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ADHD as an Evolutionary Mismatch

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Abstract

Attention Deficit Hyperactivity Disorder, ADHD, is currently classified as a mental disorder in the DSM-V. The classification of a mental disorder leads to significant issues such as over-reliance on prescription medications, removal of agency, negative self-valuation, and more. Recent data in areas such as genetics, neurobiology, and psychology support the hypothesis that ADHD may be better understood as an evolutionary adaptive process that became maladaptive as a result of substantially different environmental characteristics in the modern environment. Key symptoms of ADHD may be explained by two processes. The first process is due to a genetic variation in Dopamine Receptor D4 that may have contributed to symptoms that aided nomadic humans in migrating out of Africa. The second process may be explained by the sympathetic nervous system's suppression of the prefrontal cortex in the presence of chronic stress which led to behaviors useful for immediate survival in the context of the ancestral environment. The Evolutionary Mismatch Model of ADHD may help inform alternative interventions that can minimize the negative effects of ADHD seen in the modern environment. Alternative interventions include daily exercise, dietary supplementation of Omega 3/6 fatty acids, and increased vitamin D exposure through exposure to sunlight or dietary supplementation.

ADHD as an Evolutionary Mismatch

Michael Jordan, considered to be one of the greatest basketball players of all time, is without a doubt an individual most people would consider to be extremely successful. With achievements such as four Olympic gold medals, six NBA titles, and five MVP awards. Apart from his physical prowess, he was well known for his obsession with victory and his drive to be the best, going so far as to train five to six hours every single day. This impressive drive was not just isolated to his pursuits in professional basketball; it was an aspect that infected every facet of his life. For instance, when Christian Laettner, one of Jordan's Olympic teammates, beat Jordan in a game of table tennis, Jordan refused to accept the defeat. Jordan went so far as to have a ping-pong table delivered to his room where he trained for two days without speaking to anyone. Once ready, he walked into the locker room, demanded a rematch, and annihilated Laettner (Bhatia, 2021). This story provides a glimpse of the type of drive Jordan has for winning, certainly something instrumental in aiding him to become an idol for many.

Now let us switch gears and look at the story of Chris, a 33-year-old homeless man I had the opportunity to interview on the streets of Atlanta. From very early on in his life, Chris displayed many problematic behaviors ranging from constant fighting, an inability to sit still in class, to his complete disregard of handing in his homework. At the young age of 13, Chris had his first of many encounters with the police when he was caught shoplifting. By 15, Chris dabbled in drugs and eventually became addicted to crack cocaine. Since then, he has either been in prison or on the streets. By every metric, Chris would be viewed as a failure by most, yet he and Michael Jordan have one thing in common: they both have Attention Deficit Hyperactivity Disorder.

This common trait may lead one to question to what extent ADHD played a role in their lives. Chris is a textbook example of an individual with ADHD. Despite displaying every symptom of ADHD from an early age, Chris only received a diagnosis much later in life when he entered the prison system. There, he shared a common diagnosis with 26% of prisoners in America (Vélez-Pastrana et al., 2020, p. 180) and became another story of a child with ADHD who followed the wrong path and fell into the prison system.

A common occurrence in individuals with ADHD is the propensity for addiction. Both Chris and Michael Jordan have addictions of their own, drugs and gambling respectively. Jordan has numerous controversies related to his love of gambling. Just one of these controversies ties Jordan to a streak of bets totaling $1.1 million with one person (Quinn, 2017). Chris's addiction to drugs has led him to commit numerous felonies that even he acknowledges were irrational. Jordan has been praised for his spontaneous, impulsive decisions in his gameplay yet suffers from impulsiveness in his personal life as well. Chris disclosed to me that he has always been extremely impulsive, rarely thinking about the consequences before he acts. Despite experiencing similar symptoms of the same disease, these two men had completely different life outcomes. I argue that the differences in the types of environments in combination with the resources that Jordan and Chris received early on in their lives played a major role in how ADHD shaped their lives.

ADHD is often viewed as an inherently negative disorder. Parents may recoil when hearing the diagnosis slip from their doctor's mouth regarding their child. Teachers may shudder when they discover a student has ADHD. Children tend to ostracize their peers with ADHD and bully them for being 'weird'. The diagnosis often comes with a heavy load, an assumption of a life filled with difficulty, stress, and failure. Despite this, many individuals with ADHD not only

survive but thrive in their fields, often surpassing their neurotypical counterparts because of the very same symptoms that lead to failures for others with ADHD (Palmini, 2008). How does this happen? How could a disease, a word that implies massive disadvantages, play a major role in overwhelming success? What conditions made Michael Jordan a living legend? What conditions made Chris a career criminal? Perhaps the answer lies in the concept that ADHD may not be best understood as a disease, but instead as an evolutionary mismatch.

Evolutionary mismatch is a concept that claims that organisms may have traits that were beneficial in a previous environment, yet due to changes in environments, the traits may become detrimental to the organism(Cofnas, 2016). For example, the taste preference for sweet foods was beneficial for humans because it would lead to an increase in fruit consumption. Fruits are valuable because along with sugar, they are chock-full of fiber, vitamins, and nutrients that are not present in meat. Taste preferences for sweets could have developed to push humans to include fruits in their diet. Yet over time, humans figured out how to create calorically dense sugary foods like candy and desserts that lack the fiber and nutrients present in fruits. As a result, the once helpful preference for sweet foods remains, but it now plays a major role in obesity in the context of modern life (Breslin, 2013). Application of the concept of evolutionary mismatch may also provide insight into observed phenomena in the natural world.

Changes in the dominant phenotypes in the peppered moth species were observed prior to and following the English Industrial Revolution. The reasons for such drastic changes were largely unknown until researchers found a plausible explanation by looking at the situation through the lens of evolutionary mismatch. Before the Industrial Revolution, the peppered moths were predominantly white with speckles of black. The smog from factories killed the lichen that lived on trees, which caused the trees to expose darker bark. The moths that lived around those

trees were adapted to the lighter-colored bark. Such a sudden change in tree bark color wreaked havoc on the moth population, allowing predators to easily pick away at the lighter-colored moth population because the white and black speckle phenotype stuck out like a sore thumb on the dark bark background. Eventually, the change in tree bark color led to a significantly larger population of dark-colored moths through the process of natural selection. The adaptation of darker tones was beneficial for the moths up until the English addressed air pollution. Reforms reduced air pollution and created an environment that allowed for the lichen to return. The return of the lichen lightened up the color of the tree bark. As a result, the dark-colored moths stood out more and this once favorable phenotype became a disadvantage due to the change in environment (Cofnas, 2016). In both the human and moth examples, a once beneficial adaptation became maladaptive due to environmental changes. Evolutionary mismatch theory provides opportunities to address the environmental changes that may be the underlying causes of dysfunction instead of only treating the organism.

I argue that the classification of ADHD as a disorder is inaccurate, and that ADHD is better understood as a result of an evolutionary mismatch between the modern environment and the ancestral environment. Drastic differences in environmental characteristics, lifestyles, and the types of traits necessary for optimal functioning between the ancestral environment and the modern environment have resulted in traits such as hypervigilance, impulsivity, and hyperactivity to be categorized together to form the disorder known as ADHD. In the modern environment, these traits are largely considered to be negative; however, these traits can be seen as adaptive in the ancestral context. Shifting the lens through which ADHD is viewed allows for steps to be taken to adjust a person's environment to promote success in the modern environment. To conceptualize the value that is derived from shifting the 'lens' of how ADHD is

viewed from a disease to an evolutionary mismatch, it is critical to understand what ADHD is. In section 2, I explain how ADHD is currently understood, diagnosed, and treated. In section 3, I highlight some of the negative outcomes that individuals with ADHD may face. In section 4, I explore the problems that arise from viewing ADHD as a disease. Then in section 5, I expand on previous accounts that claim that ADHD is a result of an evolutionary mismatch by explaining how recent scientific developments further support this view. In section 6, I explore alternative interventions that mimic the ancestral environment. In section 7, I discuss how viewing ADHD as a result of an evolutionary mismatch may address the issues that are caused by the current understanding of ADHD as a disorder.

2. ADHD Defined

Attention Deficit Hyperactivity Disorder, or ADHD, is considered to be a neuro-developmental disorder that has a prevalence rate of 9.8% in the United States for children between the ages of 3 and 17 (CDC, 2022), and an average rate of 5.29% in the rest of the world (Polanczyk et al., 2007). To receive a diagnosis, an individual must display six or more symptomatic behaviors for over six months across two or more settings. Symptoms must negatively impact the individual's social, academic, or occupational functioning (Hallowell & Ratey, 2022, p. 16). Some key symptoms include a diminished attention span, consistent failure to focus on details/making thoughtless mistakes, fidgeting, making impulsive decisions, difficulty waiting for one's turn, being sidetracked by external stimuli, being overly talkative, being disinclined to begin activities that require concentration and having poor listening skills (Hallowell & Ratey, 2022, p. 17). Currently, there are no clinically recognized biological markers that are used for diagnosis. Because diagnosis is based on reported symptomatic

behavior, children tend to be diagnosed more often than adults (Newton-Howes, 2004, p. 532). This discrepancy in diagnosis rates has led to a false assumption that ADHD is a disorder that disappears as a child grows up; however, multiple reasons for the discrepancy in diagnosis rates have been found. Children are closely monitored in all facets of their lives which increases the likelihood that the people in their lives such as teachers, parents, and coaches might recognize and report symptomatic behaviors. Adults who did not receive a diagnosis in childhood are believed to have developed compensatory behaviors that allow for successful functioning (Newton-Howes, 2004, p. 533). There is no cure for ADHD; however, the CDC recommends that individuals with ADHD should receive treatment to help deal with symptoms.

