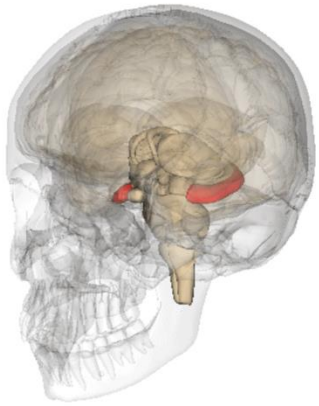
Trauma and the Brain

If the brain is likened to a supercomputer, as it often is, trauma is analogous to a virus that can disrupt normal functioning. In a general sense, trauma impacts both the structures in the limbic system, an ancient region of the brain; the prefrontal cortex, the most highly-evolved region of the brain; and the relationship between the two. There are further specificities that come with regards to the type and duration of trauma. This is a broad overview of how trauma impacts general neural function.

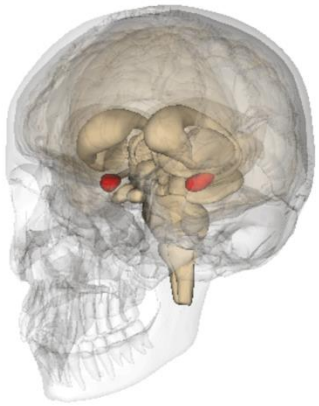


Hippocampus – Memory and Learning

The hippocampus is most notable for its roles in learning and memory. It is a dynamic structure, and one of the few brain regions that generates new neurons over the entire lifespan. This is a valuable mechanism in learning processes, but also leaves the hippocampus vulnerable to damage.

In response to stress, a small brain structure called the hypothalamus releases a hormone called cortisol. The hippocampus is much more responsive to cortisol than other brain regions. When cortisol is produced in excess—whether over a long period of trauma, or a surge after a short-lived trauma—it can overwhelm the hippocampus.

When trauma overburdens the hippocampus, hippocampal cells can begin to die. This impairs not only memory surrounding the event, but memory in general, and can impair learning as well. This is directly observable in those with post-traumatic stress disorder or severe depression, where the hippocampus is atrophied. With treatment, the progression of hippocampal damage can be slowed and even stopped.

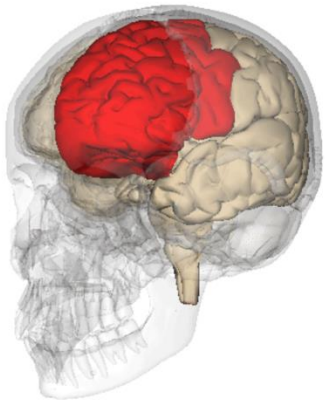


Amygdala – Fear and Emotional Memory

The amygdala mediates emotional responses, especially to strong emotional stimuli, and while it is primarily associated with fear and anger, the amygdala is also activated by intense happiness. While the hippocampus manages general memory processes, the amygdala works both alone and with other regions to manage memories that are emotional in nature.

The amygdala mediates the response to triggers, and can be responsible for the feeling of re-experiencing a traumatic event. When the amygdala is overwhelmed by emotional stimuli, it can become sensitised, meaning it is much easier to activate.

The amygdala can remain hyperactive long after the initial exposure to trauma. Reminders of the event—such as relevant images, sounds, or smells—can act as triggers that reactivate the amygdala and reignite the stress response. In some cases, simply thinking about the event can produce such a response. This can cause the amygdala to behave as though the traumatic event is reoccurring, resulting in thoughts and behaviours associated with the initial trauma experience.



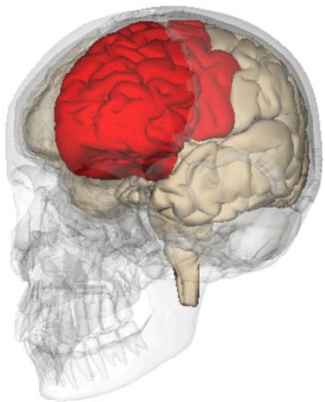
Prefrontal Cortex – Reasoning and Rationality

The prefrontal cortex (PFC) is, essentially, what gives humans their human qualities. It is the outer frontal layer of the brain, and while deeper layers coordinate essential and instinctive function, the PFC is responsible for “higher order” cognitive processes that other animals do not exhibit to the same degree as humans, such as decision-making and personality.

The PFC does not activate these processes, but suppresses instinctive behaviours in favour of more rational ones. When under stress, however, the PFC is subdued and overridden by deeper neural regions, especially the amygdala.

This causes the brain to resort back to more instinctive survival mechanisms, hence why humans experience the fight-or-flight response much the same as other animals do. The PFC becomes less active and fails to suppress the amygdala, allowing the amygdala to dominate the stress response. The connections between the amygdala and PFC also become less active, meaning there is less communication between the two—and, therefore, less intelligent, PFC-driven processing of trauma. This makes it difficult for the brain to rationalise trauma in the moment, and this pattern of activation can persist long after the immediate threat has passed, meaning that even years following trauma, the brain can continue to struggle to process the event.

When faced with immediate trauma, the brain generalises specific stressors to more general threats. While the PFC might offer subjective opinion, the amygdala interprets all traumas as just that: trauma. The amygdala cannot interpret complex threats on its own, and relies on information about the threat from the PFC and sensory regions. When the PFC is not providing that information, the amygdala fails to adequately characterise the threat. That is why it cannot be said that some traumas are “worse” than others: where the PFC sees sexual assault, military combat, or the death of a loved one, the amygdala sees only generalised trauma, and blindly responds to each the same.



Anterior Cingulate Cortex – Emotional Regulation

The anterior cingulate cortex (ACC) is situated just underneath of the prefrontal cortex, and can be likened to a more intelligent amygdala. It has unique functions in emotional regulation and social behaviour, especially with handling social conflict.

Like the PFC, trauma results in less overall ACC activity, and less communication between the ACC and amygdala; and like the hippocampus, the ACC tends to be shrunken in those who experience trauma. This can result in dysfunctional emotional regulation.

After trauma, the ACC is underactive, resulting in less emotional inhibition in response to stress. As a result, slight provocations can result in what appears to be an irrational emotional reaction, such as an angry outburst or crying spell over something that would normally be perceived as a minor inconvenience. The traumatised brain may interpret this inconvenience the same a non-traumatised brain, but can quickly find itself ill-equipped to process the associated emotions.