International Journal for Modern Trends in Science and Technology, 6(10): 26-30, 2020

ISSN: 2455-3778 online
DOI: https://doi.org/10.46501/IJMTST061005
Available online at: http://www.ijmtst.com/vol6issue10.html

Chemistry of Emotions - A Review

Varsha N [1] | Malavika B [2] | Vyshnavi V Rao [3]* | ShamsiyaRizwana[4]

[1,2]Student, Department of Chemistry, MES College of Arts, Commerce and Science, India.
[3]Assistant Professor, Department of Chemistry, MES College of Arts, Commerce and Science, India.
[4]Associate Professor, Head of the Department, Department of Chemistry, MES College of Arts, Commerce and Science, India.

To Cite this Article
Varsha N, Malavika B, Vyshnavi V Rao and ShamsiyaRizwana, "Chemistry of Emotions - A Review", *International Journal for Modern Trends in Science and Technology*, 6(10): 26-30, 2020.

Article Info
Received on 06-September-2020, Revised on 16-September-2020, Accepted on 26-September-2020, Published on 30-September-2020.

ABSTRACT

Human body coordinates through chemical signals released by the brain. Chemical signals play a major role in bio-regulatory reactions responsible for emotions. Emotions are complex chemical reactions in nervous systemcharacterized by neurophysiologic changes associated with thoughts and behavioral responses. On pinching, one can cry, skin becomes hot, heart beat increases and our brain desires to shout out loud or hit something in return. We experience a sudden influx of physical and mental stimuli underlying a basic emotion. A person experiences diverse emotions throughout the day that are helpful in learning, reasoning and creativity. Emotions are one the most central and pervasive aspects of human experience. Emotions motivate empathic and moral behavior and play a role in an individual's sense of self. While emotions enrich human experience they can also cause dramatic disruptions of judgment and performance. Since ancient days psychiatrists have been cracking the brain process responsible for emotions. Greeks were the first to find the link between the physical body and human emotional responses. Human brain is a complex network that transmit information every second via neurons through chemicals called neurotransmitters such as dopamine, serotonin etc. These chemicals essentially let the organs communicate with each other and express the emotions such as anger and happiness. Analysis of hormones and their effects on human behavior is a major contribution of biochemistry to the understanding of emotions and related behavior. In this article we are trying to provide an in-depth knowledge about chemistry of emotion which we experience every day.

KEYWORDS: *Biochemistry, Emotions, Neurotransmitters, Hormones*

INTRODUCTION

Everyoneon a daily basis experience diverse emotions such as happiness, anger and fear due to various reasons which are largely influenced by our brain. According to neuroscientists, emotion is defined as the complex collection of chemical and neural responses initiated by brain which have physical and mental components and because of emotionally competent stimulus. For most people emotions are linked with motivation, expression and creativity[1]. Emotions are generated by electrical impulses in the neurons associated with changes in chemicals composition in brain[2].

The investigation of emotions and emotional functioning has a long history, starting with Charles Darwin's work in 1872 on universal facial expressions of emotion. This momentous effort was trailed by the work of various psychologists and neuroscientists. Neuro-anatomists are mapping the regions of the brain and have identified the

brain structures involved in accessing and processing emotional experiences within the limbic system. This system acts as the central processing unit of emotions. One particular area of this system, the amygdala, is recognized as the center for emotion. Another structure, the hippocampus, is considered the center for emotional memory[5]. Neuroimaging confirms major activations in regions of the basal brain during primordial emotions in humans. The behavior of decorticate humans and animals is discussed in relation to the possible existence of primitive awareness [6].

Chemistry plays a major role in expression of emotions in the brain, chemicals also known as neurotransmitters generates high specific properties in the brain to guide the senses and a neuron can accept many chemical signals from the neighboring neuron [4]. They are endogenous chemicals are associated communication of neurons with each other throughout the body and also allows brain to process diverse emotions through the chemical synaptic transmission mechanism. The basic mechanism involves release of neurotransmitters such as dopamine, serotonin and acetylcholine from presynaptic neural cells that bind to postsynaptic receptors which triggers the emotions.The receptors are protein molecules complimentary to structure of neurotransmitters[3]. Neuropeptides and endogenous proteins exert diverse effects on behavior and emotions along with neurotransmitters [4]. Alteration in the concentration of neurotransmitters leads to neurological disorders like Alzheimer, Parkinson disease or schizophrenia depression [3].

