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The dark side of the happy hormones- a study of neurotransmitters and their role in crime

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Abstract
Crime and deviance has been, in most cases, linked with poverty and need. However, with developments in the fields of forensics and neuroscience, research reveals that the causes of crime go beyond poverty and need and be explained with regards to neurotransmitters like dopamine, serotonin e.t.c which are often dubbed as the happy hormones or pleasure hormones. Such studies suggest that while certain crimes such as theft and robbery are more often than not, a result of poverty and want, crimes like murder, sexual assault e.t.c might stem from irregular levels of neurotransmitters. Impulsive aggression as well, is characterized by an inability to regulate the effect of such aggression and is comorbid with other mental disorders such as depression and anxiety. (Dongju Seo and Christopher J. Patrick, 2008). Individuals with low dopaminergic levels or with genotypes with a coding for reduced dopaminergic levels often have a tendency towards aggression. This is further substantiated with recent studies proving the positive relation between aggression and pleasure, it is often hypothesised that people with lower levels of dopamine engage in aggressive behaviour expecting pleasure. This paper seeks to delve deeper into the relation between neurotransmitters and crime based on existing findings and research that reveal the dark side of the happy hormone.
Keywords: *Aggression, Crime, Dopamine, Neurotransmitters, Dopamine, Serotonin*

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I. Introduction

The biological school of Criminology theorises a linkage between crime and biological aspects in the body. The intriguing yet controversial theory coined by Italian Criminologist Cesare Lombroso in the 1890s hypothesised that persistent criminal tendencies were related with cases of atavism that is reversion to a primitive stage of human evolution/development after investigation of skull and facial features. In the middle of the twentieth century, William Sheldon could garner considerable support for his theory suggesting that criminal behaviour was more prevalent among Mesomorphs or people with muscular and athletic bodies rather than endomorphs that is people with tall, thin bodies and ectomorphs (people with soft, round, short bodies). This later transformed into a debate regarding the possible association of chromosomal irregularities and criminality as it was hypothesised that males with an XYY chromosome (with an extra Y chromosome) are more criminally inclined than the general population. The popularity of such theories has however waned, in spite of which, research continues to reveal important findings. One of the most recent findings was an extension of the theory suggesting a possible corelation between genetics and criminal tendencies. The later theory however, suggested that monozygotic or identical twins had a greater inclination towards criminal activities compared to dizygotic or fraternal twins, suggesting a possible genetic influence on criminal behaviour. In addition to this, studies also revealed that an adopted child with at least one parent who is a criminal has a greater criminal tendency compared to an adopted child whose biological parents are not criminals but the adoptive parent(s) are. The highest rate of criminality is found amongst the children whose adoptive and biological parents are both criminals.

This school was however, given a more defined direction in the 1980s and 1990s when with development in neuroscience, a corelation was found between neurotransmitters and criminality. Neurotransmitters, often called the body's chemical messengers are molecules that transmit signals from neurons to muscles or another neuron. The transmission of such signals occur between the synaptic cleft. These neurotransmitters have several effects on the human body and irregularities are often the cause of several disorders including Parkinson's disease and depression, the latter being characterised by a lack of the neurotransmitter, Dopamine also called the pleasure or happy hormone as increased levels of dopamine result in pleasure. One neurotransmitter, closely linked with dopamine is Serotonin, often dubbed as the feel good hormone as it regulates moods and regulates the human biological clock and hence, a lack of which results in depression, anxiety and/or insomnia.

Dopamine, which is one of the most researched monoamine neurotransmitter, is crucial for the human experience of reward and reinforcement learning. The dopamine D2 receptor gene, encodes the post synaptic D2

receptor in the brain which specially effects the mesolimbocortical dopaminergic pathway. Dopamine D2 receptor genotypes that seek to code for reduced numbers of D2 dopamine binding locations result in reduced dopaminergic brain functioning in the striatum and prefrontal cortex. This reduced dopaminergic function in the brain directly results in an impaired subjective experience of reward. As per the reward deficiency hypothesis, a reduced sense of internally generated reward causes the individual to look for said sense of reward from their external environment (Blum et al., 1996; Comings & Blum, 2000). This behaviour however, often transforms into a risk factor as it causes individuals to engage in risky behaviours that lead to intense yet short periods of reward which is mediated by the dopaminergic levels. Lower functioning dopaminergic systems, in particular, often engage in risky and impulsive behaviour such as substance abuse, risky sexual behaviour or possible aggression.

