

DOI: https://doi.org/10.48009/4_iis_2022_108

Exploring the need for specialized medication for psychopathy and artificial intelligence to improve diagnosis

Katherine Yu, *University of Missouri-Columbia, kayn9h@umsystem.edu*

The objective of this research is to compare the diagnosis and treatment of Major Depressive Disorder (MDD) and Psychopathy. Despite how dangerous psychopaths are, and how similar the condition is to the common mental illness MDD, there is no medication and limited behavioral therapy available. The two have similar imbalances in the same neurotransmitters, dopamine and serotonin, yet there is a glaring difference in the amount of treatment available. Psychopaths have tendencies to commit violent crimes with no motivation or remorse, so this paper will explore why there are no treatments available as well as ways research aims to change that. The key role of the neurotransmitters dopamine and serotonin will be discussed. Additionally, the use of Artificial Intelligence (AI) in the field of psychology and medicine is also a relatively new one, so the benefits of implementing it will also be discussed.

Keywords: Psychopaths, Major Depressive Disorder, Artificial Intelligence, Medication, Dopamine, Serotonin

Introduction and Research Objectives

How come there are individuals in society that consistently harm others violently without hesitation? In most situations where a person harms another, society expects a response of guilt in the perpetrator, which would decrease the chance of a repeat offense. Most people also have a moral compass that prevents them from physically harming another without any source of motivation. That being the case, it is clear that there is a mental abnormality in people who harm without remorse. These people, also known as psychopaths, pose a great danger to society (Freedman & Verdun-Jones, 2010; Reidy et al., 2013; Reidy et al., 2015), so there should be a way to diagnose and treat them just like other mental illnesses such as depression. Currently, there is no specialized medication available to treat psychopaths, (*Medication*) so the objective of this paper will be to investigate how we should go about developing one as well as how artificial intelligence (AI) can aid in the diagnosis process.

A good starting point lies within the chemistry of the brain, specifically in neurotransmitter activity. Neurotransmitters are the chemical messengers of the brain that regulate all functions in the body including breathing, heartbeat, concentration levels, and mood (Berry & Hammond, 2019). Seven main neurotransmitters regulate all of the biological functions in humans, and as with most substances in the body, there needs to be a balance maintained in their level and activity for proper function (Berry & Hammond, 2019; Sheffler et al., 2021; *What are Neurotransmitters*, 2017). To understand why some people

can hurt others without remorse, the functions of specifically dopamine and serotonin should be explored as well as what happens when their activity levels are altered. These two neurotransmitters are often associated with one another as both play major roles in experiencing positive emotions (Berry & Hammond, 2019), but there are clear distinctions between them.

Dopamine is associated with learning, motivation, motor skills, and reward (Berry & Hammond, 2019; Sheffler et al., 2021; *What are Neurotransmitters*, 2017). The role it plays in the brain's reward system that fuels motivations should be emphasized (Sheffler et al., 2021; *What are Neurotransmitters*, 2017). For example, if someone is interested in learning piano, dopamine is released when the person plays which results in a pleasant feeling. As a result, they are intrinsically motivated to play when they want to feel joy. Alterations in dopamine levels are connected to many neural and psychiatric disorders (Sheffler et al., 2021). On the other hand, serotonin is more involved in the regulation of sleep, appetite, and mood (Berry & Hammond, 2019). If serotonin activity is thrown out of balance, it will heavily impact neural activity and impulse control (Sheffler et al., 2021). As mentioned before, there are a variety of mental issues that can occur if the level of either neurotransmitter becomes too high or low.

Before discussing potential drug development, two neural disorders Major Depressive Disorder (MDD) and Psychopathy will be examined. Both can result from abnormal dopamine and serotonin levels, so is also important to address why one has effective treatments available but not the other. MDD is a mood disorder that results in severe, persistent unhappiness that can lead to several other emotional and physical problems (*Depression (major depressive disorder) Symptoms and Causes*, 2022). It is an increasingly common condition in modern society and is associated with low levels of both dopamine and serotonin in the brain (Belujon & Grace, 2017; Frazier et al., 2019; Nutt, 2008). Psychopathy is correlated with high levels of dopamine and low levels of serotonin (Frazier et al., 2019; Glenn & Raine, 2008) and is a condition with a lot of misconceptions. Individuals with this disorder are often stereotyped as beings that have no emotion or concept of morality. Additionally, the general public tends to refer to anyone with a neural disorder or even just unusual behavior as a psycho, but this condition is not nearly as common and is far too dangerous to have such a generalization. Psychopathy is currently defined as a disorder where an individual lacks sympathy, impulse control, and normal emotional responses, which can lead to a life of committing persistent, violent crimes (Anderson & Kiehl, 2014; Frazier et al., 2019; Freedman & Verdun-Jones, 2010; Glenn & Raine, 2008; Reidy et al., 2013). These individuals recognize how morally wrong their actions are, but do not feel any remorse, which leads to the tendency to continuously make rash and dangerous decisions (Anderson & Kiehl, 2013; Freedman & Verdun-Jones, 2010; Glenn & Raine, 2008; Reidy et al., 2015). Despite the similarity in chemical basis for these two disorders, they are vastly different in terms of symptoms, effective methods of treatment, and threat to society.