In regard to current treatment protocols, the CDC recommends a combination of behavior therapy and medication for individuals with ADHD (CDC, 2022). The FDA separates medication into two categories: stimulants and non-stimulants. Most stimulant medications contain methylphenidate (MPH) or amphetamine(AMP), which are believed to calm hyperactive children by increasing levels of dopamine in the brain (FDA, 2023). Dopamine is a neurotransmitter naturally produced in the brain and is believed to be associated with motivation, movement, and attention (Iversen & Iversen, 2007). Behavior therapy can be used to develop coping strategies such as organizational skills training, parental training in behavior management, and overall behavior-focused interventions (CDC, 2022). In clinical practice, therapy is often an afterthought, and stimulant medication tends to be used as the main form of treatment despite CDC recommendations (Patel et al., 2017). Regardless of whether an individual receives treatment or not, people with ADHD are expected to have an increased likelihood of experiencing negative life expectancies.

3. Negative Outcomes of ADHD

The negative outcomes associated with ADHD begin as early as childhood and the statistics remain unfavorable throughout the entirety of one's life. Children with ADHD are more likely to develop personality disorders such as Borderline Personality Disorder, Antisocial Personality Disorder, Avoidant Personality Disorder, and Narcissism (Miller et al., 2008). Students with ADHD are five times more likely to be in juvenile justice facilities than students without ADHD (Fletcher & Wolfe, 2009). According to the U.S. Food and Drug Administration, teenagers with ADHD are more likely to have motor vehicle accidents (FDA, 2023). Teenagers with ADHD are also more likely to partake in risky behaviors such as driving under the influence, speeding, and having unprotected sex (FDA, 2023). Reaching adulthood does not mean a person with ADHD will no longer have an increased risk of negative life expectancies. In comparison to their neurotypical counterparts, people with ADHD in early adulthood have an increased likelihood of committing a crime during early adulthood (Fletcher & Wolfe, 2009). Adults with ADHD experience higher rates of depression and anxiety, higher rates of substance misuse, and increased rates of chronic conflict with work peers and partners/spouses (Newton-Howes, 2004, p. 533). To put it simply, the odds are stacked against those with ADHD. To top it off, the statistics mentioned are only a few of the known issues associated with the condition. There are major underlying issues that result from how the condition is viewed by society that remain either unnoticed or unaddressed.

4. Issues Posed by ADHD Under the Biomedical Model of Disease

The way that society currently views ADHD as a disorder under the biomedical model of disease has caused significant issues such as an over-reliance on medication, reduction in

personal agency, negative self-valuation, discrimination from others, and the outright denial of the positive aspects of ADHD. These problems may be alleviated by changing the lens through which ADHD is viewed from the biomedical model of disease to the evolutionary mismatch model. The issues caused by the biomedical model of disease are quite serious and their consequences affect millions of people with and without ADHD.

4.1 Over-reliance on Medication

Over the past two decades, the diagnosis rate for ADHD has skyrocketed, leading many individuals to seek treatment (CDC, 2022). Family doctors are often the first group of healthcare professionals with whom individuals seeking treatment interact (Salt et al., 2005). Often these doctors prescribe medication prior to attempting other non-pharmaceutical treatments which may lead to an over-reliance on medication to treat patients (Patel et al., 2017). The issue of over-reliance on medication can be explained by multiple factors, such as a lack of clear objective criteria for diagnosis, primary care physician (PCP) inadequacy regarding both diagnosis and treatment of ADHD, as well as the consequences of using the biomedical model in relation to ADHD. These factors also play a role in stimulant misuse for those who do not have ADHD which exacerbates the current shortage of ADHD medication. The usage of powerful psychostimulants to treat ADHD has raised ethical considerations regarding their adverse effects and how quickly children are placed on medication to treat ADHD.

4.1.1Diagnostic Issues

Oftentimes, primary care physicians (PCPs) are the first type of health professionals that individuals interact with for assistance in managing ADHD symptoms (Salt et al., 2005).

Because PCPs are the main group of healthcare professionals that individuals interact with, it is critical that these doctors are properly trained and aware of the treatment options that are available for ADHD. However, there is a significant population of PCPs who report a lack of confidence in both recognizing and treating ADHD. 88% of PCPs surveyed reported that they "wanted further training in the drug treatment of ADHD" (French et al., 2019, p. 1057). Lack of education in regard to treatment options inevitably causes a reliance on the few treatment options that PCPs are aware of. A study in the UK discovered that 75% of PCPs could not properly identify ADHD, often mistaking the condition for other conditions such as social anxiety or Anti-Social Personality Disorder (Salt et al., 2005, p. 165). Failure to properly identify ADHD combined with limited knowledge of treatment options is a recipe for disaster because doctors may feel the need to prescribe medication for someone who may not need it. Part of the issue with proper identification of ADHD may be a result of the type of criteria used in diagnosis.

The criteria used to diagnose ADHD is problematic for multiple reasons that result in misdiagnosis. As mentioned in section 2, diagnostic criteria do not require any objective biomarkers, and diagnosis relies on the reported observations of symptomatic behavior. The symptomatic behavior is open to interpretation and behavior can be attributed to other underlying causes. For example, the amount of talking to satisfy 'being overly talkative' is entirely subjective and can vary between each observer. The criteria used to receive a diagnosis for ADHD are based solely on observable behavior that is often not observed by the doctors themselves. Rather, the symptoms are observed and reported by untrained individuals such as parents, teachers, or the patients themselves. Problems with this system of self-reporting arise when other variables may be the cause for ADHD-like behavior. Things as simple as too much sugar consumption can cause hyperactive behavior, but the cause of this behavior might be

mistaken for ADHD by parents and teachers (Abbasi et al., 2019, p. 81). Underlying medical issues that have similar symptoms to ADHD, such as sleep apnea, might lead to faulty self-reports (Hallowell & Ratey, 2022, p. 87). Another issue is that self-reports can be inaccurate and doctors who lack the time or knowledge to be able to accurately assess patients and evaluate their self-reports can easily misdiagnose patients. Individuals who may want to receive a prescription for ADHD medication for purposes other than treating ADHD can easily lie on a report. A PCP may take the report at face value and not recognize that their patient does not have ADHD. Individuals filling out self-reports might be influenced by other people who misinterpret behaviors and claim that the patient displays ADHD symptoms when they in fact do not. Lack of concrete, objective diagnostic criteria combined with limiting factors that affect PCPs' ability to properly diagnose patients may lead to misdiagnosis. As a result of misdiagnosis, there is an increased need for treatment options that can negatively impact those who need treatment from receiving it.

4.1.2 Biomedical Model of Disease and its Role in Over-reliance on Medication

Lack of knowledge and confidence in PCPs when it comes to treatment plays a major role in the problem of over-reliance on medication. The CDC recommends medication usage in conjunction with other non-medical interventions such as Cognitive-Behavioral Therapy, parent training, and adolescent training (CDC, 2022). However, research has shown that PCPs often prescribe medication prior to attempting other treatment options. A 2017 study has shown that of 66,719 patients, 59% were prescribed medication during the same visit in which they were diagnosed with ADHD (Patel et al., 2017, p. 684). Other factors such as limited appointment duration, perceived pressure to offer an instant solution, and financial incentives may influence

PCPs to overprescribe medication. While these factors may play a role, lack of knowledge and confidence regarding treatment options seem to be a result of the medical community viewing ADHD as a disorder under the biomedical model.

The biomedical model is an approach that the American healthcare system has used for over three decades and is still largely accepted by many doctors. The biomedical model views mental disorders as diseases of the brain and prioritizes pharmacological treatment over other forms of treatment (Deacon, 2013, p. 846). As a result of ADHD's classification as a disorder, doctors trained under the biomedical model who lack knowledge or confidence regarding ADHD might be more likely to prescribe medication as their first approach to treatment. PCPs following the biomedical model approach to ADHD are at a disadvantage when it comes to effectively treating their patients because issues surrounding diagnosis and lack of alternative treatment options may lead to an over-reliance on medication. The over-reliance on medication has worsened the ongoing ADHD medication shortage. The lack of alternative options such as therapy and skills training sets patients up for failure when they cannot fill their prescriptions due to shortages.

4.1.3 Medication Shortages

As of 2020, there has been a shortage of ADHD medication which has left many individuals struggling to fill their prescriptions. In a 2023 article by Kenichi Serino, he explains that the shortage is due to multiple factors such as increases in telehealth appointments due to the Covid-19 pandemic, production shortages, and an increased number of individuals seeking treatment. Telehealth services play a major role in the shortage because telehealth worsens the issues regarding diagnosis and treatment that already increase the pressure on the pharmaceutical

sector. People who do not actually have ADHD have been able to receive prescriptions for ADHD medication to abuse or resell much easier through the use of telehealth appointments. Telehealth appointments minimize the personal interactions between doctors and patients minimizing the opportunity for doctors to carefully evaluate patients. Telehealth also allows for doctors' offices that quickly prescribe medication for financial incentives, also known as pill mills, to be much more accessible. Pill mills substantially increase the demand for medication as more individuals who may not necessarily need the medication are prescribed large amounts of medication at once (Young et al., 2018). The Covid-19 pandemic increased the use of telehealth options by healthcare providers which in turn has allowed pill mills to reach a much wider demographic. As a result, increases in prescriptions increase the demand for the medication. The increased demand has been a leading cause of shortages that prevent many patients who rely on their prescriptions from being able to receive the medication.

Often because medication is the only treatment option patients have available, patients may struggle in their day-to-day lives dealing with their condition due to the lack of developed effective coping strategies. Individuals who have not developed alternative coping strategies or learned interventions face a larger problem when they are unable to refill their prescriptions. Individuals with ADHD who lack effective coping strategies may experience that symptoms worsen or reappear suddenly. PCP reliance on medication as the primary treatment option sets up patients to face issues when shortages occur. This reliance also increases the likelihood that the adverse effects of the medications, such as addiction, to occur.