Reduced dopaminergic levels have been scientifically linked with aggression, more specifically, impulsive violence (Seo, Patrick, & Kennealy, 2008). In experiments, where the levels of striatal dopamine were pharmacologically manipulated in mice, they showed a heightened level of aggression. Research also suggests that among children, those with a coding for low dopaminergic functioning were more linked to aggressive activities such as bullying, cruelty and volatile expressions of anger. Further along the developmental trajectory, such individuals with DRD2 genotypes traverse a more violent path from adolescence to adulthood than the rest. Individuals with DRD2 genotypes are also associated with psychopathy and violent victimization among criminal offenders. It appears, when taken together, that the individuals with DRD2 coding for low dopaminergic level are biologically pre-disposed towards engaging in reward seeking behaviour and simultaneously, pre-disposed towards violence as well. This raises a question regarding the seemingly ironic link between reward seeking and aggression due to the same factor. This irony, rises mainly due to the perception of aggression as a negative factor which arises from anger and pain while reward connotes a positive aspect. However, aggression can be said to have a cathartic and mood improving effect (Bushman, Baumeister, & Phillips, 2001). Aggression, when in retaliation to a provocation, in particular, is reported as pleasant (Ramírez, Bonniot-Cabanac, & Cabanc, 2005). Such aggression, in retaliation is associated with reward activity in the dopaminergic reward network in the brain, namely, the dorsal and ventral striatum (Krämer, Jansma, Tempelmann, & Münte, 2007). Thus, if aggression is truly rewarding, then individuals with sensation seeking (tendency to seek rewarding experience in the environment) would show a greater prevalence towards aggression. Such a connection has been proved by two studies *Derefinko K, DeWall CN, Metze AV, Walsh EC, Lynam DR Aggress Behav. 2011 May-Jun; 37(3):223-33* and *Joireman J, Anderson J, Strathman A J Pers Soc Psychol. 2003 Jun; 84(6):1287-302.* Evidences and links, such as this, from neuroscience, behavioural science and criminology, suggest that aggression is rewarding, thus violence, being a lucrative option for individuals that seek to engage in reward seeking activities, in other words, individuals with a coding for low dopaminergic functions.

An alternative explanation might also be through self control. Dopaminergic circuits in the brain extends to the regions of the prefrontal cortex that promotes self control process (Baler & Volkow, 2006; Posner, Rothbart, Sheese, & Tang, 2007). Thus, individuals with DRD2 genotypes that are low functioning, are likely to have a impaired self control from which aggression is often said to arise ((DeLisi & Vaughn, 2014; Denson, DeWall, & Finkel, 2012; Finkel, 2013). Therefore, the higher levels of aggression may occur through impaired self control.

Serotonin, is also linked with impulsive reaction and aggression. Specifically, serotonin hypofunction has been linked to a chemical that predisposes an individual towards impulsive aggression. Substance abuse, as well is linked with dopaminergic dysregulation caused from serotonergic deficiency.

II. Conceptualization

Dopamine is termed as the happy hormone. It controls mental and emotional reactions as well as physical ones. However, the most popular term associated with dopamine is "pleasure". A healthy dopaminergic level induces the feeling of pleasure while a low level results in a feeling of sadness, lack of motivation e.t.c along side several illnesses. Hence, people with low dopaminergic levels, seek to externally stimulate dopamine in their bodies by engaging in what they perceive as pleasurable activity. Dopamine levels, however, change either fast or slow. When it changes slow, it is a motivational signal but when it changes fast, it is an error signal. The latter, is a precise short yet large spike of dopamine in a small region of the brain. The former, on the other hand, creates constant, low concentration of Dopamine in several regions of the brain. Fast dopamine, usually, finds an error between what was predicted and what occurred. This error can be negative, positive or zero in nature. It is negative in nature when the error is not in the individual's favour. For example, if a person is expecting a reward but the reward is not given to them, the dopamine neurons would stop their activities and as a result the dopaminergic level would decrease, causing the individual to feel sad or unmotivated. In case of zero rewards, there is no error detected by the neurons, or the predicted event becomes a reality and since, it is expected, there is no spike or decrease in the dopaminergic levels of the individual. Positive error, happens in a case, where the predicted event is worse than the actual event. For example, if an individual is not expecting a

reward but achieves it, the dopamine neurons in their brain shall release more dopamine and the dopaminergic level shall increase. Dopamine thus, is triggered when something unexpected occurs. This fast change in dopaminergic levels is the dopaminergic change associated and linked with criminal activities, substance abuse and/or excessive hedonism of any kind.

