Serotonin System Dysfunction and Callous-Unemotional Behavior

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Callous-unemotional behavior is a pattern of behavior in children involving lack of empathy and remorse, impulsivity, antisocial behavior, and potentially criminal or violent behavior. Due to a lack of effective treatment, callous-unemotional behavior tends to be treated as a personal choice rather than a mental disorder. This paper attempts to provide an explanation for some of the biological causes for callous-unemotional behavior. A better understanding of the biological causes can influence the direction of research into treatments, as well as the general perception of the condition. The serotonin system seems to play a large role in the development of callous-unemotional traits. This paper will discuss the genetic, environmental, and epigenetic factors that lead to serotonin system dysfunction, and the effects of this dysfunction on children. Additionally, this paper discusses the potential for selective serotonin reuptake inhibitors (SSRIs) to be used in treatment of callous-unemotional behavior.

For many people, empathy is a natural part of being human. Empathy allows people to easily form friendships, give back to their communities, and come together to support others, but understanding what others are feeling is difficult for some children. When children are unable to develop empathy, they can be more likely to behave violently, hurt others, and lack remorse, which can potentially escalate into criminal behavior. This behavioral pattern is known as callous-unemotional behavior. Without treatment intervention, it can lead children to behave violently, or even develop psychopathy in adulthood. Children who exhibit these behavioral patterns are more likely to be expelled from school or incarcerated than to be provided psychological treatment, partially because no effective treatment currently exists.

Callous-Unemotional Behavior

One of the most important and pervasive callous-unemotional characteristics is the lack of empathy. Empathy is the ability to relate to others' emotions and to share those emotions to some extent (Feifer, 2009). In other words, a person must be able to both understand the emotions another person is feeling and relate those emotions back to their own. This

can contribute to a lack of remorse for their actions, since they are unable to understand or process how their actions impact others. Another callous-unemotional trait is impulsivity, or difficulty controlling behavior. Antisocial behavior, especially in males, tends to result in aggression or violence. This behavior is commonly noted as a characteristic of callous-unemotional behavior.

Callous-unemotional traits in childhood, when left untreated, can potentially lead to the development of conduct disorder, antisocial personality disorder, or psychopathy in adulthood. In many cases, children and adolescents with a history of callous-unemotional behavior end up committing violent crimes and becoming repeat criminal offenders. About 15-35% of U.S. prison populations are made up of psychopaths who displayed callous-unemotional traits as children (Kiehl & Buckholtz, 2010). Children who display callous-unemotional traits tend to be overlooked as candidates for treatment. Their inability to experience empathy and tendency towards violent behavior is often misconstrued as a personal fault instead of an emotional disorder. Even in a legal context, psychopaths are not given any different treatment despite the fact that their criminal behavior is due to an emotional processing disorder and not a personal choice (2017). To be more specific, the most recent U.S. Model Penal Code, available through Cornell Law School's Legal Information Institute, states that the insanity defense does not apply when the defendant suffers from "an abnormality manifested only by repeated criminal or otherwise antisocial conduct" (Model Penal Code Insanity Defense, 2020). This view of callous-unemotional behavior could actually be a contributor to the high levels of violent crime and recidivism shown by people who display this behavior (Kiehl & Buckholtz, 2010). An understanding of the reasons behind callous-unemotional behavior may be helpful in informing how these people should be treated.

Causes of Callous-Unemotional Behavior

Childhood abuse is often cited as a factor contributing to the development of callous-unemotional behavior (Feifer, 2009). This effect is especially strong in females, with 75% of variance in "psychopathic" traits being attributed to environmental factors. Boduszek also found that compared to other forms of abuse, childhood sexual abuse is the strongest predictor of callous-unemotional traits in adolescent females (Boduszek, Debowska, Willmott, Jones, Delisi, & Kirkman, 2019).

Callous-unemotional behavior can also develop due to many neurological factors. One of the brain systems implicated in the development of empathy is the limbic system which consists of the hippocampus, hypothalamus, amygdala, and thalamus. Its function is to process emotional information (Feifer & Leonard-Zabel, 2009). The most important part of the limbic system implicated in callous-unemotional behavior is the amygdala. Interruptions in amygdala functioning can cause fearlessness, impulsivity, and lack of remorse, all of which are common callous-unemotional traits (Hare & Neumann, 2008). The prefrontal cortex, the brain's center for logic and reasoning, is implicated in the development of empathy. It is involved in the understanding of others' emotions and how a person's actions affect others. The prefrontal cortex and limbic system are connected by special neurons called

spindle cells, which allow them to communicate, forming the biological basis of empathy (Feifer, 2009).