While the severity of MDD on the people that are diagnosed with it cannot be discredited, these individuals are not nearly as dangerous to the general public as psychopaths are. Less than 5% of the U.S. population is responsible for all of the violent crimes committed in the country, and the costs of their crimes add up to \$61 billion per year in the U.S. alone. This total considers the medical expenses involved and the expenses associated with homicide (court fees, loss of household income, funeral services, emotional damage, etc.) (Reidy et al., 2015). While that 5% is not made up of only psychopaths, medical treatment for the ones that are should be researched to help reduce the amount of overall violent crime. It is also worth investigating

if treatment for MDD can be used as a starting point to develop such medication due to how similar the two disorders are in their chemical nature.

Another area that needs to be considered is how AI can be implemented into mental health treatment as it is a relatively new venture. AI is defined as a computer system that is designed to perform tasks that would normally require human judgment (Helm et al., 2020). Current applications that have been developed include virtual therapists and cell phone applications that focus on therapy (Fiske et al., 2019). How this can be used specifically in relation to psychopathy will be discussed.

Methods

The information used and conclusions drawn in this paper were based on a literature review of 32 sources. The criteria for selecting the sources included being an article from an established and credible journal, or from the official website of a relevant professional organization such as Mayo Clinic which focuses on education and research in the medical field. The database used was Google Scholar and relevant keywords included: psychopathy, major depressive disorder, treatment, diagnosis, artificial intelligence in mental health, dopamine and serotonin, and MDD medication among others. Knowledge gained from the author's 115 hours of physician job shadowing was also referenced.

Results and Discussion

Based on the literature analyzed, this section summarizes: how dopamine and serotonin levels are measured, how the identification process for MDD and psychopathy compare, the role of dopamine and serotonin, an analysis of how MDD is currently treated, current research that has been done on psychopathy, challenges with the current progress of research and treatment of psychopathy, and finally the potential role of AI in this process.

Measuring Dopamine and Serotonin

First, let us examine how the levels of neurotransmitters are measured. Dopamine and serotonin are both commonly measured through microdialysis (Roberts et al., 2012). This is a sampling technique that collects small molecules like neurotransmitters from tissues through a probe that is directly inserted into the target organ (Castro et al., 2014; Chefer et al., 2009). Serotonin synthesis can also be measured using positron emission tomography tracers as a non-invasive alternative to microdialysis, by tagging serotonin molecules (Visser et al., 2010). Both can also be measured with blood and urine samples, but these methods provide more information on the physical disorders associated with these neurotransmitters and are less reliable with respect to mental illnesses (Fisher, 2022). The results from all of these tests are useful for determining whether a diagnosis is appropriate.

Processes of MDD Identification and Psychopath Diagnosis

The process for identifying an individual with MDD is long and thorough. Physicians will make a diagnosis based on a combination of physical exams, lab tests, psychiatric evaluation, and reference to the Diagnostic

and Statistical Manual of Mental Disorders (DSM-5) (*Depression (major depressive disorder) Diagnosis and Treatment*, 2022). After a confirmed diagnosis, further observation of the patient and their symptoms are done to decide whether a biological or environmental treatment plan is best. For biological treatments, the right medication depends on whether the cause of MDD is a lack of positivity or an influx of negativity (*Depression (major depressive disorder) Diagnosis and Treatment*, 2022; Nutt, 2008). An influx of negativity is often associated with anxiety, restlessness, and sometimes insomnia so serotonin is regulated. Experiencing a loss of positivity is often due to the inability of the brain to recognize enjoyment and interest, so dopamine is treated in this case (Nutt, 2008). Whether it is serotonin or dopamine being treated, the way medication works is the same, (Nutt, 2008) and it is important to know how the neurotransmitters themselves work to understand how these treatments are effective.