At this point, it becomes crucial to refer to the hedonistic school of psychology which identifies and bases itself on a very basic human trait of trying to maximise pleasure. In keeping with hedonistic thought, in most cases the basic human tendency is to maximise pleasure and indulge in activities that gives them a feeling of pleasure, in other words creates a surge of dopaminergic level in their bodies. This risky behaviour however increases overtime as the same activity eventually provides the individual with a more subdued experience of pleasure which causes the individual to engage more frequently in such behaviour to gain the previous level of pleasure. This point has also been observed in the Opponent Process theory, which observes that certain common patterns are present in all hedonistic or pleasure seeking activities which are described and had been first introduced in Richard Solomon's opponent process theory of acquired motives. These patterns, as Solomon, observed, comprised of two components in every case studied. He labelled the first component as A, which was characterized by it short life and intense nature. The second component, labelled B, is the hedonic opposite of A, i.e. if A is pleasure, B is displeasure. The component A is easier to build and easier to decay. For example, if an individual is worried about being passed on for a promotion but is informed of his promotion on reaching his office, he would be euphoric for a few hours, after which, however, he shall revert to his normal state/demeanour. Component B on the other hand, is slower to build up and slower to decay. This component usually builds in the absence of A. Given such a nature, this component has been dubbed as "hedonistic contrast" by Solomon. However, the key point in Solomon's theory is that as the pleasurable activity becomes repeated, component B becomes larger or stronger while A becomes smaller or weaker. In other words, the activity, no longer provides the individual with the level of pleasure as it did before. This can cause a complete hedonic reversal of the tone of an event. Therefore, what was once pleasurable now becomes aversive, and what was once terrifying, seems fun. As the event seeks to be repeated, the body adjusts to the effects and the reaction becomes weaker as the reaction eventually becomes expected and hence the trigger becomes weak. This is termed as tolerance, which increases with repetitions and eventually, the excitement fades as the activity becomes routine. This is especially seen in the case of substance abuse, where in with time, the addict is more likely to consume more drugs to feel the initial pleasure again. Solomon observes this as a paradox in which he talks about the increase in engagement with the activity in question, despite the pleasure decreasing. Hence, an individual is likely to increase the frequency of such activities with time in order to retain the level of pleasure. Individuals with a low dopaminergic coding, often engage in deviant actions which are characterized by addictions, aggression and criminal tendency.

III. SUMMARY OF LITERATURE

According to Collins (2011), neurotransmitters play a crucial role in affecting the areas of the brain that regulate aggressive behaviour. Three neurotransmitters, in particular, have been said to affect behaviour and hence, the expression of violence and aggression. These three neurotransmitters are namely, Serotonin, Dopamine and Norepinephrine.

Serotonin is responsible for creating a sense of calmness and satisfaction in humans (Lesch 2003). In absence of regular levels of Serotonin, an individual experiences depression, anxiety and impulsive aggression (cf. Nielsen et al., 1994, Ball et al., 2002, Moore et al., 2002, Ellis 2005, de Boer et al 2009, Molly et al., 2010). It has also been observed in several studies that an increase in serotonergic levels, causes a decrease in aggression level (cf. Raine 1993, Bell et al., 2001, Reif et al., 2007, Miczek et al., 2007). Said, impulsive behaviour due to lack of serotonin is mostly seen in children who express such aggression at home, school and playgrounds, young soldiers who are often expelled after such violent episodes and criminals responsible for a series of crime. Several studies have researched on the effectiveness of administering medication to boost serotonin levels in criminals, Schizophrenic patients with an inclination towards aggression and children with ADHD and people with personality disorder (Sheard 1975, Morand, Young & Ervin 1983, Siassi 1982, New et al., 1997, Soloff et al., 2000). These studies have found them to be effective in reducing aggression. However, serotonin, impacts only the basic cause of aggression and not the subsequent consequence (cf. Clark & Grundstein 2004). Several studies have also shown that an individual has higher probability of showing aggressive behaviour when dopamine is in a hyperactive state and serotonin remains unperturbed.

