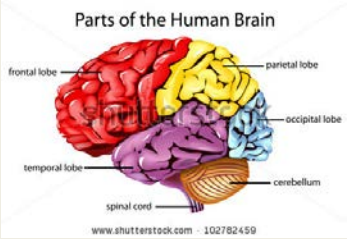
The human brain is awesome.

It functions 24 hours a day from the day we are born and only stops when we are taking an exam or FALL IN LOVE!

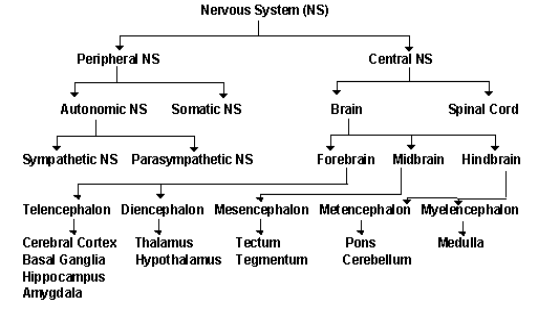
Clinical Applications of Neuroscience



Craig Strickland, Ph.D. cstrickland1977@gmail.com

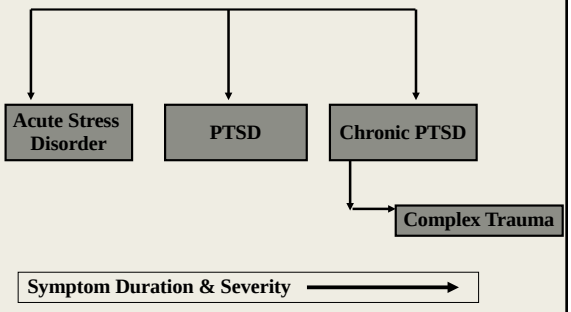
Winden Rowe, MS winden@hessandrowe.com

Overview of the Human Nervous System



Identify things/events, etc. you think may change brain structure or function

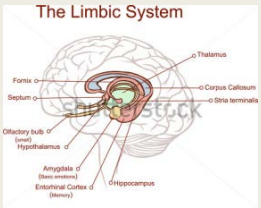
Trauma as seen on a continuum



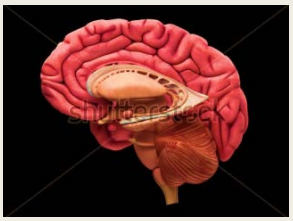
The Hippocampus and Traumatic Exposure

CNS: Limbic System

- Central role in emotional "modulation": amygdala
- Connects brainstem & "higher" cortical structures
- Integrates emotion, memory and behavior
- Limbic system dysfunction & behavioral health



Hippocampus

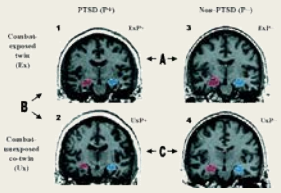


Normal Functions of the Hippocampus

- The hippocampus is a very complex structure
- Is part of the Limbic System
- Considered "transitional" tissue
- Normal functions include (but may not be limited to)
  - *Memory consolidation: works together with newer cortical brain areas*
- Integration of "emotional tone" with "higher" cognitive functions
- Cortex provides semantic influence to the more episodic (factual) "hippocampal" memories
  - *Behavioral inhibition*
  - *Inhibitory influence on brainstem activity*

The Hippocampus & Trauma

- Original studies: decrease volume (size) of the hippocampus
- Vietnam vets: 8 to 26% reduction depending on the study
- 7% reduction in women with history of childhood sexual abuse
- 16% reduction in hippocampal volume in women with BPD (often associated with a history of abuse)
  - *Gilbertson, et. al. (2002): twin studies- Chicken/Egg question (image from original study)*



Chicken or Egg?

- Apfel, et. al. (2011)
  - *Gilbertson study did not contain true longitudinal data*
  - *This of course would be nearly impossible to do in this type research*
  - *Apfel study looked at hippocampal volume in 244 male Gulf War Veterans*
- Study included those with current PTSD and those where the symptoms of PTSD were remitted

Chicken or Egg? (cont.)

