L, Campbell, J, & Ryan, L. Autobiographical memory retrieval and hippocampal activation as a function of repetition and the passage of time.
2. Moser, EI, Kropff, E & Moser, MB. Place cells, grid cells, and the brain's spatial representation system.
3. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.

Hippocampus

- Densely populated with glucocorticoid receptors[1] → **highly susceptible to damage** from excessive levels of glucocorticoids (ex. **cortisol**)[2]

1. Morimoto, M et al. Distribution of glucocorticoid receptor immunoreactivity and mRNA in the rat brain: An immunohistochemical and in situ hybridization study.
2. Sapolsky, RM, Krey, LC, & McEwen, BS. Prolonged glucocorticoid exposure reduces hippocampal neuron number: Implications for aging.

Hippocampus

- Adults: **smaller** hippocampi in maltreated vs. nonmaltreated[1]
  - But smaller effect in females
    - Possibly because of neuroprotective effects of **estrogen[2]**

1. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.
2. McEwen, BS. . Stress, sex, and neural adaptation to a changing environment: Mechanisms of neuronal remodeling. Andersen, SL &

Hippocampus

- Childhood/adolescence: evidence less strong of effects[1]
  - Might not show until **adolescence** → but studies have commonly combined both groups
  - May have "silent period" between childhood and adolescence with no discernable neurobiological differences[2]

1. McEwen, BS. . Stress, sex, and neural adaptation to a changing environment: Mechanisms of neuronal remodeling.
2. Andersen, SL & Teicher, MH. Delayed effects of early stress on hippocampal development.

Hippocampus

- May have potential **sensitive exposure periods**[1]
  - Most significant: exposure between **3-5 years old**; less degree at 11-13 years old[2]
    - Early separation stress has much greater effects on synaptic density in hippocampus[3]
  - Specifically associated with **reduction in volume** of portions of hippocampal that have been shown to be susceptible in both laboratory animals and humans[1,4-6]

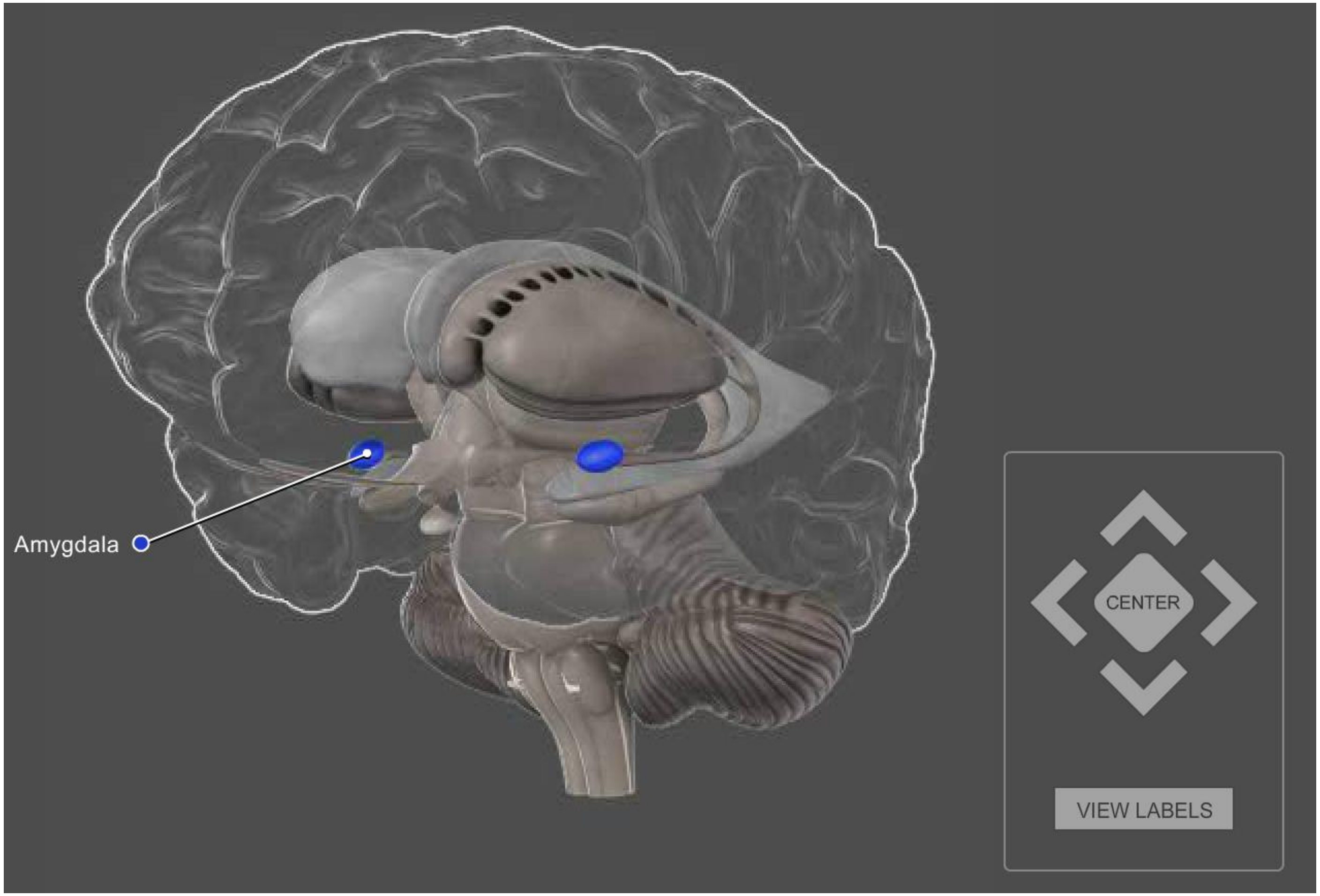
1. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.
2. Andersen, SL et al. Preliminary evidence for sensitive periods in the effect of childhood sexual abuse on regional brain development.
3. Andersen, SL & Teicher, MH. Delayed effects of early stress on hippocampal development
4. Andersen, SL & Teicher, MH. Stress, sensitive periods and maturational events in adolescent depression.
5. Pagliaccio, D et al. Stress-system genes and life stress predict cortisol levels and amygdala and hippocampal volumes in children.
6. Teicher, MH, Anderson, CM, & Polcari, A. Childhood maltreatment is associated with reduced volume in the hippocampal subfields CA3, dentate gyrus, and subiculum.

Hippocampus

- Smaller hippocampal volumes:
  - Mild cognitive impairment/Traumatic brain injury
  - Schizophrenia
  - Major depression
  - Posttraumatic stress disorder
  - Obsessive–compulsive disorder (OCD)
  - Chronic alcoholism
  - Antisocial personality disorder
  - Borderline personality disorder
- Larger hippocampal volumes:
  - Autism
- Preservation of hippocampal volume:
  - Bipolar disorder
  - Anorexia nervosa
  - Panic disorder
  - Attention-deficit/hyperactivity disorder (ADHD)

Geuze, E, Vermetten, E & Bremner, JD. MR-based in vivo hippocampal volumetrics: 2. Findings in neuropsychiatric disorders.

Amygdala



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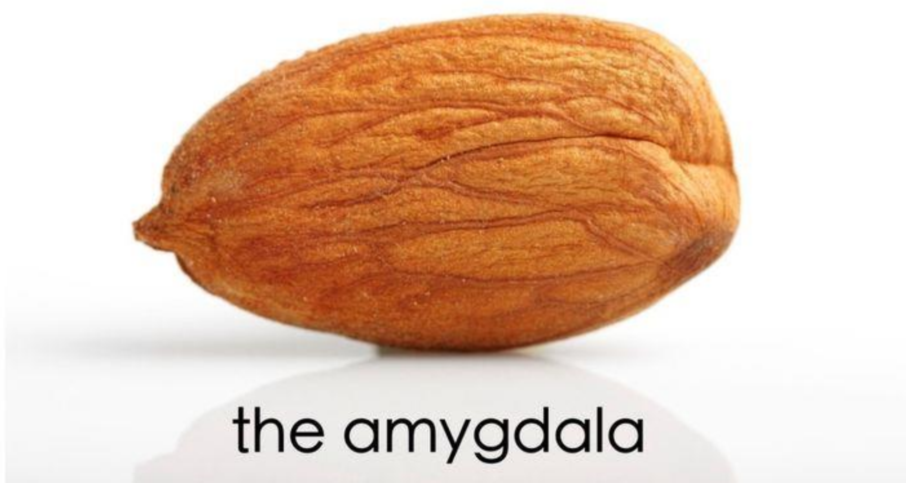
BRAIN FOOD



Amygdala

- Encoding of **implicit emotional memories**[1]
- Detecting and responding to **salient stimuli** – ex. facial expressions and potential threats[2]

1. LeDoux, JE. Emotional memory systems in the brain. Behavioural Brain Research. 1993; 58:, 69–79
2. Derntl, B et al. General and specific responsiveness of the amygdala during explicit emotion recognition in females and males. *BMC Neuroscience*. 2009; 10: 91

Amygdala

- High density of glucocorticoid receptors on stress-susceptible pyramidal cells[1]
- Postnatal developmental trajectory characterized by rapid initial growth → more sustained growth to peak volumes between 9-11 years → gradual pruning thereafter[2]
- Also **highly susceptible** to exposure to early stress[3]

1. Sarrieau, A et al. Autoradiographic localization of glucocorticosteroid and progesterone binding sites in the human post-mortem brain.
2. Uematsu, A et al. Developmental trajectories of amygdala and hippocampus from infancy to early adulthood in healthy individuals.
3. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.

Amygdala

- Both psychological stressors and stress hormones → stimulate cells → **increase** in volume [hypertrophy][1,2]
  - Opposite of effects on hippocampus[3]
- Hypertrophy, unlike hippocampal hypotrophy, **endures** long after cessation of the stressor[4]

1. Mitra, R et al. Stress duration modulates the spatiotemporal patterns of spine formation in the basolateral amygdala.
2. Vyas, A, Jadhav, S & Chattarji, S. Prolonged behavioral stress enhances synaptic connectivity in the basolateral amygdala.
3. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.
4. Vyas, A, Pillai, AG & Chattarji, S. Recovery after chronic stress fails to reverse amygdaloid neuronal hypertrophy and enhanced anxiety-like behavior

Amygdala

- Studies **do not** consistently show changes in maltreatment[1]
  - If anything, majority showed a decrease
  - For decrease: had multiple forms of maltreatment; older; worse psychopathology
- Those studies that did show increase: **early** emotional and/or physical neglect

Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.

