

**DEFICITS IN FRONTAL LOBES FUNCTION AND NEUROTRANSMITTERS AS
DETERMINANT OF VIOLENT CRIMINAL BEHAVIOURS AMONG INMATES
IN ONITSHA CORRECTIONAL CENTRE**

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Abstract

Over the past decade, violent crimes were not a scourge of Nigeria as a country. However, recently violent crimes have become scourge of Nigeria as a country. Currently in Nigeria, there is a higher increase of violent crime, including murder, rape, kidnapping, armed robbery, terrorism, and cultism. The present research investigated deficits in frontal lobes function and neurotransmitters as determinate of violent criminal behaviours among inmates in Onitsha correctional center in Anambra State, Nigeria. The objectives of this research were to investigate the relationship between deficits in frontal lobes function and neurotransmitters as determinant of violent criminal behaviours among inmates in Onitsha correctional centre in Anambra State, Nigeria, comprising both male and female. Two instruments were used in the research, namely; Crime Behaviour Rating Scale (BRS), and Adolescent Decision-Making Questionnaire (ADMQ). Correlational studies were adopted in the study, and the result demonstrated that deficits in frontal lobes and neurotransmitters had a significant relationship with violent criminal behaviours. The study observed that deficits in frontal lobe and neurotransmitters have a significant influence on violent criminal behaviour. The study agrees with the findings of Achebe and Nweke (2023); and Reddy et al; (2018), which posited that damage to frontal lobe influence violent criminal behaviours.

Keywords: **Neurotransmitters;** Violent; Criminal behavior; Inmates; Lobes function

Introduction

Criminality as posited by Davies et al (2022) is an act, action, or any behaviour that is in violent of an already constituted law made by the society or nation. This law includes both criminal law, and civil law, such as norms and the values of the society. Crime as demonstrated by Larson (2020) is an act, or action representing any behaviour that violent criminal law. These behaviours include drug trafficking, rape, stealing, murder, advance fees fraud, and kidnapping. Abrifor et al (2021) states that criminal behaviour has become one of the major challenges Nigeria as a state is facing recently including criminal justice system and the vigilant department. Violent crime according to Archer (2023), is a pattern of crime that involves use of force. Crime become violent when the perpetrator uses force on the victims, or threaten. West (2021) states that these types of crimes entail attitudes in which the act is the objectives, such as rape, murder, or kidnapping. However, it is important to note that not all violent crimes are committed with weapons. A study by Joloko (2021) indicates that violent crimes also include aircraft hijacks and car stealing. Again, west (2021) includes both sexual assault and robbery (armed) as violent crimes. Achebe and Nweke (2023) found lack of self – control, and anger as factors that lead to violent criminal behaviours.

The Major Functions of Frontal Lobes

Frontal lobes play myriad roles in human's brain activities, including language and motor functions, morality, personality, social reasoning, affect, self – awareness, cognitive processes, and executive functioning. (Chayer and Freedman, 2001).

It is important to indicate the particular regions of the brain that neglects anger and lack of self – control that leads to violent criminal behaviours. The frontal regions of the brain have been discovered to be mostly implicated in incidences of lack of self – control and anger (aggression). As noted by Segun, (2019), higher incidences of lack of self – control and anger (aggression) have been found in individuals who have had injuries in the frontal regions of the brain, mostly in the ventromedial prefrontal cortex (vMPFC), Orbito frontal cortex, and Dorsolateral prefrontal cortex. (Lebreton et al; 2009).

Ventromedial Prefrontal Cortex (vMPFC).

The ventromedial prefrontal cortex is the key brain Nigeria that is deeply involves in supporting decision – making processes. It also plays a major role in rein for cement related activities. (Lebreton et al; 2009). Injury or damage to ventromedial prefrontal cortex leads to abnormal judgments in response to moral dilemmas, and lacks of emotions (Aguiar, 2013).

