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THE AMYGDALA AND AGGRESSIVE BEHAVIOUR

To what extent does the amygdala play a role in aggressive behavior?

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ABSTRACT

The research aims to investigate the extent to which the amygdala plays a role in aggressive behavior. Physical, verbal, and relational forms of aggression reveal a complex behavioral pattern with ramifications for individuals and society. The brain's amygdala is a crucial component that has drawn attention to its function in controlling violent behavior. In order to determine the degree to which the amygdala plays a role in aggression, this paper synthesizes the body of research while taking environmental, psychological, and neurological aspects into account. Empirical research is analyzed to show that changes in the structure and function of the amygdala are associated with a higher tendency towards violence. Still, the unique function of the amygdala is complicated by the interaction of other elements, including neuronal networks, societal pressures, and hormonal impacts. Through exploring these intricacies, the purpose of this study is to offer a thorough comprehension of the role the amygdala plays in violent conduct, along with its consequences for intervention techniques and psychological research.

Keywords: Amygdala, aggression, neuroscience, society, gender, hormones, brain

INTRODUCTION

Aggression refers to the behavior that can result in both, physical and psychological harm to oneself, others, or objects around the environment. By nature, aggression centers around action, thus influencing the different types of aggressive behavior such as physical, verbal, or relational aggression (Dr. Charles Stangor). In the human brain anatomy lies a structure called the amygdala; an almond-shaped structure in the temporal lobe that is responsible for the processing of emotions (APA Dictionary of Psychology). It has historically been known for its role in processing fearful emotions. Amongst the brain regions that influence aggression, the amygdala plays a role in aggressive behavior (Dr. Charles Stangor). Also a part of the limbic system, the amygdala is involved in the behavioral and emotional responses to external stimuli. The limbic system is believed to be hierarchical when delivering signals that are passed from the lower to the higher parts of the systems in the prefrontal cortex. This is where feelings are monitored and processed, triggering a physical response. The prefrontal cortex is crucial for regulating social behavior and aggressive responses. Thus, any damage to the prefrontal cortex would reduce the activity of the amygdala which then leads to higher levels of aggression ("Tutor2u"). It is believed that since the amygdala's function is to regulate behaviors such as fear and aggression, any damage such as a lesion, swelling, atrophy in the amygdala, can lead to the portrayal of aggression/aggressive behavior. Although anger starts at the amygdala stimulating the hypothalamus, individuals with damage in this area often face difficulty in controlling their emotions, especially anger and aggression (Seladi-Schulman). Thus, establishing the underlying situation that damage to the amygdala makes controlling of emotions challenging; thus leading to aggressive behavior. Through the support of the fMRI and MRI (technological advancements), the psychological studies revolving around aggression have become more familiar with respect to the anatomy of the human brain. With the increase in aggressive behavior, studying the imperceptible topic/behavior, identifying the functions of the brain parts and understanding how any damage or change can play a major role, must be recognized and made more aware.

NEED FOR THE RESEARCH

Studying or deep research into aggression and aggressive behavior is essential to the psychological field due to a range of possible negative and detrimental public health outcomes that could lead to an array of possible consequences. These include youth violence, acts including outrange, impulsivity, or even involvement in crime or illegal actions. Understanding structural changes in the brain that are not very easily detectable, it is crucial to have knowledge of the repercussions attached to the damage of a particular part such as the amygdala, which could possibly lean to the demonstration of aggressive behavior. (Butler and Gettinger). However, there are numerous factors that cause or contribute to behavior like aggression. On one hand, although the amygdala plays a role, factors such as socio-economic, early-childhood abuse, history of being bullied, or any involvement of drug or alcohol (Fordham) are associated with aggression. There are other neurobiological factors revolving around the brain and changes in the brain that increase aggressive behavior such as video games influencing the brain, the role of hormones, and other chemical mechanisms that contribute to aggressive behavior that saliently result in aggressive behavior.