The neuro-medical examination has given a comprehensive mechanism of the origin of emotions and the causes of these processes[7]. Neuroscientists have started to investigate the physical basis of emotions, analyzing brain chemistry in rats and other animals and by scanning brain activity in humans [8].This article aims to study the chemistry of emotions in brain and also to understand the neurotransmitters and their rolein mechanisms and their functions of nervous tissue.

CHEMISTRY OF EMOTIONS

Anger

Anger is an intense emotion developed as a response to the external or internal stimuli like hurt, frustration, disappointment or threatened [9]. Anger is activated in amygdala; it is a two almond shaped structure in the brain which is meant to send signals to protect us even before the cortex [10]. Then amygdala initiates hypothalamus-pituitary- adrenal axis (HPA axis) stress response system in our brain and body [11]. When anger emotion is provoked the hypothalamus in our brain activates the pituitary gland which enrages the adrenal gland by sending the signal and triggers the release of stress hormones such as adrenaline, non- adrenaline and cortisol. As a result glucose gushes into the blood stream and muscles which gives extra strength and ability to respond faster[9]. Neurotransmitters called catechol aminescause a burst of energy and increaseheart rate, blood pressure and rate of breathing [12].

Joy or Happiness

Expression of every emotion in human beingsis the result of brain signaling. Even the joy or happiness is produced by the synergistic function of brain [13]. Joy is a mental or emotional state of mind induced by neurotransmitters or hormones in the brain and body and is different from one person to the other. According to the researchers this emotion is expressed due to the chemical transmission and signaling between the neurons [14]. The major neurotransmitters or hormones which provoke the happiness emotion in the brain are dopamine which is responsible for reward driven behavior and pleasure seeking and it has both inhibitory and excitatory effect, serotonin which takes the credit for having a good mood and hormones like epinephrine and oxytocin induce joy [13,14]. Happiness encompasses several constructs, including affective well-being (feelings of joy and pleasure), eudaimonic well-being (sense of meaning and purpose in life) and evaluative well-being (life satisfaction) [15].

Disgust and Contempt

When a person experiences disgust it hints that the place has some unpleasant thing. Disgust is an emotional response of rejection provoked by the brain [17]. Contempt is felt exclusively towards human targetsand implies sense of superiority over them, pessimistic feelings about their possibility of betterment, detachment from them, and avoidance driven by detachment [16]. According to 'Emotions of man and animals' written by Darwin, disgust is referred as "something revolting primarily in relation to the sense of taste, as actually perceived or vividly imagined; and secondary to anything which causes a similar feeling, through the sense of smell, touch or even eyesight" [17]. Disgust chemically is due to increase of activity in the right

frontal cortex which is a broad region associated with the negative effect. Researchers relate anterior insula and disgust emotion, supporting the idea of disgust having strong links to food and eating because of insula which is a part of gustatory cortex and is activated by unpleasant taste and smell [17]. When disgust or contempt emotion is expressed there will be a high serotogenic levels and depletion of tryptophan. Also, disgust is a low-dopaminergic emotionwhere one usually refuses to eat because it is proximally related to withdrawal and repulsion. The emotions such as shame or humiliation and contempt or disgust are described as self-contempt versus contempt for an object and they are assumed to be related to inner strength and self-confidence. The people who are suffering from chronic schizophrenia with anhedonia are functionally low in their dopamine axis, will experience more disgust than healthy individuals [18].

Shame and Guilt

Shame can be defined as the feeling we have when we evaluate our actions, feelings or behavior and conclude that we have done wrong. Shame is related to guilt, pride and hubris, all of which requires self-awareness. Shame bears narcissism and underlies many of our relationship with others. Responses to shame can be varied: anger, depression or withdrawal[19]. Shame drives people to hide or deny their wrongdoings while guilt drives people to amend their mistakes[20]. Pride and shame/guilt conditions both activate typical emotion-processing circuits including the amygdala, insula and ventral striatum as well as self-referential brain regions such as the bilateral dorsomedial prefrontal cortex[22]. Cortisol increase is greater in those who experience greater shame and decrease in social self-esteem under social-self threat. Threat to the social self is an important elicitor of shame, decrease in social self-esteem and cortisol increase under demanding performance conditions. Cortisol changes may be specifically tied to the experience of emotions and cognitions reflecting low self-worth [21].

