

Drug Abuse and Adolescents' Cognitive Development **—Based on the Perspective of Etiology, Impacts, and Therapy**

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ABSTRACT

Adolescents' substance abuse is a momentous problem nowadays. Adolescents are under a significant period of cognitive development. The current studies focus on the negative effects of substance use among adolescents. This article mainly focuses on the etiology, impacts, and therapy among adolescents' drug abuse. Family environment and peer pressure generate initiation of drug use. Drug use affects some cognitive functions such as attention, memory, and executive function, etc. There are also contradictory results on the neuropsychological decline among adolescents with marijuana use. The current studies show family therapy efficaciously reduces drug use among adolescents. Educational prevention is also a practical method to minimize drug user.

Keywords: *Adolescent, Cognitive development, Substance abuse.*

1. INTRODUCTION

Nowadays, drug abuse is a significant problem, and it is not effectively controlled. Drug abuse refers to a massive overdose of drugs in a way that is adverse to self or society [1]. Since marijuana became legal in New York state, there is an escalated number of sales in New York state. Adolescents consume the majority of marijuana, according to the New York City Health Department. [2]. The age-adjusted rate decreased by 4.6% to 20.7 in 2017, and nearly 70% of people overdose on drugs terminate at death [3].

Adolescents are during an essential period of cognitive development. The brain is under maturation during adolescence, especially the executive system, such as working memory, emotional-related processes, and frontoparietal systems [4]. However, adolescents have limited knowledge of the negative effects. "Addiction is tied to changes in brain structure and function is what makes it, fundamentally, a brain disease" [5]. Adolescents start using substances mainly because of peer pressure from their friends or family environment. Different drugs affect the brain differently, and drug abuse can lead to serious consequences.

Present studies show some biological effects of substance abuse. Heroin is converted into morphine in the body. It binds to opioid receptors in the brainstem.

Opioid receptors inhibit neuron activities. Overdoses can cause hard breathing [6]. Methamphetamine is one of the hallucinations which increases dopamine in the body. Overdosing can cause dehydration, teeth grinding, and a general lack of regard for personal hygiene [7]. Other effects include perspiration, beating heart, vomiting, anxiety, insomnia, social isolation, etc. Besides the physical effects, researches also reveal potential cognitive consequences. According to one study, marijuana use is associated with neuropsychological decline [8]. Another study, however, found that marijuana consumption has no significant impact on the cognitive quotient. [9]. The main goal of this article is to understand adolescents on substance abuse based on the causations, cognitive impacts, therapies, and future orientation.

2. LITERATURE REVIEW

2.1. Etiology

Adolescents' behaviors are influenced mainly by society and nearby people's behaviors. Family members are associated with adolescents' substance use. Under the complex network of society, adolescents find it hard to resist the lure of using substances while their friends are using them. Adolescents who do not use substances are usually under peer pressure.

2.1.1. Family Environment

Variation in family structures illustrates different probabilities of adolescents using substances. One study in 2013 indicates adolescents living with older siblings have a strong correlation with using alcohol ($r=1.9$), cigarettes ($r=1.6$), and marijuana ($r=2.2$) [10]. It also shows adolescents living with cousins are strongly correlated with marijuana use ($r=2.7$) [10]. Furthermore, this study illustrates that adolescents with high acculturation experience an increasing rate of substance use. Adolescents with low accumulation often encounter “acculturative stress” [10]. Another study by Brechting evaluates the correlation between adolescent males’ substance use and family environment. It indicates that socioeconomic status is strongly correlated with substance use ($r= -.123$) [11]. This indicates the male adolescents live in low socioeconomic status associated with more drug use. However, socioeconomic status is not significantly related to the amount of drug used or frequency of drug use [11]. Adolescents in functional families develop better abilities to address problems. Adolescents are less likely to use substances to overcome problems. Functional families are associated with more positive communications between adolescents and their parents. People in the secure attachment family environment show less drug use. This study also reveals that parents with substance use disorder history do not relate to substance use and family functioning [11]. However, another study by Hoffmann and Cerbone suggests that parents’ substance use disorder is positively related to adolescents’ substance use [12].

2.1.2. Peer factors

Adolescents’ behaviors are affected by society and the people nearby. According to the Theory of Planned Behavior by Ajzen and Fishbein (As shown in figure 1), behavior is determined by attitudes, subjective norms, and perceived behavioral control [13]. In this theory, subjective norms indicate the belief that an essential group of people would approve and support a particular behavior [14]. Adolescents’ attitude towards substance use depends on the attainable belief about it. Adolescents’ perspective is determined by the judgment and pressure of significant people around them such as parents and close friends. Adolescents’ behaviors follow those people’s views. If their closest nearby people believe that using substances is normal behavior, then adolescents are more likely to use substances. Social identity theory also illustrates adolescents’ substance use.