Thus, this paper will examine my research question of **"To what extent does the amygdala play a role in aggressive behavior?"**

ROLE OF THE AMYGDALA

According to Pardini, reduced amygdala volumes have been implicated in the development of severe and insistently prolonged aggression over a period of time (Pardini et al.) The study aimed to examine whether a sample of male subjects with lower amygdala volume has a history of aggression dating back to childhood and are at risk of aggression in the long run. The participants of the 2014 study conducted by Pardini et. al consisted of 56 men that were a part of the PYS - Pittsburg youth study. The PSY comprised 503 boys that were originally a part of the study which measured anti-social behavior. At age 26, a sub-sample of 56 men from the first PYS study with varying histories of violence were recruited for the 2014 study. After the participants underwent a violence history questionnaire, a series of functional and structural neuroimaging scans series followed. This examined the relationship between the amygdala volume and the participant's levels of aggression, violence, and psychopathic characteristics. The results of the study suggested that men with lower amygdala volume exhibited higher levels of aggression through their childhood up to their adulthood. Pardini et. Al's findings concluded from this longitudinal study that men with lower amygdala volume have a longstanding history of aggression and are at a higher chance of committing future violence and portraying aggression (Pardini et al.)

Since the study of Pardini et. Al's sample consisted of a specific and narrow sample of men aged 26 that were pre-assessed for anti-social behaviors, the generalizability decreases since all men don't show antisocial behaviors. Additionally, taking into account that the sample had been selected out of a longitudinal study, the participants may have wanted to opt out. In this context, for the field of psychology to identify that men with lower amygdala volume necessarily demonstrate a significant chance of exhibiting aggressive behavior in the future.

AMYGDALA ACTIVITY

There is a relation between reactive aggression and the amygdala as suggested by the recent technological advancements of structural imaging. The results of the scans have shown a positive correlation between reactive aggression and the right volume of the amygdala. With the help of brain imaging, psychologist and researchers have been able to arrive at a conclusion when there is significant involvement of the brain anatomy. It has been shown altered amygdala activity during emotional processing in children and adolescents with ODD and CD. ODD or oppositional defiant disorder is a behavior disorder in which a child portrays combative or cranky behavior which is often expressed through arguments and shouting with other peers and their family; a form of aggression ("Oppositional Defiant Disorder: Causes, Symptoms & Treatments"). On the other hand, CD or conduct disorder is a behavioral disorder that is characterized by hostile and physically violent behavior. It is also highly possible that the individual may show early signs of physical and verbal aggression ("Conduct Disorders: Symptoms, Causes, Diagnosis and Treatment").

The study of Aggensteiner et. Al, aimed to assess whether aggression-related subtypes such as reactive and proactive aggression predict variation in amygdala activity during emotional processing. In this study, Aggensteiner et. Al, used 177 participants aged 8 to 18. All of the participants performed an emotional-face matching functional magnetic resonance imaging task. From the results of the study, the researchers established that their results showed differences in amygdala activity responses to emotional faces between cases with ODD/CD and typically developing.

As the study used advanced machinery it enables the detection of the amygdala activity responses to the emotional faces. The age bracket of 8 to 18 was taken into consideration as this is the age pool when aggression and signs of anger and violence are at their peak. Since the participants already had ODD or CD, there might have been previously increased volumes of activity in the amygdala which must have increased due to exposure to emotional-face matching activity.

INCREASED ACTIVATION

It is a common discussion that aggression and antisocial behavior are a result of a lack of response to emotional cues under a social environment. Due to maldevelopments, individuals may face difficulty in the normal way of responding to emotional cues in the social environments that then arise as a consequence. Emotional cues involve other feelings that may occur concurrently with anger. This consists of feeling angry when there is a sense of abandonment, fearsome, disrespected, guilty, humiliation, impatience, jealousy, or rejection. These emotions may also influence any action that is followed by the arousal of these emotions ("Anger Cues and Control Strategies - at Health").

In the study of Sterzner et. Al, the researchers asked a group of adolescents with CD or conduct behavior whether neural responses evoked by affect-laden pictures would be abnormal. (Sterzer et al.) Affect-laden images are those that trigger or enhance the ability to think about thoughts involving affect themes such as aggression, sex, affection, or anxiety illustrating this blending of affect and cognition (Petty). Using the fMRI during display; the pictures with neutral or negative affective valence were conducted on 13 male adolescents with severe conduct disorder that ranged between ages 9 to 15 and the researchers used 14 control subjects that fell under the same age bracket. The main effects of the negative-neural affective valence system are mainly responsible for the responses to aversive situations or moments such as anger or fear. This also included activation in the amygdala along with other parts of the brain (Sterzer et al.). The results also found reduced responsiveness to the left amygdala to the negative pictures in patients compared with the control group. Thus, the findings reflect an impairment of both the recognition of emotional stimuli and the cognitive control of emotional behavior in patients with Conduct Disorder, resulting in a propensity for the portrayal of aggressive behavior.

