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Critical Review of the Biological Psychology of the Development of the Brain's Emotional Functions

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Abstract: Based on a biopsychological background, this paper critically examines the emotion regulation functions of various brain regions and their role in different stages of development. The paper argues that the limbic system and the limbic cortex play an important role in the brain's emotion regulation processes.

Keywords: Biological psychology, Brain's emotional functions, Critical review.

1. Introduction

Research in biological psychology reveals the critical and complex role of the brain for human beings and other animals. The brain is responsible for numerous important functions in the body and controls motor skills, vision, breathing, and every process that regulates the body. Further, through its different parts, the brain facilitates thoughts, memory, emotions, and touch (Davis & Panksepp, 2011). The review requires a substantive scientific approach that explains the growth of the brain's emotional function, changes and the consistency expected through the lifespan (Tottenham, 2017). This includes developmental differences that occur throughout the lifespan such as changes in the effectiveness of executing and regulating emotions. It is also important to consider issues that may arise throughout this process and the consequences they may have for emotional functioning and regulation. This paper will provide a clear, critical review of the biological psychology of the development of the brain's emotional function during different stages of growth.

2. The Brain's Emotional Function

A scientific approach accepts that there are continued gaps in the description of the brain's role in the overall emotional function. While there is a range of factors that determine the emotional state of a being, different areas of the brain are known to contribute to overall emotions (Davis & Panksepp, 2011). Emotions that are studied often include fear, anger, and joy, all of which are dependent upon the limbic system for their functioning. The limbic system is a group of interconnected structures that are responsible for behavioral and emotional responses (Roxo, Franceschini, Zubaran, Kleber, & Sander, 2011); it includes the hypothalamus, hippocampus, amygdala, and the limbic cortex.

The hypothalamus is a part of the brain located just below the thalamus and above the pituitary gland and brain stem. It has been referred to as the busiest part of the brain, with homeostasis (regulating the body at a certain optimum condition) being the main function. In addition to maintaining homeostasis, the hypothalamus also acts as the emotion regulation organ of the brain (Roxo, Franceschini, Zubaran, Kleber, & Sander, 2011). It allows for emotional reactions (such as anger, excitement, fear, or stress) to trigger physical responses. During these instances, the hypothalamus causes an increase or decrease in heart rate depending on the nature of the occurrence (Roxo, Franceschini, Zubaran, Kleber, & Sander, 2011). The autonomic nervous system is regulated through the hypothalamus and functions by altering the pulse, blood pressure, breathing, and arousal in response to emotional circumstances.

The hippocampus is the second organ of the limbic system that is responsible for behavioral and emotional responses. It creates new memories, preserves old memories, and allows for the retrieval of information from memory. Psychologically, it helps one relate to the environment in a positive or negative way (Roxo, Franceschini, Zubaran, Kleber, & Sander, 2011). For instance, when one has suffered PSTD, it is the hippocampus that keeps bringing up the memories that trigger panic attacks. In the same way, memories relating to a loved one can be triggered to bring out positive emotions like joy. As such, it plays a major role in emotional expression

The amygdala is the third organ making up the limbic system and is primarily involved in the processing of emotions and memories associated with fear. It allows individuals to assess and respond to environmental threats and challenges. This happens through the evaluation of the emotional importance of incoming sensory information, therefore prompting an appropriate response to the specific threat (Roxo, Franceschini, Zubaran, Kleber, & Sander, 2011). In addition, the amygdala is also involved in linking certain emotions to memory which contributes to the larger functions of reward processing or decision-making (Roxo, Franceschini, Zubaran, Kleber, & Sander, 2011). Information about emotions is relayed to the prefrontal, sensory cortices, and the hippocampus which allows for an association between certain emotions and cognitive activities.

The limbic cortex is a multi-organ part of the limbic system made of the cingulate gyrus and the Parahippocampal gyrus. Together, these two areas are responsible for the brain's response in terms of mood, motivation, and judgement. It coordinates the exchange of information between higher regions within the neocortex and subcortical limbic structures. Its role in emotional regulation by the brain is to allow for information exchange and variation in behavioral reactions through moods and motivation drives (Tottenham, 2017). It is the limbic cortex that relays information to the cognitive parts of the brain on whether or not the environment is providing the expected satisfaction, thus facilitating changes in mood or willpower to conduct oneself in a certain way.