As illustrated in Figure 1, the process starts with an electrochemical signal that triggers the release of neurotransmitters from the vesicle they are contained into the synapse where the receptors are (Sheffler et al., 2021). Binding to a receptor results in a response in the target cell (ex. muscle cells, nerves, or glands) (Sheffler et al., 2021; *What are Neurotransmitters*, 2017). Once the intended task has been completed, the neurotransmitters return to the vesicle through the reuptake pump until another signal triggers the process to be repeated (*What are Neurotransmitters*, 2017). The most common medications prescribed for the lack of neurotransmitters in MDD patients are ones that will increase dopamine or serotonin activity by inhibiting the reuptake function (Nutt, 2008). However, these medications may not be the best way to treat the patient, especially in cases where the dopamine/serotonin level does not fall much lower than the normal range. In these cases, situational therapy will often be enough to treat the patient (*Alternatives-Antidepressants*, 2021). Counseling, exercise, self-help groups, and cognitive behavioral therapy are all effective alternatives available (*Alternatives-Antidepressants*, 2021) if a patient cannot take medication or simply prefers not to.

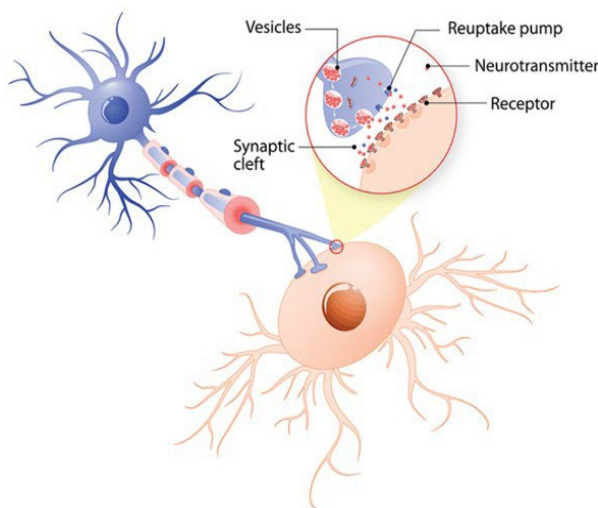


Figure 1 Process of Neurotransmitters

Source: "What Are Neurotransmitters?" *Queensland Brain Institute*

The diagnosis of psychopathy uses a 20-item rating scale called the Psychopathy Checklist (Glenn & Raine, 2008; Reidy et al., 2015). Every document with information on the individual including school records, police files, and social work files, is gathered and analyzed. The individual is then scored by multiple

experts on a scale of 0-40, and if the average score is over 30, the person is diagnosed as a psychopath (Reidy et al., 2015). While not nearly as abundant as for MDD, behavioral therapies have been developed for both psychopaths and their victims. This includes rehabilitation programs, criminal interventions, and programs to help improve the lives of the victims (Reidy et al., 2015). Since there have been no effective biological treatments developed for psychopathy, additional research has been done to better understand psychopathic behavior and identify other factors that contribute to it.

The Role of Dopamine and Serotonin in MDD and Psychopathy

As mentioned before, MDD is associated with low levels of both dopamine and serotonin,(Belujon & Grace, 2017; Frazier et al., 2019; Nutt, 2008) while psychopathy is associated with high dopamine and low serotonin (Frazier et al., 2019; Glenn & Raine, 2008) The neurotransmitter ratio is intuitive for MDD. Not enough dopamine would mean losing focus, learning ability, and the internal reward system that makes activities enjoyable. As a result, the individual loses motivation and drive for both business and recreation. A lack of serotonin can lead to inconsistent sleep and mood, which will inhibit performance and add a sense of hopelessness. However, the dopamine to serotonin ratio for psychopathy may not seem accurate at a first glance. MDD is characterized by an extreme lack of motivation and activity while psychopathy is a dangerously excessive amount of the two. Therefore, it is reasonable to think that the neurotransmitter levels should also be exact opposites, meaning serotonin levels should also be high for psychopathy. However, serotonin plays a large role in impulse control and can serve as a dopamine inhibitor (Frazier et al., 2019) Keeping in mind that a lack of serotonin contributes to the uncontrolled levels of dopamine should clear up any misconceptions. So, what exactly is an abnormal level of neurotransmitter activity? Based on the literature review done, it is suggested that a normal range is 12.3-31.3 ng/L for dopamine(Ambade et al., 2009) and 101-283 ng/mL for serotonin (Scaccia, 2020) Anything that falls out of that range can potentially indicate a cause for concern. As the level falls further out of range, the likelihood of developing a more severe case increases.