The ventromedial prefrontal cortex is always activated when humans are contemplating on different aspects of themselves, and their lives, such as their traits, experiences, preferences, goals, and abilities. (Reddy et al; 2018). It has been found that psychopaths brain always demonstrates reeducation connections between ventromedial prefrontal cortex and the part of brain region that is responsible for sentiment; - including empathy and guilt and amygdale which control fear and anxiety (Achebe and Nweke, 2023). Brown et al; (1996) shows that impairment in the ventromedial prefrontal cortex lead to impaired decision-making, leading to frustrations and anger (aggressions) that arises from the impaired decision-making. One of the examples is a case of a 16-year-old high school boy who has an injury in ventromedial prefrontal cortex, later demonstrating violence attitudes toward his friends, and members of their family, including his mother. He attacked a woman and injured her son. He was later arrested, and taken to court. However, he was later granted bail based on that his actions were caused by impairment in the brain. This case was among the cases brain imaging results was used to explain the link between brain regions dysfunction and violence criminal behaviour (Davis & Traynor, 2012; Schlitz et al; 2013).

Orbito Frontal Cortex

Orbit frontal cortex as noted by Reddy et al (2018) contains the secondary taste cortex, in which the reward value of taste is represented. A study by Blair (2004) shows the role of human orbito frontal cortex as a nexus for sensory integration, modulation of visceral reactions, and participation in learning, prediction and decision-making for emotion, and reward-related behaviours. Orbito frontal cortex regulates the choice of desirable outcomes, and also contribute to the function of impulse control, emotional reactions, value-based, decision-making, and social behaviour. Both acquired antisocial disorder, and the development of borderline personality disorder have been linked to the early impairment in the functioning of orbito frontal cortex region. (Blair, 2004; Seguin, 2009). Case of Mr. Michael, a 40-year-old school teacher is a good example for this particular argument. Mr. Michael as narrated by his Family is a good husband, father, and grandfather.

In the school where he teaches, he was never accused of any inappropriate behaviour, including sexual harassment, or sexual abuse. However, Mr. Michael at a time started exhibiting aggressive behaviour towards his wife, and made sexual advances toward his 11-year-old daughter, including other people he met on the way, and in social gathering. School authority later caught him viewing pornographic movies in his office, and he was later convicted for his inappropriate behaviour, mostly, sexual advance, and aggression. Authority later found that he was suffering from highly painful and persistent headaches. Neurologist was contacted, and a MRI scan was performed, and the result indicates that a tumor developed in his orbito frontal cortex. Glenn and Raine (2014) states that Mr.

Michael underwent surgery two times, and the tumor was removed, and his behaviour returned to normal again.

Dorsolateral Prefrontal Cortex

The Dorsolateral Prefrontal Cortex (DLPFC) as noted by different studies is a region of the frontal cortex that is involved in general executive control functions, including cognitive functions, such as task switching and task – set reconfiguration, working memory, prevention of interference, planning, abstract rules maintaining, inhibition, goal – driven attention, novelty-seeking, and problem solving (Mathews et al; 2005; Woermann et al; 200; Reddy et al; 2018).

Impairment to DLPFC often involved Deficit in executive functioning seen mostly in obsessive-compulsive disorder, that is, it involved unwanted thought, self – control and emotional regulation (Blair, 2004).

Anterior Cingulate Cortex (ACC)

Anterior cingulate cortex is part of frontal lobes regions that plays a major role in fundamental cognitive processes, including decision-making, motivation, avoidance learning, and monitoring conflict (error), and cost-benefit calculation (Glenn and Raine, 2014). ACC often highlighted its role in signals error and reward, and inform decisions on switching, or to continue with the current behaviour (Rushworth, et al; 2012). Anterior cingulate cortex is also involved in emotion because it is involved in linking reward and punishment information. A study by Glenn and Raine (2014) found that damage to the anterior cingulate cortex leads to aggression and disinhibition, and damage to the dorsolateral prefrontal cortex leads to antisocial behaviours, including poor impulse and lack of behavioural control. Again, personality disorder, including antisocial, and borderline are linked to the early impairment in orbito frontal region (Seguin, 2009), and high incidences of aggression as found by Glenn and Raine (2008) have been linked to the damage to the ventromedial prefrontal cortex.

