

# Aggression & Neurotransmitters

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**Abstract:** In recent few decades interest has been developed and research has been carried out to study aggressive behaviour. It is known that neurotransmitters control aggression but the mechanisms involved are still not clear. The current pandemic led to many psychological issues. In this study, we did a small online survey and used online reports (newspapers, digital publications) to analyze the psychology of the person because of novel COVID-19 lockdown in India and many psychological health issues experienced by society.

This study focuses on aggressive behavior of the person, chemistry & factors related to neurotransmitters with respect to serotonin. Studies suggest that people with low serotonin concentration are aggressive in nature)

**Index Terms:** Aggression, DLPFC (Dorsolateral Prefrontal Cortex), Human genome wide association studies (GWAS), Neurotransmitters, SSRs (Selective serotonin reuptake inhibitors), OFC (Orbitofrontal Cortex), Transcriptome

## I. INTRODUCTION

Due to COVID-19 outbreak, few individuals were overwhelmed with pain & filled with great void because of being lonely and isolated at home. It has been observed that in these cases feeling of aggression and frustrating response increased. Scenarios of destructive aggression, possibility of trauma and violence were produced.

This complex forced lockdown increases fear, stress, progressive humiliation, domestic violence at home. As compared to 2019, domestic violence increased in 2020 during lockdown. All complaints were registered through e-mails Combination of Covid-19 and Domestic Violence are the *Twin Public Health Emergencies* in our nation.

Apart from these issues, others like physical abuse, Intimate Partner Violence, verbal abuse, non-verbal abuse against children & young adults were common things observed with COVID-19 outrage. Evidences showed that serotonin is one of

the responsible factors for aggression. To normalise the level of serotonin medical professionals can prescribe drugs against called as SSRs (Selective Serotonin Reuptake Inhibitors). Fluoxetine is most widely studied.  $\beta$ -adrenergic agonists are also one of the well-known drug used for dementia, brain injury. (Adolphs, R., Tranel, D., & Damasio., et al. (1994)

In this category happened with aggression so questions which arise in our mind are:

*What is aggression? Why human behaved in inhuman way? Is COVID-19 the reason? What is the chemistry behind this? Can Aggression be controlled-with the help of medicines?* Answers to all these questions lie in understanding CHEMISTRY of Neurotransmitters.

Aggression is a behavior intended to threaten or injure the victim's security or self-esteem. It aims at inflicting pain or injury on objects or persons. it means 'to go against' 'to assault' or 'to attack'. (Townsend., 2009).

### A. Types of Aggression

Studies showed that there are many types of aggression. Out of these the main two are Proactive & Reactive (Wrangham., R.W., (2017).

Impulsive are very common. Proactive & Reactive are associated with the contrasting expression. Proactive aggression appears to be more frequent in human beings and is visible during war. Reactive aggression is very common in Apes. To understand the evolution of human aggression we should know the neural pathways for the responsible neurotransmitter with levels. Aggression is a psychological construct in which the individual is not able to control mood impulses. It is closely linked to depression, suicidal tendencies, and substance abuse. In other words, such people show impulsive aggression towards oneself and others and become depressed under the stressful situations of life. Aggression & COVID-19 has emerged as a global public health crisis & threat. From the neurobiological point of view, there are structures, neuronal circuits that play a

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decisive role in the mechanism of aggression. The neuronal center of aggression i.e. the Hypothalamus and the connections with the amygdala and hippocampus, located near the temporal lobe. For the management of higher cognitive processes, frontal lobe plays an important role. i.e. regulations of emotions (Bufkin & Luttrell, 2005). Centre for regulation of negative emotions, aggressive & violent behavior, impulsive acts, are situated in Prefrontal Cortex & the temporal regions of the brain.