Additional Contributing Factors and Treatments of MDD

Stressful situations, loss of a loved one, unexpected life changes, and even medication for other physical ailments are all common situational factors that can cause depressive symptoms (Nabeshima & Kim, 2013) With cases of MDD becoming increasingly common in modern society, it is natural that the process of diagnosing someone is so thorough. There is a fine line between depressive symptoms that come with development and daily life, and depressive symptoms that require medical intervention. Even after an official diagnosis, based on the observations of the author through job shadowing, physicians tend to communicate with the patient thoroughly before deciding if the best treatment is biological, environmental, or a combination of both.

A lot of antidepressants are controlled substances due to their high potential for addiction and abuse,(Evans & Sullivan, 2014) and there are a lot of alternative therapies available, such as lifestyle changes or various types of counseling(*Alternatives-Antidepressants*, 2021) that need to be considered. As mentioned before, if the condition of the patient is severe enough to need antidepressants, studies show that medication that will inhibit the reuptake function is most commonly prescribed (Nutt, 2008). This causes the target

neurotransmitters to stay in the synapse for a longer time, allowing more opportunities for them to bind to the receptor and trigger the effects. While effective, the consequence of this type of drug explains why there is such a high potential for addiction. Eventually, the brain will habituate to the extra dopamine/serotonin and will require a larger amount to produce the same effect. That being the case, observations from the author's physician shadowing show that patients on controlled substances are required to visit the doctor every three to six months, depending on the medication. These frequent visits allow the physician to monitor the effects of the drug and the behavior of the patient closely.

Current Progress in Psychopathy Research

Studies on psychopaths can be divided into three general categories: observational, experimental, and quantitative. Observational studies make correlations based on recorded behavior or neurotransmitter levels with no direct manipulation from the researcher. One study analyzed how psychopaths tend to act, while another compared the upbringing and socioeconomic background they experience (Freedman & Verdun-Jones, 2010). Experimental studies compare how psychopaths respond to certain stimuli compared to average individuals. One experiment recorded how psychopaths respond to fear-inducing phrases compared to average adults, as well as how well both groups could identify various facial features (Freedman & Verdun-Jones, 2010). Another experiment measured dopamine levels of young boys with psychopathic traits in response to punishment and reward compared to normally developed boys (Reidy et al., 2015). A third analyzed brain activity in response to stress for average individuals with different upbringings to see if certain conditions result in similar patterns to psychopaths (Frazier et al., 2019). Finally, quantitative studies identify anatomical differences and use brain imaging techniques (Glenn & Raine, 2008). Magnetic resonance imaging (MRI) is used to analyze any structural differences (Frazier et al., 2019), and functional magnetic resonance imaging (fMRI) is used to identify unusual brain activity (Freedman & Verdun-Jones, 2010).

Challenges with Current Psychopathy Diagnosis and Treatment

Even after almost 80 years of research,(Reidy et al., 2013), the knowledge on how to properly identify and intervene with psychopathic behavior is still very limited. This is made obvious in contrast to the abundant and definitive information available for MDD after 90 years of research (Paykel, 2008). Again, the process for identifying and treating MDD is long and thorough to prevent misdiagnosis and to treat it safely, so the current lack of knowledge on how to do the same for psychopathy emphasizes how the research is far behind where it should be. Present-day methods of defining psychopathy are far less concrete and there is a severe lack of proper treatments available, especially considering the threat these individuals pose to public health and criminal justice (Reidy et al., 2015). The Psychopathy Checklist is the only method of diagnosis, (Glenn & Raine, 2008; Reidy et al., 2015) and even with multiple experts scoring an individual, it is a highly subjective form of evaluation. Additionally, the few forms of therapy available have shown to be largely ineffective when it comes to preventing repeat offenses (Reidy et al., 2015). The reasons why become clear from the results of the studies done to understand psychopathic behavior.

One reason is that it is difficult to administer effective therapy without knowledge of what demographic it will be used for. The observational studies conclude that it is very hard to identify psychopaths, especially

ones without a criminal record or ones that are young. The results show that psychopaths are often very good at making positive, benevolent first impressions (Frazier et al., 2019; Freedman & Verdun-Jones, 2010; Glenn & Raine, 2008; Reidy et al., 2015), allowing them to easily take advantage of others without raising any suspicions.

There has also been a study that attempted to identify psychopathic traits as early as possible, but it is difficult to distinguish between natural development and truly psychopathic traits in children. High levels of impulsivity, aggression, and irresponsibility are natural for developing youths. Children are also growing out of an egocentric worldview and learning how to sympathize with others (McLeod, 2018; Reidy et al., 2015), so it would not be accurate to label a 5-year-old as a psychopath just because they think selfishly (Reidy et al., 2015). However, the same study also concludes that the severity of a child's action can help identify if the aggressive behavior is natural or not. The earlier and more violently a child reacts, the stronger the suggestion that it is a cause for concern. A similar study concluded that psychopathic behavior is more telling as the child develops into adolescence (Reidy et al., 2015). This makes sense because teenagers should have grown out of a worldview that revolves around themselves (McLeod, 2018), so a complete lack of sympathy should be taken more seriously.