- In addition to measuring symptoms of PTSD (using the Clinician Administered PTSD Scale (CAPS) assessment tool:
  - *Measured presence or absence of depression*
  - *Measured lifetime drinking history*
  - *History of other (non-combat related) stressors*
- Used structural MRI techniques to measure hippocampal volume

Chicken or Egg? (cont.)

- Ended up with four groups of subjects
  - *Subjects with no traumatic exposure*
  - *Subjects with exposure but no PTSD*
  - *Subjects with a previous diagnosis of PTSD but have recovered*
  - *Subjects with chronic PTSD (lifetime and current)*
- The first two groups had identical hippocampal volume and were combined into one group for the further analysis

Chicken or Egg? (cont.)

- Results
  - *Subjects with current/lifetime PTSD*
- Subjects with current/lifetime PTSD had smaller hippocampi by 5.1% than those who had never developed PTSD
- 6.5% smaller hippocampi than those who had recovered from PTSD
  - *Note: there was no difference in hippocampal size between those who never had PTSD and those who had recovered from PTSD*
- Interpretations?

Chicken or Egg? (cont.)

- The significant differences remained even after accounting for the following factors:
  - *Early life trauma*
  - *Current and lifetime alcohol use*
  - *Depression and treatment with antidepressants*
- Thus, a smaller hippocampus cannot be a vulnerability factor (e.g. a genetically driven cause) of PTSD; if this were the case, the group that recovered should have a hippocampal size that is smaller than those who never developed PTSD. This finding does NOT mean that hippocampal size is NOT related to the symptoms of PTSD

Chicken or Egg? (cont.)

- The results raise the possibility that hippocampal volume is state-dependent and might vary over time e.g. the hippocampus may itself recover from the effects of PTSD; support for this interpretation?
  - *Duration & severity of PTSD symptoms are negatively correlated with hippocampal volume*
  - *Hippocampal volume can increase as a result of long-term Paxil treatment*
  - *Hippocampal volume might change as a result of exercise, other medications and abstinence from alcohol*
- E.G. Neurogenesis

Another Interpretation of the Data

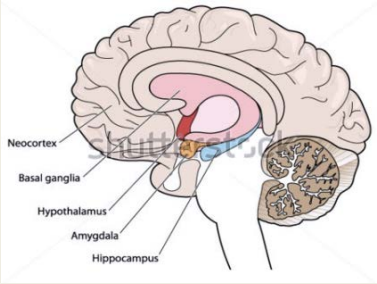
- People who recover from PTSD or who recover more readily may not have experienced a smaller hippocampal volume
- However, those who have the smaller (perhaps genetically driven) hippocampi are
  - *More prone (higher risk) to develop PTSD which may be more treatment resistant*
  - *Thus a smaller hippocampus would be detrimental to recovery*
- Bottom line: does this study show a causal effect of a smaller hippocampus on the development of PTSD?

Symptoms Associated with Hippocampal Damage? (Re-experiencing)

- Dissociation and/or intrusive thoughts
- Illusions and/or hallucinations
- Behavioral disinhibition: causes the definition of incoming stimuli towards fight/flight responses
- Along with amygdaloid activation, hippocampal damage may prevent proper evaluation & categorization of experiences/stimuli
  - *May lead to reacting to new or neutral stimuli as threatening*
  - *This would lead to either aggressive behavior or possibly to withdrawal*

The Limbic System and PTSD:
The Amygdala

Limbic System: The Amygdala



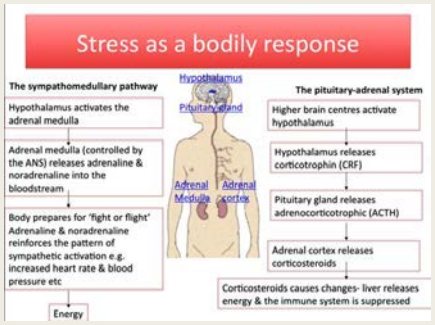
Normal Functions of the Amygdala

- Normal amygdala functioning
  - *Evaluates the emotional significance of incoming stimuli (emotional meaning)*
  - *Amygdala activated by feared stimuli (conversely, destroying the amygdala through surgery eliminates fear responses)*
  - *Amygdala mediates fear related behaviors*
- Does so through the hippocampus, hypothalamus and certain cortical areas (prefrontal cortex)
- E.g. has an “upstream” and “downstream” effect