Amygdala

- **Early exposure** to stress sensitizes amygdala → **volume reduction** with subsequent exposure to stress (ex. early childhood stress, then later exposed to combat → increased risk to develop **PTSD**[1]
- Longer-term study:[2]
  - **Early** maltreatment → increase in volume
  - **Later** exposure → decrease in volume

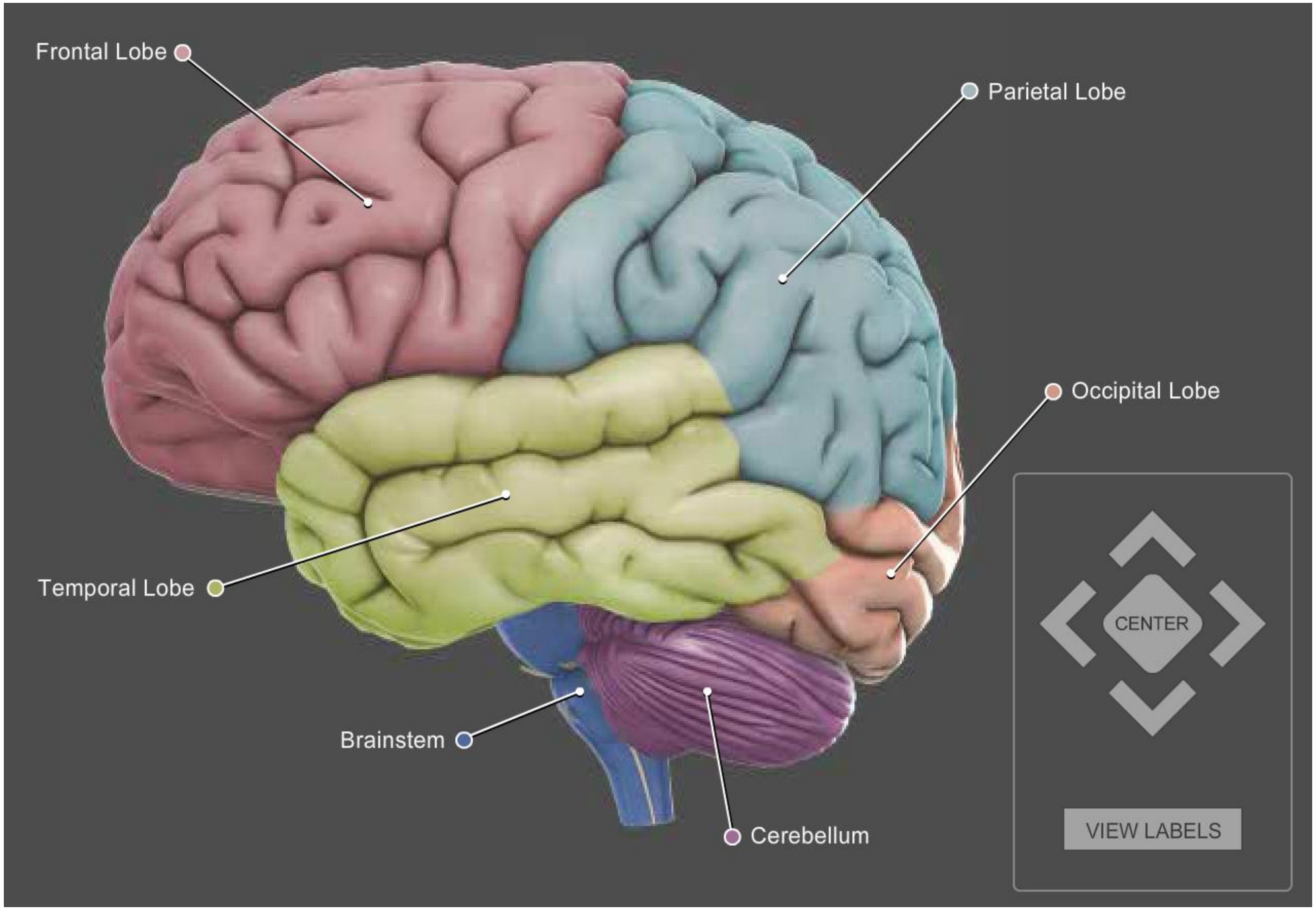
1. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.
2. Whittle, S et al. Childhood maltreatment and psychopathology affect brain development during adolescence.

Amygdala

- Therefore:
  - **Early** exposure to maltreatment or neglect → **initial increase** in amygdala volume (particularly noticeable during **childhood**)
  - Early exposure may also **sensitize** the amygdala to further stress → result in a substantial **decrease** in amygdala volume (most noticeable in late **adolescence or adulthood**)

Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.

Cerebral Cortex



Genes to Cognition. Accessed at http://www.g2conline.org/

Cerebral Cortex

- Population of stress-susceptible (pyramidal) cells with a high density of glucocorticoid receptors → peaks during **late adolescence/early adulthood**[1]
- Glucocorticoid receptors on (glial) cells that are most densely distributed during the neonatal period → gradually **decline**[2]

1. Sinclair, D et al. Dynamic molecular and anatomical changes in the glucocorticoid receptor in human cortical development.
2. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.

Cerebral Cortex

- Therefore: **two periods** of heightened stress sensitivity[1]
  1) Infancy to early childhood
     - **Sensory** and **motor** cortical regions develop earlier[2]
  2) Late adolescence to early adulthood[3]
     - Protracted developmental course of **prefrontal** cortical regions

1. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.
2. Lenroot, RK et al. Differences in genetic and environmental influences on the human cerebral cortex associated with development during childhood and adolescence.
3. Sarrieau, A et al. Autoradiographic localization of glucocorticosteroid and progesterone binding sites in the human post-mortem brain.

Cerebral Cortex

- Overall effects (non region specific)
- Region specific
  - Higher order associations or polysensory cortex
  - Primary and secondary sensory cortex

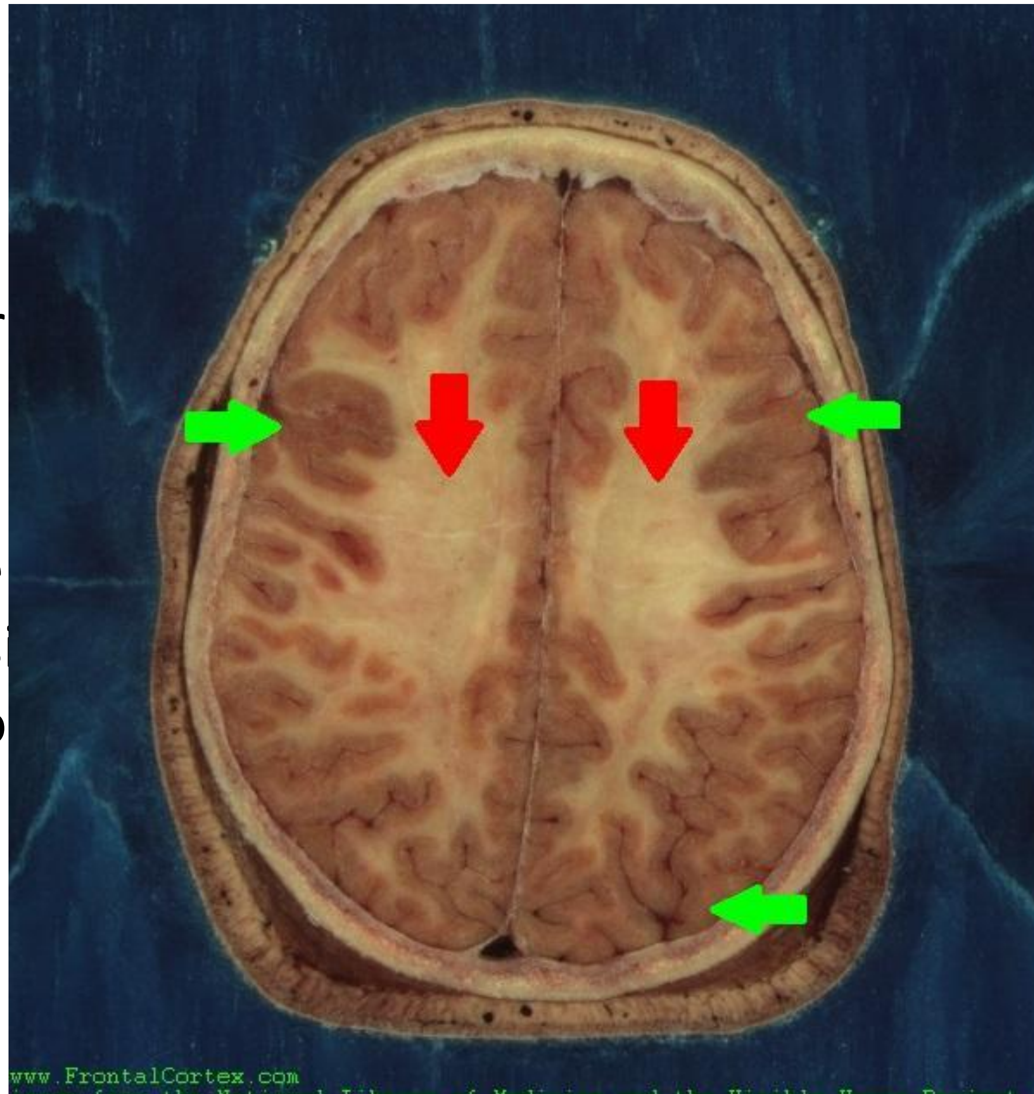
Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.

Cerebral Cortex

Sheridan, MA et al.. Variation in neural development as a result of exposure to institutionalization early in childhood.

Cerebral Cortex

- Overall
  - From ct[1]
    - Ear al care:
      -
      -
    - Ide mly assi en 7-33 mo
      -
      - and adopted



Sheridan, MA et al.. Variation in neural development as a result of exposure to institutionalization early in childhood.

