Posttraumatic Stress Disorder: Neurophysiology of Trauma

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Time course of reactions

Traumatic event

Acute stress reaction first 48 hours
Acute stress disorder up to 4 weeks
Acute PTSD 4-12 weeks
Chronic PTSD 12 weeks +
Bremner hypothesized that hippocampal damage represents the anatomical basis for the psychological effects of stress. (mind-body perspective)

Data from MRI studies showed an 8% reduction of left hippocampal volume in Vietnam vets and similar decreases in the right sides of physically and sexually abused women.
LeDoux, Scientific American, 1994
The Neurophysiology of PTSD

Cortex

PFC

Sensory Thalamus

Amygdala
TWO PATHWAYS OF FEAR

• When the brain receives a sensory stimulus indicating a danger, it is routed first to the thalamus.

• From there, the information is sent out over two parallel pathways:
  1. the thalamo-amygdallic pathway ("low road")
  2. the thalamo-cortico-amygdallic pathway ("high road").
The "high" road

The "low" road

FEAR

Thalamo-cortico-amygdalic pathway
Thalamo-amygdalo-fugal pathway
SNAKE?

VINE?
The Low Road

• conveys a fast, rough impression of the situation, because it is a sub-cortical pathway in which no cognition is involved.

• this activates the amygdala which, through its central nucleus, generates emotional responses before any perceptual integration has even occurred and before the mind can form a complete representation of the stimulus.
Phew! Vine
Pre-Trauma Processing of “ordinary” stimulus
Threat!!

Danger!!

Post-Trauma Processing of “ordinary” stimulus
Trauma produces an anatomical change in the brain

Post-trauma fear network in Amygdala
Post-trauma fear network in Amygdala

A landscape of fear-inducing cues
Neurobiology of Non-Traumatic Memory

Integrated Narrative
LTP builds the neural networks that create new memories

Neurobiology of Traumatic Memory
Neurobiology of Traumatic Memory

Hippocampus

Trauma interferes with LTP functioning

Results in loss & fragmentation of memories

Neurobiology of Traumatic Memory
Failure of Extinction in PTSD

• Extinction: Decrease in conditioned response due to nonreinforcement

• PTSD:
  » Inability to extinguish conditioned fear responses
  » Inability to distinguish between dangerous and safe situations
Battlemind: Dys-coordination of Threat Response & Dissociation

Medial Prefrontal Cortex
Anterior Cingulate Cortex

PFC bypass

dissociation

AMYGDALA

Hippocampus

Sights
Sounds

Thalamus

Smells

Coordinated Response