Fear

During and after a traumatic experience, fear is a natural reaction. The fear and stress responses enable the organism to react, being responsible for "fight-or-flight" response. This response is important for survival and adaptation in nature. Epinephrine may induce liver cells to release glucose into the bloodstream and glucose may lead to a subsequent increase of the energy source in the central nervous system and enhance contextual fear learning [23]. Studies have shown that the amygdala is critical to fear responses and emotional memory. In humans, examination of patients with lesions in the amygdala suggested that the amygdala is involved in fear [24]. As the virtual predator grew closer, brain activity shifted from the ventromedial prefrontal cortex to the periaqueductal Gray. This shift showed maximal expression when a high degree of pain was anticipated [25].The role of the endogenous corticotropin-releasing hormone (CRH) system in the regulation of heart rate, PQ interval (a measure of vagal activity), gross activity and release of adrenocorticotropic hormone (ACTH), noradrenaline and adrenaline into the blood during conditioned fear[26]. Fuller understanding of the role of amygdala glutamate systems in fear and fear learning may suggest novel pharmacological approaches to the treatment of clinical anxiety disorders[27].

Excitement

Excitement or interest is a basic emotion which is reinforcing and coupled to a basic feeling of inner strength. This emotion of interest is high-dopaminergic and hence is motivating, rewarding and reinforcing. Dopamine plays a major role in appetite, love, drug addiction, exploratory excitement and is supported by serotonin releasing agent 3,4-methylenedioxymethamphetamine. Excitement or interest is considered as high-serotonergic basic emotion. High non-adrenaline content is also one of the reasons for the excitement/ interest[18].

Surprise

Surprise can be a pleasant experience for users because it allows them to experience or learn something new[28]. Surprise is described as a mental and behavioral phenomenon with first attempts of its theory building, dates to Aristotle. Among the first to discuss surprise in modern times were the empiricist philosophers Hume and Smith [29]. Surprise is a fundamental link between cognition and emotion. It is shaped by cognitive assessments of likelihood, intuition, and superstition, and it in turn shapes hedonic experiences [30]. The dopamine pathways projecting to prefrontal cortex and the basal ganglia are assumed to play a major role in such emotion cognition interactions [31]. Inverse fMRI activation patterns in amygdala and medial prefrontal cortex

(mPFC) depending upon more negative interpretations of surprised faces are associated with greater signal changes in the right ventral amygdala, while more positive interpretations are associated with greater signal changes in the ventral mPFC[32].

CONCLUSION

Our body functions are mainly depending on the chemical reactions occurring in our body and brain. Emotions are one among them and are defined as an experience which we come across in our daily lives due to external and internal stimuli, state of mind and experience. Emotions are the biproduct of billions of biochemical reactions occurring in our system. Chemicals in the brain are called as neurotransmitters which act as messengers between the synapses of neurons in the brain and vary the amount depending on the situation. For example when we are happy a neurotransmitter called dopamine will likely flood the synapses. There are many neurotransmitters and hormones involved in expression of emotions like Serotonin, Acetylcholine, GABA (gamma-aminobutyric acid), Norepinephrine and epinephrine, oxytocin and testosterone. Emotions play a critical role in virtually all aspects of learning, reasoning, and creativity. Surprisingly, it may play a role in the construction of consciousness. Emotions are often expressed differently by every person through facial expressions, physiological responses like increase in heartbeat, sweating and blood rushing to the face. Emotion is as much amenable to scientific study as any other aspect of behavior. It essential for survival and is an expression of basic mechanisms of life regulation developed by forces of evolution.

ACKNOWLEDGEMENT

Authors express their sincere gratitude to the other faculty members of the Department of Chemistry, MES College of Arts, Commerce and Science, Malleswaram, Bengaluru for their bountiful support.

REFERENCES

[1] Post SG, Underwood LG, Schloss JP, Hurlbut WB. Altruism and altruistic love: Science, philosophy, and religion in dialogue. Oxford University Press; 2002 Mar 28.

[2] Adolphs R, Anderson DJ. The neuroscience of emotion: a new synthesis. Princeton University Press; 2018 Jun 5.

[3] Sheffler ZM, Reddy V, Pillarisetty LS. Physiology, Neurotransmitters. InStatPearls [Internet] 2020 May 21. StatPearls Publishing.

[4] Uddin MS, Mamun AA, Kabir MT, Nasrullah M, Wahid F, Begum MM. Neurochemistry of neurochemicals: messengers of brain functions. Journal of Intellectual Disability-Diagnosis and Treatment. 2017;5(4):137-51.

[5] DeMaria R. The Chemistry of Relationships: Emotions, the Brain, and the Experience of Love. National Healthy Marriage Research Center. 2011:1-9.