Cerebral Cortex

- Overall effects (non region specific)
  - Other studies have shown similar deleterious effects to children exposed to physical abuse, sexual abuse or witnessing domestic violence[1-3]

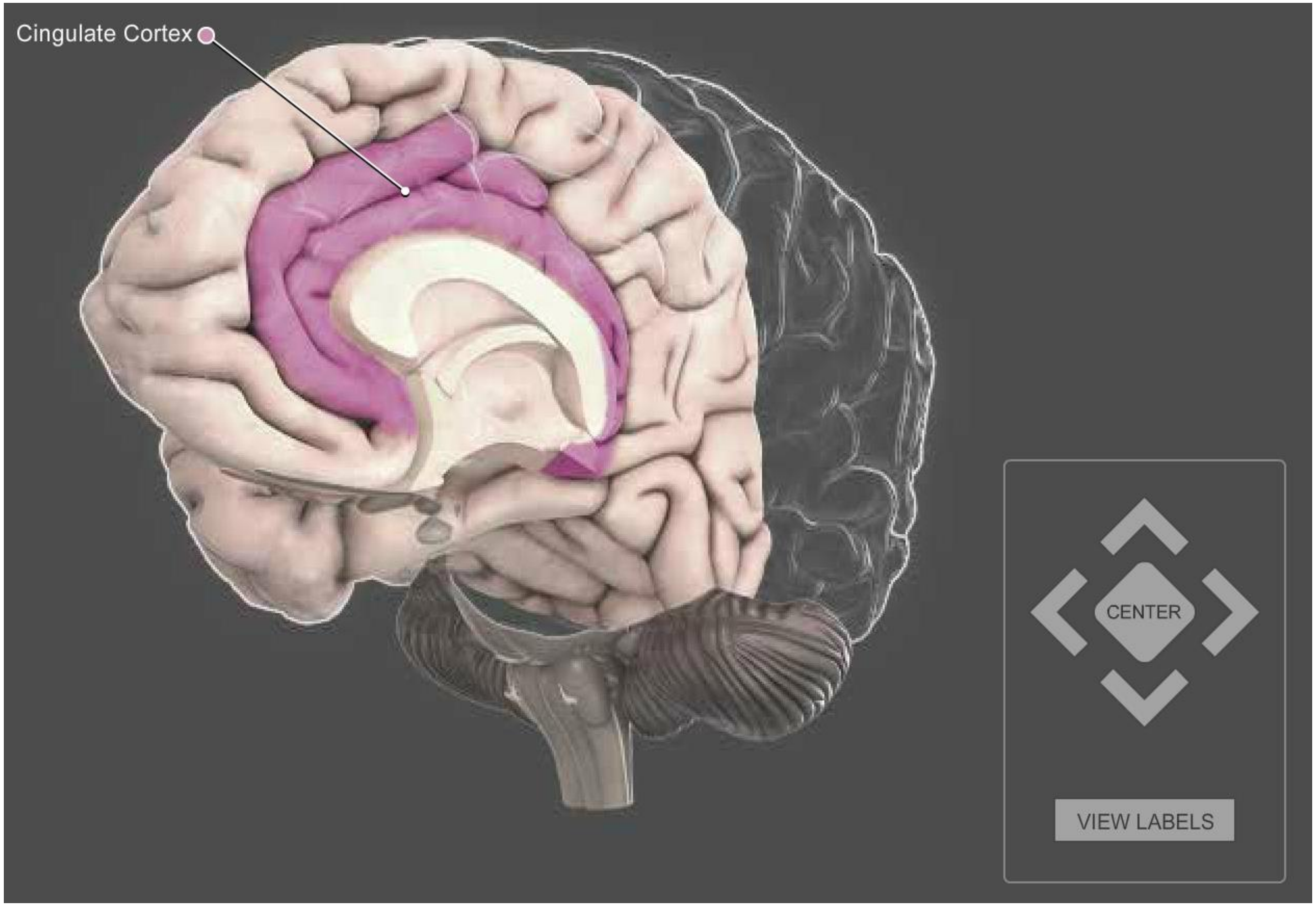
1. Carrion, VG et al.. Attenuation of frontal asymmetry in pediatric posttraumatic stress disorder.
2. De Bellis, MD et al. Developmental traumatology. Part II: Brain development.
3. De Bellis, MD et al. A pilot longitudinal study of hippocampal volumes in pediatric maltreatment-related posttraumatic stress disorder.

Cerebral Cortex

- Region specific
  - Higher order associations or polysensory cortex[1,2]
    - Attenuated development of the **anterior cingulate cortex (ACC)** was the most consistent findings → most have reductions on both sides
    - Attenuated **dorsolateral prefrontal cortex**
    - Attenuated **orbitofrontal cortex**
  - Total prefrontal grey matter volume appeared to be most sensitive to maltreatment **between 14-16 years old**

1. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.
2. Andersen, SL & Teicher, MH. Stress, sensitive periods and maturational events in adolescent depression

Cingulate Cortex



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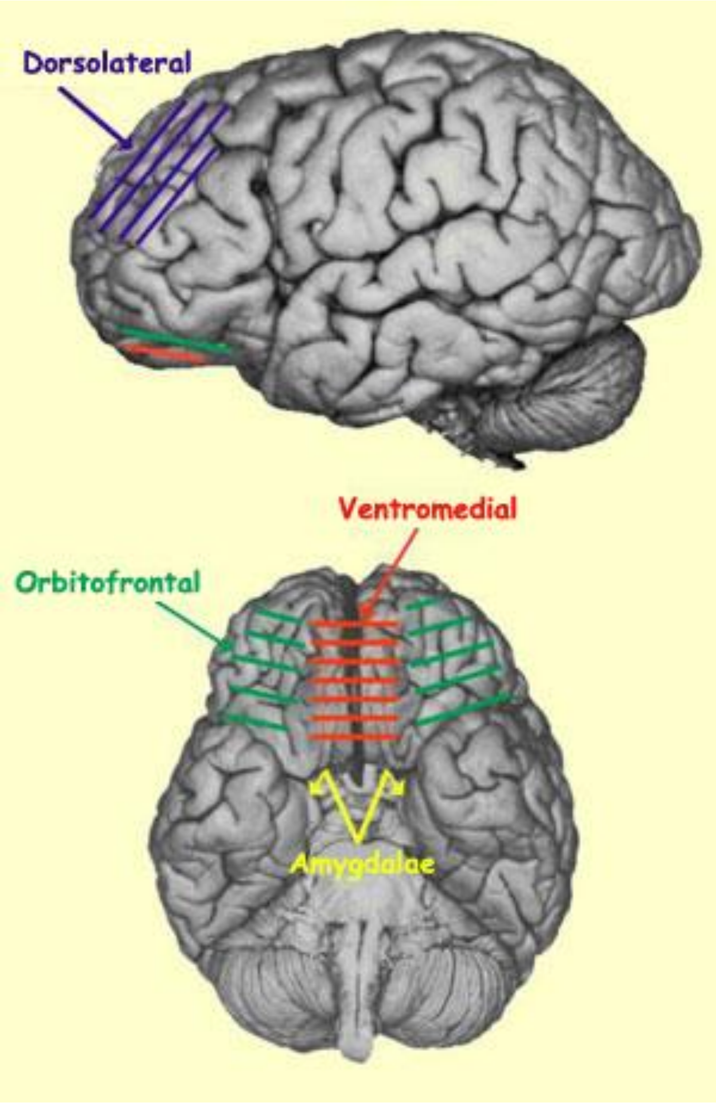
Prefrontal Cortex



The Brain From Top to Bottom

Cerebral Cortex

- Region specific
  - Higher order associations or polysensory cortex
    - These three regions: important role in **decision-making** and **emotional regulation**[1]
      - Have a role in **addiction**[2] → therefore, maltreatment may lead to brain changes that increase risk in addiction
    - Changes in those with a history of sexual abuse and psychotic disorder[3]

1. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.
2. Koob, GF & Volkow, ND. Neurocircuitry of addiction.
3. Sheffield, JM et al. Reduced gray matter volume in psychotic disorder patients with a history of childhood sexual abuse.

Cerebral Cortex

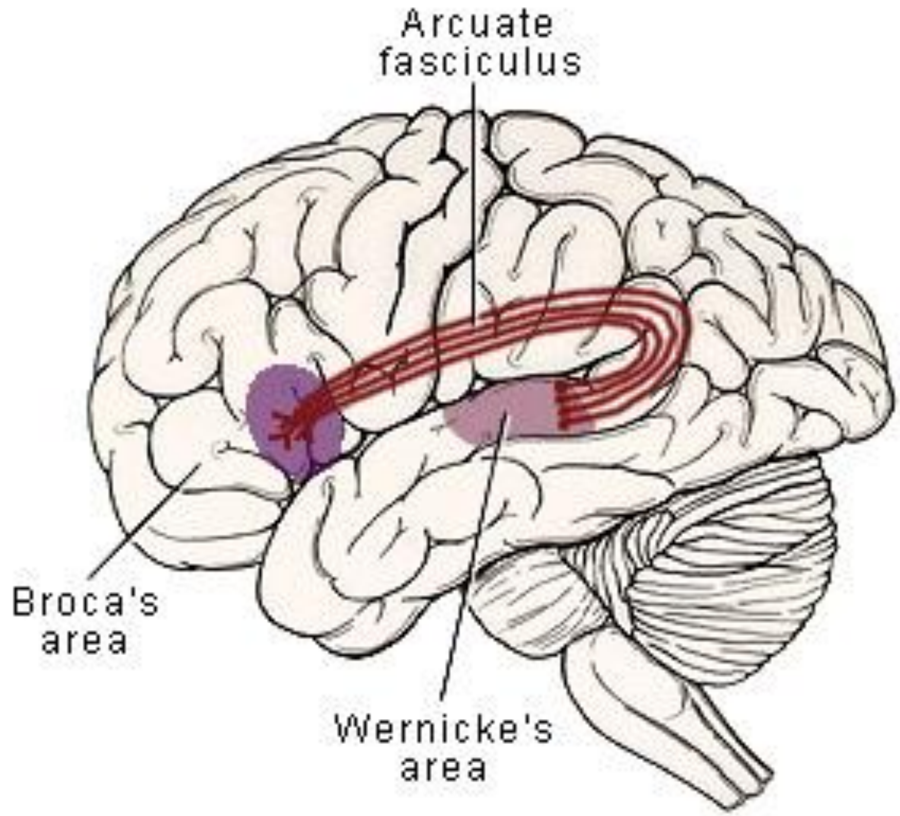
- Region specific
  - Primary and secondary sensory cortex
    - Most reliable correlates of exposure to **severe parental verbal abuse**:[1]
      - Grey matter volume alterations in left **auditory** cortex
      - Diminished integrity of the left arcuate fasciculus **language** pathway

Tomoda, A et al.. Exposure to parental verbal abuse is associated with increased gray matter volume in superior temporal gyrus.