Ventromedial prefrontal cortex plays a major role in related activities, such as reinforcement, the orbito frontal cortex controls the order of choice of desirable events, while the dorsolateral prefrontal cortex resolves and also monitors the response conflict. Injuries to the frontal lobes in some cases lead to impaired decisions, motivation, avoidance learning, and monitoring error. Blair (2008) found that injuries to the frontal lobes are responsible for high impulsivity, and lack of inhibition and sensitivity in humans.

However, it is important to note that frontal lobes lesions do not predict violent crime, rather it only increases tendency for risk of violent attitudes (Brower & Price, 2001). In a study

conducted by Brown et al (1996), it was demonstrated that the participants with frontal lobes lesions, mostly in the ventromedial region scored higher in aggression and violence scales when compared to normal participants.

Brown and Price (2001) states that frontal lobes also play an executory function, mostly where social cues are processed, and people that are involved in inappropriate behaviour are based on these social cues.

Proper functioning of frontal lobes helps individuals to behave proper, and move away from situations that are likely to attract aggressive acts, or behaviours. Damage in frontal lobes always results in gauging situation differently, such as taking poor decision, and engaging in conflicts. (Aguiar, 2013; Blair, 2001). Similarly, damage in frontal lobes also leads to misidentification of expression of emotions, this include socially inappropriate behaviour, that is being indicates through facial and vocal. In a research conduct by Hornak et al; (1996) found a strong positive correlation between damage in frontal lobes and disinhibition, related problem behaviour, and impaired emotional behaviour.

Bechara, Damasio, and Damasio (2000) somatic markers hypothesis found that impairments or lesions in the frontal lobes often result in poor decision making, autonomic reactivity reduction to socially events stimuli and psychopaths. Again, Damasio (1994) state that impairments to ventromedial prefrontal cortex always result in bad characteristics, including inability to learn from previous mistakes, and difficulty in assessing and controlling emotional reaction. However, it is important to note, that factors, such as premorbid personality, including hormonal regulation, prior to damage in the frontal lobes are also responsible in aggressive tendencies (Aguiar, 2013). In support of this, a study by Sollberger et al; (2009), on front temporal dementia individuals indicates a loss moral behaviour with a disorder on the ventromedial prefrontal cortex and anteromedial temporal regions. According to Sollberger et al (2009), affiliative traits including warmth and empathy rely on ventral medial prefrontal cortex and anteriomedial temporal regions. However, Mendez (2010) states that sociopathic behaviour results from impairment in orbito frontal cortex, which causes disinhibition.

The Limbic System and its Role

Different studies have found positive relationship between the role of limbic system in crime and violent (Siever, 2008). Emotion centric region is located in the limbic system, mostly the amygdale, which is responsible for emotions including fear and anger (aggression). Foreman (2000) demonstrates that fear conditioned response has been linked to the functioning of the amygdale. Siever (2008) found that damage to this region often lead people to engage in antisocial actions, or acts without thinking, or worrying about the

consequences of this action. Different impulsive behaviour as noted by Sutton (2016), were found to be linked to impairment in amygdale, hypothalamus, and periaqueductal grey region of the brain. It is important to note that primarily prefrontal cortex is responsible for behaviours that involve critically decisions – making and meticulous planning, and it also plays role in directing individuals towards socially appropriate attitudes. However, reduction in the grey matter in the frontal regions have been found to be involved in individuals suffering from antisocial personality disorder (Yang, et al; 2009). Yang et al (2009) further indicates that reduction in functioning of the amygdale, including reduction in its volume leads individuals in blunted emotions, and also engaging in colder and uncalculated hostile behaviours. Damage to the amygdale always results in lessened fear, lessened in the perception of danger, and related facial expressions (Glenn & Raine, 2014). The role of the limbic system in crime and violence have been demonstrated by Siever (2008). When temporolimbic “bottom-up” that prominently drives the limbic system, mostly the amygdale cannot be inhibited by “top-down” prefrontal regions structures, including the orbito frontal cortex and anterior cingulate cortices. It is important to indicate that there are many neuronal circuits that link both the limbic system and frontal lobes together. Aggression occurs when inhibition cannot control amygdale, impulses in the limbic system, substance abuse, and anger provocation are frequently involved in this act. Pathways from the thalamus to the amygdale and to the frontal lobes are activated as noted Reddy et al; (2018). Reddy et al; (2018) states that the amygdale pathway is faster and it triggers automatic affective responses, and frontal lobe pathways is slower and triggers-controlled processes. The indirect cortical pathway always stands to inhibit, or suppress the direct amygdale pathway, however, the process, and response elicited from amygdale inhibits critical reasoning, rational thinking, and any impairment to the frontal lobes is likely to disrupt its activities to suppress the overly affective responses.

