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How Cocaine Addiction Affects Decision-Making Processes in the Brain?

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Abstract

Drug addiction is a chronic medical disorder that known as Cocaine Use Disorder (CUD). The purpose of writing this annotated bibliography is to critically examine the potential psychological, social, and physical harms associated with drug addiction, a growing public health concern that has become increasingly prevalent in contemporary society. The younger demographic is frequently linked to cocaine addiction. However, the aging population has made it an increasing issue. Impulsive decision-making that may have negative long-term effects is a hallmark of addiction. Andrea et al., suggested that the mechanism by which controlled, voluntary drug use develops into compulsive drug use is the change from flexible prefrontal cortical control to automatic reaction driven by the striatum circuitry. (p.32). The chemically structured drug cocaine also has an impact on several areas of the brain. This literature review investigates the effects of cocaine on the brain's decision-making process.

Keywords: Cocaine, Addiction Affects, Brain.

Introduction

Yu et al., suggested that both addiction and making decisions under uncertainty have been linked to the anterior insular cortex (AIC) and connecting brain areas. (p.1). Using fMRI, Ju-Chi Yu et al. (2020) assessed the selection uncertainty in a motor decision task. 25 healthy controls and 61 cocaine users with cocaine use disorder participated in this study. An individual's assessment of decision uncertainty, or the likelihood that a choice will result in any outcome other than the chosen outcome, is the fundamental computational component modeled in the study. For the best decision-making process, this computation is essential. The relevance and significance of insular activity may greatly rely on the context of the task; neural responses in the insular may not simply be classified as "healthy" or "unhealthy." Ju-Chi Yu et al., (2020) mention, "a dysfunctional AIC-neurocircuitry would then lead to mistakes in uncertainty estimations and therefore increased probability to select actions that are very likely to be associated with 'unhealthy' outcomes, such as deciding to return to drug-related environments and eventually, relapse." (p.11). Additionally, CUD subjects who showed a more potent stimulatory connection from AIC to dACC during ambiguity encoding refrained for longer lengths of time. These results show that relapse prevention and abstinence promotion depend on an AIC-driven, uncertainty-encoding brain circuit.

Johns et al. (2018) was studied the age-related behavioral and impulsive variability of cocaine usage. The Instant Memory Task and the Barrett Impulsivity Scale-11 were used in the study to assess both older and younger cocaine users. In comparison to older cocaine-dependent subjects, younger cocaine-dependent participants scored significantly higher on motor impulsivity tests. On the IMT, however, commission errors were noticeably higher among older cocaine-dependent subjects. On the other hand, Johns et al., (2018) state age-related changes in gray matter volume were studied between healthy controls and cocaine addicts between the ages of 18 and 50 by Ersche et al. (2018). Age-related gray matter volume was significantly reduced in patients with cocaine dependency, particularly in the prefrontal and temporal areas. (p. 4). Additionally, older cocaine users exhibited higher situational impulsivity, which raises the possibility that cocaine use accelerates the aging process of the brain. This had been an impact on how cocaine consumption is determined by age.

Researchers Nigro et al. (2021) study cocaine addiction and HIV. Participants in this study included people with and without HIV, cocaine users, and non-users of cocaine. The objective is to comprehend how cocaine addiction affects a person's ability to make high-risk decisions. They underwent the Iowa Gambling Task (IGT) to gauge their capacity for making decisions. Nigro et al., (2021) mention the study did not find a significant HIV cocaine interaction on Total Net Score, substance use puts an HIV-positive person at a significantly higher risk of medication non-adherence and risk-taking behaviors. The moderate sample size also made it difficult to further interpret the relationship between HIV and cocaine dependence on decision-making abilities. (p.12). It was also stressed that individuals with cocaine dependence should be given effective treatments to lessen their cocaine use and increase drug compliance because cocaine addiction is linked to decision-making disorders.

Andrea et al., (2019) conducted the effects of cocaine and HIV on brain function and decision making with measuring monetary choice and risk taking evaluating. Research consist of 3 neurobehavioral assessment. BART, participants use a virtual balloon pump and balloons that worth 1 cent, and if the balloon pops, participants lose the money. MCQ, participants chose between instant small and big rewards. IGT, participants chose cards to save as much money as possible, also, there is a chance to lose. Linear regression analyzes examined cocaine use as a moderator between network rsFC and impulsivity in decision-making tasks. Results shows that cocaine users at were more likely to take risks due to a stronger inverse relationship between the left cognitive control network and the extended reward network. Cocaine addicts have been found to make more impulsive decisions. This suggests that the interhemispheric connection of cognitive control networks is decreased in chronic cocaine users. It can be seen from the fMRI. Briefly, impulsivity in drug use was influenced by an imbalance between reward and executive control circuits.