## II. METHODOLOGY

Neuroimaging studies show that experimentally induced anger in humans showed increased activation in the DLPFC (Dorsolateral Prefrontal Cortex) and OFC (Orbitofrontal Cortex). In non-human primates, OFC & DLPFC lesions reliably produce increased aggressive behavior. Studies also shows that Aggression in humans may be associated with decreased functioning in orbital and dorsolateral prefrontal cortical areas, and increased functioning in medial temporal (especially amygdala) brain regions. All neuronal pathways are complex. Studies showed that aggression in humans is due to decreased level of serotonin neurotransmitter. (Kringelbach, M.L. 2005) The human orbitofrontal cortex: linking reward to hedonic experience.

It is a type of neurotransmitter and the key hormone that stabilizes our mood, feelings of well-being, and happiness. Entire body gets affected due to the impact of this hormone. It is also responsible for communication between brain cells and other nervous system cells with each other. It also helps with eating, digestion and sleeping, However, lower level of this hormone in the brain shall lead to depression. In contrast, if the brain has too much serotonin, it may increase excessive nerve cell activity. It reduces depression and also regulates anxiety. It is present in stomach, intestine, bones. The chemical structure & metabolic pathway of serotonin is given in Fig. 1 and Fig. 2 respectively.

It is a derivative of tryptophan. Through metabolic pathways it synthesized and decomposed. It metabolizes mainly into **5-hydroxy indole acetic acid (5-HIAA)** by the liver. In metabolism first step is oxidation by monoamine oxidase in to the corresponding aldehyde. In rate-limiting step, hydride

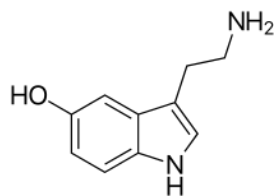


Fig. 1. Structure of Serotonin by en.Wikipedia.org

transfer from serotonin to the flavin cofactor, then oxidation occurs which is catalyzed by aldehyde dehydrogenase to 5-HIAA, the indole acetic-acid derivative. The latter is then excreted by the kidneys.

A **serotonin pathway** identifies aggregate projections from neurons which synthesize and communicate the monoamine neurotransmitter serotonin. They are relevant to different psychiatric and neurological disorders. The spinal cord, medulla and cerebellum innervated heavily by the caudal serotonergic. Manipulation of the caudal nuclei (e.g. pharmacological, lesion, receptor knockout) results in decreased activity decreases movement. Due to manipulations if increases