The Serotonin System

In addition to the brain's systems, there is growing evidence that serotonin is involved in social behavior. According to *Medical News Today*, serotonin is involved in regulating "mood and social behavior, appetite and digestion, sleep, memory, and sexual desire and function" (McIntosh & Wilson, 2018, p.1). The serotonin system is the collection of chemical systems in the brain dedicated to transporting and processing serotonin. The serotonin receptor and transporter are both involved in regulating the amount of serotonin in the brain and allowing it to perform its functions properly.

Multiple studies have produced results showing that lower serotonin levels are linked to callous-unemotional behaviors and suggest that serotonin system dysfunction may be partially responsible for these behaviors on a biological level. Moul and colleagues (2013) reported a correlation between lower levels of serotonin in blood and higher callous-unemotional personality scores in young boys. The researchers compared boys' self- and family-reporting questionnaires for callous-unemotional traits and blood samples for serum serotonin in blood. Some genotype differences relating to the serotonin receptor were also found to have an association with higher levels of callous-unemotional traits (Moul, Dobson-Stone, Brennan, Hawes, & Dadds, 2013). This provides concrete evidence for the relation between serotonin and callous-unemotional behavior.

The effects of serotonin on individual callous-unemotional traits has been researched extensively. One study by Harmer investigates how serotonin levels impact peoples' ability to recognize emotions in facial expressions. This is a critical part of empathy. Callous-unemotional individuals especially have difficulty recognizing fear in facial expressions (Kiehl & Buckholtz, 2010). In their 2003 study, Harmer found that an experimental group, given a selective serotonin reuptake inhibitor (SSRI) to increase their serotonin levels, were able to identify facial expressions of fear and happiness faster than the control group (Harmer, Bhagwagar, Perrett, Völlm, Cpwen, & Goodwin, 2003). Insufficient serotonin may play a role in callous-unemotional children's inability to recognize facial expressions, particularly fear. Serotonin has also been shown to have an impact on levels of aggression, which is a trait common among children and adolescents showing callous-unemotional behavior patterns. In their 2014 experimental study, Fanning compared the levels of provoked aggression responses between two groups: one who had been given an SSRI and one who had been given a placebo. They found that in the placebo group, there was a correlation between levels of primary psychopathic traits and aggression, but in the group with the SSRI, everyone had similar levels of aggression regardless of psychopathic traits (Fanning, Berman, Guillot, Marsic, & Mccloskey, 2014). This suggests that for some of the people with higher psychopathic traits, disposition for aggression had been at least partly mitigated by the SSRI.

Some studies have shown that certain callous-unemotional traits are associated with higher levels of serotonin, while others are associated with lower levels. In a separate 2015 study, Moul found that overexpression

of the serotonin receptor gene, HTR1B, is linked to the standard callous-unemotional traits, while underexpression is linked to impulsivity and antisocial behavior (Moul, Dobson-Stone, Brennan, Hawes, & Dadds, 2015). Similarly, Dolan and Anderson (2003) found that higher levels of serotonin were linked to more arrogant and deceitful behavior, while lower levels were linked to more impulsive and antisocial behavior. Beyond suggesting that these dimensions of callous-unemotional behavior each have their own biological mechanisms, these findings suggest that serotonin is implicated in each of these mechanisms and is therefore fundamental to the development of callous-unemotional behavior.

Causes of Serotonin System Dysfunction

Like callous-unemotional behavior in general, the cause of serotonin system dysfunction is not clear; multiple studies have shown evidence for both genetic and environmental influence on the function of the serotonin system. Every gene in the human genome begins with a promoter, which is a section of DNA that signals to the cell's transcription systems where to bind in order to start the transcription and translation process. The gene for the serotonin system promoter, 5-HTTLPR, has two main alleles, one with a longer promoter and one with a shorter promoter. In their 2020 study, Widom and colleagues explored the correlation between 5-HTTPLR alleles and levels of callous-unemotional traits. They found that people who had inherited two long alleles for the gene had significantly higher callous-unemotional scores than people who had inherited two short alleles (Widom, Miller, Li, Gordon, & Brzustowicz, 2020). This supports the idea that there is a direct connection between genetics, the serotonin system, and callous-unemotional behavior. Additionally, in their 2013 study, Moul and colleagues analyzed the association between the serotonin receptor genes, HTR1B and HTR2A, and callous-unemotional behavior. They found a significant association between genotype differences for these two genes and levels of callous-unemotional traits (Moul et al., 2013), which again suggested a link between genetic factors and the serotonin dysfunction implicated in callous-unemotional behavior.