Cerebral Cortex

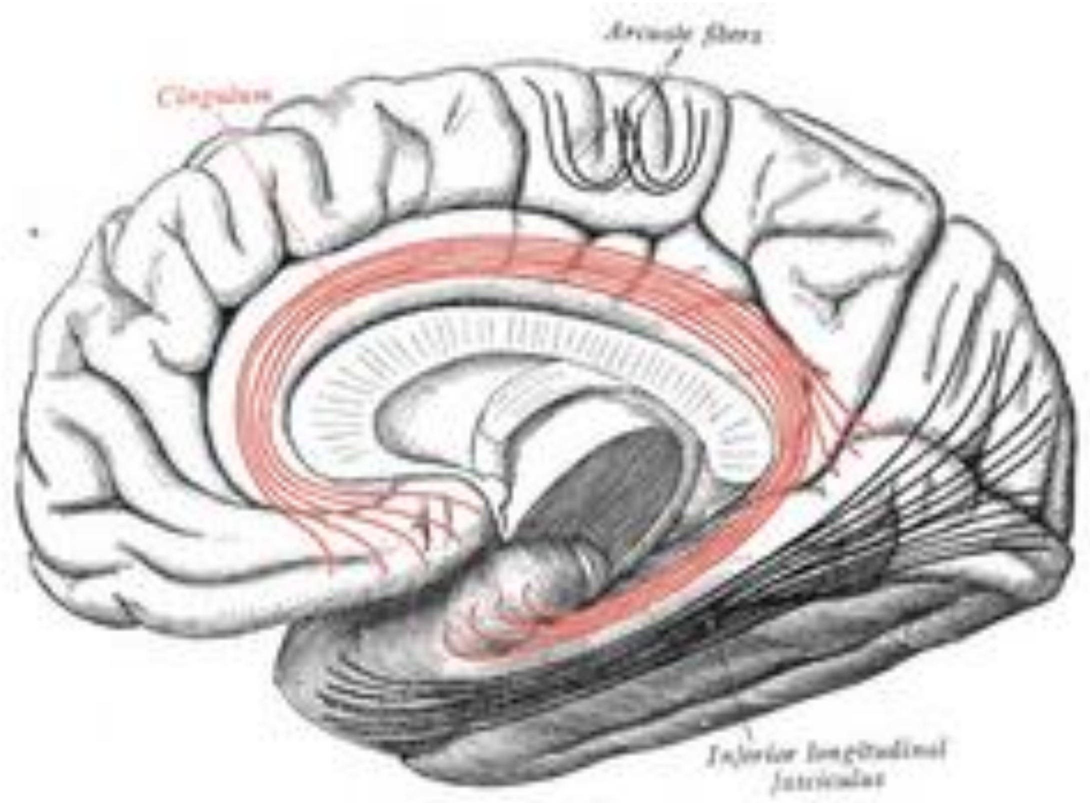
- Region specific
  - Primary and secondary sensory cortex[1]
    - 3 fiber tracts[2]
      - Left arcuate fasciculus: Critically involved in human language[3] with **lower verbal comprehension** and **verbal IQ** scores
      - Left cingulum bundle: Correlated with **depressive** and **dissociative** symptoms
      - Left fornix: Associated with symptoms of **anxiety** and **somatization**

1. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.
2. Choi, J et al.. Preliminary evidence for white matter tract abnormalities in young adults exposed to parental verbal abuse.
3. Rilling, JK et al. The evolution of the arcuate fasciculus revealed with comparative DTI.



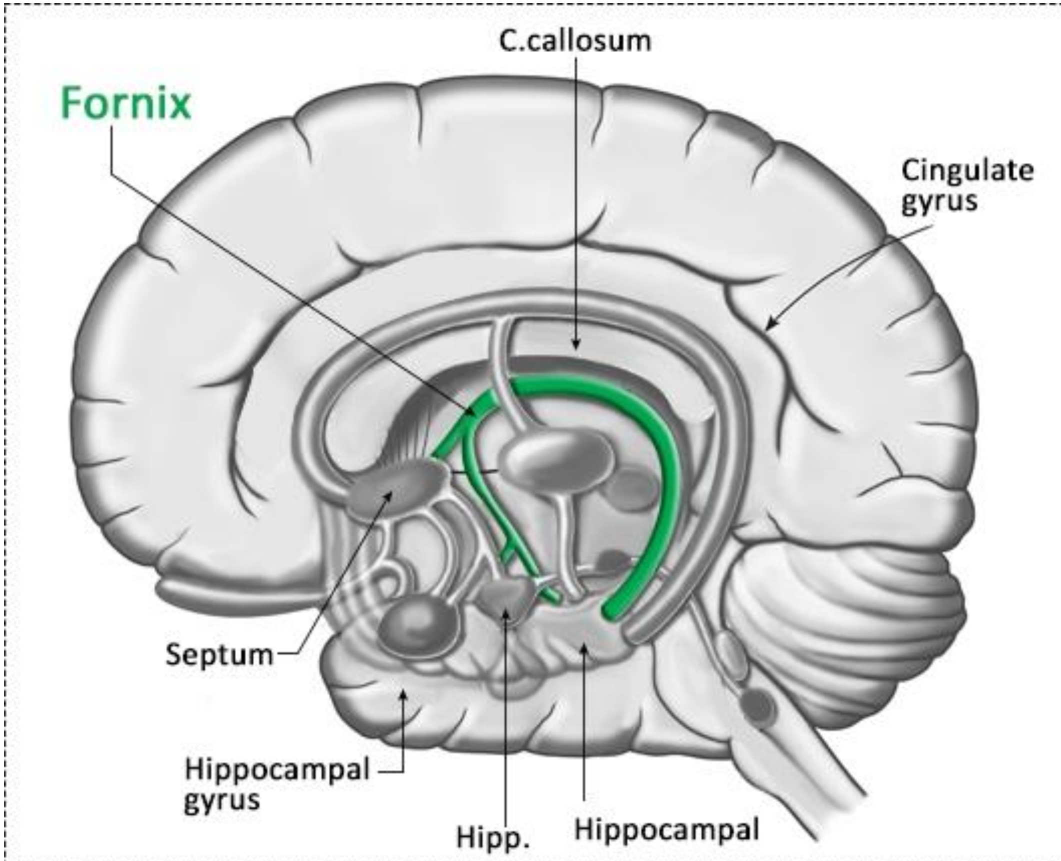
Arcuate Fasciculus

Critically involved in human language with **lower verbal comprehension** and **verbal IQ** scores



Cingulum Bundle

Correlated with **depressive** and **dissociative** symptoms



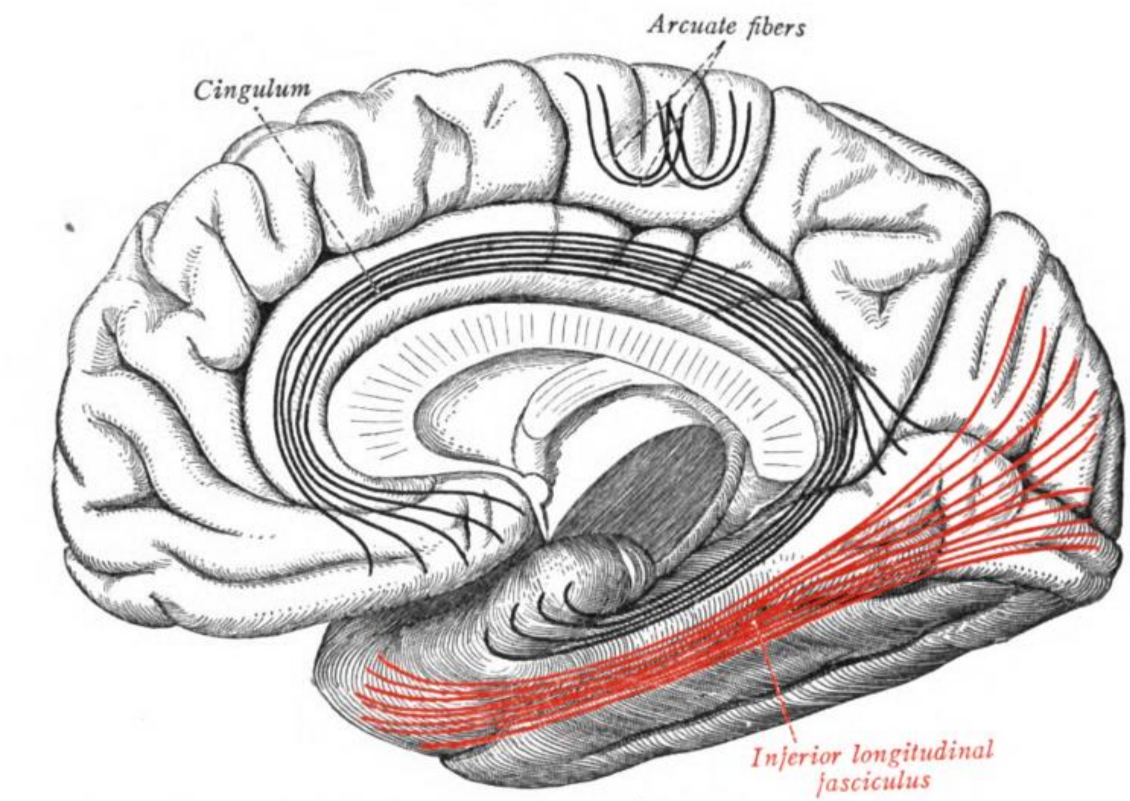
Fornix

Associated with symptoms of **anxiety** and **somatization**

Cerebral Cortex

- Region specific
  - Primary and secondary sensory cortex
    - Exposure to **witnessing** multiple episodes of **domestic violence** [especially between ages 7-13][1]
      - Left inferior longitudinal fasciculus: key component of the visual-limbic pathway → subserves **emotional, learning and memory functions** (specific to **vision**)[2]
        - » Correlated with depression, anxiety, somatization, 'limbic irritability' and neuropsychological measures of processing speed
      - Right lingual gyrus: early processing component of the visual system involved in **visual memory for shapes, faces and letters**
        - » Involved in **nonconscious** processing [especially ages 11-13][3]

