Is the amygdala responsible for our emotions

Much of the new information about the neural networks underlying emotion stems from experiments on animals. Understanding fear mechanisms in animals gives us insight on human fears and may help researchers study other emotions. Research is focused on the amygdala, a tiny structure deep in the brain that is important for the formation of memories about significant emotional experiences. Damage a rat’s amygdala and it “ forgets” to be afraid (Phelps & Le Doux, 2005).

Le Doux conditioned rats by pairing a loud noise with a mild electric shock to their feet. The rats showed fear when they heard the noise minus the shock. Fear conditioning occurs because the shock modifies the way in which neurons in several brain regions interpret the sound of the stimulus. In time, the rats slowly lose their fear of the sound. Some part of the rat’s brain outside the amygdala seems to control the fear response but it does not eliminate it. In more tests, a small region of the rat forebrain was damaged. The rats lost their fear but remained afraid much longer, indicating that the frontal region helps control emotional memories forged in the amygdala and may prevent responses that are no longer useful. Such emotional moments register with such strength that it primes the body to react to life-threatening emergencies by fighting or fleeing.

LeDoux found a direct pathway from the ear to a way station called the sensory thalamus that led directly to the amygdala, an almond-shaped structure in the forebrain. When this pathway was cut, rats could not be conditioned to fear a sound. Most of the time, the amygdala is silent. But when it receives a strong stimulus, hairs get upright, the heart race and fight or flight hormones flood the body.

Further examination found that the amygdala is designed to detect predators. When rats are threatened, they emit very high frequency screams. When another rat hears this scream, a signal goes from the auditory cortex, where sounds are processed, directly to the amygdala. When these sound waves penetrate the rat brain, the amygdala is instantly activated even though it not aware the sound is coming from another rat. The human brain is similarly connected. A visual stimulus, perhaps the sight of a spider in a corner will travel to the amygdala in a few thousandths of a second. The human amygdala contains cells that fire in response to expressions on faces and may also react to objects of fear (Adolphs, Russell, & Tranel, 1999).

The amygdala is specialized for reacting to stimuli and triggering a physiological response, a process that one can describe as the ” emotion” of fear (Ohman, 2005). That is distinct from a conscious feeling of fear. Feelings arise from a second, slower pathway that travels from the ear to the amygdala and then on to the higher cortex. There, the frightening stimulus is analyzed in detail, using information from many parts of the brain, and a message is sent back down to the amygdala. If the message is a false alarm, say it is not a spider, the cortex will try to hamper the amygdala’s alarm signals. But already the individual will have gotten a surprise because of the initial arousal of the amygdala.

This double road is very different from the limbic system. The limbic system is a hypothetical construct of networks in the forebrain, which contains the hippocampus, amygdala and a few other tiny structures, that apparently gathers the sensory input from the external world; sight, smell, hearing,

touch and taste as well as from the viscera (Kalat, 1995) When these sensations are united in the limbic system, emotional experiences occur. The basic idea that emotion is alienated from cognition is acceptable.. But when the fear circuit is actually traced, the hippocampus and other ” limbic” structures do not play much of a role. The amygdala is focused at the centre. Sensory data comes in and motor actions are sent out (Pessoa & Adolphs, 2010).

Emotion and cognition are separate but interacting mental functions mediated by separate but interacting brain systems. Such double wiring can create problems for some people. Neural connections from the cortex down to the amygdala are less developed than are connections from the amygdala back up to the cortex. Thus, the amygdala exerts a greater influence on the cortex. Once an emotion is turned on, it is difficult for the cortex to turn it off. It is not surprising humans have trouble controlling their emotions. Fear is only one emotion, the amygdala has 12 to 15 distinct regions and only two so far have been clearly implicated in fear (Segerie, Chochol, & Armony, 2008).

Previous data assumed that the amygdala, part of the brain that registers emotion, depended on signals from the neocortex, the thinking part of the brain, to form an emotional reaction (Cardinal, Parkinson, Hall, & Everitt, 2002). LeDoux (2005) suggests that in many cases the amygdala triggers an emotional reaction before the thinking brain has fully processed nerve signals. Emotional reactions and emotional memories can be formed without any conscious, cognitive participation at all. Emotional memories such as deep fears or resentment are formed and stored in the amygdala. While

some emotional memories may reach consciousness, there are many emotional memories that lead to actions, but which one does not consciously remember LeDoux refers to the amygdale as the “ Wheel of Fear.” There are a handful of patients in the United States and Europe who have totally lost the use of the amygdala. While they are not necessarily fearless, they do display subtle social quirks, like an unusually trusting manner and an inability to recognize fear in other people’s faces (Adolphs, 1999)

Whalen (2002; as cited in Carlson, 2010) confirmed that humans can indeed activate their fear circuitry without ever being aware of it. The researchers used an approach in subliminal advertising known as ” masking”; they showed subjects in M. R. I. machine photographs of fearful faces in a time lag. The subjects had no conscious memory of seeing the fearful faces, yet their brains certainly did. The amygdala lighted up even during the brief flash of a fearful face, but not afterward and not during the brief exposure of a happy face. It is a fast and preferential way to get information,

Scientists set out to determine if people became aware of fearful, neutral or happy expressions at the same speed. The findings, showed that people became aware of fearful faces more quickly than of other expressions. The team believed that the shape of frightened eyes played a crucial role in this, because they represented a visual cue which could take a shortcut through the brain to the amygdala. The amygdala receives information before it goes to the cortex, which is where most visual information goes first. The amygdala has a mediocre ability to process stimuli and it can cue some other visual areas to what they need to focus on. The volunteers processed smiling faces more slowly than any other emotion. It may be that happy faces signal

safety and if something is safe, one does not have to pay attention to it (Wickens, 2000).

While animal experiments have helped scientists trace exact pathways for fear, the question of how emotions such as joy, sadness, anger or shame are connected in the human brain is more difficult to answer. When specific parts of the brain are damaged, patients may lose the ability to feel emotions, sometimes with disastrous consequences.

A bi-laterally damaged amygdala patient, was tested in her ability to interpret the emotional content of sounds, including human voices. The woman heard sounds associated with emotions, like laughter for happiness and growling for anger. Again, she had the most trouble recognizing anger and fear but performed normally for the other emotions. The amygdala plays an important role in social cognition and is especially evolved for interpreting fear and anger (Gallagher & Chiba, 1996)

In a recent study, both sexes looked at erotic photographs while an M. R. I. took snapshots of their brains. The photographs triggered heavy brain activity, particularly in the amygdala of men. But the two groups reported equal arousal most of the time. Here one sees that the amygdala is involved in the anticipation of positive emotions. In a study in 1989, scientists trained caged male rats to gain access to females by pushing a lever. The researchers then destroyed part of the amygdala. The rats lost interest in pressing the lever. Yet despite this lack of motivation, they had no problem engaging in sexual intercourse when the females were placed in their cages. .

Lane compared the brain areas involved when people either watched film clips that evoked happiness or sadness, or called to mind happy or sad moments. In all cases there was heightened activity in the thalamus and the prefrontal cortex, suggesting a role for these regions in each of these emotions, no matter how it was evoked. During the film, not during emotional memories, two parts of the limbic system were active: the amygdala and the hippocampus, suggesting that these structures are involved in evaluating whether a situation is of emotional importance (Adolphs et al., 1999).

The role of the amygdala is to set off fear and anger instantly, without conscious thought, so that a person can freeze or run away from danger, But the emotion of fear is not only present exclusively in the amygdala because it can be elicited from memory and other brain states.