2.2. Impacts

People become addicted to drugs through the reward pathway. Having drugs increase their dopamine in the ventral tegmental area and nucleus accumbens. It reinforces the motivation to keep using drugs.

Adolescents are under a crucial period of cognitive development. The development and maturation of the brain are around adolescence.

2.2.1. Addiction

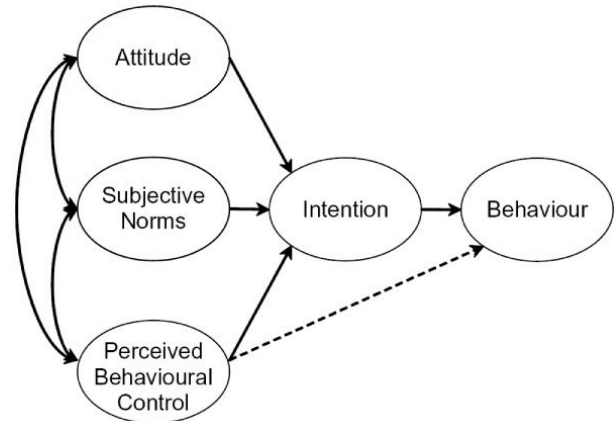


Figure 1 Theory of planned behavior

The Ventral Tegmental Area (VTA) is in the reticular formation, and it is related to motivation and reward. Nucleus accumbens (NA) is the neural intersection between motivation and action (As shown in figure 2). The prefrontal cortex is in charge of cognitive control functions. Dopamine (DA) is a neurotransmitter that makes people feel pleasure. Lots of drugs are associated with dopamine, such as cocaine, amphetamine, and heroin, etc. When people use drugs, dopamine activates the VTA or NA. The prefrontal cortex commands to keep using drugs by reinforcing the reward pathway. This is how people become addicted. Different drugs activate VTA in different ways. Heroin converts to morphine and binds with opioid receptors which can decrease the inhibitory BAGA to release, to increase the dopamine to activate the reward pathway [15]. Cocaine blocks the reuptake receptors in NA. Therefore, an increase in dopamine reinforced the reward pathway [15]. Different drugs reinforce the reward pathway in different ways.

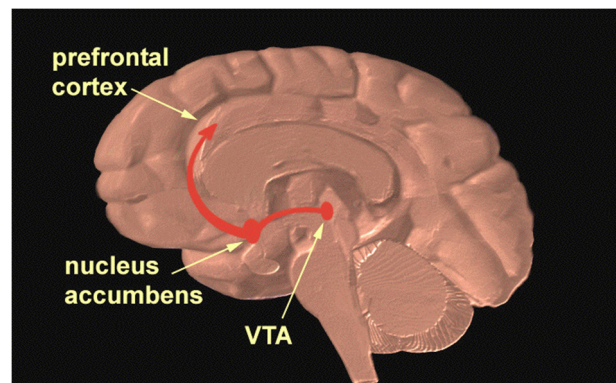


Figure 2 The reward pathway

2.2.2. cognitive effects

Studies of substance abuse among adolescents show various impacts on adolescents' cognition. In the last decade, most research has focused on memory, attention, executive function, processing speed, and neuropsychological performance.

Several studies show the impacts of drug use on cognitive functions and indicate the correlation between drug use and cognitive functions. A study in 2010 showed the correlations between substance use and cognitive functions such as memory, attention, executive function composites, and processing speed. Thoma and his colleagues did a study on the effects of alcohol and marijuana on adolescents. The study divides participants into 3 groups; a healthy control group with no substance use history and no parental history of substance use; an FHP group with no substance use history and with parental AUD; a SUD group which everyone with alcohol abuse and some participants in SUS group also met KID-SCID criteria for marijuana dependence [16]. The participants are all healthy enough for this study, the range of age is between 12 to 18, and all participants didn't use any substances within 48 hours before this study. The study valued verbal reasoning, visuospatial ability, executive function, memory, attention, and processing speed as its dependent variables [16]. As result, the study showed active and parental history use of substances can cause poorer performance on attention, executive function composites, memory, and processing speed. According to the study, heavy drinking of alcohol in adolescence can cause a reduction in attention and executive functioning, and marijuana use may lead to a negative effect on memory [16]. Similar results on academic achievement and emotion are shown in Silveri's study. This study tested the emotional and cognitive effects of high/low-risk adolescents. The participants are split into two groups FH- and FH+ by their difference in family histories of drug or alcohol abuse. The study is a one-year longitudinal study, the assessments included the structured clinical psychiatric interview using the Kiddie-Schedule for Affective Disorders and Schizophrenia (K-SADS) and emotional intelligence, the Bar-On Emotional Quotient Inventory, the Multidimensional Anxiety Scale for Children (MASC), and the Perceived Stress Scale (PSS, data only available at follow-up) [17]. The study applied with Academic and Cognitive Screening Tests and Data Analyses, which allow researchers to examine participants' emotion, academic and cognitive measures. As a result, the participants from no substance background show a better performance on emotional intelligence ($P < .02$) and show a lower score in anxiety ($P < .01$) [17]. In the academic achievement part, the girls with substance background scored a lower reading score than those boys and girls from a no substance