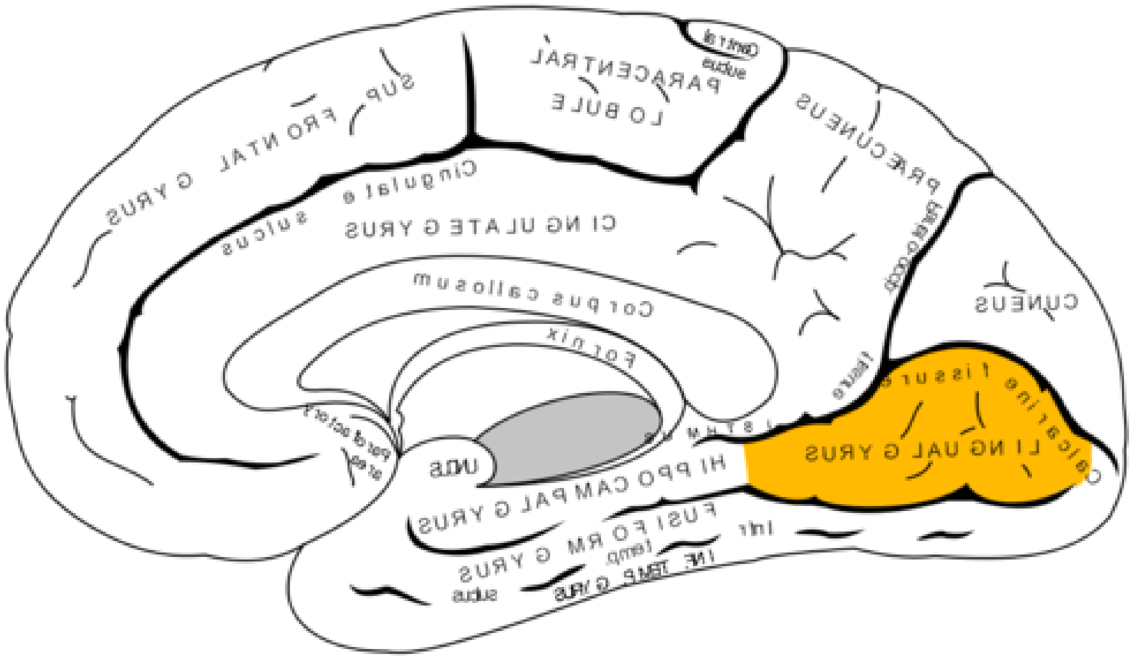
1. Choi, J et al. Reduced fractional anisotropy in the visual limbic pathway of young adults witnessing domestic violence in childhood.
2. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.
3. Tomoda, A et al. Reduced visual cortex gray matter volume and thickness in young adults who witnessed domestic violence during childhood.



Inferior Longitudinal Fasciculus

Key component of the visual-limbic pathway → subserves **emotional, learning and memory functions** (specific to vision)

Correlated with depression, anxiety, somatization, ‘limbic irritability’ and neuropsychological measures of processing speed



Lingual Gyrus

Early processing component of the visual system involved in **visual memory** for shapes, faces and letters

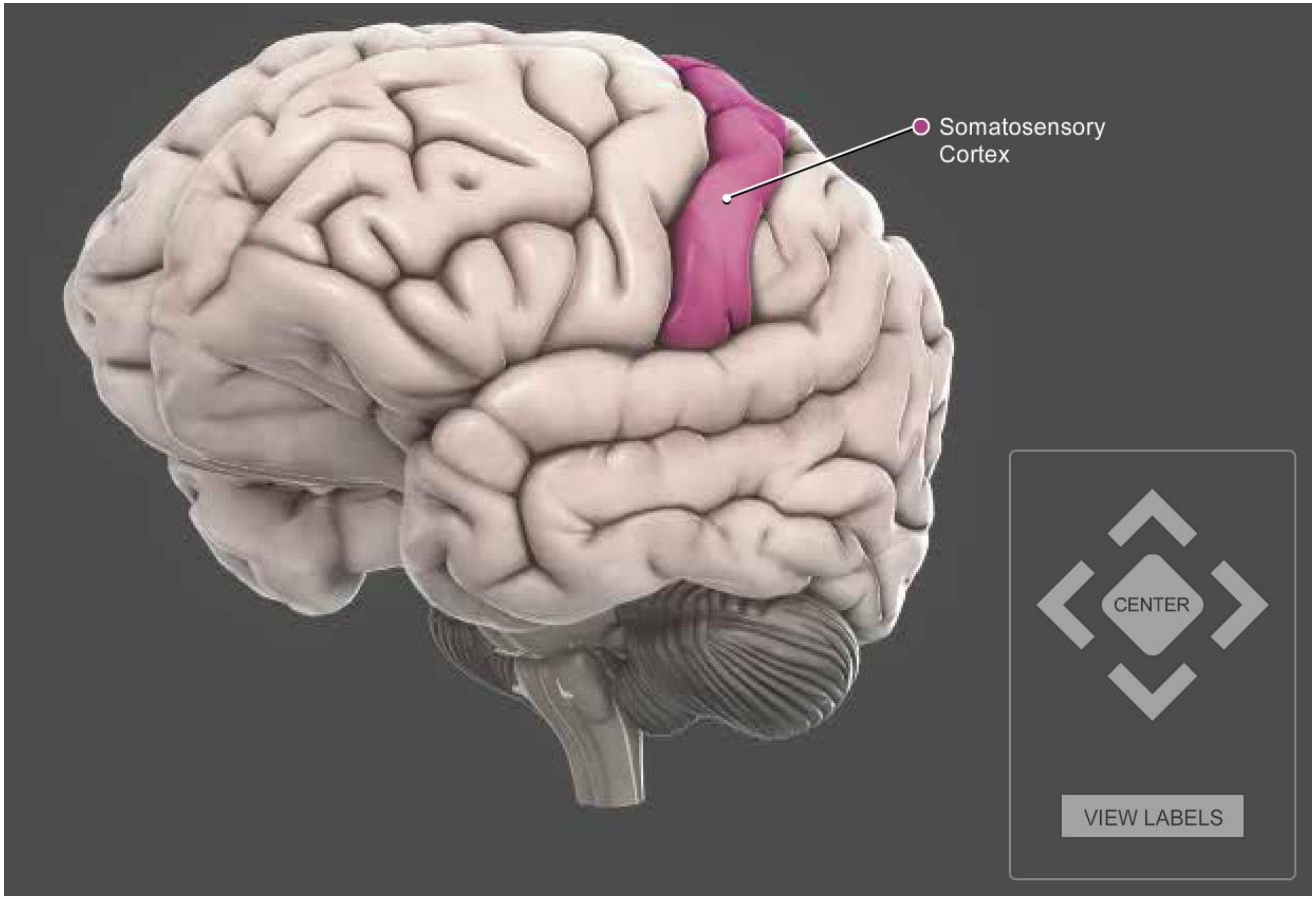
Involved in nonconscious processing [especially ages 11-13]

Cerebral Cortex

- Region specific
  - Primary and secondary sensory cortex
    - Exposure to childhood **sexual abuse** was specifically associated with thinning of the portion of **somatosensory cortex** representing the clitoris and surrounding **genital area**[1]

Heim, CM et al. Decreased cortical representation of genital somatosensory field after childhood sexual abuse.

Somatosensory Cortex



Genes to Cognition. Accessed at http://www.g2conline.org/

Cerebral Cortex

- Region specific
  - Primary and secondary sensory cortex[1]
    - Exposed to **single type of maltreatment**: possible that brain regions and fiber tracts that process, convey adverse sensory input of the abuse may be **specifically modified** by this experience
    - Exposure to **multiple types of maltreatment**: more commonly produce alterations in corticolimbic regions involved in **emotional processing and stress response**

1. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.

Cerebral Cortex

- Region specific
  - Primary and secondary sensory cortex[1]
    - Changes in maltreated individuals represent ***modifications or adaptations*** rather than nonspecific damage
      - Neuroplastic cortical adaptations may protectively **shield** a child from the **sensory processing** of the specific abusive experience[2]
        - » But thinning of the somatosensory cortex may lead to the development of behavioral problems
        - » May lead to **impairments in verbal comprehension, visual recall and emotional responses to witnessed events** later in life

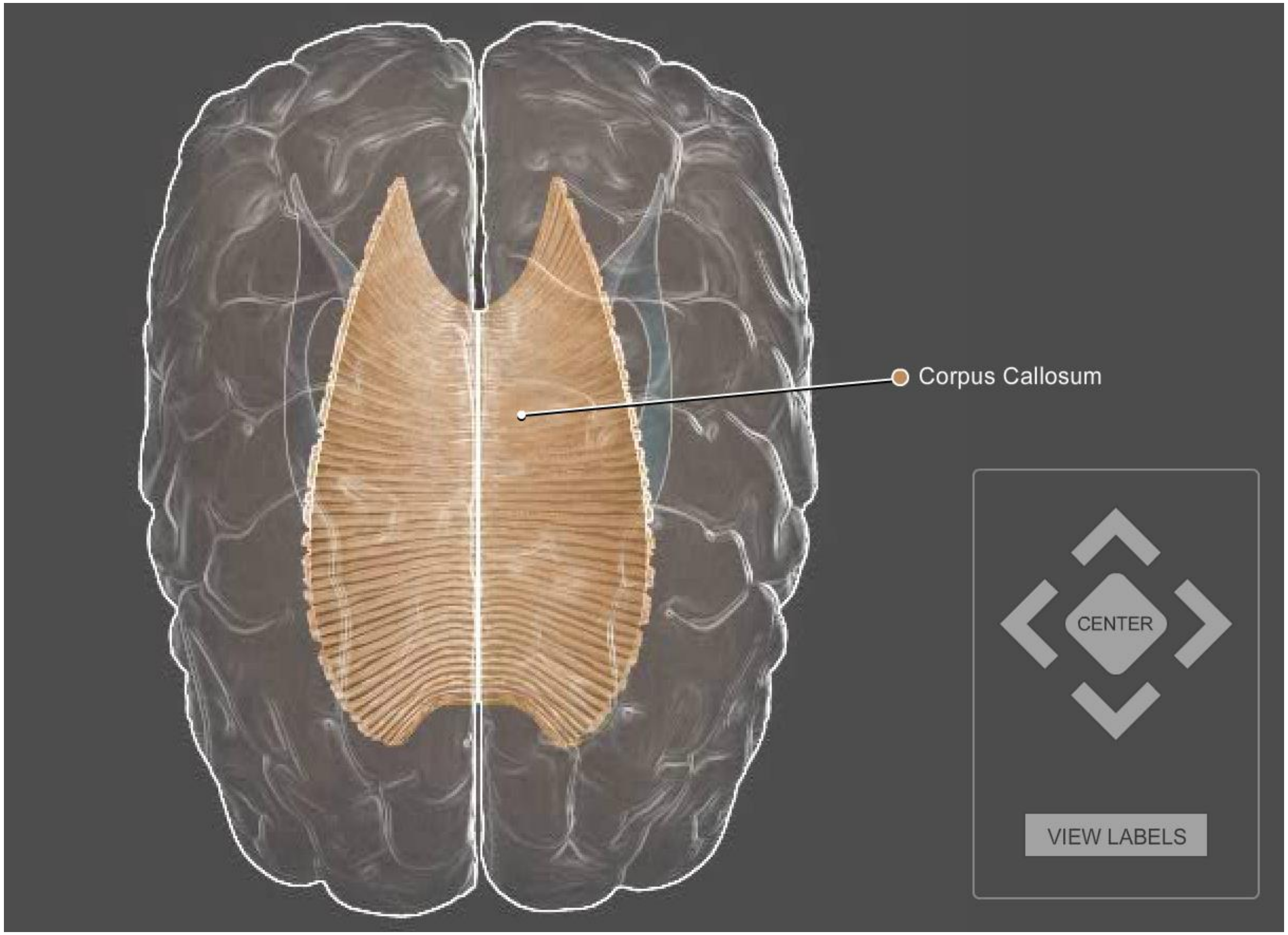
1. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.
2. Heim, CM et al. Decreased cortical representation of genital somatosensory field after childhood sexual abuse.