4.1.4 Adverse Effects of Medication

The medications that doctors tend to prescribe are extremely powerful, and their effects are not limited to only aiding the symptoms of ADHD. Using medication to aid in treating ADHD is the equivalent of using a hammer on a screw. It will work in resolving some symptoms, but significant issues occur elsewhere in the body. There are two classes of medications predominately used in ADHD: stimulants and non-stimulants. This section's focus is on the adverse effects of stimulants, particularly methylphenidate (MPH) and forms of dextroamphetamine (d-AMP) because they are prescribed more often than nonstimulants (Weyandt et al., 2014, p. 224). In comparison to non-stimulants, stimulant medications have a higher potential for abuse, a higher risk of addiction and they have more dangerous adverse effects (Weyandt et al., 2014, p. 225). In a 2012 meta-analysis by Lakhan and Kirchgessner, they noted that individuals with ADHD who use prescribed stimulants may experience impaired cognitive flexibility, impaired short-term acquisition of information, and increases in distractibility due to drug-induced impulsivity (Lakhan & Kirchgessner, 2012, p. 667). In addition, they also highlight the potential adverse effects of chronic stimulant usage can lead to the induction of schizophrenic-like states with hallucinations and delusions. (Lakhan & Kirchgessner, 2012, p. 671). Chronic use can also lead to anorexia, suicidal thoughts in children, psychosis, and sudden death (Lakhan & Kirchgessner, 2012, p. 671). Other notable adverse effects include apathy, docility, emotional depression, hypomania, mania, and obsessive-compulsive behavior (Breggin, 1999). The full understanding of exactly how these medications work on the body remains largely unknown other than the fact that they increase dopamine.

Medication can be effective and should not be abandoned entirely because of the adverse effects. However, the issues related to overdiagnosis, and the perceived lack of alternative

treatment options increase the prescription rates for these medications. Higher rates of prescription may increase the likelihood that someone will experience adverse effects when it may not have been necessary to take the medication in the first place. No solution is a one-size-fits-all solution; however, the biomedical model of disease inherently limits treatment options to focus on medication. As stated previously, using these drugs to treat ADHD is like using a hammer on a screw. It does work, but it comes with significant costs and irreparable damage when other tools may be better to use for the given task. These powerful drugs pose significant risks, and the fact that they are the first 'solution' that PCPs tend to offer raises many ethical questions.

4.1.5 Ethical Considerations Regarding the Use of Medication to Treat ADHD

Ethical considerations regarding the use of powerful medications as the primary treatment option have been raised by parents, patients, and activists. How ethical is it to expose children to extremely powerful, addictive, mind-altering psychostimulants for a significant part of the development process without at least attempting non-pharmacological interventions first? What happens when individuals who lack other coping strategies are unable to receive their medication? Is it fair to these individuals to get them addicted and dependent on these medications without their informed consent? It seems unethical for doctors to prescribe medication if there are other less invasive interventions available, such as therapy or those discussed below. The supply of medication has historically been unreliable with many shortages occurring. Knowing this, it seems unfair to patients to get them addicted to medications that have known withdrawal effects. If a patient cannot fill their prescription due to a shortage or lack of insurance, it seems that they are just abandoned to face the consequences. The lack of effort to

develop effective coping strategies through therapy or other interventions will inevitably lead patients to deal with severe dysfunction in their lives at some point in the future when they cannot fill their prescriptions. These questions are not some imaginary thought experiments, they have real consequences that need to be addressed. It seems that the current biomedical model of disease as it is currently applied to ADHD cannot resolve these issues, and perhaps it is time to change how ADHD is approached.

Overall, the biomedical model of disease is the underlying cause of the current over-reliance on medication and the issues associated with it. The over-reliance on medication for treating ADHD can be seen as a result of the combination of issues related to diagnosis, PCP education regarding treatment options, and the perception that the biomedical model imposes on doctors. The perception that most diseases and disorders need to be treated through medication has caused medication to be the first solution. The increases in prescription rates due to misdiagnosis also impact the current shortage making it harder for those who need medication to receive it. The reliance on medication has caused many people to face the adverse effects of medication when other treatment options are available.

4.2 Removal of Agency

The biomedical model of disease places the focus of the relationship between the individual and their environment entirely on the individual. The approach under the biomedical model does not allow for critical observation or the resolution of the other factors that may influence symptomatic behavior. Under the biomedical model, the environment is not considered, only the ‘diseased’ individual is. Following the model, it is assumed that regardless of the environment, the individual will face the same issues of the condition, yet this assumption

is implausible. As mentioned previously in 4.1, the primary method of treatment tends to be the use of medication despite there being effective, non-pharmacological interventions that account for the relationship between the individual and their environment. The false assumption that the individual can only take medication to aid in managing symptoms inherently attacks the individual's agency.

As a result of medication being the primary treatment pathway, the individual with ADHD may feel as if they lose their sense of agency when it comes to managing their condition. I am not saying that all individuals will feel as though they lose agency when they use medication; in fact, some people may feel as though they gain a stronger sense of agency once they receive medication. But some people may feel a diminished sense of agency in treating their condition if their only perceived solution is medication because they become reliant on external conditions to manage their symptoms. When conditions that prohibit the individual from using medication arise, they may feel as though they have no other options available; that all they can do is just accept their symptoms. In reality, new research has found that this is not the case and there are steps that can be taken to change the environment that result in fewer symptoms overall.

4.3 Negative Self-Perception and Perception from Others

As social creatures, humans have an innate talent for dividing up into groups based on differences between each other. As a result of the separation of groups, people seem to find ways to create tension between members of one group and another. Experiments such as the Stanford prison experiment (Zimbardo, 1972) have shown us how quickly and easily people can begin to identify with an arbitrary group and do unspeakable things to members of the 'out-group'. Any

differences between people can be used to facilitate group hostility and ostracism towards others, especially if a deviation from the norm is labeled as ‘bad’. The applied label to ADHD as a disorder is no different. The negative label can lead to significant issues related to how one perceives themselves and how one is treated by others. Survey data has shown that children who know that a peer has ADHD tend to report a greater likelihood of having a negative attitude toward that peer, and a greater desire to maintain social distance from them (Bisset et al., 2022, p. 539). It is not a stretch to assume that children who tend to have negative attitudes toward peers can and will manifest those attitudes into discriminatory behavior which can take the form of ostracism, social isolation, bullying, physical violence, etc.

Furthermore, ADHD can lead to issues with one’s self-perception on an ontological level. A brief overview of Existential philosophy and how it relates to psychotherapy can aid in understanding how viewing ADHD through the disease model can play a role in causing major psychological problems. Rollo May, the father of Existential Psychotherapy, explains that the term ‘existence’ means literally “to stand out, to emerge” (May, 1983, p. 43). In the context of ontology, the term relates to how an individual stands out in an environment. A person alone in an environment simply lives. They act and are not aware of themselves as being the individual doing the act of sitting; they are simply sitting. There is no image of themselves in their mind as a being ‘sitting’. At this point, there is no self-perception, which means one cannot negatively perceive themselves. This relationship changes when another human enters the environment.

One sees this other person and that ‘other’ stands out. They are distinct from a chair or the floor, and I* recognize them as being a human. By this recognition that they are human, I

* First-person terminology is being used for the sake of simplicity in distinguishing between individuals and manifesting the subjective first-personal features of this existential analysis.

unconsciously attribute to them the ability to recognize me as having the same capacity. This recognition is different from noticing an object because another human is unpredictable. They are an agent that thinks and manipulates the environment in the same way that I can. By understanding that they recognize me, I can now see a mental image of myself as a person doing the sitting. There is now a ’me’ that is perceived. ‘I’ can see ‘me’ as the one doing the sitting. I become self-aware of my body doing this action of sitting and how I am perceived by the other. This awareness of a perceived self allows for a value to be tied to how I view myself.

The awareness of myself as being perceived by the other grants me the ability to understand that we are on equal grounds in terms of our existence and that we are both capable, conscious creatures distinct from a chair or a pencil. There is a level of unknown when it comes to how we act and how we are perceived. The uncertainty of the other is scary, and to determine if the individual is a threat, the human mind tries to categorize the other’s behavior and appearance. Based on the categorization, I treat the other in a manner that supports whatever category they are placed in. If they were placed in the ‘friend’ category, my behavior towards them would be guided by what friendship means to me in my mind. The categorization affects how I view the world, how I treat the person, and how the person treats me. How the other person treats me relates to their perception of me. How I am treated by the other informs me on how I should view myself.

Say it was to be made known to the other person that I had ADHD. If they did not know much about it other than it is a mental disease, they would categorize me as diseased. The label could force me into a category in their mind. That category may present me in a negative light despite there being no evidence from my actions to treat me negatively prior to their learning about my condition. Through this relation, whether consciously or subconsciously, their behavior

may shift to justify the categorization of ‘diseased’. If they treat me differently or negatively, I may internalize their behavior and see myself as diseased. The internalization may eventually lead to a negative self-perception even in the absence of the other who knows about my condition. I will carry the mental burden of fear about my behavior and how it is perceived into new interactions with people who do not know about my condition.

The application of Existentialist thought to ADHD being labeled as a disease helps to explain the very real struggles that people with ADHD face. A qualitative survey focused on the lived experiences of those with ADHD has shown that people with ADHD may feel like outsiders and that they are hesitant to share their diagnosis for fear of being seen as stupid or less capable (Hansson Halleröd et al., 2015). Some interviewees mentioned that once someone finds out about their condition they see noticeable shifts in behavior towards them, “You become a different person in the eyes of others… your thoughts and opinions are not valued as highly as before” (Hansson Halleröd et al., 2015, p. 7). Some have even expressed fears of discrimination in employment and relationships if they were to share their diagnosis. Others have said they tell people they have dyslexia as opposed to ADHD to not be labeled in the group of ADHD(Hansson Halleröd et al., 2015, p. 9). The labels used to describe things may not seem important on the surface; however, the labels and categorizations have a real and important effect on how we perceive the world and treat others.

ADHD being labeled as a disease can make those who know nothing about the condition other than the label treat those with ADHD in a negative manner. Through the usage of the term disease or disorder, a person with ADHD is put into a negative category that affects not only how others see them, but how they perceive themselves as well. Changing how ADHD is viewed to be a result of an evolutionary mismatch will change the categorization of the condition to

something that is not inherently negative. By changing the categorization of the condition, pressure may be alleviated from people with ADHD because those who know little about it except the label may be less inclined to view it negatively.