[6] Denton DA, McKinley MJ, Farrell M, Egan GF. The role of primordial emotions in the evolutionary origin of consciousness. Consciousness and cognition. 2009 Jun 1;18(2):500-14.

[7] Lastovetska L. Chemistry of emotions. 2019.

[8] Mlot C. Probing the biology of emotion. Science. 1998 May 15;280(5366):1005-7.

[9] Hendricks L, Bore S, Aslinia D, Morriss G. The effects of anger on the brain and body. InNational forum journal of counseling and addiction 2013 (Vol. 2, No. 1, pp. 2-5).

[10] Yadav PK, Yadav RL, Sapkota NK. Anger; its impact on human body. Innovtative Journal of Health Science. 2017; 5(4):1–5.

[11] Bezdek KG. Frontiers for Young Minds. Age. 2017;8:15.

[12] Mills H. Physiology of anger. MentalHelp. net. 2005.

[13] Hamid B. CHEMISTRY OF HAPPINESS.

[14] Datta A. CHEMICAL BASIS OF HAPPINESS: A DISCUSSION. European Journal of Social Sciences Studies. 2018 Jun 21.

[15] Steptoe A. Happiness and health. Annual review of public health. 2019 Apr 1;40:339-59.

[16] Miceli M, Castelfranchi C. Contempt and disgust: The emotions of disrespect. Journal for the Theory of Social Behaviour. 2018 Jun;48(2):205-29.

[17] Rozin P, Haidt J, McCauley CR. Disgust. InHandbook of emotions.

[18] Lövheim H. A new three-dimensional model for emotions and monoamine neurotransmitters. Medical hypotheses. 2012 Feb 1;78(2):341-8.

[19] Lewis M. Shame: The exposed self. Simon and Schuster; 1995 Aug 8.

[20] Shen L. The evolution of shame and guilt. PloS one. 2018 Jul 11;13(7):e0199448.

[21] Gruenewald TL, Kemeny ME, Aziz N, Fahey JL. Acute threat to the social self: Shame, social self-esteem, and cortisol activity. Psychosomatic medicine. 2004 Nov 1;66(6):915-24.

[22] Roth L, Kaffenberger T, Herwig U, Brühl AB. Brain activation associated with pride and shame. Neuropsychobiology. 2014;69(2):95-106.

[23] Oliveira A, Martinho R, Serrão P, Moreira-Rodrigues M. Epinephrine released during traumatic events may strengthen contextual fear memory through increased hippocampus mRNA expression of Nr4a transcription factors. Frontiers in molecular neuroscience. 2018 Sep 25;11:334.

[24] Hyman SE. A new image for fear and emotion. Nature. 1998 Jun;393(6684):417-8.

[25] Mobbs D, Petrovic P, Marchant JL, Hassabis D, Weiskopf N, Seymour B, Dolan RJ, Frith CD. When fear is near: threat imminence elicits prefrontal-periaqueductal gray shifts in humans. Science. 2007 Aug 24;317(5841):1079-83.

[26] Nijsen MJ, Croiset G, Diamant M, Stam R, Kamphuis PJ, Bruijnzeel A, de Wied D, Wiegant VM. Endogenous corticotropin-releasing hormone inhibits

conditioned-fear-induced vagal activation in the rat. European journal of pharmacology. 2000 Feb 11;389(1):89-98.
[27] Walker DL, Davis M. The role of amygdala glutamate receptors in fear learning, fear-potentiated startle, and extinction. Pharmacology Biochemistry and Behavior. 2002 Mar 1;71(3):379-92.
[28] Ludden GD, Schifferstein HN, Hekkert P. Surprise as a design strategy. Design Issues. 2008 Apr;24(2):28-38.
[29] Reisenzein R, Horstmann G, Schützwohl A. The cognitive-evolutionary model of surprise: A review of the evidence. Topics in cognitive science. 2019 Jan;11(1):50-74.
[30] Mellers B, Fincher K, Drummond C, Bigony M. Surprise: A belief or an emotion?.InProgress in brain research 2013 Jan 1 (Vol. 202, pp. 3-19). Elsevier.
[31] Subramanian L, Hindle JV, Jackson MC, Linden DE. Dopamine boosts memory for angry faces in Parkinson's disease. Movement Disorders. 2010 Dec 15;25(16):2792-9.
[32] Kim H, Somerville LH, Johnstone T, Alexander AL, Whalen PJ. Inverse amygdala and medial prefrontal cortex responses to surprised faces. Neuroreport. 2003 Dec 19;14(18):2317-22.