One of the experimental studies also gave insight into recognizing warning signs. The results of the experiment measuring brain activity in response to stress showed that certain environmental factors may shape psychopathic behavior. Even in normal adults, neglect and lack of quality care during the first three years of life are strongly correlated with brain abnormalities. Individuals that were maltreated during this critical development period showed enhanced release of dopamine during stressful situations (Frazier et al., 2019). While not to the extreme of true psychopaths, this can cause these individuals to seek out these situations rather than avoid them. Again, this is hard to identify since humans cannot accurately recall their earliest years, but this experiment concluded that malnourishment from infancy can be one of the factors used to identify potential psychopaths (Frazier et al., 2019). These studies are a good start to definitively identify psychopathic behavior, but unfortunately do not give a way to stop it.

The experimental studies comparing average and psychopathic reactions also gave insightful results. In response to fear-inducing phrases, it was shown that average adults both correctly identify what phrases are fear-inducing and produce a physiological response (increased heart rate, tense muscles, perspiration, etc.). Psychopaths were able to identify which phrases should induce fear, but do not respond physiologically (Freedman & Verdun-Jones, 2010). As expected, normal adults were also found to consistently and accurately connect facial expressions to emotions. Interestingly, psychopaths did not have trouble identifying happy or excited facial expressions but tended to categorize faces exhibiting fear or sadness as neutral (Freedman & Verdun-Jones, 2010). This disproves the common misconception that psychopaths do not feel or recognize any emotion, as it is just negative ones that are difficult for them to process. In the experiment comparing young boys, the group with normal characteristics showed high levels of dopamine in response to reward and low levels in response to punishment, while the levels of the boys with psychopathic traits were equally elevated during both conditions (Reidy et al., 2015). This experiment implies that the unregulated dopamine causes psychopaths to feel pleasure regardless of whether they are punished or rewarded. That being said, it is clear why they do not fear punishment and why criminal behavior is repeated despite the consequences society has set in place. With that, another reason there are

issues with the current programs for violent criminals is brought to light. Rather than trying to solve the problem at the source and prevent violence before it occurs, the focus is on making the best out of the circumstances after the damage has been done. However, the results from all three experiments discussed support the idea that psychopaths are intrinsically motivated to repeat punished behavior despite knowing that they are causing a lot of unjustified harm (Anderson & Kiehl, 2014; Frazier et al., 2019; Freedman & Verdun-Jones, 2010; Glenn & Raine, 2008). Methods such as incarceration and rehabilitation do not properly address the lack of impulse control and remorse of psychopaths. Therefore, they are impractical for preventing future violent crimes by these individuals.

The quantitative studies that were done on brain structure and function also make it clear why behavioral therapy is ineffective. The results support that psychopathy is more of a biological problem than an environmental one (Frazier et al., 2019; Freedman & Verdun-Jones, 2010; Glenn & Raine, 2008; Reidy et al., 2015). Of course, situational factors cannot be completely ignored as shown by the study that emphasized the importance of quality infant care (Frazier et al., 2019). However, they are not deciding factors as there are plenty of people from impoverished upbringings that are not criminals, and psychopaths that grew up in a stable, loving home (Freedman & Verdun-Jones, 2010). The results indicate that there could be other biological factors in psychopaths in addition to dopamine and serotonin imbalances.

Prior research consistently showed that the volume of the amygdala, a structure located in the center of the brain, is low in psychopaths compared to an average individual (Frazier et al., 2019; Freedman & Verdun-Jones, 2010; Glenn & Raine, 2008; Reidy et al., 2015). There are two amygdalae in the brain, one in each hemisphere, and they are largely involved in fear processing. The low volume would explain why psychopaths have difficulty feeling fear, and therefore do not respond as expected to punishment. Additionally, psychopathic behavior is associated with a severed link between the limbic system and the amygdala (Glenn & Raine, 2008). The limbic system is highly involved with emotions, so the lack of communication with the amygdala supports the fact that psychopaths cannot connect fear to emotions the same way normally developed adults can (Freedman & Verdun-Jones, 2010; Glenn & Raine, 2008). Both are located in the right hemisphere of the brain, which psychopaths have shown to have difficulty activating based on fMRI data (Freedman & Verdun-Jones, 2010).