3. Developmental of the Limbic System through Experience

As outlined earlier, the limbic system of the brain is responsible for regulating a number of behaviors to ensure survival among vertebrae species such as human beings. The system aids in controlling appropriate responses to stimuli with respect to the social, emotional, and motivational environment surrounding the person (Tottenham, 2017). These responses are known to develop from circuits regulating innate behaviors. While these structures function effectively at maturity, it is important to further explore development to maturity, as well as the different factors that affect development (Tottenham, 2017). Gaining a better understanding of this developmental trajectory also provides a basis for exploring neurodevelopment disorders such as autism which are characterized by limbic system dysfunction.

During the early years of life, the prefrontal cortex (limbic system) is not used for emotional regulation in the same way as it is used in mature humans. The prefrontal context develops the most through ontogeny (Tottenham, 2017). Because it requires many connections with other cortical and subcortical targets, this brain region forms slowly. In humans, this developmental process is documented during adolescence and into adulthood. This slow-paced growth and sustained development allow the prefrontal context to be influenced by external stimuli (Tottenham, 2017). It is vulnerable to environmental abuses such as early psychosocial adversity. However, the plasticity of the region also provides great potential for extensive learning in positively enhanced environments. As such, growth and development are highly dependent on caregiver behaviors and the immediate environment that is experienced as individuals age.

It is important to note that, despite the differences in how the mature and immature prefrontal context perceives information and reacts emotionally, there is evidence that emotion regulation is possible even at young ages (Rolls, 2015). How are young individuals able to accomplish emotional regulation tasks? Infant rodent (non-human) experiments suggest that individuals display forms of emotional regulations such as instances where they can extinguish a learned fear. However, the process by which this occurs may be different for infants vs. adults (Rolls, 2015). Because the infant rat is dependent on adults for survival, there is a presence of a phenomenon known as species-expectation that, during the need to react in a certain way, an attachment figure will be present to protect or shield the infant from the challenge. The caregiver (in rats and humans) acts as an external social regulator. Young children depend on their parents to observe the correct emotional responses to different situations (Rolls, 2015). In humans, children will routinely look to their parents for guidance in the navigation of the emotional landscape. This social referencing is a major source of emotional guidance in early life. As individuals acquire emotional knowledge from their parents, the hippocampus creates memories in order to store this information (Floresco & Ghods-Sharifi, 2006). The rest of the limbic system references what has been stored in the hippocampus to evaluate the ways in which the individual should react to specific environments, both emotionally and physically.

In addition to social referencing, another mechanism that is used in the regulation of emotions among infants is the modulation of stress reactivity and fear learning by the parents (Sapolsky, 2003). At the onset of an incident that triggers fear, parents buffer their reaction to harden the limbic systems of their young ones from traumatic responses (Sapolsky, 2003). Researchers reviewing this growth process have indicated that during a certain sensitive stage in development, access to parental cues is the sole external source of emotional regulation. Parents can modulate their responses to threat (parental cues) in order to dampen elevations in the stress hormone cortisol in their children.

Parental cues are associated with decreases in activity in the amygdala which can prevent threat learning. These parental cues are aimed at ensuring that the infant does not learn to associate threatening stimuli with a cue (such as light or tone). However, in incidences where parents express defensive behaviors, cues surrounding threatening scenarios have been quite effective in amplifying the amygdala reactivity (Sapolsky, 2003). Parents effectively serve as an external limbic system for infants during periods when the prefrontal cortex is not mature (Sapolsky, 2003). It is also important to note that parental cues not only provide instructions during growth but also contribute to the high degree of plasticity in the limbic region during the growth period.

4. Conclusion

The emotional function of the brain is one of the most complex areas of biological psychology in terms of understanding human behavior. As outlined in this paper, it is evident that human beings have a system, the limbic system, that is responsible for behavioral and emotional responses (Floresco & Ghods-Sharifi, 2006). Comprised of three organs in the brain, the limbic system is able to ensure that human beings have a standard way of reacting to the environment through emotion regulation. The hypothalamus is responsible for turning emotions into physical responses such as anger, excitement, fear, or stress (Ghashghaei, Hilgetag, & Barbas, 2007). The hippocampus helps in creating new memories and preserving and retrieving old ones, while the amygdala is involved in the processing of emotions and memories associated with fear (Ghashghaei, Hilgetag, & Barbas, 2007). Finally, the limbic cortex (cingulate gyrus and Parahippocampal gyrus) is responsible for the brain's response in terms of mood, motivation, and judgement. As the limbic system develops, human beings are able to adapt to their experiences of the outside world and learn the appropriate emotional reactions.

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