The Role of Neurotransmitters and Hormones

Neurotransmitters and hormones have been linked in emotional and crime related actions, or acts. Lowering serotonin level in the brain have been found in triggering aggressive behaviours as found in different researches conducted with both human animals (Reddy et al; 2018). Substance abuse, and injuries, or destruction in this region of the brain, mostly those that is linked with serotonin neurons. Lowering serotonin in the brain also trigger self – inflicted harm, including suicide (Badaway, 2003; Glick, 2015; Krakowski, 2003). Badaway (2003) research indicates that serotonin also inhibits both affective aggression, and predatory. The serotonergic hypofunction as noted by Glick (2015) is rooted in hereditary in the GSC of affective aggression, and always predisposes individuals towards impulsive and hostility behaviours. Reduction in serotonergic has been found in the circuit

that control emotional regulation (Krakowski, 2003), including prefrontal cortex and anterior cingulate cortex, which trigger affective aggression. Patrick and Kennelly (2008) states that dysfunctions in the prefrontal cortex is camrbid with the affective aggression in different other condition, including suicidal tendencies and substance abuse. Research by Badaway (2003) that examined the link between levels of serotonin and aggression, found that it is the low serotonin syndrome that imply individuals in to state of an impulsive personality, and irritable aggression. According to Glenn and Raine (2014), low levels of serotonin in the cerebrospinal fluid (CSF) are the characteristics of individuals who often show aggressive and impulsive. Similarly, Rubia et al; (2005), found that the functioning of the orbito frontal cortex often decreased when the levels of serotonin fail to function normally in the brain, and damage in this particular region have been observed in individuals with anti-social behaviour patterns. As noted by Rubia et al (2005), other neurotransmitters including catecholamines, dopamine and norephinephrine is likely to potentiate violent behaviour.

Dopaminergic system as posited by Patrick and Kennelly (2008) is involved in behavioral activation, processing of reward, and motivation. Similarly, it modulates aggression. Again, it is involved in decrease in emotional regulation and increase in impulsivity. Driver-Dunkley et al; (2003) states that pathological gambling is an act of impairment in dopqmine, and L- dopa is likely to also trigger impulse control dysfunction (ICD). Stamey and Jankovic (2008) study with Parkinson's disease patients demonstrates that loss of dopamine in the ventral segmental region, and decreased innervations of the nucleus accumbens produces typically cautious, avoid risk, and seek less reward. Aggression as noted by Stamey and Jankovic (2008) is a product of dopamine. Stamey and Jankovic found a link between norephinephrine, dopamine, and serotonin in behaviour dysfunctions. Norephinephrine and dopamine as demonstrated by Patrick and Kennealy (2008) play an important role in restrain predatory aggression. Patrick and Kennealy (2008) also implicated a link between serotonin system and dopamine system. Patrick and Kennealy demonstrate that and dysfunction in the functioning of serotonin system, including deficiencies in it, often produce an increased activity of the dopamine system, which leads to impulsivity and aggression. However, it is important to indicate that increased dopamine function is secondary to the serotonergic activities, or functioning. This increase in dopaminergic functions, relating to serotonin deficiency leads to addictive behaviours, depression, and substance abuse.