Artificial Intelligence and Current Applications in Psychology

AI started as a theory that stated it was possible for machines to express an intelligence that would require a human brain and has evolved to having a physical form and concrete application (Helm et al., 2020). Such applications in the field of psychological therapy include new methods of treatment and providing care for underdeveloped countries that currently lack quality treatment (Fiske et al., 2019). As mentioned before, depression is an increasingly common mental illness. As a result, there has been AI developed that helps reduce the symptoms of individuals suffering from depression. Its algorithm can process language and recognize facial expressions that are associated with distress to give advice on how to recognize and work through emotionally difficult situations. (Fiske et al., 2019) If this AI is researched more and implemented properly, it could greatly benefit underserved populations where there is a severe lack of physicians and quality treatment. Even for individuals that live in developed countries, this type of AI can bring convenient

mental health care to those who do not have health insurance or those who prefer therapy to be conducted in their homes. (Fiske et al., 2019)

Since psychopaths are very good at making good impressions and manipulating human emotions (Frazier et al., 2019; Freedman & Verdun-Jones, 2010; Glenn & Raine, 2008; Reidy et al., 2015), research has started to explore the use of AI as a possible remedy to objectively identify the signs (Gullapalli et al., 2021), since they are not subject to bias to the extent humans are. (Miller, 2018; Topol, 2019) There has been an AI developed where it was discovered that certain head movements are linked to psychopathic traits (Gullapalli et al., 2021). This study was done by recording interviews about the life stories of a group of incarcerated males in New Mexico. The camera is positioned so that only the participant can be seen and is fully visible to said participant. The results of the AI study showed that, during interviews, people with high levels of psychopathic traits tend to keep their heads still and focus directly on the camera or interviewer (Gullapalli et al., 2021). This implies that psychopaths are more focused on selling their story (manipulation) rather than telling it objectively. However, this is about the extent of development done, so these results still need to be verified and generalized.

Limitations

This paper addresses the beginning/starting points for treating psychopaths and using AI to identify symptoms, and only the literature was reviewed. More experimentation and fieldwork is needed to confirm the hypotheses and proposed work. Additionally, the use of AI in mental health treatment has not been widely integrated, and the criteria for identifying the symptoms of psychopathy for AI to use are not concretely established yet. There is abundant potential for AI to greatly benefit how psychopaths are diagnosed and treated, which are also reasons why more fieldwork is needed.

Proposed Research for Psychopath Diagnosis and Treatment

Unlike the multiple tools available in MDD diagnosis, the 20-items Psychopathy Checklist is currently the only tool available for psychopathy diagnosis. Based on the literature review and findings, it is proposed that more research should be done on using/developing AI for guiding the psychopathy diagnosis process as well as the development of biological treatment. Without any human emotion to manipulate, AI has the potential to discover consistent signs of psychopathy and combat the subjective nature of the Psychopathy checklist. AI can also help increase the efficiency and accuracy of analysis and decrease the subjective nature of the Psychopathy Checklist by processing and cross-referencing large amounts of data including school records, social media postings, medical records, etc. in a short amount of time. Through various data mining and machine learning methodologies, AI can detect patterns and signs from various data sources that may not be accessible to or may be overlooked or missed by experts/doctors. Further research and more studies similar to the Gullapalli study should be done to establish clear and concrete symptoms of psychopaths for AI to recognize.

In current practice, the response to low levels of activity in MDD is inhibited neurotransmitter reuptake through medication that allows a prolonged and increased effect. As mentioned before, psychopathy is characterized by high levels of dopamine and low levels of serotonin. It would be useful to investigate the

possibility of developing medication that would enhance neurotransmitter reuptake to combat the high amounts of dopamine activity in psychopaths. If used with the serotonin reuptake inhibiting medication available, this could potentially help combat the dysfunctional reward system and impulsive nature of psychopaths.

Conclusion and Future Research

The two common mental illnesses MDD and psychopathy have similar imbalances in the same neurotransmitters, dopamine and serotonin, but the diagnosis and treatments for psychopathy are not as comprehensive and effective as MDD as summarized in Table 1.