In the current investigation, Huhn et al. (2019) sought to ascertain if prefrontal brain (PFC) activity during a risky decision-making task is related to cocaine usage in MMPs throughout a 90-day follow-up. Electronic health records were using to track MMPs for 90 days to assess treatment outcomes, including cocaine usage, which was confirmed by urine drug testing with the Balloon Analog Risk Task (BART) and the Barratt Impulsivity Scale version 11. (BIS-11). Participants who took cocaine throughout the follow-up period showed higher right lateral PFC brain activity during active decision-making during BART, which was corrected at baseline, leading to a loss. However, neither significant decision-making that resulted in a win nor differences in people who used or did not use opioids during the 90-day follow-up met the a priori criteria for neural activity. Huhn et al., (2019) also state "Discriminant function analysis using both neural activity in the right lateral PFC during baseline- corrected, active decision-making that led to a loss and past 30-day cocaine use correctly classified 96.4% of participants who did or did not use cocaine during the 90-day follow-up." (p. 6). By using just MMPs and establishing that elevated DLPFC activity during risky decision-making distinguished between MMPs who took cocaine relative to those who did not throughout a 90-day follow-up, the current study advances this line of research.

Bolla et al. (2003) investigates the poor judgment of cocaine addicts. The Iowa Gambling Task, a decision-making test, was used in research on cocaine users who had been using the drug for 25 days. PET was used to examine the test results to determine whether they indicated modifications in the orbitofrontal cortex's normalized cerebral blood flow. The left putamen and left postcentral gyrus of cocaine users were more activated than those in the control group, according to PET studies. Contrarily, cocaine users displayed less activation in the right cerebellum, left middle temporal gyrus, left medial frontal gyrus, and right upper parietal lobule than did controls. Bolla et al., (2003) "abstinent cocaine abusers show greater activation during the Iowa Gambling Task in the right OFC and less activation in the right DLPFC when compared to controls. Less activation in the left MPFC was also observed in the cocaine group." (p. 1091). These findings imply that prefrontal brain networks involved in decision-making have chronic functional abnormalities in cocaine addicts and that these effects are related to cocaine usage. On the other hand, it appears that those with right OFC dysfunction, like as cocaine users, may not draw connections between current emotions and unpleasant memories even though they are aware of the negative repercussions.

According to Kirschner et al., the general motivational deficits and disordered decision-making that characterize cocaine use disorder are linked to the mesolimbic dopamine system's heightened sensitivity to drug-induced rewards and diminished sensitivity to rewards unrelated to drugs. In order to test this, they looked at whether cocaine users (CU) could self-regulate the ventral tegmental area and important nigra (VTA/SN) using mental thoughts of non-drug rewards. Participants were prompting to voluntarily up-regulate VTA/SN activity with non-drug reward images, either by themselves or in conjunction with rtfMRI NFB, whether they used cocaine or not. Kirschner et al., (2018) mention "According to the PIT measures, neither symptom severity of obsessive-compulsive thoughts nor the amount of cocaine use impaired the ability to vividly imagine rewarding non-drug-related " (p. 492). According to the findings, those who used drugs for obsessive-compulsive disorders more severely in CU had a lower ability to self-regulate the VTA/SN. Although there were no transfer effects at the end of the session, the NFB improved the effect of the reward image. Thus, cocaine users can deliberately stimulate dopaminergic midbrain activity by viewing drug-rewarding images, and rtfMRI NFB can further this ability.

Decision-making issues that support the initiation and persistence of drug use are frequently linked to chronic cocaine usage. According to Kluwe-Schiavon et al(2020) .'s investigation, cocaine users may be less sensitive to the knowledge of gain, loss, and the likelihood of loss at risk than stimulant-naive controls. He tested 96 cocaine users and non-users for this using the Columbia Card Task without feedback. Cocaine users tended to make more cautious decisions in positive decision situations compared to controls, but they took more risks in negative decision scenarios than controls. It also demonstrates how people who take cocaine might not fully consider all available information and restrictions when making unsafe judgments. Cocaine users performed poorly on the Iowa Gambling Task, exhibiting maladaptive behavior similar to that of patients with vmPFC lesions. Kluwe-Schiavon et al., (2020), mentions "Such impairments in integrating all of the available information could be related to vmPFC dysfunction, as this brain region has been associated with the integration of subcortical signals within a single representation of net value, which is accumulated over time until the individual decides to accept or reject an option " (p. 18). In short, cocaine users are significantly more likely to make risky decisions than non-users.

Conclusion

In conclusion, various internal functional neural networks coordinate learning and decision-making in the brain circuits implicated in addiction. Cocaine users had less connection in the striatum reward circuitry than cocaine-free controls, which indicates compulsive drug use and relapse. Cocaine users exhibit altered functional connectivity in specific executive control-related cortical brain areas, such as the cognitive control and attentional salience networks. The possibility that someone will use cocaine to make unsafe decisions was also increased by these changes in the brain.

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