A study conducted by Seiver (2008) indicates that maladaptive functioning of cholinergic activity, triggers aggressive tendencies by activating the sub cortical limbic system part of brain. Jong and Neumann (2017) found that gamma – amino butyric acid receptors also produce aggressive behaviour. Reduction in oxytocin level increase feelings of mistrust and

fear in individuals. According to Jong and Neumann (2017) it directly hinders the functioning of amygdale in the brain system. This oxytocinergic functions vary from individual, as related to social phenomeno, stress, seasonal changes, hereditary, including other unknown events that is likely to cause it that is yet to be research on. Campbell (2008) found that lowered oxytocinergic functioning also produces aggressive behaviour, and higher functioning is linked with inhibition of aggression. Oxytocon however, have negative correlation as posited by a study conducted by Reddy et al (2018). Campbell (2008) shown that in female oxytocin effects varies from male, because it is been modulated by estrogen.

Normally, oxytocin is produced in the hypothalamus. It is always been released into the blood through the pituitary gland to other of parts of brain regions and the spinal cord, where it links to oxytocin receptors to influence behaviours and physiology functions. Oxytocin is one of the ancient reptide molecules that is responsible for reproduction, sociality, and survival in human, including both female and male. Kern et al (2008) demonstrates that pre frontal cortex plays a major contribution in regulating H Hypothalamus-Pituitary Adrenah (HPA) Axis which control, and also responds to stress and release hormone and cortibol.

Van Bokhoven et al (2005) states that low levels of cortical at early stage of life produces increased amount of aggressive behaviourr in later age. In support of this study, van Goozen et al (2007) shows that different major psychological stress is likely to produce a permanent change in HTP Axis of the particular individual; and is likely to predispose the individual to demonstrate antisocial behaviours. Different cultural studies conducted on this as noted by Batrinos (2012) linked more incidences violent criminal behaviour with men, and this utter difference is associated with the hormone testosterone which is more in males than females. Castration as noted by Batrinos (2012) reduce, or decreases aggressive behaviour, as the and organ affection had a direct influence, or effects on the aggression that is likely to be exhibited by individuals that is involved in it. Testosterone as found by Glenn and Raine (2008) is likely to produce aggressive, though it is found to been more linked with dominance than aggression. In a single study conucted by Glenn and Raine (2014), a causal positive relationship was found between testosterone and aggression in adult males when it was administered in the research, and an increase in aggressive attitudes were also found among them. In support of these, research by vain Bokhoven (2006) indicated that in some individuals at age of 10 to 12, when the levels of testosterone were high, it is likely to predict assaults and aggressiveness by the age of 12 to 14. It is likely also to predict violation of an already made rules and laws by the society by the age of 16, and abuse of drug, and its usage by the age of 19. Van Bokhoven et al (2006) found a positive relationship between violent criminal behaviours in adulthood and higher testosterone levels in their study.

Summers et al (2000) found different social events and stimuli that produce a serotonergic response. This serotonergic response as posited by Summers et al (2000) is been modulated by the level of testosterone and corticosterone.

Brain Imaging Studies Results

One of the most recent brains imaging result that was used in a criminal case was the famous case of Brain Dugan, a murderer and a convicted rapist. Dugan was convicted for killing different ladies after raping them. Even in the prison, Dugan still indicate hostile toward other prisoners, and his ability to control his hostile impulses was taken into consideration in the prison. (Wolf & Koenig, 2005) based on brain imaging result, it was found that Dugan was a psychopath, this means that he has an impairment in limbic part of brain, which produce control, empathy, regret, and this makes him more likely to commit violent crimes, including aggressive behaviours. The FMRI seams result demonstrated that there was diminished activity in amygdale region, and this affected the regulation of his behaviours. Brain Dugan's case was the first-time brain imaging result was accepted at us court of law during a criminal case trial based on an expert testimony (Wolf & Koenig, 2015). Importance of magnetic resonance imaging data (FMRI) is brought to light through this particular case, and it also brought what the field of forensic sciences viewed as a land mark for the intersection between criminal justice system and neuropsychology, neuroscience, and forensic sciences. Brains imaging results and its studies have established a major and clear link between brain dysfunctions and violent criminal behaviours.