Table 1. Comparison of Potential Causes, Diagnostic Tools, and Treatments of MDD vs Psychopathy

| | Major Depressive Disorder (MDD) | Psychopathy |
|------------------|--|--|
| Potential Causes | Imbalances in the neurotransmitters of dopamine and serotonin <ul style="list-style-type: none"> • low levels of both dopamine and serotonin | Imbalances in the neurotransmitters of dopamine and serotonin <ul style="list-style-type: none"> • high dopamine and low serotonin |
| Diagnostic Tools | <ul style="list-style-type: none"> • Physical exams • Lab tests • Psychiatric evaluation • DSM-5 reference | <ul style="list-style-type: none"> • 20-Item Psychopathy Checklist |
| Treatment | <ul style="list-style-type: none"> • Behavior interventions and counseling • Specialized Medication: often increases dopamine or serotonin activity by inhibiting the reuptake function. | <ul style="list-style-type: none"> • Behavior interventions and rehabilitation • Specialized Medication: not yet available |

Although the Psychopathy Checklist and current behavioral interventions are not as effective, they are a good start. Still, more exploration needs to be done in terms of how to successfully address the danger psychopaths pose to the general public. The study of Gullapalli et al. (2021) shows the potential of using AI as the results indicated that it objectively gives a concrete set of traits and behavioral patterns that psychopaths have. More studies in this area will give more data to guide the development of effective treatment and methods of diagnosis. In addition to reducing the human bias that may be present, applications of AI can also improve the efficiency of processing a high volume of data and documents used for the Psychopathy Checklist. Furthermore, the use of AI may reveal additional behavior patterns and warning signs from cross-referencing school records, medical records, social media postings, social work files, or police files.

The behavioral methods currently used can be useful but will not have long-term benefits. For that reason, researching ways to use medication to treat psychopathy is worth the time, effort, and funding as it would be an effective way to approach the issue of the violent crimes they persistently commit. It is worth pointing out that MDD is often treated with a combination of both therapies that involve drug prescription and ones that don't (Evans & Sullivan, 2014). This further supports the need for a medication that can treat psychopaths at the chemical level. Once one is developed, it can be used to work alongside the existing programs that treat them at the behavioral level. Alongside this treatment, there would need to be a way to enhance amygdala and right hemisphere activity to address the inability to feel sympathy or fear.

References

- Alternatives-Antidepressants*. (2021). National Health Service. Retrieved March 12 from <https://www.nhs.uk/mental-health/talking-therapies-medicine-treatments/medicines-and-psychiatry/antidepressants/alternatives/>
- Ambade, V., Arora, M., Singh, P., Somani, B. L., & Basannar, D. (2009). Adrenaline, Noradrenaline and Dopamine Level Estimation in Depression: Does it Help? *Medical Journal Armed Forces India*, 65(2), 216-220.
- Anderson, N. E., & Kiehl, H. A. (2014). Psychopathy: Developmental Perspectives and their Implications for Treatment. *21*(1).
- Anderson, N. E., & Kiehl, K. A. (2013). Psychopathy and Aggression: When Paralimbic Dysfunction Leads to Violence. *Neuroscience of Aggression*, 17, 269-393.
- Belujon, P., Ph.D, & Grace, A. A., Ph.D. (2017). Dopamine System Dysregulation in Major Depressive Disorders. *International Journal of Neuropharmacology*, 20(12), 1036-1046.
- Berry, J., & Hammond, N. (2019). *What are Neurotransmitters*. Medical News Today. Retrieved March 12 from <https://www.medicalnewstoday.com/articles/326649>
- Castro, V. H. C., Valenzuela, C. L. L., Sanchez, J. C. S. S., Pena, K. P., Lopez Perez, S. J., Ibarra, J. O., & Villagran, A. M. (2014). An Update of the Classical and Novel Methods Used for Measuring Fast Neurotransmitters During Normal and Brain Altered Function. *Current Neuropharmacology*, 12(6), 490-508.
- Chefer, V. I., Thompson, A. C., Zapata, A., & Shippenberg, T. S. (2009). Overview of Brain Microdialysis. *Current Protocols in Neuroscience*, 47(1), 7.1.1-7.1.28.
- Depression (major depressive disorder) Diagnosis and Treatment*. (2022). Retrieved March 12 from <https://www.mayoclinic.org/diseases-conditions/depression/diagnosis-treatment/drc-20356013>