Genetic inheritance is not the only path to serotonin system dysfunction. As mentioned earlier, child abuse and similar adverse experiences in childhood can develop into callous-unemotional traits. This association may be linked to the serotonin system through epigenetics. Epigenetics allows environmental factors to change the way genes are expressed through chemical changes in the genome. There are several types of epigenetic chemical changes, but the most common is DNA methylation, where methyl groups are added to the gene's promoter, making it harder for the cell's systems to transcribe and express. Essentially, methylation leads to reduced expression.

Being raised in an abusive environment may lead to increased methylation in serotonin system genes, causing those genes to be underexpressed and have negative impacts on the child's emotional functioning. Vijayendran analyzed the correlation between history of child abuse and methylation in the serotonin transporter gene promoter and found a significant relationship between people who had been abused as children and

the likelihood to have more methylation in their serotonin transporter genes (Vijayendran, Beach, Plume, Brody, & Philibert, 2012). When these genes are methylated, it leads to abnormal functioning in the serotonin system due to reduced expression.

Studies have found that the methylation of genes related to the serotonin system is a factor that correlates with callous-unemotional behavior. Moul and colleagues performed a study analyzing the relationship between methylation of the HTR1B serotonin receptor gene and levels of callous-unemotional behavior. They found that HTR1B methylation was statistically significant as a predictor of callous-unemotional behavior (Moulet al., 2015). This link completes the already well-researched relationship between child abuse and callous-unemotional characteristics. Child abuse leads to serotonin system gene methylation, which leads to serotonin system dysfunction, which then leads to callous-unemotional behavior. The study of epigenetics provides an explanation for how environmental factors influence behavior on a biological level.

Potential for Treatment

This analysis of serotonin, epigenetics, and callous-unemotional behavior has provided a potential explanation for how this behavior develops on a biological level, but the real implications come in applying it to potential treatment methods. Treatment for people who show callous-unemotional behavior is limited and oftentimes unsuccessful. Although there have been some advances in potential therapy intervention, the use of medication has not been well-researched because callous-unemotional behavior is often responded to with punishment instead of treatment (Kiehl & Buckholtz, 2010).

In the treatment of several mental disorders, such as anxiety and depression, the use of medication in conjunction with therapy tends to be the most effective method (Kiehl & Buckholtz, 2010). Medication is helpful in these cases because it addresses chemical imbalances in the brain that make it difficult for the patient to show progress with therapy alone. Like in anxiety and depression, several of the studies mentioned earlier found evidence that chemical imbalances contribute to callous-unemotional behavior in children. In proving that theory, many studies used SSRIs to increase serotonin levels in subjects. With the use of SSRIs, Fanning (2014) found that callous-unemotional traits no longer increased aggression. Harmer (2003) found that subjects who took SSRIs showed improved recognition of emotions in facial expressions. Although these studies were completed with non-callous-unemotional individuals, the findings still show potential for the use of SSRIs as a supplement to treat children who show callous-unemotional behavior. Future research is needed to determine the effectiveness of this treatment.

Conclusion

Callous-unemotional traits in childhood can lead to conduct issues, criminal behavior, and even psychopathy in adulthood. In order to prevent children from committing violent crimes, early intervention is essential. Just as in many other mental disorders, early intervention allows the symptoms to be reduced or stopped before they have a significant impact on the child in the future. However, unlike most other disorders, there is currently no accepted treatment for callous-unemotional

behavior. Instead, it is often met with punishment in educational, home, and criminal environments. This focus on punishment disregards the fact that callous-unemotional behavior is a fundamental problem with how people process emotions and is not a personal fault. The potential of SSRIs as treatment for callous-unemotional behavior not only provides a method to possibly make therapy more effective but opens the door to a more medically focused approach to the treatment of individuals with callous-unemotional behavior.

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