One hindering point of consideration is the age group of adolescents is most violent and aggressive as the children do not learn to resort to non-aggressive or violent solutions or strategies in responding to an external threat or emotions such as anger or frustration (Garbarino). This might have aided or increased the effect in the activation of the amygdala.

Children with conduct disorder have the tendency of enjoying causing harm, being oblivious of the social norms or what society deems as good behavior, or committing physical harm, the use of affect-laden pictures as an external tool aided in the trigger, leading to the portrayal of aggressive behavior. However, with the help of 14 control participants, the researchers could compare the results or findings with the results of the 13 adolescent samples. The narrow and specific sample size of children with conduct disorder and male children restricts the generalizability of the findings of the study to a larger pool of the population. In addition, the fMRI scanning results would generate a reliable and accurate report to help the researchers come to a conclusion that the recognition of emotional stimuli and the cognitive control of emotional behavior in the participants with Conduct Disorder, resulting in the tendency of the portrayal of aggressive behavior. Additionally, the amygdala is activated when an individual sees fearful stimuli including fear-induced images. Thus helping the amygdala to increase activation.

Activation in the amygdala

The studies and researches that study the brain have recently been thoroughly studied. However, it is quite ambiguous if there are functional deficits in the specific brain region of which the primary or major symptom is impulsive aggression or aggressive behavior.

The study of Coccaro et. Al employed a socio-emotional provoking probe of amygdala functions in individuals with impulsive behavior. (Coccaro et al.) As an established relation, it has been individuals with IED or Intermittent explosive disorder performed poorly on facial emotional recognition tasks which share symptoms of reactive aggression. With a sample of 10 unmedicated individuals with IED and 10 healthy, matched comparisons subjects underwent fMRI during viewing blocks of emotionally noticeable faces. The researchers compared amygdala reactivity between the healthy sample and the participants with IED. During this, the researchers examined the relationship between the extent of activation in the amygdala and the extent of past history of the portrayal of aggressive behavior.

Participants sharing the symptoms of reactive aggression and IED that of sudden impulsivity and aggression or verbal outbursts supported an increased activation in the amygdala. However, a sample size of 10 participants is very small to generalize the findings. In addition, individuals with a history of aggressive behavior may have different reasons that must have triggered the aggression. From an ethical standpoint, the blocks of emotionally-savvy noticeable faces possibly went against the ethical consideration of 'no physical or mental harm', aggravating the increased amygdala activity.

AMYGDALA VOLUMES

As there have been numerous brain imaging studies that have focused and investigated the role of the amygdala in the context of neuropsychiatric conditions such as aggressive behavior in epilepsy or personality disorders, to understand in-depth the role of the amygdala in modulating aggressive behavior, the study conducted by Matthies et. Al investigated the relationship between amygdala volumes and lifetime aggression in individuals. The study had morphometric brain scans that were collected of 20 healthy volunteers. The way that the amygdala volumes were measured was by manually outlining the boundaries of the structure in the brain. Later, to assess for a lifetime or prolonged aggressiveness, the researchers of the study conducted assessments. (Matthies et al.) The results of the study showed that the volunteer switch's higher aggression scores displayed a reduction of amygdala volumes. Additionally, there was a significant negative correlation between the amygdala volumes and aggression. This means when the amygdala activity reduced, there was an increase in aggressive behavior. However, the differences in the study suggested that amygdala volumes might be a marker or factor for the personality property of aggressiveness; when individuals portray aggressive behavior (Matthies et al.) The study used both, psychometric and psychiatric assessment to exclude any hindrance of disorders. The study used a sample of 20 participants who were volunteers. Since the sample used in the study was limited and the volunteer bias was high, this can restrict the generalizability of the results of this study.

OTHER FACTORS CONTRIBUTE TO AGGRESSIVE BEHAVIOR

Understanding that although the amygdala plays a part in aggressive behavior, there are other biological influences contributing to aggressive behavior. Some of the other factors include video games, the role of drugs, the role of hormones, and other brain parts that play a role in aggressive behavior.