4.5 Prevents Identification of the Positive Aspects of ADHD

The term ‘disease’ implies a divergence from normal functioning in a way that adversely affects an individual afflicted by it. By approaching ADHD through the lens of the disease model, we are inherently limited to viewing the symptoms in a negative manner. As a result, many limitations are placed on how the condition can be viewed as beneficial. For example, symptoms such as impulsivity may be viewed as troublesome as it can lead to rash decisions, mistakes that could be avoided, and an inability to follow rules. Yet in times where lightning-fast decisions need to be made, such as a house fire or in the context of sports, ADHD may be quite useful because of impulsivity (Hallowell & Ratey, 2022, p. 17). Restlessness and trouble waiting for one’s turn to speak, are a result of a mind constantly thinking, constantly in ‘GO’ mode, and it can lead to making careless mistakes, forgetfulness, and difficulty in social situations. However, the same ‘issue’ can also lead to creativity, enhanced problem-solving, innovation, and interesting conversations (Hallowell & Ratey, 2022, p. 18). Issues with long-term sustained focus can lead to procrastination, giving up on projects, and boredom. Yet individuals with ADHD have reported experiences where time flies when they are enthralled by a project, where they get so much done in one sitting (Hallowell & Ratey, 2022, p. 18). Traits of ADHD may be beneficial, but the stories that are told about the condition being entirely negative prevent people from seeing how the traits can be applied to aid in performance.

Michael Jordan and other athletes often attribute their success in sports to ADHD (Selinger, 2019). Hypervigilance is important in basketball matches as it allows a person to be aware of all the important information such as where each player is, how much time is left, etc. Hyperactivity can help a person feel as though they have boundless energy which might motivate them to train more often. Hyperfocus might allow a person to 'lock in' and fully embrace the moment.

These are only a handful of examples of how some symptoms can be viewed as negative while being extremely useful in other situations. Due to the terminology used to label the condition, the positive aspects and how they can be used are overlooked both by those with ADHD and researchers. By only focusing on the negatives of ADHD, researchers tend to only research how to minimize the negative aspects while largely ignoring the reported benefits of ADHD and how to increase the positive aspects of the condition.

5. The Evolutionary Mismatch Model as a Result of New Data

Authors such as Thom Hartmann have suggested that ADHD may be an evolutionary adaptive condition that helped early hunters succeed (Hartmann 1993 p. 23). Traits such as hyperactivity, impulsivity, risk tolerance, and novelty-seeking behavior are common symptoms diagnosed in ADHD. Hartmann argues that these traits may have been quite useful for hunters in humans' ancestral environments. However, the condition has long been seen as an inherently negative disorder that was hypothesized to be a result of brain trauma, parental smoking during pregnancy, or exposure to toxins from a young age. New research shows that many of the traits associated with ADHD are heritable and certain traits can be results of biological processes in response to environmental factors such as chronic stress. Recent data supports the idea that

ADHD traits may have been genetically passed down over generations because the traits may have been useful in the ancestral environment, increasing survival and reproductive success. Major changes in the environment and the types of traits that are prioritized in modern society make these once useful traits to be seen as problematic by modern institutions which caused the condition to be labeled as a disorder.

The term ‘ancestral environment’ describes the conditions of human ancestors who lived in the wilderness, and their nomadic lifestyles that relied on subsistence techniques such as hunting, foraging, and fishing. The ancestral environments can be characterized by higher instances of mortal danger, shorter life expectancies, and presence of fewer stimuli in comparison to the modern environment. The term ‘modern environment’ refers to characteristics of recent humans, especially in industrialized societies, such as largely sedentary lifestyles in which significant parts of the average individual’s day are spent inside. Modern environments are characterized by fewer instances of mortal danger, easier access to calories, longer life expectancies, and increased environmental stimuli.

ADHD traits can be seen as adaptive or maladaptive depending on the differences between environmental demands. Differences can include the types of behavior that can effectively reduce stressors, the causes of stress, variations of environmental stimuli, types of traits that are socially prioritized, and consequences of behaviors. Interventions focused on changing an individual’s current environment to better match specific characteristics of ancestral environments may relieve pressure from people with ADHD traits.

Certain aspects of ADHD such as emotional dysregulation, short-term decision-making, and impulsivity may be the results of a suppressed prefrontal cortex. I argue that these traits may be the result of an evolutionary adaptation that prioritizes short-term survival traits over

calorically expensive processes during reoccurring moments of high stress by a bodily process that suppresses the prefrontal cortex. The process may have been useful in the ancestral environment because stressors such as food insecurity or the presence of predators may have been effectively resolved by things such as impulsivity, fast decision-making, and emotional dysregulation.

Traits that supported short-term survival at the cost of long-term health may have been effective in minimizing the stressors of the ancestral environment; however, in modern environments these once adaptive traits may be problematic. This adaptation is problematic because the types of stressors faced in the modern environment tend to be less mortally dangerous and are more likely to be resolved with traits such as long-term planning, patience, emotional stability, and self-restraint. Emotional dysregulation, short-term-focused decision-making, and impulsivity may make modern stressors such as financial insecurity worse and increase stress. The stress caused may lead to a feedback loop in which the adaption process will continue to suppress the prefrontal cortex as a result of continued stress in hopes that the traits associated with ADHD would resolve the stressors. However, the process does more harm than good because the type of traits needed in modern-day society to resolve many stressors are primarily associated with a more active prefrontal cortex. Modification of an individual's environment to minimize stress and support in resolving the stressors seen in the modern environment may lead to a reduction of the traits mentioned by decreasing the body's stress response that suppresses the prefrontal cortex. Interventions that focus on developing the prefrontal cortex may also lead to the expression of traits that are better suited for resolving modern stressors.

5.1 Recent Discoveries

New developments in genetics, neurobiology, and psychology have paved the way for a better understanding of ADHD and how it really works. New discoveries allow for the development of evolutionarily informed treatment plans. Biological markers, or biomarkers, have been found to be effective at diagnosing the condition as well as predicting drug response in individuals with ADHD. Developments in neurobiology have also illuminated how ADHD may be affected by dopamine and how the condition works on a chemical level. Discoveries in neuroimaging have taught us more about the brain and how thinking works regarding attention both in neurotypical individuals and those with ADHD. Psychological studies have also noted that specific environmental factors have been associated with higher instances of ADHD symptoms. Recent discoveries may offer a glimpse into how the traits can be seen as adaptive in the ancestral environment, but maladaptive in the modern environment. For each section, I start with brief explanations of the research followed by how the research may be applied to the evolutionary mismatch theory. Because research in genetics provides the clearest support for the evolutionary mismatch theory, I start with an exploration of genetic variations. Environmental psychological data in combination with information about the prefrontal cortex may point to a possible adaptive process that may have aided in survival in ancestral environments during times of chronic stress; however, the process can lead to difficulties in the modern environment.

5.1.1 Biomarkers

Evolutionary theories rest on the premise that genes that are beneficial to survival get passed down to offspring. ADHD is one of the most heritable conditions in comparison to all psychiatric disorders, to the point that it is almost as heritable as physical traits such as height

(Turic et al., 2010, p. 75). Hence, the exploration of genetics and biomarkers is particularly interesting as the establishment of a connection between ADHD-like behavior and genetics can support the concept that ADHD may in part be a result of natural selection. Genetic variation of alleles on Dopamine Receptor D4 (DRD4) has been found to be a genetic link to ADHD. Specifically, the 7R allele variation of (DRD4) has been found to be "associated with low neuronal reactivity and increased exploratory behavior, novelty seeking, and risk-taking, collectively considered novelty-seeking trait (NS)" (Matthews & Butler, 2011, p. 382). A brief summary of how dopamine works is needed in order to see the link between dopamine receptors, and ADHD, in order to explain how this genetic variation may have aided humans in survival in the ancestral environment.

Dopamine is one of the most critical neurotransmitters in biology. It is responsible for the control of movement, cognition, emotional and motivational responses (Turic et al., 2010, p. 64). Too little dopamine may cause Parkinson's disease, and too much dopamine may cause Schizophrenia (Iversen & Iversen, 2007). The dopamine system is essentially the brain's reward process and is responsible for motivating behavior. When someone eats sugar or attains a goal they worked hard for, the brain releases dopamine and makes them feel good. The pleasure derived from dopamine motivates humans to seek pleasure and avoid pain to release more dopamine. Data has shown that ADHD-like behavior may be a result of dopamine dysregulation (Turic et al., 2010, p. 67). The 7R allele variation of the DRD4 gene has been found to downregulate dopamine receptor activity which in turn decreases dopamine sensitivity (Bonvicini et al., 2020, p. 16). Decreased dopamine sensitivity means that a person with this trait will not derive as much pleasure or be motivated to the extent as those who lack the 7R allele when exposed to the same stimulus. Combine this with the principle of habituation, in which

repeated exposure to the same stimulus over time tends to decrease the amount of dopamine released upon further exposure to the same stimulus (De Luca, 2014), and it is clear how the 7R variation is tied to ADHD traits, such as novelty seeking behavior.

The motivational drive to experience novel stimuli as a result of decreased dopamine sensitivity explains the aspects of ADHD such as distractibility, increased exploratory behavior, and novelty-seeking behavior. The second aspect of any evolutionary theory is that the traits that are passed down and remain in the gene pool should result in some benefit to the organism. The 7R variation of DRD4 would have been beneficial in the ancestral environment because it pushed individuals to explore new areas that may have offered more food and less competition. In fact, the presence of the 7R allele variation of DRD4 in humans has been found to be associated with farther migration distance out of Africa in comparison to humans without the variation (Matthews 2011 p.383). Investigations in genetic anthropology have found that the 7R allele is up to ten times younger than other variations of DRD4 and began to show up in the Neolithic Era (Bonvicini et al., 2020, p. 16). This data supports the hypothesis that the 7R variation may have been a mutation that became "a high-frequency allele by positive selection at a time of the major expansion of the human population… it may have conferred a reproductive advantage in male-competitive societies" (Bonvicini et al., 2020, p. 16). Essentially, 7R seems to be a genetic mutation that was beneficial for nomadic lifestyles because it motivated individuals to search for novel stimuli in unfamiliar lands.