Cerebral Cortex

- Region specific
  - Corpus callosum: largest white matter tract[1]
    - Critically important role in **inter-hemispheric communication** (particularly between contralateral cortical regions)

Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.

Corpus Callosum



Genes to Cognition. Accessed at http://www.g2conline.org/

Cerebral Cortex

- Region specific
  - Corpus callosum:
    - **Reduced** in maltreated children[1-3] and adults[4,5]
      - Reduced 2x greater in boys than girls[1-3,6,7]
      - Most susceptible to neglect in males and to sexual abuse in females[3]
    - Potential reversibility of the effects of early neglect on the corpus callosum[8]

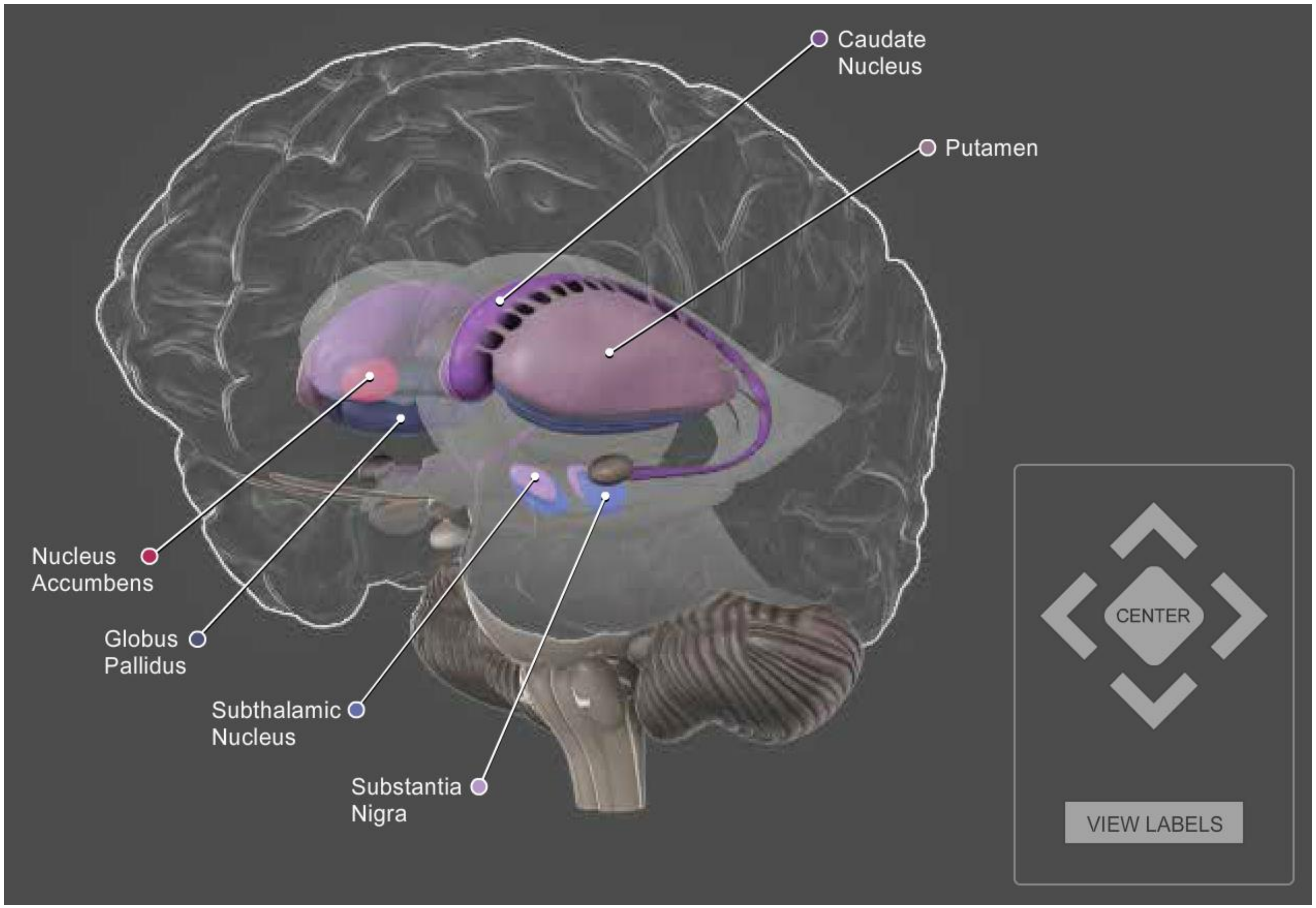
1. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.
2. De Bellis, MD et al. Developmental traumatology. Part II: Brain development.
3. De Bellis, MD et al. Brain structures in pediatric maltreatment-related posttraumatic stress disorder: A sociodemographically matched study.
4. Teicher, MH et al. Childhood neglect is associated with reduced corpus callosum area.
5. Andersen, SL et al. Preliminary evidence for sensitive periods in the effect of childhood sexual abuse on regional brain development.
6. Teicher, MH et al. Hurtful words: Association of exposure to peer verbal abuse with elevated psychiatric symptom scores and corpus callosum abnormalities.
7. Bellis, MD et al. Brain structures in pediatric maltreatment-related posttraumatic stress disorder: A sociodemographically matched study.
8. Teicher, MH et al. Preliminary evidence for abnormal cortical development in physically and sexually abused children using EEG coherence and MRI.
9. Sheridan, MA et al.. Variation in neural development as a result of exposure to institutionalization early in childhood.

Cerebral Cortex

- Region specific
  - Striatum: **inconsistent** results (sometimes decreased, sometimes no change)
    - May not be sensitive to early life stress
    - Possibly different age and gender effects

Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.

Basal Ganglia (Striatum)



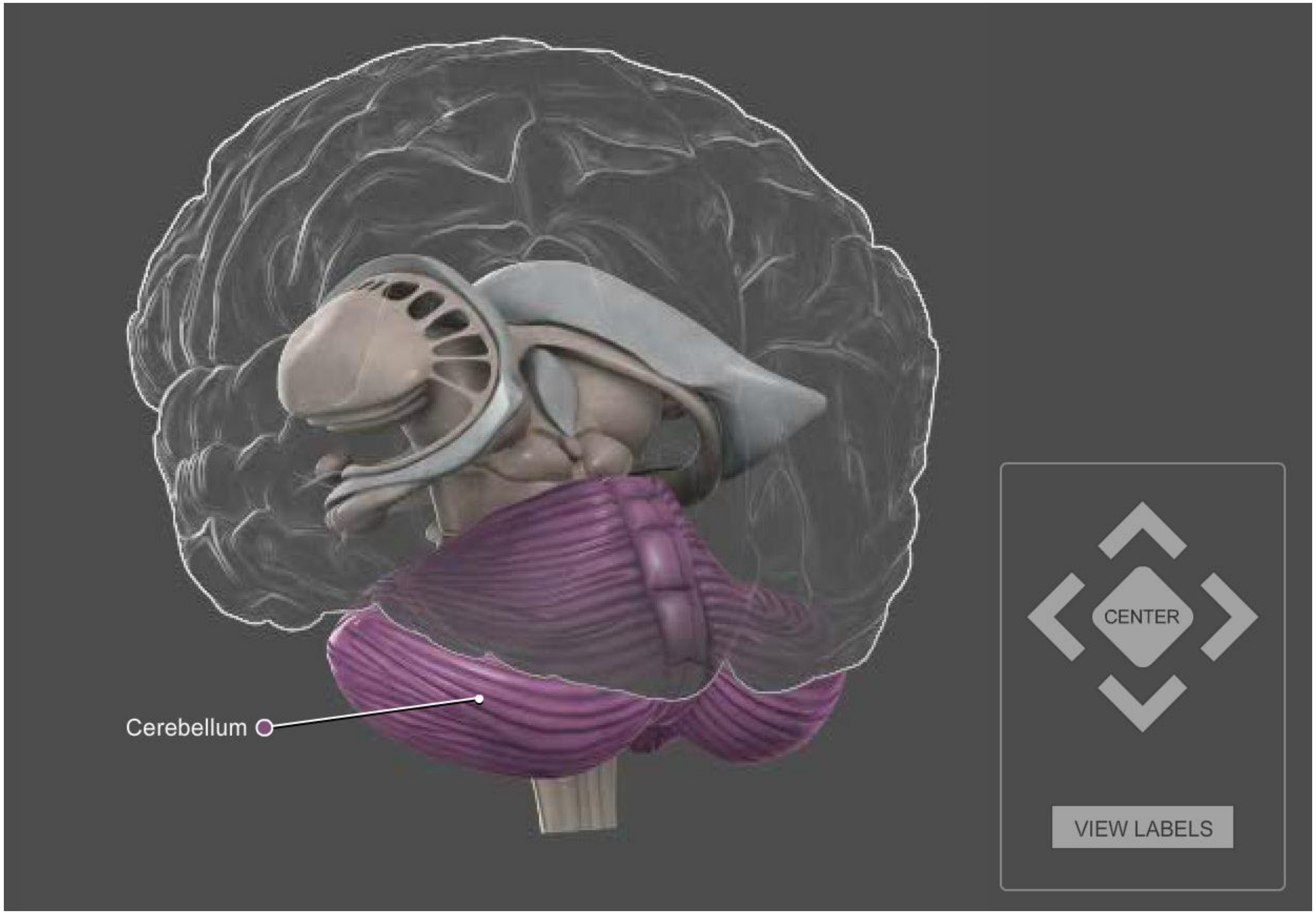
Genes to Cognition. Accessed at http://www.g2conline.org/

