International Journal of Research (IJR) Vol-1, Issue-9, October 2014 **ISSN 2348-6848**

Limbic-based artificial emotional neural networks

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Abstract

Limbic-based artificial emotional neural networks(LiAENN) are a novel computational neural model of the emotional brain that models emotional situations such as anxiety and confidence in the learning process, shortest paths, the forgetting process, and inhibitory mechanisms of the emotional brain. In the model, the learning weights are adjusted by the proposed anxious, confident decayed brain emotional learning rules (ACDBEL). In engineering applications, LiAENN is utilized in facial detection, and emotion recognition. According to the comparative results on ORL and Yale datasets, Lyon shows a higher accuracy than other applied emotional networks such as brain emotional learning (BEL) and emotional back propagation (EmBP) based networks.

Keywords:
LiAENNz; limbic; Amygdala; BELBIC; Cognition; Emotion; Emotional state; Learning.

1.Introduction

The limbic system (or paleomammalian brain) is a complex set of brain structures that lies on both sides of the thalamus, right under the cerebrum. It is not a separate system, but a collection of structures from the telencephalon, diencephalon, and mesencephalon. It includes the olfactory bulbs, hippocampus, amygdala, anterior thalamic nuclei, fornix, and columns of fornix, mammilla body, septum pellucid, habenular commissural, cingulated gyros, Parahippocampal gyrus, limbic cortex, and limbic midbrain areas.

The limbic system supports a variety of functions, including emotion, behaviour, motivation, long-term memory, and olfaction. It appears to be primarily responsible for emotional life, and it has a great deal to do with the formation of memories. Emotional experience has two distinct components in human beings: 'automatic' and 'attended'. The former of these is based more heavily on the ventral and limbic areas of the brain; the attention part is concerned with cognitive aspects of experience, and involves more dorsal components. A rapidly increasing body of knowledge about these two separate components of human experience is being developed through brain imaging, single cell recording and deficit analyses under emotional as compared to neutral inputs. We start by summarizing this data. We then incorporate the data into a recently developed engineering control model of attention and motor responses. The crucial extension of this model involves a ventral/limbic brain network building representations of salience and valence. A simulation of a simple paradigm is used to demonstrate the considerable dissociation possible between the cognitive and emotional components.

The system is developed to give an extension of standard artificial neural network architectures to a new class, in

which attention effects are explicitly included through adaptive feedback modulation. Learning laws are developed which extend BEP to the attention case. An artificial emotion recognition system is developed as part of this architectural analysis.

2.The emotional brain

Present brain imaging and deficit results support the existence of two interacting but distinct circuits in the brain: a dorsal one for cognitive processing, and a ventral one for emotional content and recognition. The former of these has been extensively discussed in recent experimental reviews Parietal and dorsal prefrontal sites are involved in a network of areas, creating control signals to achieve attention focusing on a specific input, or in a manner to solve a particular task. An engineering control model has been developed from these data in which an inverse model controller in parietal cortex is created, by preferential goal signals, to focus attention signals which modulate activity in posterior cortical sensory (or motor) areas. Brain imaging and deficit results in depressives have supported the division of processing into two separate circuits, one ventral (for emotional) and the other dorsal (for cognitive aspects of experience) . Thus May berg has suggested that in depression there is a failure to regulate the balance between these two components, especially through the common areas in the two associated networks. She has singled out the anterior cingulated as a specific site for such deregulation, and for which there is now support from brain imaging in patients with severe depression.

3.Brains related area of emotions

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 Paul Broca (1878), James Papez (1937), and Paul D. 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, cingulated cortex, hippocampus, 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.

4.Limbic system structure in brain:

The Limbic System, as part of the mammalian creature's brain, is mainly in charge of the emotional processes. The Limbic System located in the cerebral cortex consists mainly of following components: amygdala, Orbit frontal Cortex, Thalamus, Sensory Cortex, Hypothalamus, Hippocampus and some other less important areas.

In this section, we try to describe briefly these main components and their tasks. Fig. 1 illustrates the anatomy of the main components of the Limbic System. The first sign of the affective conditioning of the system appears in the amygdala, which is a small almond-shaped in sub-cortical area. This component is placed in a way to communicate with all other Sensory Cortices and areas within the Limbic System.

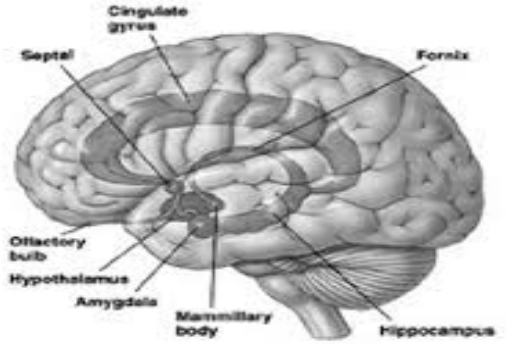

fig1-Limbic system structure

5.Conclusions

Emotional experience has two distinct components in human beings: 'automatic' and 'attended'. The former of these is based more heavily on the ventral and limbic areas of the brain; the attention part is concerned with cognitive aspects of experience, and involves more dorsal components. A rapidly increasing body of knowledge on these two separate components of human experience is being developed through brain imaging, single cell recording and deficit analyses under emotional as compared to neutral inputs. We start by summarizing this data. We then incorporate the data into a recently developed engineering control model of attention and motor responses. The crucial extension of this model involves a ventral/limbic brain network building representations of salience and valence. A simulation of a simple paradigm is used to demonstrate the considerable dissociation possible between the cognitive and emotional components. The system is developed to give an extension of standard artificial neural network architectures to a new class, in which attention effects are explicitly included through adaptive feedback modulation. Learning laws are developed which extend BEP to the attention case. An artificial emotion recognition system is developed as part of this architectural analysis.

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