Symptoms associated with Amygdaloid hyperactivity (hyperarousal)

- Neutral stimuli are seen as fearful
  - *Through connections with other limbic structures, enhanced autonomic and neurohormonal responses*
- Increased sympathetic nervous system activity
- Hypervigilance
- Exaggerated startle response
- Irritability or outbursts of anger
- Destruction versus stimulating the amygdala
- Increased Hypothalamic/Pituitary Adrenal axis activity (known as HPA)

The HPA and the Sympathetic Nervous System & Limbic Involvement



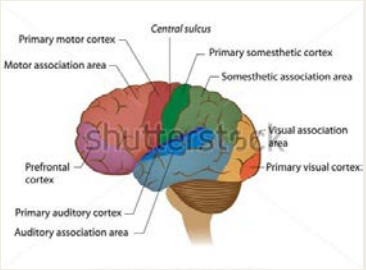
Taken from Bing Images 2017

Fear Extinction

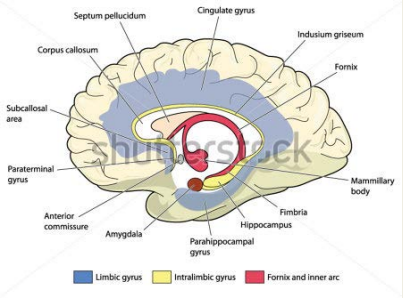
Brain Areas Involved in Fear Extinction

- Ventromedial Prefrontal Cortex (vmPFC)
- Hippocampus
- Amygdala
- Entorhinal Cortex
- Anterior Cingulate Cortex

Extinction: vmPFC



Anterior Cingulate Cortex: Extinction



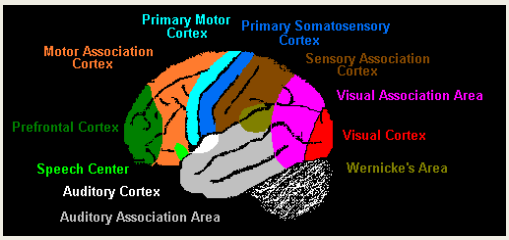
Lack of ability to extinguish conditioned emotional response

- Decrease in activity in the vmPFC and/or decrease in hippocampal and/or portions of anterior cingulate cortex (ACC)
- In fact, direct correlation between ACC volume and treatment response to extinction therapy
- Amygdala: amygdala activity should change as relationship between a stimulus and it's consequence changes (e.g. CS+ or CS-) through learning

DISSOCIATION

Dissociative Phenomena (cont.)

- "Physiologically, they may respond as if they are being traumatized again, but this may be dissociated from semantic knowledge" (van der Kolk, 1997)

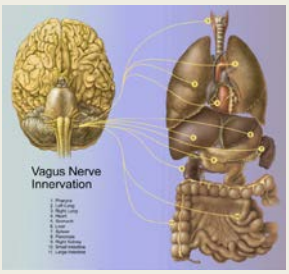


Dissociative Phenomena (van der Kolk)

- Failure of left-hemisphere functioning at the time of the trauma (i.e. during extreme arousal)
  - *Decreased activation of Broca's area (Broca's area is involved in labeling emotions)*
- Cannot communicate what is going on, cannot label the internal state
- Thus, during extreme arousal/intense emotions, the individual cannot "understand" what is going on
  - *Left-hemisphere: also involved in sequencing events and categorizing experiences. Dysfunction leads to:*
- Trauma being seen as timeless
- Trauma being seen as "ego-alien"