Cerebral Cortex

- Region specific
  - Cerebellum: should be **highly susceptible to early** life stressors; research shows usually lower volume in maltreated[1]
    - Highest density of glucocorticoid receptors during the neonatal period in rats[2]
    - Postnatal neurogenesis occurs in cerebellum[3]
    - Exposure to high levels of glucocorticoids during early development exerted a more persistent effect on cerebellar than hippocampal volume in rats[4]

1. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.
2. Pavlik, A & Buresova, M. The neonatal cerebellum: The highest level of glucocorticoid receptors in the brain.
3. Walton, RM. Postnatal neurogenesis: Of mice, men, and macaques.
4. Ferguson, SA, & Holson, RR. Neonatal dexamethasone on day 7 causes mild hyperactivity and cerebellar stunting.

Cerebellum



Genes to Cognition. Accessed at http://www.g2conline.org/

Cerebral Cortex

- Region specific
  - Cerebellum: should be highly susceptible to early life stressors; research shows usually lower volume in maltreated[1]
    - Vermis in particular seems to be susceptible region
      - » Autism[2]
      - » Schizophrenia[3]
      - » Bipolar disorder[3]
      - » MDD[3]
      - » ADHD[3]

1. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.
2. Courchesne, E et al. Hypoplasia of cerebellar vermal lobules VI and VII in autism.
3. Baldacara, L et al. Cerebellum and psychiatric disorders.

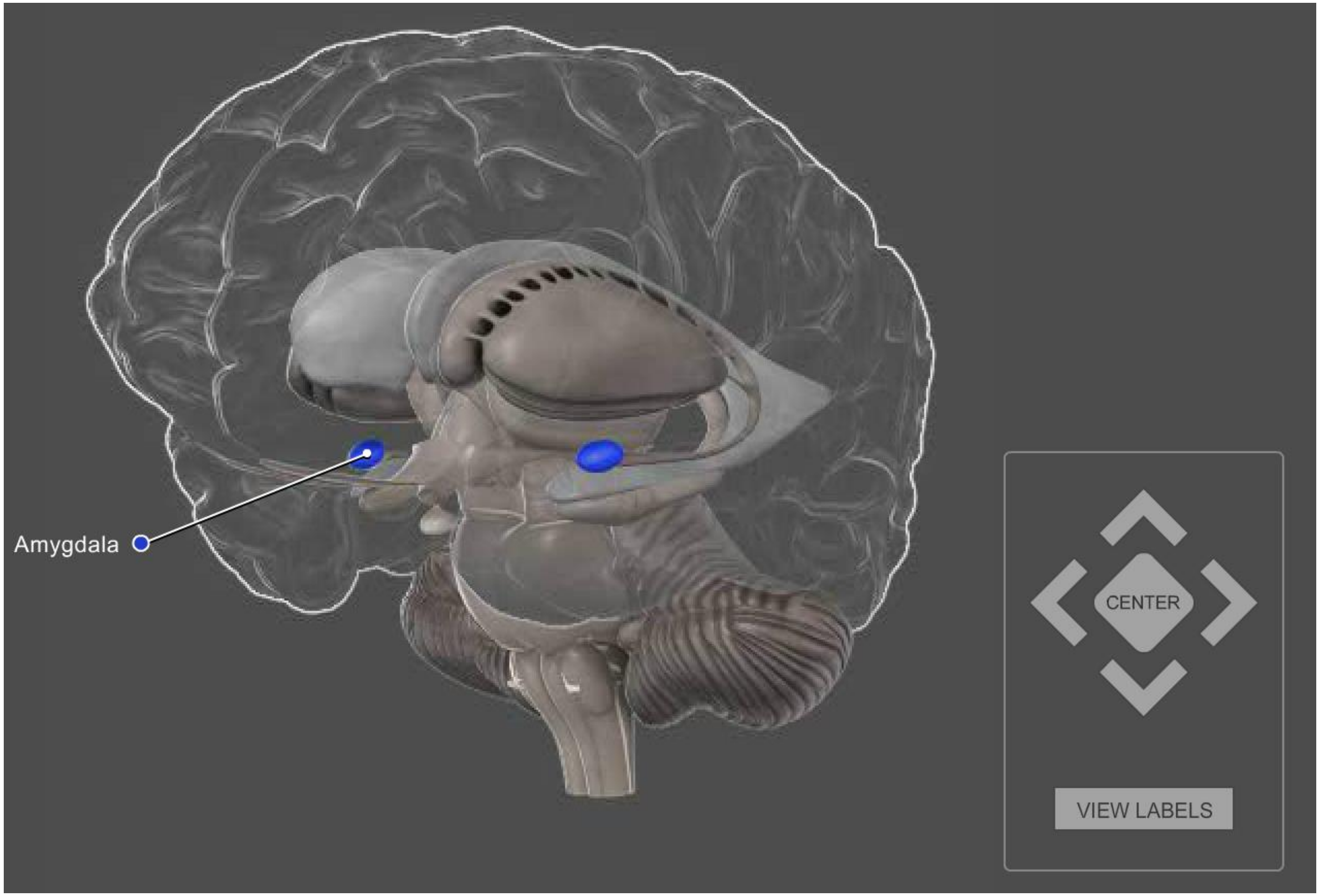
Differences in Structure and Function for Those Maltreated

Functional Differences

- Differences in response to facial expressions
  - Maltreated = increased amygdala reactivity to emotional faces

Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.

Amygdala

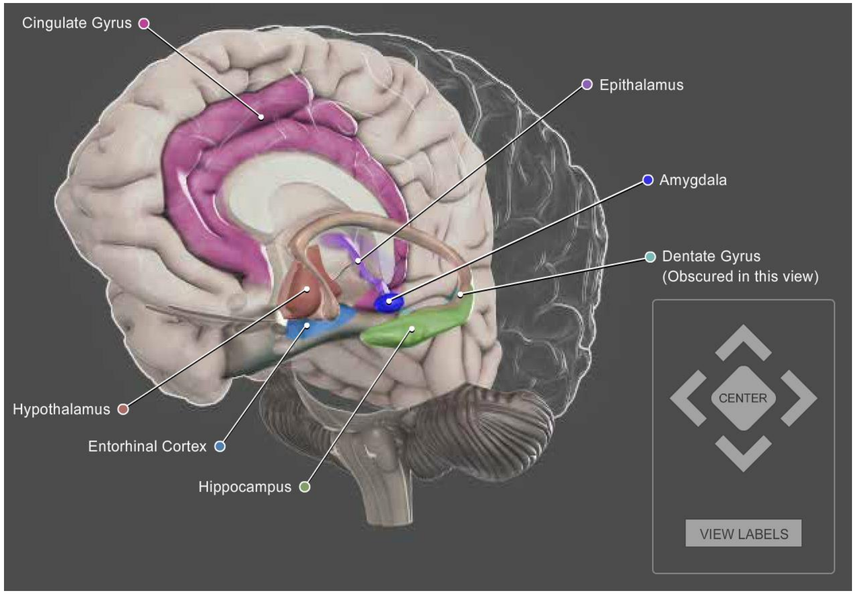


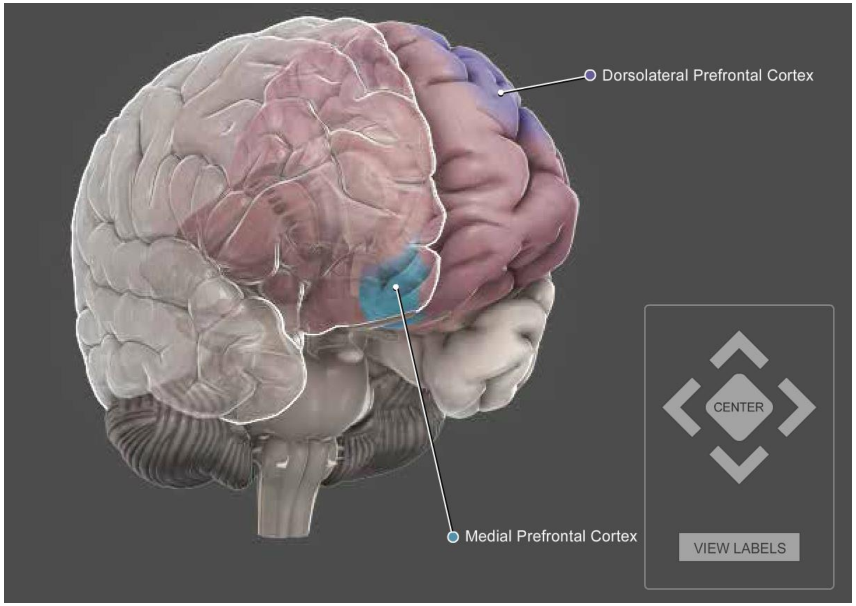
Genes to Cognition. Accessed at http://www.g2conline.org/