Other aspects of ADHD that result from the 7R variation such as distractibility would have directly aided ancestors in their expeditions into unexplored areas. Hartmann suggests that what is currently seen as distractibility, should be classified as hypervigilance instead because the fewer stimuli present in the ancestral environment would be important to be aware of

(Hartmann, 1999, p. 25). When the rustling of leaves in a nearby bush can either be a delicious turkey or a hungry tiger, it is extremely important to shift attention to the stimulus. In circumstances where the presence of a minor stimulus could signal the possibility of a predator, hypervigilance would have helped early humans be aware of the possible danger and react accordingly.

Differences in the modern environment in comparison to the ancestral environment tend to make hypervigilance and novelty-seeking behavior disadvantageous. The inclination to seek novel stimuli is incompatible with success in many of the types of jobs and education formats seen in the modern environment. Modern institutions such as schools and office jobs tend to assign individuals with repetitive, mundane tasks that require sustained long-form attention. Novelty-seeking behavior might increase the likelihood that an individual would lose focus on a task, or even leave a job that they view as boring due to the habituation of tasks and decreased dopamine sensitivity. A person who consistently switches jobs to scratch that itch for novelty faces financial disadvantages because many modern institutions reward long-term stability. Those who job hop may miss out on pay raises that they would have received if they stayed in a company long enough. These individuals may not receive job offers from potential employers due to the fear of instability in the position.

To top it off, many workplaces and schools are in buildings that remain constant in appearance which makes any form of distracting stimuli particularly appealing. The modern environment has an unfathomable number of stimuli ranging from social media platforms to advertisements and forms of entertainment that are all expertly crafted to grab one’s attention. Unlike the ancestral environment, the number of attractive yet non-useful stimuli are abundant. In the ancestral environment, the overall number of stimuli was significantly less but the stimuli

that were there were much more important to be aware of for survival. Of course, individuals with the inclination to seek novel stimuli as a result of decreased dopamine sensitivity who are assigned boring tasks in stale environments are going to get distracted by chasing dopamine.

Hyperactivity is another dimension of ADHD that can be vital to success in the ancestral environment but is detrimental in large portions of the modern environment. The need for constant movement might be one of the most useful traits in nomadic life. Hyperactivity and feeling energized to move are evolutionarily adaptive in environments that require chasing down prey or avoiding stagnation in an environment where resources do not replenish as quickly as they are consumed. (Hartmann, 1999, p. 27). Modern institutions tend to keep individuals inside and stationary for the majority of the day. Limited movement and hyperactivity do not mix well, and schools tend to punish students who cannot sit still and stop talking.

The discovery of the 7R variation of DRD4 is critical for the evolutionary mismatch model and it can also be used as a form of objective diagnostic criteria. Individuals who have this gene may experience key traits of ADHD such as hypervigilance, hyperactivity, and novelty-seeking behaviors. This gene variant likely emerged in the Neolithic Era when humans are believed to have lived primarily nomadic hunter-gatherer lifestyles (Bonvicini et al., 2020). This provides further support for Hartmann's hypothesis that certain traits of ADHD may have aided in survival in the ancestral environment. The requirement for an evolutionary mismatch theory that requires a beneficial trait that is now maladaptive can be satisfied by the existence of the 7R variation on the DRD4. Differences in the types of environmental characteristics between the ancestral and modern environments may lead individuals who have the 7R variation of DRD4 to face challenges that were not present in the ancestral environment. The genetic connection that

the 7R variation provides in explaining ADHD can also be used in testing for ADHD to provide a form of objective criteria for diagnosis.

5.1.2 Differences in Brain Structure and Environmental Factors

Certain aspects of ADHD such as emotional dysregulation, short-term-focused decision-making, and impulsivity may be the results of a survival process that suppresses the prefrontal cortex in times of chronic stress. I argue that these traits may be the result of an evolutionary adaptation that prioritizes traits that led to immediate survival in the ancestral environment over calorically expensive mental processes by a bodily process that suppresses the prefrontal cortex in the presence of chronic stress. The process may have been useful in the ancestral environment because stressors such as food insecurity or the presence of predators may have been effectively confronted by actions driven by traits such as impulsivity, risk tolerance, fast decision-making, and emotional dysregulation. However, issues with how the body interprets stress, differences in the types of stressors, and the traits needed for successful stress resolution in the modern environment make this once-adaptive process disadvantageous. Background information regarding the prefrontal cortex, environmental stress, and how these two factors relate to ADHD symptoms is necessary to illuminate how a faulty biological adaptation may account for certain traits of ADHD.

One of the most notable discoveries regarding ADHD is the discovery of differences in grey matter within the prefrontal cortex between neurotypicals and people with ADHD. This finding is so important because differences in grey matter quantity in the prefrontal cortex may be the consequence of an adaptive process that has gone haywire as a result of major differences between the ancestral environment and the modern environment. The prefrontal cortex is

responsible for regulating thoughts, actions, and emotions (Arnsten, 2009) and is essential for high-order thinking. The prefrontal cortex uses complex neuronal networks throughout the rest of the brain to "maintain information in the absence of environmental stimulation" (Arnsten, 2009, p. 410). It allows for complex mental processes such as working memory, complex decision-making, and planning for the future. Essentially, the prefrontal cortex has connections to many different parts of the brain and uses information from them in tandem to allow humans to think, regulate emotions, and plan without needing the information it is thinking about to be present in the environment. Research has found that people with ADHD have decreased amounts of grey matter in the prefrontal cortex in comparison to their neurotypical counterparts (Bralten et al., 2016).

A significant aspect of the hypothesis regarding how certain ADHD symptoms might be explained by an evolutionary process is how the body reacts to stress and how certain aspects of the environment cause stress. When there is a presence of danger or even perceived danger, whether it is from hearing the screams of a mountain lion, or fleeing from a bear, the sympathetic nervous system kicks in. The sympathetic nervous system is the body's fight-or-flight response. It suppresses the nonessential processes for survival and stimulates many of the body's organs to increase effectiveness for intense physical demand (Alshak & Das, 2023). The sympathetic nervous system releases a bunch of stress hormones and for a short time, stress hormones help the body escape or fight off the danger. The sympathetic nervous system does things such as increase heart rate to increase oxygen delivery to muscles, activate energy stores in the liver, and slow down the digestive system to conserve energy. The sympathetic nervous system also increases alertness and widens the pupils to improve vision (Alshak & Das, 2023). Problems arise when stressors keep this system firing constantly. Over time, if one is in a constant state of

stress, then the body will eventually suppress processes nonessential for immediate survival (Alshak & Das, 2023). The suppression of bodily functions sacrifices long-term health in favor of short-term survival.

The evolutionary process of the sympathetic nervous system has evolved primarily in the ancestral environment over thousands of years which has made the sympathetic nervous system effective in responding to the particular stressors faced in the ancestral environment. However, due to the drastic changes in the environment over such a relatively short period of time, the sympathetic nervous system has not had enough time to adapt to the demands of the modern environment. A major flaw regarding the body's stress response is that the body cannot distinguish between causes of stress. Whether it is stress from threats of predators or anxiety about giving an important speech, the body perceives and responds to stress the same way (Harvard School of Public Health, 2020). Combined with the fact that most stressors of the modern environment tend to not be nearly as physically demanding or life-threatening; the sympathetic nervous system's processes may end up being less than suitable for success in modern contexts.

Certain symptoms of ADHD may be a result of chronic stress and the sympathetic nervous system's response to stress by suppressing the prefrontal cortex. The prefrontal cortex is one of the most evolutionary complex parts of the brain, but it is also the most sensitive to stress. Arnsten notes that even a mild amount of stress can cause significant loss in cognitive abilities and prolonged stress can cause architectural changes in this region (Arnsten, 2009, p. 411). Research has shown factors such as low socioeconomic status, abusive households, and other stressors have been linked to impaired development in the prefrontal cortex and behaviors similar to ADHD (Swanepoel et al., 2017, p. 413). These findings are consistent with data that

shows there is less grey matter in the prefrontal cortex in people with ADHD (Bralten et al., 2016). Increased occurrences of ADHD symptoms of inattentiveness, hyperactivity, risk-taking, and emotional dysregulation have been found to be associated with dangerous environments, high instances of stress, and little emotional security. Specifically, factors such as low socioeconomic status, having an insecure attachment style to parental figures, having an abusive family, and a stressful or traumatic childhood, have all been linked to ADHD-like symptoms (Swanepoel et al., 2017, p. 413). Factors that lead to increased stress, especially during childhood when the brain is developing, are dangerous for the development of the prefrontal cortex (Arnsten, 2009). In the modern environment, abilities such as emotional regulation, long-term planning, and the ability to sustain attention over long periods of time are highly valued and impairment of the prefrontal cortex can be devastating to successful functioning in modern life. On the surface, impairment to the prefrontal cortex as a result of stress that leads to symptoms of ADHD may seem like an unintended consequence of complex biological processes. I argue that the impairment of the prefrontal cortex in times of chronic stress and the resulting ADHD traits were adaptive in the ancestral environment.