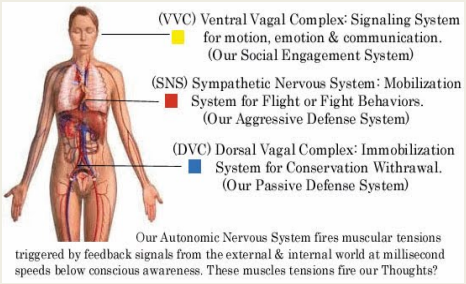
SOCIAL ASPECTS OF TRAUMATIC EXPOSURE

Polyvagal Theory, Vagal Nerve Stimulation (VNS) and Trauma & Depression



Picture provided by
Peter Jurek, MA, MS
http://www.peterjurek.com

Polyvagal Theory: Dr. Stephen Porges



Taken From Bing Images 2016

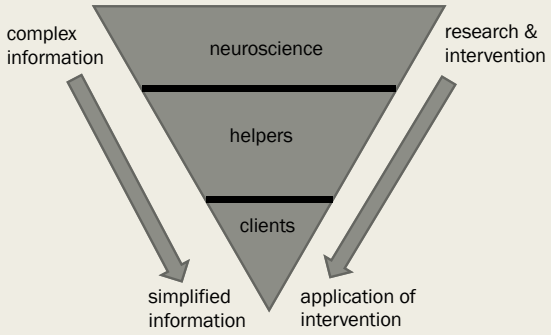
Social Engagement System (upper vagal branch)

- Changes in cardiopulmonary function
- Voice quality: prosody
  - *Intonation and tone*
  - *Stress and rhythm*
  - *Vocalizations in our pets (my lovely Noelle!)*
- Eye contact and movement
- Facial and head muscles

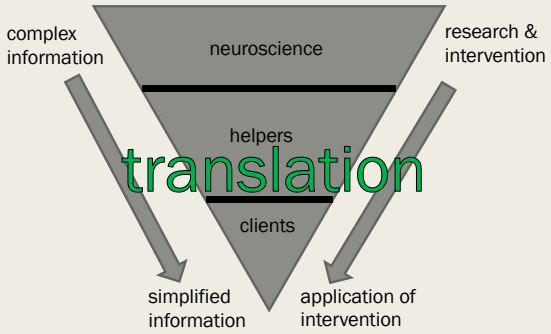
Polyvagal Theory in Practice: what can we do?

- Explain the roles the different systems play
- Educate that what their nervous systems/bodies are doing is based on survival, trying to keep the person safe (minimize disappointment, shame or anger about these biological responses)
- Discuss that interpersonal interactions can change nervous system function
- Minimize “older” circuit activity

Review and repackaging



Review and repackaging



trauma treatment

- Helping clients to get answers to:
  - What will work?
  - When do I do this work?
  - At what stage?
  - How will it work?
  - And why are you suggesting this treatment?
- However… A cautionary thought:
  - Trauma treatment is ***always always always*** POST-trauma. Otherwise what we are doing is essentially PFA (psychological first aid)

trauma treatment

- Begins once the traumas have ended
- Helping clients to get answers to:

  - What will work?

- Before *we (the helpers)* can get to that we have to make sure we are properly oriented in order to best intervene

Self-care enhances and creates the proper environment for effective and sustained treatment and recovery.

The Society for the Advancement of Psychotherapy December 2014

Babette Rothschild's Foundations framework

- Goals orientation when working with trauma

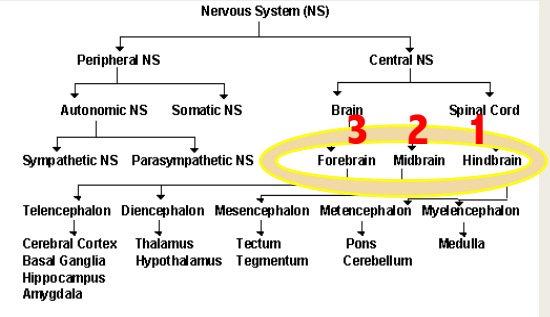
  - *The **primary** goal of trauma **recovery** is to improve on the individual's daily quality of life whereas….*
  - *The **ultimate** goal of trauma recovery is help the mind **and the body** realize that the trauma is over and to help intrusive memories find an appropriate place to be stored away (not deleted)*

Image borrowed from Linkedin 2016

INTERVENTION

Image borrowed from Linkedin 2016

Review of the Human Nervous System



Judith Herman's Stages of Recovery for Trauma (complex)

1. Stabilization, safety (**1-** hindbrain)
2. Remembering and mourning (**2-** midbrain)
3. Meaning and reconnection (**3-** forebrain)