- Depression (major depressive disorder) Symptoms and Causes.* (2022). Mayo Clinic. Retrieved March 12 from <https://www.mayoclinic.org/diseases-conditions/depression/symptoms-causes/syc-20356007>
- Evans, E. A., & Sullivan, M. A. (2014). Abuse and misuse of antidepressants. *Substance Abuse and Rehabilitation, 5*, 107-120.
- Fisher, A. (2022). *Neurotransmitter Testing: What can it do for you?* Retrieved March 12 from <https://www.alexfisherhealth.com.au/neurotransmitter-testing-what-can-it-do-for-you/#:~:text=These%20tests%20are%20now%20available,the%20kidneys%20via%20your%20urine>
- Fiske, A., Henningsen, P., & Buyx, A. (2019). Your Robot Therapist Will See You Now: Ethical Implications of Embodied Artificial Intelligence in Psychiatry, Psychology, and Psychotherapy. *Journal of Medical Internet Research, 21*(5).
- Frazier, A., Ferreira, P. A., & Gonzales, J. E. (2019). Born this way? A review of neurobiological and environmental evidence for the etiology of psychopathy. *Personality Neuroscience, 2*. (National Center for Biotechnology Information)
- Freedman, L. F., & Verdun-Jones, S. N. (2010). Blaming the Parts Instead of the Person: Understanding and Applying Neurobiological Factors Associated with Psychopathy. *Canadian Journal of Criminology and Criminal Justice, 52*, 29-53.
- Glenn, A. L., & Raine, A. (2008). The neurobiology of psychopathy. *Psychiatric Clinics of North America, 31*, 463-475.
- Gullapalli, A. R., Anderson, N. E., Yerramsetty, R., Harenski, C. L., & Kent, K. A. (2021). Quantifying the psychopathic stare: Automated assessment of head motion is related to antisocial traits in forensic interviews. *Journal of Research in Personality, 92*.
- Helm, M. J., Swiergosz, A. M., Haeberle, H. S., Karnuta, J. M., Schaffer, J. L., Krebs, V. E., Ramkumar, P. N. (2020). Machine Learning and Artificial Intelligence: Definitions, Applications, and Future Directions. *Current Reviews in Musculoskeletal Medicine, 13*, 69-76.
- McLeod, S. (2018). *The Preoperational Stage of Cognitive Development.* Simply Psychology. Retrieved March 12 from <https://www.simplypsychology.org/preoperational.html>
- Medication.* Retrieved 5/1/2022 from <https://psychopathyis.org/treatment/medication/#:~:text=No%20medications%20have%20been%20developed,Medications%20are%20not%20a%20cure.>
- Miller, A. P. (2018). Want Less-Biased Decisions? Use Algorithms.

- Nabeshima, T., & Kim, H.-C. (2013). Involvement of Genetic and Environmental Factors in the Onset of Depression. *Experimental Neurobiology*, 25, 235-243.
- Nutt, D. J. M. D., Ph.D. (2008). *Relationship of Neurotransmitters to the Symptoms of Major Depressive Disorder*. J Clin Psychiatry. Retrieved March 2 from https://www.psychiatrist.com/wp-content/uploads/2021/02/16970_relationship-neurotransmitters-symptoms-major-depressive.pdf
- Paykel, E. S. (2008). Basic concepts of depression. *Dialogues in Clinical Neuroscience*, 279-289.
- Reidy, D. E., Kearns, M. C., & DeGrue, S. (2013). Reducing psychopathic violence: A review of the treatment literature. *Aggression and Violent Behavior*, 18(5), 527-538.
- Reidy, D. E., Kearns, M. C., DeGrue, S., Lillienfeld, S. O., Massetti, G., & Kiehl, K. A. (2015). Why psychopathy matters: Implications for public health and violence prevention. *Aggression and Violent Behavior*, 24, 214-225.
- Roberts, J. G., Lugo-Morales, L. Z., Loziuk, P. L., & Sombers, L. A. (2012). Real-Time Chemical Measurements of Dopamine Release in the Brain. *Methods in Molecular Biology*, 964, 275-294.
- Scaccia, A. (2020). *Serotonin: Functions, Normal Range, Side Effects, and More*. Retrieved March 2 from <https://www.healthline.com/health/mental-health/serotonin>
- Sheffler, Z. M., Reddy, V., & Pillarisetty, L. S. (2021). *Physiology, Neurotransmitters*. National Center for Biotechnology Information. Retrieved March 12 from <https://www.ncbi.nlm.nih.gov/books/NBK539894/>
- Topol, E. J. (2019). High-performance medicine: the convergence of human and artificial intelligence. *Nature Medicine*, 25, 44-56.
- Visser, A. K. D., van Waarde, A., Williensen, A. T. M., Bosker, F. J., Luiten, P. G. M., den Boer, J. A., . . . Dierckx, R. A. J. O. (2010). Measuring serotonin synthesis: from conventional methods to PET tracers and their (pre)clinical implications. *European Journal of Nuclear Medicine and Molecular Imaging*, 38, 576-591.
- What are Neurotransmitters*. (2017). University of Queensland. Retrieved March 12 from <https://qbi.uq.edu.au/brain/brain-physiology/what-are-neurotransmitters>