To see how this process may have been adaptive it is important to evaluate the cost-benefit analysis of the prefrontal cortex in the face of chronic stressors faced in the ancestral environment such as food insecurity and the presence of predators. It is believed that the prefrontal cortex is a relatively recent development in human evolution. Anthropologists have argued that the rapid development of the prefrontal cortex was a result of increased caloric intake and absorption from cooked food and other food sources (James et al., 2019). The prefrontal cortex is mainly responsible for high-order thinking, and this costs a lot of energy. For example, it is estimated that an elite chess player can burn 6000 calories a day due to intense cognitive

load (Gilani, 2019). Even when the brain is not being used for intense cognitive processes, it is estimated that the average brain consumes between 20-25% of all the energy in the human body (Gilani, 2019). Calorically speaking, the brain is a very expensive investment. From an evolutionary perspective, it makes little sense to invest in the brain much more than what is necessary for survival in times of caloric insecurity. Things that the prefrontal cortex is responsible for such as emotional responses, sustained focus, long-term planning, and drawn-out risk calculation may not be the most essential for immediate survival in the presence of immediate threats to one's life. However, the traits that are associated with ADHD that are the result of an impaired prefrontal cortex may be useful in dealing with food insecurity and immediate danger.

Traits resulting from impaired prefrontal cortex such as emotional instability, less emphasis on long-term planning, risk tolerance, and distractibility would have been useful in the ancestral environment. Risk tolerance seems to be much more useful in the short term where every action poses mortal risk. Comfort in dangerous environments as a result of poor risk calculation abilities could allow for immediate action by not being overwhelmed by the potential outcomes of every action(Hartmann, 1999, p. 28). Planning for the future years is not as necessary when starvation or predators are a constant threat. Emotions might get in the way, grieving over a lost sibling or tribe member might prevent a hunter from taking a shot when they need it most. Perhaps emotional dysregulation that allows mental states to switch from sad to focused to happy based on environmental stimuli might be better for staying alive and keeping the individual in the 'here and now'. Distractibility, or as Hartmann puts it, hypervigilance of all environmental stimuli could mean spotting a predator before it gets to attack (Hartmann, 1999, p. 26). Some traits of ADHD may have led to the successful resolution of immediate stressors in the

ancestral environment. Suppression of the prefrontal cortex in the face of chronic stress could have been an effective survival strategy; however, this process may lead to problems in the modern environment.

The evolutionary adaptive process that causes behaviors that lead to short-term success as a result of stress is maladaptive in the modern environment due to the differences in types of stress and how they are resolved. ADHD behaviors may impair the ability to resolve the stressors experienced in the modern environment and cause even more stress. The evolutionary functions underlying ADHD end up causing a cycle of stress that further increases symptoms because the types of traits needed to resolve many modern stressors are associated with strong prefrontal cortex functioning. Failure to resolve the stressors in turn adds more stress which suppresses the prefrontal cortex even further.

Differences in the types of stress due to environmental variations require different types of traits that lead to the successful resolution of environmental stressors. In the modern environment, the likelihood of being eaten by a predator is low, food is significantly easier to access than having to hunt and forage for the next meal. Things such as modern medicine, increased access to food, and decreases in mortal dangers have led to significant increases in life expectancies for humans in the modern environment. The fact that life expectancy in hunter-gatherers is around mid to late-twenties while in most modern countries it is closer to around eighty (Burger et al., 2012) indicates how far less dangerous the modern environment is in comparison to the ancestral environment. As a result of a much higher life expectancy, long-term planning, and risk aversion are much more necessary for long-term survival in the modern environment. The causes of stress vary too; as opposed to having to hunt for food and physically protect oneself, modern humans need to acquire money to be able to pay for food, housing, and

security. An emphasis on financial security in order to resolve physical needs exposes individuals to new types of stress. The need to acquire currency requires individuals to enter the workforce and interact with modern institutions.

Modern institutions prioritize traits like the ability to sustain attention over lengthy periods of time, risk aversion, emotional stability, and long-term planning. Modern society largely promotes concepts such as stability, saving for retirement, and sacrificing short-term pleasures for long-term gain. Schools favor the ability to maintain sustained focus, and most jobs and schools focus on sedentary, complex thinking which makes the prefrontal cortex vital for success. As mentioned before, many of the modern institutional characteristics are not compatible with the traits seen in ADHD. This mismatch can lead to issues with financial stability and increase stress. For example, novelty seeking, and impulsivity may lead to unnecessary purchases that may affect one's financial stability. An individual with ADHD who may not do well in their job may lose their job or constantly job hop, which further reduces financial stability leading to stress. Access to vices such as drugs and gambling satisfy dopamine cravings and provide the sense of risk that many crave. Both these things may cause further financial instability and stress. Chronic stress that leads to suppression of the prefrontal cortex would make it harder to adhere to the types of traits that tend to relieve financial stress.

The evolutionary mismatch model, in sum, suggests that traits that supported short-term survival at the cost of long-term health may have been effective in minimizing the stressors of the ancestral environment, while in modern environments these traits are often problematic. This adaptation is problematic because the types of stressors seen currently tend to be less mortally dangerous and are more likely to be resolved with traits such as long-term planning, patience, emotional stability, and self-restraint. Emotional dysregulation, short-term-focused decision-

making, and impulsivity may make modern stressors such as financial insecurity worse and increase stress. The stress caused may lead to a feedback loop in which the adaption process will continue to suppress the prefrontal cortex as a result of continued stress in hopes that the traits associated with ADHD would resolve the stressors. Because the type of traits needed in modern-day society to resolve many stressors are primarily associated with an active prefrontal cortex, the process does more harm than good. Modification of an individual's environment to minimize stress and support in resolving the stressors seen in the modern environment may lead to a reduction of the traits mentioned by decreasing the body's stress response that suppresses the prefrontal cortex. Interventions that focus on developing the prefrontal cortex may also lead to the expression of traits that are better suited for resolving modern stressors.

6. Alternative Interventions

By viewing ADHD through the evolutionary mismatch model, new pathways for treatment can be explored. The evolutionary mismatch model provides benefits that are not possible under the biomedical model. Interventions that can mimic key aspects of the ancestral environment may ease the burden of the evolutionary mismatch, leading to a minimization of dysfunction. Environmental interventions are less invasive, more affordable, effective, and safer than the primary form of treatment in the biomedical model. Due to the discovery that ADHD symptoms may appear because of dopamine dysregulation, interventions that primarily focus on increasing dopamine naturally can be used. Issues that lead to disruption in the development of the prefrontal cortex can be mitigated either by taking steps to remove known stressors or by strengthening neural pathways. Dietary supplementation can also be used to resolve issues regarding both dopamine dysregulation and strengthen neural pathways. Ideal interventions

should not only aim to both increase dopamine and strengthen neural pathways but also should be able to be implemented easily into daily life and allow individuals to use interventions on their own.

6.1 Dietary Supplementation

Interest in dietary intervention has been growing and recent developments have found it to be as effective as stimulant medication in treating symptoms of ADHD. Dietary supplementation can be useful because it decreases barriers to traditional treatment plans, decreases the demand for medication, and can be personalized. Certain dietary supplements can increase dopamine as well as strengthen neurons. Traditional treatment for ADHD with medication can be extremely costly, especially without insurance. Constant doctor visits, prescription refills, and behavioral interventions are both expensive and time-consuming which can prevent struggling families from being able to effectively treat their children. Dietary supplementation can be significantly cheaper and personalized based on what is effective for the individual. Dietary supplementation also has the added benefit that allows modern environmental conditions to better match conditions in the ancestral environment.

Vitamin D is one of the most critical vitamins for healthy functioning and it has been noted that children with ADHD tend to have decreased levels in comparison to those without ADHD (Meyer & Goodall, 2020, p. 23). Vitamin D supplementation has been found to effectively reduce negative symptoms and may lead to improved cognitive function (Meyer & Goodall, 2020, p. 24). Vitamin D has been found to increase dopamine, protect from cognitive decline, and it is vital to the development of neurons (Anjum et al., 2018). Vitamin D's effects on dopamine and neuronal development seem to be the underlying reasons why supplementation

can be effective in treating ADHD. Vitamin D is particularly interesting because it can be produced in the body from sun exposure or from dietary sources, which makes Vitamin D one of the cheapest treatment interventions. Interventions focused on increasing sun exposure are one of the easiest things to implement, and they do not require any sort of training. Interventions focused on increasing Vitamin D synthesis can be as simple as increasing time spent outside, for instance by increasing recess for school-aged children or other outdoor activities. Adults can implement exposure to the sun by eating their lunch outside during work, tanning, or exercising outside.

A vitamin D deficiency would have been rare in the ancestral environment because most people would have spent a large part of their lives outside. However, the major difference in the modern environment is that people spend the majority of their day-to-day lives inside and away from the sun. Aiming to increase vitamin D either through exposure to the sun or through dietary supplementation allows modern humans to be able to create an environment inside their bodies that mimics the amount of vitamin D that ancestral humans received from the sun. These interventions address the environmental mismatch without having to sacrifice major lifestyle changes and luxuries of modern life.

Omega-3 and Omega-6 fatty acids are another group of compounds that are being investigated for their role in ADHD. Though research is growing, some studies have shown that certain people with ADHD may show a significant reduction in ADHD symptoms with Omega 3/6 supplementation (Johnson et al., 2009, p. 394). The reduction of symptoms may be explained by the role of fats in relation to neurobiological function. Lipids are essential for neuronal development and can increase the rate at which neurons fire. Lipids also have been found to have anti-inflammatory properties that protect the brain (Chianese et al., 2018). Overall, the

supplementation of Omega-3/6 fatty acids is useful in aiding brain development as well as protecting from cognitive decline which can aid in developing neuropathways in the brain. With further research, Omega-3/6 supplementation may prove to be another effective and cheap option for managing ADHD symptoms.

Although the modern environment has a general increase in access to calories, a large proportion of the calories come in the form of processed foods that lack essential vitamins and nutrients that are present in natural foods (Fardet, 2018). Obviously, ancestral humans did not have access to processed foods and the foods they did eat were filled with nutrients such as omega-3 and omega-6 fatty acids (Fardet, 2018). Luckily, the environmental mismatch in the general quality of foods can be easily managed. Deficiencies in nutrients obtained from the quality of food can be addressed by both supplementation and increased dietary intake of whole foods.