ROLE OF HORMONES:

Testosterone is the hormone present in males and females and is commonly linked closely with aggression. There are various findings that have suggested the relationship shared between testosterone and aggression. Popma et. Al's study aimed to investigate the moderating effect of cortisol on the relationship between subtypes of aggression and testosterone in a sample of male adolescents. With an average age of 14 years, the 103 participants underwent a laboratory examination where the levels of cortisol and testosterone were determined from samples of salvia (Popma et al.). To avoid any hindrance or disturbances with the results, the participants were instructed to refrain from consuming any food for a minimum of 60 minutes before entering the laboratory. The researchers used a swab to extract saliva out of the participant's tongue. The way the test results were detected was with the process of radioimmunoassay; a technique used to measure the concentration of specific elements such as the hormone in this study testosterone (APA). After data collation, the results of the study indicated a positive correlation where one variable increases, the other one also increases. Therefore, the study shows that an increase in testosterone increases levels of aggression in subjects with low levels of cortisol. However, there was no relationship established with subjects with high levels of cortisol ("Sci-Hub | Cortisol Moderates the Relationship between Testosterone and Aggression in Delinquent Male Adolescents | 10.1016/J.biopsych.2006.06.006"). Therefore, this study demonstrated how testosterone has a significant role in aggressive behavior.

This study lacked triangulation as the samples of testosterone were only taken once. Since the mean age of the boys was 14, it is difficult to tell if they developed the hormone to the extent to which grown-up men do. Additionally, the internal validity of the study is low since the saliva was the way that testosterone was tested for and this can not be a stand-alone factor contributing to overt aggressive behavior, thus establishing a cause-and-effect relationship established in the study of Popma et. Al cannot be explained by other factors.

OTHER BRAIN STRUCTURES

Apart from the amygdala, the frontal lobes play an important role in the exhibition of aggressive behavior. The frontal lobes are located directly behind the forehead and are responsible for the regulation of emotions and moods, expression of personality, and controlling behaviors (Seladi-Schulman). Damage to this region can cause mood swings, vast changes in behavior such as socially inappropriate behavior, and loss of motivation and attention (Seladi-Schulman). The role of the frontal lobes; a brain part and its influence on aggressive behavior are studied by Grafman et. al.

In 1996, the study conducted by Grafman et. Al aimed to establish the link between frontal lobe lesion and aggressive behavior. This study comprised a total of 336 participants of which 279 were ex-soldiers and 57 as control subjects. All the ex-soldiers were matched for their age, education and time served in Vietnam. These veterans were those who suffered penetrating and severe head injuries. To

assess aggressive behavior, Grafman et. Al used various methods of collating data such as neurologic history, family observations, language, and speech testing. There was an aggression evaluation method that consisted of different forms of reports such as the family questionnaire, the neurobehavioral rating scale, and the pre-and-post military forces qualification test. The results indicated that patients with the frontal ventromedial lesions demonstrated aggression as their scores on the tests were significantly higher than the patients with injuries and lesions on the other brain areas/parts. This leaned towards verbal aggression and aggressive behavior slightly more than physical aggression and violence ("Sci-Hub | Frontal Lobe Injuries, Violence, and Aggression: A Report of the Vietnam Head Injury Study | 10.1212/WNL.46.5.1231"). This study encountered response bias as the study considered various views such as from friends, family, and wives specifically. The frontal lobes are related to the regulation of mood, behaviors, and responses, in this case, the veterans with brain damage to specific parts of the brain such as the frontal lobes were unable to regulate their aggression. This was because the ability to control this behavior was impaired by the damage. Thus, the veterans with brain damage in the fontal love tended to exhibit more aggressive behavior than others. The study encountered social desirability effect/bias as the veterans knew that they were being tested from their answers and responses to the self-reporting questionnaire.

One point of discussion is that the study used data triangulation such as different questionnaires and forms of tests to gather data that strengthened the findings of the results. The study considered participant variability since the veterans were matched for their age, education and duration served in Vietnam, this enabled the researchers to avoid any extraneous factors that could alter the results of the study. However, since the sample of the study were specifically ex-soldiers who had injured the brain part, the results of the study are difficult to generalize to a larger population.

