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Editorial: 'Love and Fear' as portraited by Affective Neuroscience

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ABSTRACT

Modern neuroscience is on the verge of exploring new frontiers within various subdisciplines.

The question of how our brain with over hundred billion neurons puts together cognition, emotion and behavior has always been captivating. As such, the study of neural processes through which we not only maintain our survival and homeostasis, but also stay productive and functional, has attracted cognitive neuroscientists for decades. With the advent of neurotechnologies and ever-growing research facilities, modern neuroscience has seen a tremendous progress in dealing with such questions. This letter argues the most referenced theories with respect to key concepts in affective neuroscience, i.e. fear, love and related emotions or traits. We hope the present letter is found thought-provoking with regards to further theoretical models and empirical research in affective neuroscience and neuropsychology

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1. Overview

Although the link between various aspects of emotion and behaviors are being systematically studied (1-3), some fundamental issues have remained unclear in terms of the trilateral relations between cognition, emotion and behavior. That is perhaps why neurobehavioral scientists keep arguing already positioned basic theories and conceptual frameworks before hypothesizing novel ideas and designing new experiments in the study of emotion. In the context of Affective Neuroscience, empirical research are still underway to help answering each of the questions. Studies on the nature of emotion are expected to further reveal the central issues in emotion research and theory in the words of many of the leading scientists working in the field today (4).

2. The theoretical background for studying emotion

Among theories which describe emotion as concrete unconscious behaviors versus conscious processing of information flow at cortical and subcortical levels, two models have gained more attention. These theoretical frameworks include the model proposed by Antonio Damasio and Gil Carvalho (2013) (5) as well as the one by Joseph LeDoux (2002) (6) .

The idea of how emotion corresponds to evolutionary aspects of neurodevelopment has attracted multimodal approaches in neuroscience research for years (7, 8). While there exist several conceptual models to explain the nature of emotion in relation with our feelings, much argument revolves around the cognitive model put forward by Demasio and Carvalho versus the one by Joseph LeDoux (5, 6). As per the Demasio and Carvalho's model, external stimuli tend to program emotions to serve the organism's homeostasis and survival through adaptive behaviors. That said, phenomena including hunger, thirst, libido, and attachment to mates are taken as examples of drives serving survival (5). Rather, Ledox's model is more in favor of relating feelings to the conscious processing of emotion (6). Either way, it appears that the reverberating cortical-subcortical information flow is the process whereby our fronto-limbic neural network gets entrained for a learned response-behavior to emotional stimuli (9).

Love and fear were the two emotional phenomena comparatively discussed by LeDoux. He contextualized that attachment and love are examples of emotion in the same way that fear is (6). Meanwhile, Damasio and Carvalho viewed attachment differently. Though they categorized fear as an emotion, to them, attachment was considered as a drive and taken separate from fear (5). While both theories are quite valid at certain points, Demasio and Carvalho's approach seem to have potentially undermine LeDoux's definition of emotion.

Based on Demasio and Carvalho, conscious and subconscious processes involved in emotion are considered as evolutionary phenomena where survival is the key purpose. Moreover, such processes involve in action programs by which our brain and body maintain homeostasis. Accordingly, they classify action programs into drives and emotions. In that vein, when fear for instance is an emotion, feeling feared refers to the conscious experience of such an emotion. In other words, feeling and emotions are considered as separate yet linked entities (5).

For LeDoux however, studying emotion requires a multifaceted approach. For instance, when studying fear, the efferent pathways which end up in amygdala are considered more salient. Meanwhile, the prefrontal cortex and its relationship with limbic structures should also be attended to as key contributors to the neural processes which underlie fear. That said, neurohormones, oxytocin, vasopressin and using antagonists to block the receptors seem to be the essential components of LeDoux's model for studying emotion. The above multimodal approach to the study of emotion may potentially explain how the nature of a stimulus drives a particular behavior (6).

Based on the above two theories which are briefly and comparatively being discussed in this opinion paper, we will hypothesize whether modulating underpinning processes involved in an emotion-related behavior, namely romantic love or other types of attachment, may result in an improved emotional health.