Research into dietary interventions to treat mental disorders is a growing area of interest which may lead to effective treatment alternatives for ADHD as well. The evolutionary mismatch perspective has allowed a new route for treatment to be opened. By looking at the differences in environmental characteristics, the differences in the overall quality of food and sun exposure between ancestral humans and modern humans stand out. Changes in diet due to the increased availability of processed food in the modern environment have increased the risk of developing nutrient deficiencies in modern humans (Fardet, 2018). As a result of nutrient deficiency, chronic diseases are becoming more apparent and growing research is showing that adapting diet to increase nutrients may help avoid issues. In contrast to modern humans, ancestral humans had significantly lower rates of chronic illness (Gardner et al., 2020). Further research into dietary supplementation in treating ADHD may lead to alternative options that

allow for affordable and effective combinations to be made that allow for personalized treatment options with less risk compared to stimulant medication.

6.2 Exercise

On the evolutionary mismatch model, exercise is by far the best intervention for ADHD for a multitude of reasons. Exercise can take many forms, which means that it is easy to implement into daily life, accessible, and can be personalized. Exercise can stimulate brain development, protect against stress, release dopamine, and specific protocols can be tailored to target specific areas in the brain for those with ADHD. Along with all these benefits, exercise has practically no negative side effects, can be done anywhere, and is extremely easy to implement in institutions such as schools. Exercise also allows modern humans to reap the benefits of movement without having to risk their health that ancestral humans faced.

The cerebellum is a part of the brain that is responsible for balance and control of motor skills. Exercise increases the number of neurons in this area which improves motor skills and balance (Hallowell & Ratey, 2022, p. 38). An interesting discovery that has been a game changer is that the cerebellum is also involved in regulating emotion, sustaining focus, and other cognitive processes (Hallowell & Ratey, 2022, p. 38). The expansion in understanding of the role the cerebellum plays in human cognition has led to substantial findings in treatment for ADHD. Interventions focused on balance training have shown significant decreases in ADHD symptoms (Hallowell & Ratey, 2022, p. 45). This finding is revolutionary for both treatment and it further supports the Evolutionary Mismatch Model.

Modern society is extremely sedentary. Schools remove recess after elementary grade levels, most office jobs are sedentary, commuting to work is usually done through cars or public

transportation, and even the most common forms of entertainment usually involve sitting and consuming media. The modern environment also tends to have people stuck inside for large parts of the day when the sun is out and that can lead to Vitamin D deficiency. It is inevitable that issues would arise from leaving an environment and lifestyle in which the human body has evolved over thousands of years to suddenly sitting inside all day. Exercise is as close as we can get to the benefits of hunting and nomadic lifestyles in modern society without the dangers of being eaten. Hyperactivity may have been a trait that aided in the nomadic lifestyle, but in the context of sedentary life, it can be quite problematic. All that energy needs to go somewhere, and if it is not channeled correctly it might lead to children acting out. Luckily, exercise creates an environment where the boundless energy of hyperactive people can be harnessed in a productive manner. Furthermore, exercise is usually done outside, which increases exposure to sunlight and as a result, leads to increased Vitamin D. Exercise in the form of team sports can provide opportunities for social interaction similar to the social opportunities present in group hunting(Hartmann, 1999, p. 24). From an evolutionary perspective, exercise is essential to mimic the ancient environment.

Institutional interventions focused on exercise do not have to be complex. Interventions in schools focused specifically on people with ADHD can take the form of balance training. Schools can try to implement more opportunities for recess throughout all grade levels, mandatory gym classes, or even emphasize student participation in sports. Employers can have recreational leagues for employees or gyms in office buildings. Not every institution has the ability to provide opportunities for exercise, and this fact must encourage the individual to implement their own exercise regimen.

From the evolutionary mismatch perspective, exercise is the best intervention. Exercise can help resolve issues related to the major decrease in movement in modern life without having youth chase down big game. Exercise may also increase overall exposure to sunlight and allow for social bonds to be formed similar to those seen in hunting bands. Exercise as a form of treatment simply would not have been considered under the biomedical model of disease. Yet, the evolutionary mismatch model shifts the perspective on why the issues with ADHD occur and allows researchers to address the environmental differences that may be the cause of the issues.

7. How the Evolutionary Mismatch Model Addresses Issues Caused by Biomedical Model

The evolutionary mismatch model changes the perspective of how ADHD is viewed and allows for many of the issues of the biomedical model to be addressed. Changes in perspective allow for a shift in how treatment is approached because the evolutionary mismatch model questions what aspects of the environment may play a role in dysfunction. For example, increasing vitamin D exposure and implementing exercise in order to resolve ADHD symptoms would not have been less likely to be the focus of the biomedical model.

Awareness of how ADHD works and the reasons for it can resolve issues such as over-reliance on medications, negative self-perception in those with ADHD, and negative perceptions from others regarding the condition. It can facilitate better interventions, and increased feelings of agency. Things such as targeted mental health education programs can help aid in removing the stigma and push for stronger societal support for those with ADHD to help ease the burden of symptoms and the problems associated with the current model.

7.1 Relieves Over-Reliance on Medication

The evolutionary mismatch perspective can help resolve many of the issues with over-reliance on medication that the biomedical model may not be able to address as effectively. Genetic biomarkers that link ADHD can be used as criteria for objective diagnosis in order to minimize rates of misdiagnosis. A focus on environmental manipulation as a first step for treatment may bypass the need for medication entirely as well as decrease misdiagnosis rates. As a result, shortages in medication may be decreased and fewer individuals may face the adverse effects of the medication.

Recall that MPH works in mitigating symptoms of ADHD by blocking dopamine transporters from removing dopamine which increases the presence of dopamine. However, this increased presence of dopamine is not necessarily effective if the receptors for dopamine are suppressed by the 7R allele. Offering a horse its favorite food is not going to motivate the horse to move if it is full, and the same concept applies to the brain. As a result, MPH ineffectiveness can be reliably predicted by the presence of the 7R allele (Bonvicini et al., 2020, p. 16). On the other hand, for those individuals with the 4R allele who display ADHD symptoms, downregulation in DRD4 is not present and MPH can effectively minimize the symptoms of ADHD (Bonvicini et al., 2020, p. 16). The discovery that DRD4 variations can be used to predict ADHD susceptibility and drug effectiveness for MPH opens the door for more objective criteria to be used in diagnosis and treatment. The establishment of objective biomarkers that can determine if the individual is more susceptible to ADHD can minimize the rate of misdiagnosis that is caused by faulty self-report tools, subjective behavioral-based diagnostic criteria, and lack of training in PCPs regarding ADHD. The establishment of biomarkers that can predict MPH response also allows doctors to determine the likelihood that the drug would be effective prior to

prescribing it. The use of these biomarkers can further prevent unnecessary prescriptions being written which in turn has multiple benefits such as alleviating the demand for MPH, and it may prevent individuals from facing unnecessary health issues from the drug.

Issues with over-reliance on medication can further be mitigated if doctors make a conscious effort to consider how characteristics of the individual's environment may lead to increased symptoms of ADHD. Accounting for the environment-individual relationship allows for steps that can be taken prior to medication. If alternative interventions are successful, then medication may not be necessary. Therefore, reliance on medication may be reduced because the effective resolution of symptoms via non-pharmacological interventions may be explored.

With a focus on the evolutionary mismatch model, environmental manipulation would be the first route for treatment which would ease reliance on PCPs for diagnosis and treatment. Environmental manipulation and intervention strategies are primarily the focus of psychologists, not PCPs. PCPs face less pressure from patients and parents for an immediate fix because PCPs would refer the patient to a psychologist. Referrals allow for a second opinion for a proper diagnosis, a less invasive treatment plan, and it makes it much more difficult for those individuals who are seeking the medication for ulterior purposes to receive a prescription. I am not saying that objective criteria and non-pharmacological intervention strategies are the only things medical professionals should do; instead, these developments should be the first treatment routes taken. If those attempts are not effective, medication should be used as another treatment option, not the first option. Research has shown that the aforementioned interventions are effective; however, research is limited and needs to be expanded upon to further determine the accuracy of the current findings.

7.2 Negative Self-Perception and Perception from Others

Modification of the perspective in which ADHD is seen as a result of evolutionary mechanisms can help minimize the issues regarding self-perception and perceptions held by others. Public health campaigns to re-address how ADHD is viewed by the public can help change what people with limited knowledge about ADHD think. As mentioned previously, people with limited knowledge about the condition tend to view ADHD negatively largely because the label of disease implies that ADHD is inherently negative or at least abnormal. Surveys have noted that attributing ADHD symptoms to biological causes leads to a reduction in negative attitudes from others (Bisset et al., 2022, p. 544). It is also noted that the symptoms alone do not contribute to the desire to maintain social distance. The attribution of symptoms to be the effects of ADHD was the reason some people expressed their desire to maintain social distance (Bisset et al., 2022, p. 544). These findings show how important labels are to how ADHD is perceived, and it further supports the idea that if ADHD was to be viewed as an evolutionary mismatch it may resolve negative attitudes from other people.

As a result of decreasing the stigma of ADHD, people with ADHD may experience less discrimination from others. Decreased instances of discriminatory behavior may positively impact one's self-perception. Also, educating people that ADHD is not a disease, but an adaptive strategy that happens to not be compatible with certain environments may prevent negative self-perception. Awareness that stress may increase negative symptoms of ADHD can allow individuals and institutions to directly address the causes of stress to promote healthy functioning. For example, a college football player named Alex may report to his coach that he has always had issues concentrating in class throughout the day which has led to poor academic performance. The coach approaches the issue from an evolutionary mismatch perspective and

adds an extra workout in between Alex's classes in the middle of the day. Alex begins to see improvements in his academic performance as a result of the known benefits of exercise in aiding ADHD symptoms. In turn, this adjustment increases Alex's perception of himself because he sees himself as a good student (Swanepoel et al., 2017). The idea of implementation of exercise to treat ADHD symptoms might not have even been considered under the biomedical model. Alex would have just been forced to accept that he was a bad student. The stress caused by poor academic functioning throughout Alex's life may have triggered the body's chronic stress response leading to suppression of the prefrontal cortex. As a result, Alex's academic performance would have further declined and would have fed into the stress he experienced. Under the biomedical model, Alex's only treatment option would have been medication which would not have resolved the root cause of the problem.