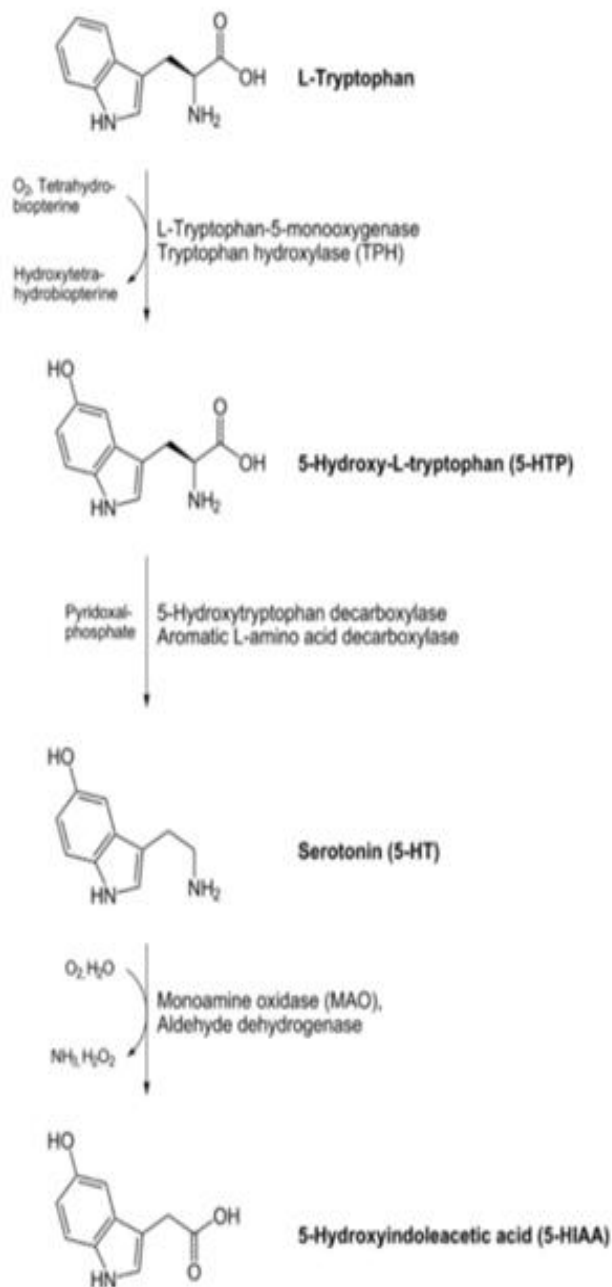


Fig. 2 Metabolic Pathway for the synthesis of Serotonin from tryptophan (by en.wikipedia.org)

caudal activity cause an increase in motor activity. It also affects

the sensory processing, to increase in extracellular serotonin in the neocortex. These pathways can be to modulate eating, both the amount as well as the motor processes associated with eating. Serotonergic projections into the hypothalamus are particularly relevant, and an increase in serotonergic signaling is generally decreases food consumption (evidenced by fenfluramine, these pathways are projecting into the limbic forebrain are also involved in emotional processing, with decreased serotonergic activity resulting in decreased cognition and an emotional bias towards negative stimuli. The function of serotonin in mood is more nuanced, with some evidence pointing towards increased levels leading to depression, fatigue and sickness behavior; and other evidence arguing the opposite.

A study showed that specific set of genes is responsible for aggression in human & rodents (Yanli Zhang & et.al., 2018). The studies done in Transcriptome & Human genome -wide association studies (GWAS), in which, they had selected four studies for the adult GWAS gene set & five for the child gene set out of which nine genes showed aggressive behaviour. In rodent

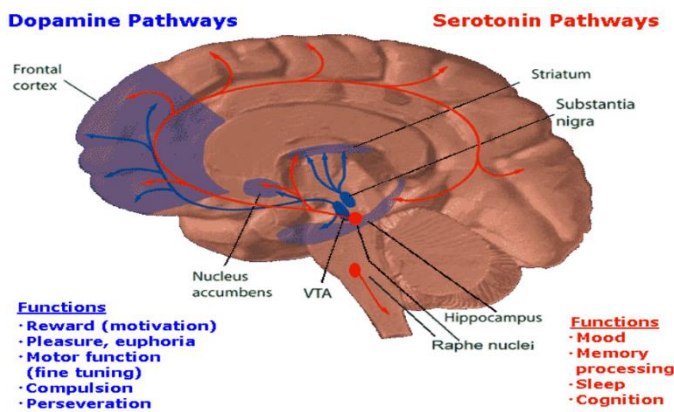


Fig. 3. Pathways of Serotonin and Dopamine by Researchget.net (National Institute of Health, United States Department of Health and Human Services)

genome -wide transcriptome data four genetic models showed aggression i.e. three in mouse one in rat strain. According to the Yanli Zhang & et.al, (2018) an Integrated analysis of genes & functional pathways for aggression in human & rodent models. Estimation of genetic correlation of aggression with six more cases like (Schizophrenia (SCZ), Attention Deficit Hyperactivity Disorder (ADHD), major depression disorder etc. through largest aggression GWAS meta-analysis of adults & children. However, none of them reported SCZ, ADHD, MDD so far. The polymorphic genetic variants of the serotonergic system are deeply affected by genetic predisposition that alters serotonin levels in the central & peripheral nervous system i.e., rate of serotonin production, synaptic release & pathways. These genetic overlaps suggest genetic etiology of human & rodent aggression both involved in different sets of genes. They used EAGLE software analysis, weighted ranking method to provide proper sequence of genes responsible for aggression. In case of