VIDEO GAMES

Video games have an impact on the human brain which then causes aggressive behavior. Research shows that violent video games are associated with increased activity in the brain regions which are triggered by emotional reactions, arousal, and anxiety. Although there are studies that show violent video games don't affect the brain and aggressive behavior, the study of Anderson et. al in 2010 proves the effects of video games on aggression. The meta-analysis aimed to investigate the short and long-term effect of violent video games on 6 variables from which aggressive behavior was one. The researchers predicted that playing violent video games will increase aggressive behavior in the short and long term. Although the study focused on 6 outcome variables, the first five used 130 research reports with around 130,000 participants. The study consisted of high-quality experimental studies that used noise blasts and movement such as electric shocks. The participants underwent self-reports, standardized questionnaires and the study used data triangulation such as reports from peers, teachers, and parents; increasing the credibility of the findings. The results of the study showed there is a significant increase in risk for aggressive behavior ("Sci-Hub | Nailing the Coffin Shut on Doubts That Violent Video Games Stimulate Aggression: Comment on Anderson et Al. (2010). | 10.1037/A0018567") .

Violent video games affect the structure of the brain and cause functional changes in the neural system. With this, it can be seen there are other factors such as violent video games can affect the brain and chemicals in the brain which also increase aggressive behavior (Nichols).

DRUGS AND AGGRESSION

Relational aggression is a nonphysical form of aggression that is directed towards another individual. This form of aggression is a behavior that manipulates and harms relationships which include forms of bullying and humiliation (APA)

Drugs contribute to aggressive behavior as the intake of drugs can alter the various hormones and neurotransmitters such as neurotransmitters dopamine, norepinephrine, and serotonin (Anderson and Bokor). Drugs such as alcohol and marijuana alter various activities in the brain which then lead to an increase in violence and aggression.

The study of Skara et al. aimed to investigate the relationship between physical and relational aggression with later drug use such as alcohol, hard drug,s, and cigarettes), moderating the gender as well. The hypothesis of the researchers was that males would engage in more physical aggression than females, whereas females would present more relational aggression. ("Sci-Hub | Physical and Relational Aggression as Predictors of Drug Use: Gender Differences among High School Students | 10.1016/J.addbeh.2008.05.014"). Before the study, self-reported data were gathered from 2,064 high school students. Additionally, the researchers had another hypothesis that physical aggression would be a strong drug use indicator for males and likewise for relational aggression for females. Physical aggression was tested with questions around 4 items and relational aggression was measured by asking the participants based on 5 items. The findings of this research showed that males reported higher engagement with physical aggression. However, for both males and females, relational aggression shared similar rates. Although after a year-later finding again, relational aggression was found to denote

the use of cigarettes and drugs such as marijuana ("Sci-Hub | Physical and Relational Aggression as Predictors of Drug Use: Gender Differences among High School Students | 10.1016/J.addbeh.2008.05.014").

The internal validity of the study is low as the results were taken from the answers to the questions such as usage of weapons, having slapped or injured someone, and speaking about others behind their back. Since the participants were being tested on the answers, due to the social desirability bias, there might have been a change of responses to the questions. Additionally, the researchers constantly mentioned that anonymity and confidentiality of the information and responses would be met.

CONCLUSION

After taking into account all the studies and findings, it is seen that aggression and amygdala volume and activity share a negative correlation. When the amygdala volume and activity go down, the aggression level increases or is predicted to appear/aggravate in the future. However, as seen in the studies, there is a high probability that due to the external aid of affect-laden images or sample sizes with disorders that share symptoms of aggressive behavior, the participants react with an aggressive response. Although there are various factors that aggravate aggressive behavior, any damage or trigger to the amygdala plays a significant role in the exhibition of aggression or aggressive behavior in an individual.

Thus, it can be concluded that lesions, atrophy, or damage in the amygdala play a role in aggressive behavior. However, as seen in the studies discussed, there are several other factors apart from damage in the amygdala for which an individual becomes aggressive as a way of reacting/responding. These factors include video games, neural and hormonal mechanisms, and how other brain structures such as the frontal lobes play trigger aggressive behavior. Understanding there are other aspects or roots of aggression like socio-economic and cognitive factors that contribute to aggressive behavior, the amygdala is one of the various factors that play a large role in aggressive behavior. Thus, to conclude, the amygdala plays a crucial role in aggressive behavior to an extent as there are numerous other factors that collectively influence/trigger aggressive behavior.

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