The evolutionary mismatch model provides an opportunity to change how people with and without ADHD understand the condition. As a result of changing the label, people with limited knowledge about ADHD may not hold the same negative perceptions about ADHD as they do under the current biomedical view. This may lead to decreases in discriminatory behavior which in turn can affect the self-perception of people with ADHD. Decreases in discriminatory behavior provide an equal ground where people treat each other based on their behaviors and not labels. Thus, the evolutionary mismatch perspective may resolve the ontological issues faced in the current perspective with how one views oneself through observing how others treat them. Labeling ADHD as an evolutionary mismatch also allows improved treatment options that take the form of environmental manipulation. Improved treatment options lead to better functioning which can ultimately lead to improvements in self-perception.

7.3 Environment and Agency

The evolutionary mismatch model restores agency in people with ADHD by encouraging changes in the environment that are not possible under the biomedical model. An individual's agency is inherently limited due to the limiting nature of the biomedical model's focus on the individual. The biomedical model of disease zooms in entirely on the individual as being the problem and minimizes the role of the environment to an afterthought at best. The evolutionary mismatch model zooms out and allows for the individual with ADHD to recognize there are aspects of their environment that can be adjusted to better suit their condition. Awareness of how the environment can increase or decrease one's negative symptoms allows a person to manipulate their environment to resolve the underlying causes of dysfunction. The focus on individual change in the evolutionary mismatch model reintroduces the sense of agency that is inherently stripped away from the person by the disease model.

Research has shown interventions focused on the modification of the environment such as more physical exercise, exposure to vitamin D, dietary supplementation, and parental and school-focused interventions have been effective in reducing the negative aspects of ADHD (Meyer & Goodall, 2020). Children may develop a stronger sense of agency if they are taught that not every environment is best suited for their strengths and that they are responsible for modifying their environment to better support their needs.

Environmental factors that cause stress can be targeted to minimize the impact on prefrontal cortex development. Educating individuals about the effects that environmental stressors have on ADHD symptoms allows the individuals themselves to be able to target specific aspects of their environment that cause stress. Placing the power on the person to reduce

environmental stressors establishes agency in that individual because they are able to take actions to mitigate stressors and resolve issues by themselves.

Education in regard to career options and how certain aspects of ADHD can be beneficial in specific careers may lead to a developed sense of agency. Education on ADHD and careers better suited for people with ADHD allows people to make educated decisions for themselves. By contrast, the biomedical model removes agency in people with ADHD. The biomedical model leads to the false assumption that ADHD is inherently negative and that people with ADHD would struggle in any career. They are expected to 'suck it up' and force themselves into careers that they may despise. When an individual with ADHD ends up performing poorly in an unsuitable environment, they may attribute the reasons for their performance to themselves. This attribution may lead to negative feelings towards oneself that could be avoided by changing the environment to a job that better suits the individual.

The evolutionary mismatch model resolves issues regarding minimized agency that are caused by the biomedical model. Education in careers, and environmental interventions such as resolving known causes of stress and changing one's lifestyle to better match the ancestral environment are only a few of the possibilities for increasing agency under the evolutionary mismatch model. Agency can be strengthened by revising the narrative that ADHD is inherently negative to the idea that ADHD can be beneficial in some contexts and detrimental in other contexts.

7.4 Allows for Further Research

The evolutionary mismatch perspective broadens the scope of research in regard to ADHD. Research into things such as what environments and environmental factors support

flourishing in those with ADHD, development of non-pharmaceutical interventions, and exploration of the strengths of ADHD would be possible. The current application of the biomedical model of disease to ADHD limits the research scope due to the limiting nature of its focus. The biomedical perspective places the emphasis entirely on the individual and the negative aspects of the condition. Many researchers who subscribe to the biomedical model may not even think to explore other avenues of research in ADHD. The evolutionary mismatch model can shift the perspective researchers have to account for the environment and it allows for researchers to further investigate what aspects of ADHD may be beneficial. Researchers who previously subscribed to the biomedical model may change the scope of the type of research they conduct. The ideas of researching the evolutionary environmental factors of ADHD or the beneficial aspects of the condition are simply not thought of in the biomedical model because of the condition's label as a disorder.

Broadening the questions asked as a result of considering the evolutionary mismatch model may attract more researchers. More researchers in a field conducting researchers means more research proposals and ideas. Increased research interest can attract more funding. Increased funding leads to better quality research that can lead to stronger findings. As a result, those findings can further support the findings of the emerging research that has faced limitations in both funding and participant size. Further research may also go the other way and disprove the findings of recent discoveries and the evolutionary mismatch model. Regardless, an initial shift to the evolutionary mismatch perspective raises more questions that broaden the research scope. This shift in perspectives can lead to the addition of overall knowledge that would not be found using the current research perspective of the biomedical model of disease.

8. Conclusion

Labels and categories significantly impact how we perceive the world. The way in which ADHD has been historically perceived as a disorder over the past few decades seems to be incompatible with new research that points to the condition as being an evolutionary adaptive strategy. The biomedical model of disease as it is currently applied to ADHD has caused many issues to arise, ranging from an over-reliance on medication, removal of agency, negative self-perception, and perception by others. The evolutionary mismatch theory applied to ADHD aims to resolve many of those issues by shifting the perception of the condition to be seen as a condition that is maladaptive in the modern environment, but it may have been adaptive in the ancestral environment. Understanding how environmental differences and societal expectations for healthy functioning from an evolutionary perspective can help inform interventions that resolve many issues seen in the application of the biomedical model of disease to ADHD.

New research in genetics and the relationship between stress and brain development have provided further supporting evidence for the evolutionary mismatch theory that Thom Hartmann has offered. The 7R variation of DRD4 provides both the genetic link necessary for an evolutionary theory and an explanation of how it may have been beneficial in survival in the ancestral environment. The 7R variation of the DRD4 has been found to account for many of the traits associated with ADHD such as risk-taking and novelty-seeking behavior. In the ancestral environment, these traits may have pushed our ancestors to explore new areas with more food and less competition (Matthews & Butler, 2011). This gene is so strongly linked to ADHD that it is recommended for use in both diagnosis and predicting MPH response to treat symptoms of ADHD (Bonvicini et al., 2020). Novel research that links decreased grey matter in the prefrontal cortex with ADHD, information regarding chronic stress and its inhibitory effects on the

prefrontal cortex can provide a glimpse into the possible underlying mechanisms that lead to the development of ADHD. The fact that the body responds to all of the causes of stress in the same way (Harvard School of Public Health, 2020) can explain how modern stressors such as poverty, abuse, and institutional deprivation are linked to the increased occurrences of symptoms of ADHD (Swanepoel et al., 2017). In the ancestral environment, chronic exposure to the causes of stress such as food insecurity and danger from predators may have been resolved with traits associated with ADHD such as hypervigilance and short-term focused decision-making. However, the types of traits necessary to effectively resolve many of the causes of chronic stress in the modern environment vary drastically from the traits needed in the ancestral environment. The stress response remains the same, suppression of the prefrontal cortex to save calories and promote traits necessary for short-term survival. Environmental differences make this response problematic in the modern environment, which has led to the misclassification of this condition as a mental disorder.

A shift in understanding ADHD as an evolutionary mismatch allows institutions to take better steps to lighten the burden that many people with ADHD carry. Institutions such as the healthcare sector, government, schools, and workplaces all have the ability to make changes in their own ways that can help up to 10% of the population diagnosed with ADHD to succeed. Interventions focused on resolving the underlying causes of ADHD symptoms such as dopamine dysregulation, and environmental stressors that impact brain development can help minimize the negative aspects of the condition to support flourishing in the modern environment. Steps such as increasing the time spent outside, higher quality food options, and increased prioritization on exercise and sports in schools can help students with ADHD improve in the modern environment. Increased funding and access to psychologists in schools can help increase the

availability of behavioral interventions and proper diagnosis for children, especially those from lower socioeconomic backgrounds who otherwise may not be able to receive proper support. An emphasis on mitigating stress such as financial or abusive home environments by government agencies may also help ease stress and the effects of stress on the prefrontal cortex. The healthcare sector can implement procedures that can minimize the over-reliance on medication such as the use of genetic testing to aid in diagnosis, and primary care physician referrals to psychologists for ADHD initial treatment. Workplaces can take steps such as offering gym memberships, creating recreational sports leagues, and finding ways to increase the time spent in sunlight.

Revisiting the stories of both Michael Jordan and Chris through the lens of the evolutionary mismatch model may provide some insight into how ADHD may have impacted them and how this perspective may have led to improvements in their lives. Perhaps if Chris had been given better resources to learn about his condition and how to treat it, he may have learned how to manage his condition to avoid the negative outcomes that he experienced. Early diagnosis by a school psychologist may have allowed him to learn how to play to his strengths. Exposure to interventions such as exercise may have provided Chris with a productive outlet to channel his hyperactivity. Government aid may have reduced the financial pressures for him to commit crimes to survive, which would have eased the stress that played a role in worsening his symptoms. Exposure to sports early on in Michael Jordan's life may have been a significant factor in his success in healthy functioning with ADHD. Yet the case can be made that access to more resources and education may have helped Jordan build better habits that could have helped him avoid many of his vices such as gambling. Understanding that increased risk tolerance and

decreased dopamine sensitivity in ADHD make things like gambling and drugs quite attractive may have prevented both Chris and Michal Jordan from trying these things.

Changing how ADHD is viewed in society from a disorder to an evolutionary mismatch may resolve many issues that arise as a result of the biomedical model of disease that could not be resolved otherwise. A shift to the evolutionary mismatch model may open the door for drastic changes that may aid in reducing the challenges that people with ADHD may experience. Results of the change in perspectives such as increased research scope, improved interventions, individualized treatment options, and education on the aspects of ADHD, can all lead to improved functioning in the modern environment.

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