Explaining the role of amygdala in recognizing emotion

The amygdala plays a special role in physiological and behavioural reactions to objects and situations, that have biological significance, such as those that warn of pain, or signify the presence of food, water, salt, potential mates or rivals, or infants in need of care. Research on humans and animals have shown that single neurons of the amygdala become active when emotionally relevant stimuli are presented. Several examples, such as the sight of a device that has been used to squirt either a bad tasting solution or a sweet solution into the animal's mouth, or the smell of smoke, have shown that neurons become excited by these different stimuli (O'Keefe & Bouma, 1969; Jacobs and McGinty, 1972; Rolls, 1982; Leonard et al,. 1985). More importantly LeDoux (1996) argued that the amygdala is the central emotional computer for the brain since it has connections to the right places to fulfil this role.

The amygdala is located within the temporal lobes. It consists of several groups of nuclei each with different functions (Amaral et al., 1992). It is subdivided into several regions but the most important ones are media nucleus, the lateral nucleus the basal nucleus and the central nucleus. The media, lateral, and basal nucleus receive sensory information and they all send information to the central nucleus.

The central nucleus of the amygdala is the fundamental part of the brain for the expression of emotional responses urged by aversive stimuli. When threatening stimuli are presented, the neural activity and the production of Fos protein increase (Pascoe & Kapp, 1985). Damage to the central nucleus reduces or removes a wide range of emotional behaviours and physiological responses. Animals with central nucleus damage have shown no signs of fear

when confronted with stimuli that that have been paired with aversive events. Also their blood levels of stress hormones are lower, and they are less likely to develop other forms of stress induced illness (Coover, Murison, & Jellestad, 1992; Davis, 1992; LeDoux, 1992).

The central nucleus of the amygdala is particularly important for aversive emotional learning. Some stimuli automatically produce fear reactions. Loud unexpected noises, the approach of large animals, heights, or specific sounds or odours are some examples. Even more important, is the fact that we can learn that a particular situation is dangerous or threatening. This is called conditioned emotional response which is produced by a neutral stimulus that has been paired with an emotion producing stimulus.

LeDoux (1996) supported this idea by studying the conditioned emotional responses in rats by pairing an auditory stimulus with a brief electrical shock delivered to their feet. He presented several pairings of a loud tone for a few seconds and then an electrical shock that was delivered to their feet. The rat’s heart rate and blood pressure increased and its breathing became more rapid. The next day the experiment was repeated but this time, after the tone the shock was not presented. Upon hearing the tone the rats showed the same type of physiological responses as they had when they were shocked the previous day.

In addition LeDoux et al. (1998) destroyed two regions of the brain that receive projection from the central nucleus and what they found was that lesions of the lateral hypothalamus interfered with the change in blood pressure, whereas lesions of the periaqueductal gray matter interfered with

the freezing response. Thus, two different mechanisms, both under the control of the central nucleus of the amygdala, are responsible for the autonomic and behavioural components of conditioned emotional responses.

A considerable amount of evidence shows that the amygdala is involved in emotional responses in humans. One of the earliest studies observed the reaction of people who were being evaluated for surgical removal parts of the brain to treat severe seizure disorders. These studies found that stimulation of parts of the brain produced autonomic responses that are often associated with fear and anxiety but only when the amygdala was stimulated did the people report that they actually felt these emotions (White, 1940; Halgren et al., 1978; Gloor et al., 1982).

Lesion of the amygdala decrease people’s emotional responses. LaBar et al., (1995) found that people with lesions of the amygdala showed impaired acquisition of a conditioned emotional response, just as rats do. Angrilli et al. (1996) found that the startle response of a man with a localized lesion of the right amygdala was not increased by the presence of an unpleasant emotion. Usually a person’s startle response is larger when the person looks at unpleasant photos that when they look at neutral ones. Angrilli’s patient showed the same startle response regardless of the nature of the photographs.

Studies have shown that damage to the amygdala interferes with the effects of emotions on memory. When people encounter events that produce a strong emotional response, they are more likely to remember these events but patients with amygdala damage show no such increase in memory. To

support this theory Cahill et al. (1995) studied a patient with bilateral degeneration of the amygdala. The patient was presented with a story about a young boy walking with his mother on his way to visit his father at work. During the story, they were showing a series of slides. At one part of the story, the boy was injured in a traffic accident and gruesome slides illustrated his injuries. Normal subjects usually remember this part of the story. However the patient with the amygdala could not recall it. In similar context Mori et al., (1999) questioned patients with Alzheimer disease who had witnessed the devastating earthquake that struck Kobe, Japan, in 1995. What they found was that patient the more the patient's amygdala was degenerated, the less likely they would remember the earthquake.

Imaging studies have also shown that the amygdala participates in emotional responses. In an experiment conducted by Cahill et al., (1996) participants had to watch one neutral film and one emotionally arousing film. After watching both films the participants were place in a PET scanner and they were asked to recall the films. What they found was that the activity of the right amygdala increased while the subjects recalled the emotionally arousing film but not when they recalled the neutral one.

In another PET study, Isenberg et al. (1999) found that when participants saw words that signify threatening situations there is an increase in activity of the amygdala. Participants had to look at words presented in various colours on a computer screen. Some of the words were neutral (e. g. book, car, list) and some were threatening (e. g. rape, evil, blood). Then they were asked to name the colour of the letters. Seeing the threatening words caused

a bilateral increase in the activity of the amygdala but the same thing did not happen when they saw the neutral words.

As it was mentioned before amygdala has a unique role in emotion. What is very interesting is the role it plays in emotion of fear. A study on patient SM who has bilateral brain lesions in the amygdala, known to be critical in the perception of fear has shown that the patient cannot recognize fear from facial expressions and that is because she fails to look spontaneously towards the eyes on a face (Adolph et al., 1994). When shown a face displaying an expression of terror, she tends to fixate unworriedly on the nose mouth regions, neglecting the scared eyes. In contrast, normal people in the same situation will look at the eye region of the face. What is very interesting about this study is that when the SM was instructed to look at they eyes could restore normal recognition of fearful expressions, indicating that she still knows what fear looks like. These results reveal that damage to the amygdala might impair attention, rather than causing a perceptual deficit (Vuilleumier, 2005).

In conclusion, even though there have been many studies that show that amygdala play an import role in emotion recognition and especially fear, the unusual features of SM will certainly provide much food for future thought.