

# Affective Neuroscience: Decoding the Biology of Emotion

Authored by  
**mohammad looti**

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Affective neuroscience is the study of the neural mechanisms of emotion. This interdisciplinary field combines neuroscience with the psychological study of personality, emotion, and mood.

### **Brain areas related to emotion**

Emotions are thought to be related to activity in brain areas that direct our attention, motivate our behavior, and determine the significance of what is going on around us. Pioneering work by Broca (1878), Papez (1937), and MacLean (1952) suggested that emotion is related to a group of structures in the center of the brain called the limbic system, which includes the hypothalamus, cingulate cortex, hippocampi, and other structures. Research has shown that limbic structures are directly related to emotion, but non-limbic structures have been found to be of greater emotional relevance. The following brain structures are currently thought to be involved in emotion:

**Amygdala** -- The amygdalae are two small, round structures located anterior to the hippocampi near the temporal poles. The amygdalae are involved in detecting and learning what parts of our surroundings are important and have emotional significance. They are critical for the production of emotion, and may be particularly so for negative emotions, especially fear.

**Prefrontal cortex** -- The term prefrontal cortex refers to the very front of the brain, behind the forehead and above the eyes. It appears to play a critical role in the regulation of emotion and behavior by anticipating the consequences of our actions. The prefrontal cortex may play an important role in delayed gratification by maintaining emotions over time and organizing behavior toward specific goals.

**Anterior cingulate** -- The anterior cingulate cortex (ACC) is located in the middle of the brain, just behind the prefrontal cortex. The ACC is thought to play a central role in attention, and may be particularly important with regard to conscious, subjective emotional awareness. This region of the brain may also play an important role in the initiation of motivated behavior.

**Ventral striatum** -- The ventral striatum is a group of subcortical structures thought to play an important role in emotion and behavior. One part of the ventral striatum called the nucleus accumbens is thought to be involved in the experience of goal-directed positive emotion. Individuals with addictions experience increased activity in this area when they encounter the object of their addiction.

**Insula** -- The insular cortex is thought to play a critical role in the bodily experience of emotion, as it is connected to other brain structures that regulate the body's autonomic functions (heart rate, breathing, digestion, etc.). This region also processes taste information and is thought to play an important role in experiencing the emotion of disgust.

**Cerebellum** - Recently, there has been a considerable amount of work that describes the role of the cerebellum in emotion as well as cognition, and a "cerebellar cognitive-affective syndrome" has been described. Both neuroimaging studies as well as studies following pathological lesions in the cerebellum (such as a stroke) demonstrate that the cerebellum has a significant role in emotional regulation. Lesion studies have shown that cerebellar dysfunction can attenuate the experience of

positive emotions. While these same studies do not show an attenuated response to frightening stimuli, the stimuli did not recruit structures that normally would be activated (such as the amygdal). Rather, alternative limbic structures were activated, such as the ventromedial prefrontal cortex, the anterior cingulate gyrus, and the insula. This may indicate that evolutionary pressure resulted in the development of the cerebellum as a redundant fear-mediating circuit to enhance survival. It may also indicate a regulatory role for the cerebellum in the neural response to rewarding stimuli, such as money, drugs of abuse, and orgasm.

### **Relationship to cognitive neuroscience**

In its broadest sense, cognition refers to all mental processes. However, the study of cognition has historically excluded emotion and focused on non-emotional processes (e.g., memory, attention, perception, action, problem solving and mental imagery). As a result, the study of the neural basis of non-emotional and emotional processes emerged as two separate fields: cognitive neuroscience and affective neuroscience. The distinction between non-emotional and emotional processes is now thought to be largely artificial, as the two types of processes often involve overlapping neural and mental mechanisms. Thus, when cognition is taken at its broadest definition, affective neuroscience could also be called the cognitive neuroscience of emotion.

### **Affective Neuroscience and Learning**

There are many ways affect plays a role during learning. Recently, affective neuroscience has done much to discover this role. Deep, emotional attachment to a subject area allows a deeper understanding of the material and therefore, learning occurs and lasts . When reading, the emotions one is feeling in comparison to the emotions being portrayed in the content affects ones comprehension. Someone who is feeling sad will understand a sad passage better than someone feeling happy . Therefore, a student's emotion plays a big role during the learning process. Emotion can also be embodied or perceived from words read on a page or a person's facial expression. Neuroimaging studies using fMRI have demonstrated that the same area of the brain being activated when one is feeling disgust is also activated when one observes another person feeling disgust . In a traditional learning environment, the teacher's facial expression can play a critical role in students' language acquisition. Showing a fearful facial expression when reading passages that contain fearful tones facilitates students learning of the meaning of certain vocabulary words and comprehension of the passage.