Norepinephrine or Noradrenaline, seeks to affect aggression in three distinct levels which are inter-related with one another, namely – (i) hormonal level, (ii) autonomous sympathetic nervous system, (iii) central nervous system (Terbeck et al., 2016). Research suggests a relation between norepinephrine and aggression (McEllistrem 2004, Terbeck et al., 2016). In recent studies have also documented wide changes in noradrenergic neurotransmitter activity in limbic, diencephalic and mesencephalic regions while engaging, preparing or recovering from activities that result in an adrenaline surge, including violence and aggression. However, there

has been no evidence of noradrenergic marks that could selectively be identified with the propensity to indulge in violent or aggressive acts.

Another study observes that individuals who had/have a history of abuse as a child or at an young age, have low levels of activity due to Monoamine Oxidase or MAOA which deconstructs serotonin, dopamine and other neurotransmitters such as adrenaline or noradrenaline, expressed a violent and aggressive behaviour (cf. Caspi et al., 2002, Foley et al., 2004, Meyer-Lindenberg et al., 2006, Buckholtz & Lindenberg 2008, Stone 2009, Ferguson 2009). This finding strengthens the corelation between low dopaminergic and serotonergic levels and criminal tendency. Simultaneously, research also finds a corelation between high dopaminergic levels and violent behaviour. However, this tendency depends largely on the pace of change. Slow change tends to create a feeling of motivation and is not linked with criminal tendency while, fast, dynamic change, chooses to release or hold back dopamine secretion based on error and whether such change is positive, negative or zero.

Another neurotransmitter often related with aggressive behaviour is testosterone. However, the core reason behind this linkage was due to high testosterone level in adolescents who engaged in bullying and antisocial behaviour. It has also been observed that high testosterone level leads to criminal tendency when serotonin levels are low. Therefore, research corelates criminal inclination with low levels of serotonin and not high testosterone (cf. Archer 1991, Schaal et al., 1996, Higley et al., 1996, Harris 1999, Rowe 2004).

Several studies have also observed that high levels of Arginine Vasopressin led guinea pigs to display a more aggressive behaviour. However, on being Arginine Vasopressin being administered externally, the guinea pigs showed a diminished level of aggression (cf. Ferris et al., 1997, Wersinger et al., 2002, Wersinger et al., 2007). Research also finds a corelation between Arginine Vasopressin, however, this corelation is observed to be stronger in men rather than women. However, arginine vasopressin plays a crucial role in expression of aggression. (cf. Coccaro et al., 1998, Veenema 2009)

Objectives of study

This study aims at delving deeper into the link between neurotransmitters that are responsible for happiness and/or pleasure and crimes.

Crime usually has been credited to sociological and psychological factors, if not arising from need and poverty. However, research reveals the connection between neurotransmitters that are responsible for motivating and keeping an individual happy and criminal tendency. Such a linkage arises when the levels of the neurotransmitter in question is irregular which results in imbalance in the body and in cases, of dopamine, impaired self control. This paper aims on elaborating on said link on the basis of previously done reports. This paper also aims on hypothesising possible techniques to tackle this that have been followed in the past and analysing how the present criminal penal system in India that follows the reformative theory of punishment can incorporate this aspect into its practices.

IV. Methodology

This paper deals with a significant theory as to why crime occurs. This question regarding the roots of crime has been dealt with in several other theories such as the psychological school, sociological school etc. The effect of neurotransmitters and their role in criminal tendency in individuals in a product of the biological school. Delving deeper into the theories of the three schools, it can be observed that no one school manages to explain the cause of crime completely by itself. The biological and psychological school ignores any social factor such as poverty, labelling and the effect of the social environment of an individual, which explains a part of the cause of crimes. Similarly, the sociological and biological schools ignore any psychological factor that play a role in criminal tendency, which is best seen in most cases of serial murders. The psychological and sociological school, similarly have overlooked the biological factors that cause criminal tendency. Thus, anyone school of criminology cannot provide the sole explanation of crimes. This paper has been made on the basis of secondary data available from previous research and experiments. This paper has referred to theories from neuroscience and Psychology such as the opponent process theory of motivation to supplement the said research. This paper has also referred to theories of Criminology and criminal punishment systems as well.