Stage 1 impact of trauma

- Hindbrain - brain stem activity
  - *Instinctual reactions*
  - *Autonomic dysregulation*
    - Heartrate elevates
    - Shallow breathing
    - Slowed digestive processes
    - Hypertension
    - Swallowing
    - Blood pressure

Stage 1 recovery & interventions

- Brain stem responses - need to relearn regulation – CONTAINED
- Stabilization and Safety
  - *Yoga*
  - *Breath work*
  - *Grounding exercises*
  - *Tai chi*
  - *Simple sharing of daily events*
  - *Body scanning, mapping*
  - *Posturing exercises*
  - *SSRI and other pharma for short-term*
  - *Mindfulness of somatic expression*
  - *Considerations for early recovery*

Stage 2 impact of trauma

- The midbrain - limbic system

- *Survival*
- *Sensing and responding*
- Fight, flight, freeze
- *Interpretation of information*
- *Assessment of internal and external environments*
- *Sequencing*
- *Alarm on without switching off*
- *Emotional tagging and rating*

Image borrowed from Victoria Stillwell Online, 2016

Stage 2 recovery & interventions

- The midbrain- limbic system
- Remembrance and Mourning - less containment

- *Feeling identification*
- *Guided imagery*
- *Memory integration exercises*
- *Timelining*
- *Emotional responses to stress*
- *EMDR (!)*
- *TFCBT*
- *DBT*
- *Mindfulness (of thought, of feeling)*
- *Early 12 Step recovery*

Stage 3 impact of trauma

- The forebrain

- *Recalling facts and information*
- *Accurate details of events*
- *Verbal expression*
- *Recognition of time*
- *Understanding environment*
- *Verbal recognition*
- *Social isolation*
- *Inability to ID accurate self-concept*
- *Memory consolidation*

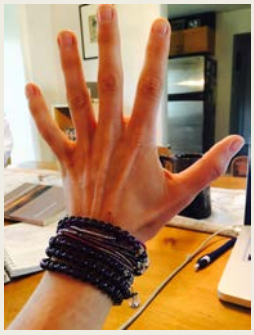
Stage 3 recovery & considerations

- The forebrain
- Meaning and reconnection – open processing

- *Cognitive processing*
- *Self expression*
- *Self actualization*
- *Posttraumatic growth*
- *Making connections*
- *DBT*
- *TFCBT*
- *Mindfulness (open thought meditation)*
- *12 Step (later steps)*

Image borrowed from Happy OnePlus Forums online, 2016

Siegel's Hand Model of the Triune Brain



Optimal functioning incorporates all parts

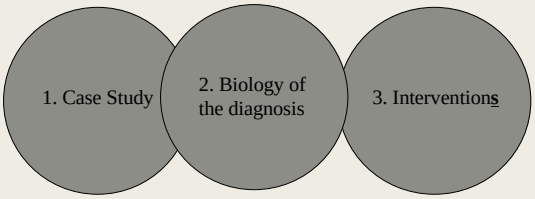
Mindsight: Transform Your Brain with the New Science of Kindness, Daniel Siegel, Oneworld Publications, 2010

Useful language

- ADAPTED – **not** broken, damaged
- TYPICAL/ATYPICAL – **not** abnormal, disordered
- GROUND – **not** control, calm down
- PLASTICTY – **not** broken
- FIGHT, FLIGHT, FREEZE – ID responses
- RECOVERY - not illness, disease

Trauma Essentials: The Go-To Guide By Babette Rothschild W. W. Norton and Company: April 11, 2011

Case Study Exercise



*and considerations for self-care

Case Study Exercise

1. What important factors did you perhaps overlook when first considering this case? For example, are there any resources that you could offer in addition to current interventions? Community resources?
2. Is this individual post-trauma or perhaps still actively engaged in toxic environments? If so, what are important considerations to address with yourself/that client?
3. Regarding the neurobiology of trauma and presenting symptoms, what adjustments would you make regarding intervention, why, and how would you explain that to your client?

Case Study Exercise

4. What changes could you make in your language use in order to best support the client's self-concept and how they see the trauma and its impact?
5. And most of all, what are ways that you can engage in self-care before, during, and after treating this case?