humans, only six common genes are present in adults & children GWAS sets i.e., ALK, LAMA2, NFKBI, OSMR, RBFOX1 & WDR62. Out of these sets only one RBFOX1 splicing factor is responsible for many development and psychiatric disorders and aggression. Other genes responsible for tyrosine kinase receptor linked to neuroblastoma, extracellular matrix protein, cytokine receptor family, transcription factor involved in regulation of neurons. They concluded that there is strong relation between genes, pathways & neurotransmitters (serotonin & dopamine) and humans' aggression.

### III. RESULT AND DISCUSSION

To check psychology & aggression amongst people of age group from 22 to 67 years and having history of epilepsy, asthma, diabetes, hypertension, heart, related problem etc. during COVID-19 lockdown, we carried out an online survey. The analysis have shown that sudden lockdown due to novel Corona virus (COVID-19) in rural area resulted in following consequences like lack of confidence, restlessness, lack of concentration, domestic violence- both verbal and non-verbal, nervousness, irritability, gender-based abuse, destructive thoughts, feeling to hit someone, frequent arguments at home, insecurity with spouse, violence at home and overthinking. Analysis of the survey has been reported in form of bar graph and pie diagrams (Fig. 4, Fig. 5 & Fig. 6).

Studies done by scientists have also shown that serotonin plays major role in aggressive behavior. It was observed that

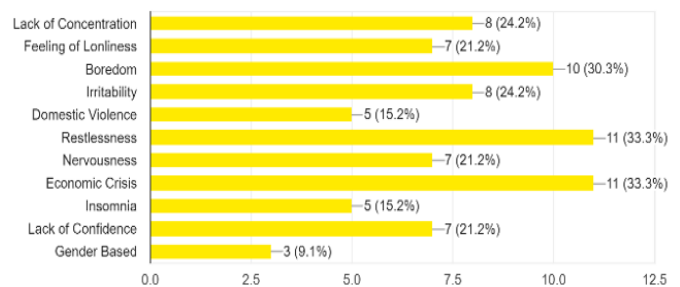


Fig. 4. Percentage of people's behavioral activity during Lockdown

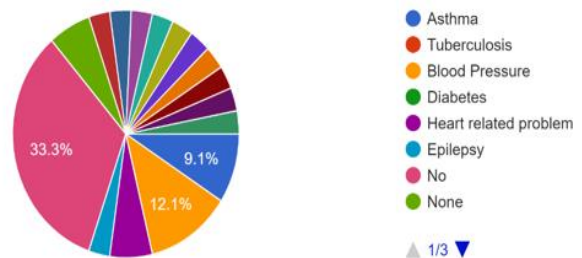


Fig. 5. People suffers from chronic medical Illness

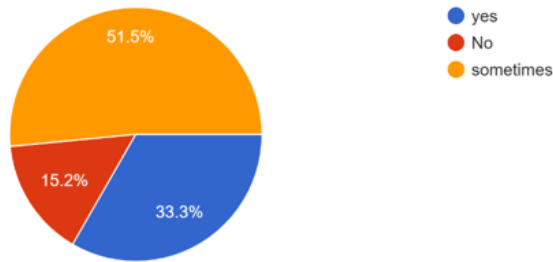


Fig. 6. People feel like to hit someone on provocation

suicidal cases & attempted suicide cases increased in lockdown period (Pathare., S. & Co-workers 2020). Studies have suggested that during quarantine period Counselling program is needed to prevent all these activities. According to Yanli Zhang- James & co-workers' aggression is inherited.

#### CONCLUSION

We concluded that if people do not socialize then the level of serotonin decreases leading to negative thoughts, depression, impulsive behavior, and arrogant nature. Even criminal tendency may develop in normal person for no reason. So, Serotonin plays a crucial role to maintain mood of person and it has been proved by genetic etiology.

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