V. FINDINGS

A psychopath is defined as an individual suffering from chronic mental disorder with violent and aggressive behaviour. Such individuals are often perceived as cold criminals who disregard any consequences of their action that leads them to their goal. However, a 2010 study from Vanderbilt University, found that a hyperreactive dopamine reward system could be a possible foundation for most problematic behaviours linked with psychopathy such as aggression and violent behaviour. This research also found that not only do psychopaths lack empathy, interpersonal skills and fear, but they also have, impulsivity and high attraction towards rewards and risk taking, in abundance, which are more closely linked with criminal behaviour. According to David Zald, associate professor of psychology and of psychiatry and co-author of the study, the

lack of fear, people skill and empathy are not very good predictors of criminal behaviour. However, a brain that is wired for reward seeking, explains the criminal tendencies associated with psychopaths. Such traits, namely, impulsivity and reward seeking, can be explained through a fault in the dopamine reward circuit. It was also found that while anticipating reward, in psychopaths, the area of dopamine reward area in the brain, that is nucleus accumbens, were more active compared to an average individual.

From a legal point of view however, neurocriminology can coordinate with law in three aspects: punishment, prediction, prevention. Punishment refers to the extent, a person can be held accountable for their actions, based on blameworthiness (Glenn & Raine, 2014). In the legal context, such accountability, is responsibility. Given the current humanistic belief of reformative theory of criminal punishment, it is easier to incorporate such findings in the present compared to the past. The best example of such incorporation was done by the first woman IPS officer Kiran Bedi in Tihar jail in India. Tihar jail which is the largest complex of prisons in South Asia, was infamous for the aggression and anarchy carried on by the inmates. On being posted there, she introduced practices of Vipassana, Yoga, exercise e.t.c in the jail which transformed the situation at hand. The levels of aggression and violence, were noted to be less post these changes. These activities, resulted in regulation of the neurotransmitter levels of inmates, which reduced their criminal tendency.

Prediction is based on the ideal that prevention is better than cure. Prediction seeks to identify the factors causing and/ or indicating crime or criminal tendency and control it prior to the act, thus preventing such acts. This is corelated to the next aspect, prevention. Neurocriminology identifies the corelation between irregular levels of neurotransmitters. This can be used for both prediction and prevention as the administration introduces activities that help in such regulation of such neurotransmitters. An example of this is seen in the cultures and traditions practiced by ancient civilizations. In the ancient Indian culture, for example, simple daily rituals such as Surya Namaskar and Yoga, cause physical exercise, that boosts serotonin. Practices like meditation, regulate the change in dopamine levels by keeping slow and constant.

However, since its initiation, neurocriminology has not resulted or caused any major change in the criminal justice system till date and without a major revolution, the chances of the same are not high. However, given the change in the field of neurocriminology in the last two decades, one might anticipate certain modest changes, that prima facie, shall not contribute to much but have the potential of hitting the roots of psychopathy and violent aggression.

VI. SUGGESTIONS

Criminal punishment system is one of the most important pillar of any society. The systems of such punishment, is based on various theories of punishment, which at the moment are- retributive theory, deterrent theory, preventive theory and reformative theory. Today, as the world has shifted to a more humane outlook on life, the criminal punishment system of most nations have adopted such an outlook as it seeks to accomplish more than just punish and prevent crime by trying to reform the lives of the convicted individuals as well. Such an outlook, is a feature of the reformative theory of punishment. This aims at rehabilitating the criminals and introducing them back to society as law abiding individuals.

Such an ideal, can only be realised if the steps for such reform is planned keeping in mind the causes of an individual for turning towards crime. Hence, criminals whose crime stems from need should have a different punishment than an individual with psychopathic tendencies. Therefore, it is crucial that the punishment system of a nation consider punishment not as mere repentance but as a true reform by incorporating such factors. In particular, the neurocriminological findings, corelating irregular levels of neurotransmitters with criminal tendencies, can be incorporated through practical means without any requirement of medication by introducing regulating practices.

The administration can simultaneously, seek to introduce community practices that encourage activities that help in regulating such neurohormones.

VII. CONCLUSION

Science and technology have advanced by leaps over the last century and as a direct result of such an advancement, there have been several breakthroughs in different fields. These breakthroughs have resulted in coining of several theories. However, without being utilised, such theories wouldn't have any purpose. Similarly, the theory relating neurotransmitters and criminal tendencies, needs to be incorporated into the criminal justice system and administrative system in order to take a stronger step towards tackling crime.

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