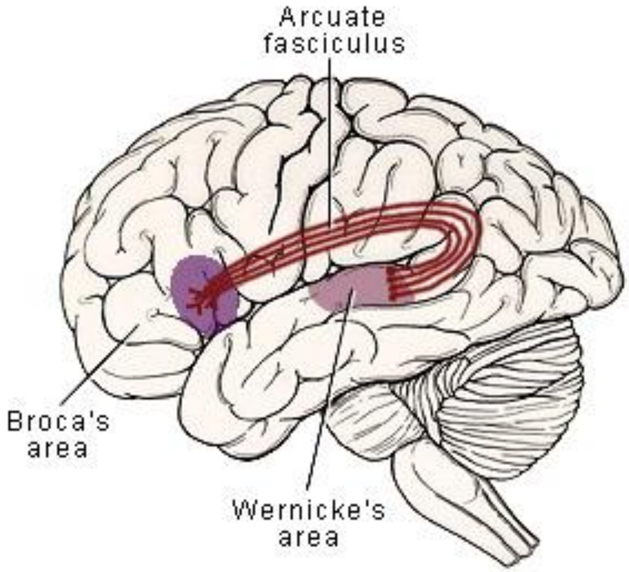
Functional Differences

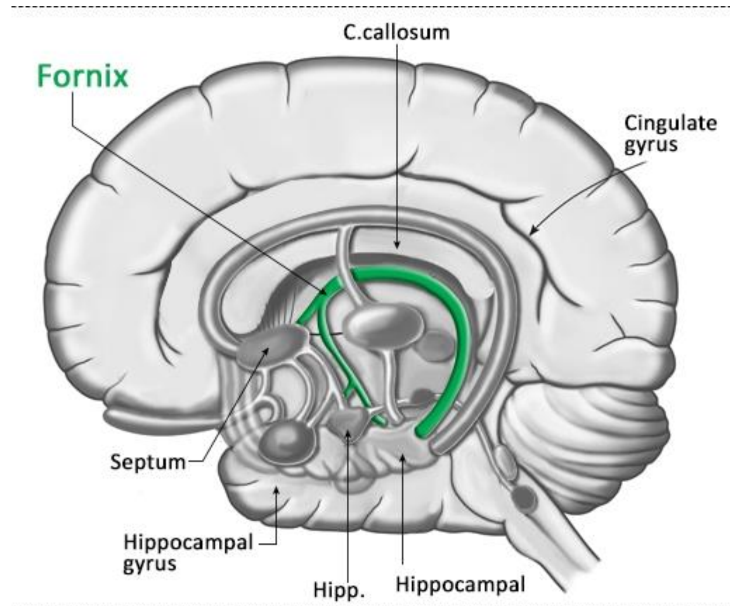
- Altered response to threatening stimuli
  - Thalamus, visual cortex, anterior cingulate cortex, ventromedial prefrontal cortex, amygdala and hippocampus
  - Decreased integrity of fiber tracts
    - inferior longitudinal fasciculus, superior longitudinal fasciculus/arcuate fasciculus, uncinate fasciculus, cingulum bundle and fornix.
  - Therefore: **most of the regions previously discussed** are also involved in **threat detection**

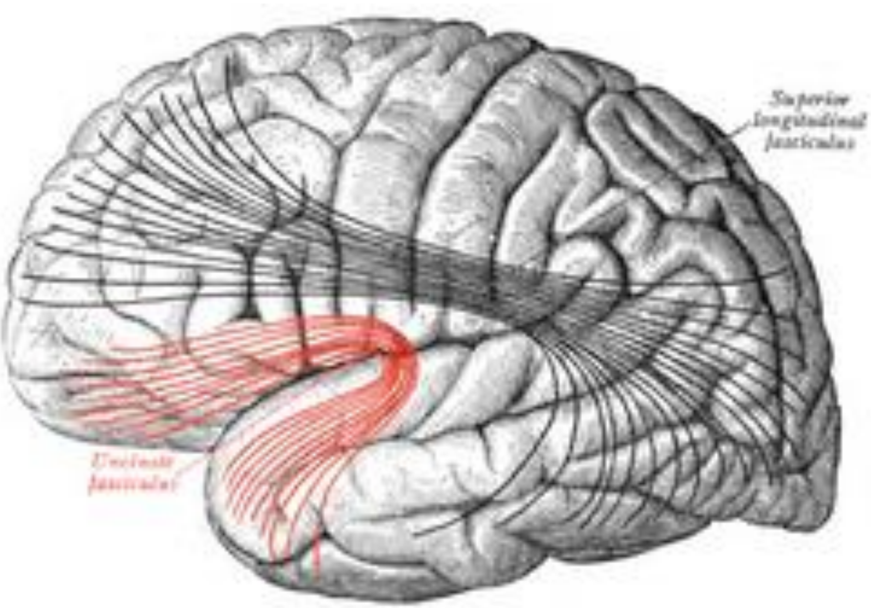
Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.

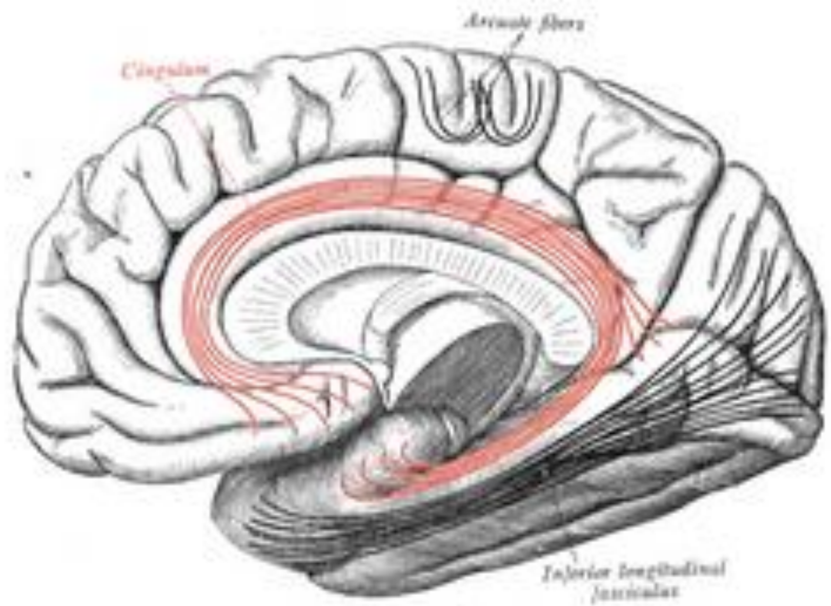

Cingulate Gyrus
Epithalamus
Amygdala
Dentate Gyrus
(Obscured in this view)
Hypothalamus
Entorhinal Cortex
Hippocampus
CENTER
VIEW LABELS


Dorsolateral Prefrontal Cortex
Medial Prefrontal Cortex
CENTER
VIEW LABELS


Arcuate fasciculus
Broca's area
Wernicke's area


C.callosum
Fornix
Cingulate gyrus
Septum
Hippocampal gyrus
Hipp.
Hippocampal


Superior longitudinal fasciculus
Uncinate fasciculus


Arcuate fibers
Cingulum
Inferior longitudinal fasciculus

Functional Differences

- Therefore: changes in brain regions may be **adaptive modifications** to trauma → **enhanced threat detection, more rapid recognition of fearful stimuli**[1,2]
  - Circuit: **rapidly** responsive **nonconscious** subcortical path and a **slower conscious** cortical path to the amygdala
  - Maltreatment-related alterations in sensory cortex: diminish the influence of the conscious component favoring **rapid but less nuanced** response via the subcortical pathway

1. Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.
2. Masten, CL et al. Recognition of facial emotions among maltreated children with high rates of post-traumatic stress disorder.

Functional Differences

- Differences in sensitive exposure periods of different regions
  - Range: hippocampus (3-5 years old) to prefrontal cortex (14-16 years old)
    - Therefore: Because multiple different regions involved in these circuits → **can have multiple different reasons for same overall outcome**

Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.

Functional Differences

- Reward anticipation
  - Areas involved: Many of the same ones we have just covered
  - Again, may of these regions affected in those with maltreatment
  - Overall: **reduced response to anticipatory reward**
    - May be adaptive: if decrease belief that an action will be rewarded, more likely to **avoid** (like avoiding things that lead to maltreatment)

Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.

Network Architecture

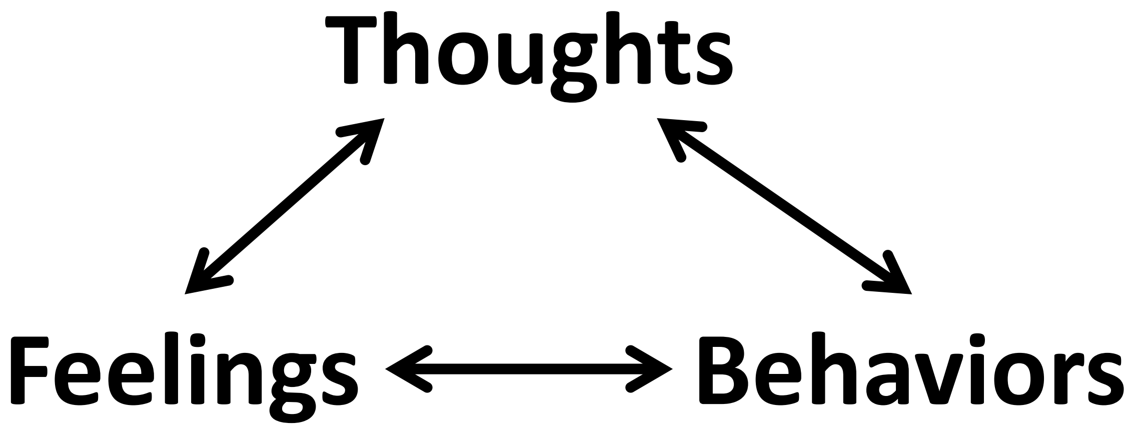
- Maltreated individuals have **diminished** capacity to:
  - Regulate impulses and emotions
  - Accurately attribute thoughts and intentions to others
  - Be mindful of oneself in a social context
- Maltreated individuals have **increased**
  - Experience of internal emotions and cravings
  - Greater tendency to think about oneself and to engage in self-centered mental imagery

Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.

Network Architecture

- Therefore: neurobiological explanations for why psychotherapy for these individuals focuses on:
  - Enhance emotional regulation
  - Correct misconceptions about self and others
  - Diminish focus on internal feelings and to reduce harmful self-centered thinking

Teicher, MH & Samson, JA. Annual research view: Enduring neurobiological effects of childhood abuse and neglect.


Thoughts
Feelings
Behaviors

Summary

Summary

- There are many effects that come with maltreatment, including both direct and indirect effects of domestic violence
- While there are clear associations between chronic trauma and the development of PTSD, maltreatment has far ranging consequences both in terms of cognitive development and the increased risk of a large variety of mental health disorders
- The focus here has been primarily "organic" changes that come with being a part of domestic violence → however, we are increasingly learning about the direct and indirect psychological consequences of these events

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Questions?

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