3. Substrates of our feelings as seen by Demasio and Carvalho

Several theories in cognitive and evolutionary neuroscience have proposed how emotions are critically involved when we attend to, encode, and process the external stimuli. Some theories have been proposed as means of understanding how emotions are critically involved in our interactions with external stimuli (10). Based on Demasio and Carvalho's model, our feelings are largely coded through evolutionary and neurobiological origins. For them, our emotions are predominantly action programs derived by external stimuli. In fact, the process through which the brain monitors the external world (exteroceptive) largely defines how our emotion and perception are interoceptively biased (5).

As such, salient phenomena such as love and attachment are referred to as a feeling and a drive, respectively. As per their cognitive model, while fear is considered as an emotion and feeling, phenomena including hunger, thirst, libido, and attachment to mates are examples of drives (5, 10).

4. LeDoux's position on "how emotions define who we are"

"Synaptic Self" LeDoux's thought-provoking book where he took a processing approach to explain the study of emotion. To him, emotion serves as an evolutionary purpose to help the organism survive. In fact, what LeDoux discusses refers to the neurological processes that handles our emotions. Such neural processes get coded in limbic structures before ending up in the neocortex. It appears that our brain estimates the value of a stimulus largely through such processes.

For LeDoux, studying emotion requires a multifaceted approach. For example, when studying fear, the efferent pathways which end up in amygdala are considered more salient. Meanwhile, the prefrontal cortex and its relation with limbic structures should also be attended to as key contributors to the neural processes which underlie fear (6, 11). That said, neurohormones, oxytocin, vasopressin and using antagonists to block the receptors seem to be the essential components of LeDoux's model for studying emotion. The above multimodal approach to the study of emotion defines how the nature of a stimulus provokes a given behavior (6).

Other than the evolutionary perspectives, emotion are known to be coded through cortical-subcortical (fronto-limbic) processes by which our behaviors and actions get programmed. When a behavior continues to sustain and repeat over again; genes, neural networks and systems reform toward key evolutionary purposes which are homeostasis and survival (6, 12).

5. Cognition to steer drives and behaviors

Apparently, when we refer to learned behaviors, or learning in particular, cognitive processes come into play. The fact of the matter is despite the subcortical emotional responses we show to maintain survival and homeostasis (5, 10), we tend to cognitively monitor and process our emotions to formulate conscious emotional perception at cortical level (6). It is therefore the 'cognition-emotion interface' where complex emotional phenomena such as love and motivation are programmed. Cognitive emotion regulation (CER) theories have attempted to explain the above in earlier research (13).

Based on the two models discussed above, love as a complex emotional process does not seem to be an identical emotion like fear is. In that sense, if we want to classify complex emotional constructs such as 'love' into a category, 'drive or motivation" would be a better fit. Some other researchers have endorsed this approach in the way they classify distinct behaviors based on drives. To them, drives are internal states of the organism that lead to the instigation, persistence, energy, and direction of behavior towards a goal (14). Given that, our drives root in our goals and our goals perse are affected by our thoughts, memory, attentional bias, dreams, and fantasies (15).

To examine how complex emotion-related behaviors (such as love, laughter, mercy, envy, vindictiveness, jealousy, passion, etc.) and their cognitive corelates are tied to each other, multimodal neurocognitive and behavioral assessments need to be done. Although future approaches to the study of emotion need to be pragmatic, they should keep rigorous evidence criteria. When emotions recompile at difference valances and intensities, they may form complex emotional states and even concepts of traits. We understand people's traits from their manner of acting, reactivity to objects and stimuli, their expressive activities, and their current emotional and conative reactions. Hence, the study of emotional diversities requires even-more advance affective neuroscience approaches (16).

6. Conclusion

A comparative review on the above conceptual models prompted us to question whether complex affective responses such as love are just beyond only subcortical processes. It is then hypothesized that cortical-subcortical (i.e. top-down) regulation is predominant when individuals love someone or something. At interpersonal level, the disparities between neural substrates of romantic love and other forms of attachment are also worth to be evaluated. If the drive-related cortical and subcortical regions, hubs and connectomes become well-defined, then modulating such neural networks with the available noninvasive neurotechnological tools might potentially provide novel solutions for affective disorders, including depression.

Future research should then address relatively untapped questions such as: 1- the nature of information flow upon exposure to emotional stimuli at cortical-subcortical level, 2- delineating cortical hubs as opposed to subcortical regions involved in the process of complex emotions, drives and traits such as romantic love and other types of attachment, and 3-the possibility of cortical neuromodulation in ameliorating affective symptoms.

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