Foreman (2000) found that the brains of murderers had lower glucose metabolism. This demonstrates that the brain regions that are responsible for inhibitory behaviours were not functioning normal. In this study, foreman includes both healthy volunteers and implicated murders as participants in the research. A PET scan result indicates that violent criminal behaviours have a positive relationship with lower glucose metabolism. Brower and price (2001) found decreased cortical blood flow in patients with forensic psychiatric individuals as to compare to healthy individuals. PET scan results in this study demonstrate a positive relationship between brain dysfunctions and violent criminal behaviours. Rain et al (1998) used positron emission tomography to examine glucose levels in the prefrontal and sub cortical regions of the brain. The types of murderers were examined in the research were the predatory type, and affective aggression type. The predatory type involved well planned and structured hostility, and affective aggression involved unstructured affective arousal and aggression. Rain et al found that affective type has a lesser prefrontal functioning, greater sub cortical functioning in the right hemisphere, and a lesser ration of prefrontal sub cortical in the right hemisphere. This study indicate that affectively motivated and impulsive aggression made it difficult for individuals, mostly murderers to control and

regulate their sub cortical regions, and this is because of the deficient regulation of the prefrontal cortex regions of the brain. The largest reduction in the structure and function of the frontal lobe as noted by Schiltz et al (2013), mostly the orbito frontal cortex, anterior cingulate cortex, ventromedial prefrontal cortex and dorsolateral prefrontal cortex was demonstrated by meta – analysis of structural and functioning imaging results of violent criminal behaviours. Schiltz et al (2013), found those normal and healthy individuals who have head injuries is likely to been involved in violent behaviours, because it would later precede to the frontal lobes, mostly the orbitofrontal cortex. Structural and functional abnormalities in the regions of the brain that control cognition, affective, and social functioning in the psychopaths as demonstrates by Reddy et al (2018). Reddy et al found that the functional connectivity between the anterior cingulate cortex and the insular were impaired in the brain of psychopaths. Mathews et al (2005) found very low frontal lobe activation in psychopaths when compared to non-psychopaths, and this low frontal lobe activation always produces higher levels of aggressiveness. In individuals with temporal lobe epilepsy as posited by Woermann et al (2005), demonstrates a reduction in the neocortical grey matter in the frontal lobe that produces violent behaviours, such as aggression.

Method

Inmates in Onitsha correctional center were used as participants. Two different instruments were used in the study, crime behaviour rating scale (BRS) and Adolescent Decision – making Questionnaire (ADMQ). The study was conducted between March and April 2024. Approval for the study was given by the authority. The mates were told the reason for the study. Correlation design was used because the study aims to examine the relationship that exists between the variables.

Summary of the Finding

The result of the research indicates that deficits in frontal lobes function and neurotransmitter has a positive correlation with violent behaviours. This indicates that brain dysfunction mostly the prefrontal lobes produce violent criminal behaviours.

Discussion

This study examined deficits in frontal lobes functions and neurotransmitters as determinates of violent criminal behaviours among in mates in Onitsha correctional centre in Anambra State Nigeria. The major aim of the study was to investigate the relationship between deficits in frontal lobes function neurotransmitters as determinates of violent

criminal behaviour among participants. The study found that there is positive relationship significantly, between the variables. The findings of the research agree with the findings of Achebe and Nweke (2023), which found that damage to the frontal lobe leads to violent criminal behaviours. Again, the study agrees with the findings of Reddy et al (2018), which demonstrates that damages in the ventromedial prefrontal cortex (vmPFC), leads to violent criminal behaviours. Similarly, the research is on online with the findings of Blair (2004), which posited that damage in orbitofrontal cortex leads to violent criminal behaviours. The findings of the study agree with the findings of seguin (2009) that early impairment in the functioning of orbito frontal cortex lead to violent criminal behaviours. In the same vein, the current study agrees with the result of findings of both Mathews et al (2005), and Woermann et al (2000), that damage in dorsolateral prefrontal cortex leads to violent criminal behaviours.

Implication of the Study

The findings of this present study indicate that deficits in frontal lobes functioning and neurotransmitter leads to violent criminal behaviour among the population.

The study found that most individuals that were involved in violent criminal behaviour were individuals who have deficits in frontal lobes functioning and neurotransmitter. The study found that frontal lobes control individual's decision-making planning, and execution of that decision – making and planning.

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