background, and the same result also applied on the arithmetic subtest [17]. The participants who are from a substance abuse background show poorer performance [17].

Besides the cognitive function influences, the impact on neuropsychological performance is the most controversial topic. Meier states that there is about a 6 points decline in IQ if adolescents keep using marijuana persistently [18]. However, a contradictory result is shown in Jackson's twin study. His study illustrates that there is no significant difference between twins discordant for marijuana use [19]. Both studies are longitudinal. Wesler Ince Scale is used in both studies, and both studies use surveys to demonstrate the amount of marijuana use.

In the Meier study, Participants test IQ at ages of 7, 9, 11, and 13 which are before cannabis use. Another IQ test is held at the age of 38. The cannabis use surveys are held at the ages of 18, 21, 26, 32, and 38. In the survey, it divides the participants into five groups: i) those who never used cannabis, ii) those who used cannabis but never diagnosed, iii) those who diagnosed at one wave, iv) those who were diagnosed at two waves, and v) those who diagnosed at three or more waves [18]. As a result, cannabis use is correlated to a neuropsychological decline and is about 6 points of decrease. It also indicates that participants with more diagnoses show more decline in IQ. Moreover, the impairment of the neuropsychological functions is global ($P = 0.55$) [18]. Neuropsychological functions are not recovered after cessation. Furthermore, cannabis use only indicates the correlation of the neuropsychological decline but not causation, because cannabis users completed fewer years of school, and the effects of tobacco, hard-drug, alcohol, or schizophrenia remained statistically significant ($P = 0.0282$) [18].

However, In Jackson's study, there are two groups of participants which are MTFs and RFAB, and the MTFs group contains a cotwin control group, which is designed to control other variables. In the cotwin control group, IQ is compared within the twin for one is a marijuana user and another is not. There is a decline in verbal ability and general knowledge for the marijuana user in MTFs. However, there is an insufficient baseline before marijuana engagement. The baseline in the MTFs group already showed the gap between users and nonusers [19]. Moreover, there is no significant difference in the cotwin control group between twins discordant for marijuana use. The study claims that other factors other than marijuana might cause a decline in IQ.

2.3. Therapies

There are various types of therapies such as family therapy, cognitive-behavior therapy, and education, etc.

The environment and the social relationship are essential for drug reduction.

2.3.1. Family therapy

Family therapy is one of the most common therapies for drug abundance. Several studies show that family treatment reduces adolescents' drug use. Szpocznik and his colleagues did a study on strategic structural family therapy with intervention and strategic structural family therapy alone as posttreatment. As a result, 93% of adolescents engaged in family therapy with intervention, and 77% of patients completed the treatment. By contrast, only 42% of adolescents engaged in family therapy alone, and only 25% of patients completed the treatment [20]. Another study by Joanning and his colleagues compared three types of therapies, structural-strategic family therapy, adolescent group therapy, and family drug education. As a result, more adolescents in the family therapy group were restrained on drugs (54%), and only 28% and 16% in adolescent group therapy and family drug education group dropped drugs [21]. Waldron and her colleagues did a research on drug abstinence among adolescents in 4 conditions, functional family therapy (FFT), individual cognitive-behavioral therapy (CBT), a combination of FFT and CBT, and a psychoeducational group [22]. The study followed up after 4 and 7 months of treatment. This study revealed that two conditions with family therapy had more abstainers comparing to the other two groups. All conditions show some efficiency, but family therapy is the most eminent therapy.

2.3.2. Prevention

Understanding that the negative effects the drug can bring to adolescents, prevention for school students to use substances become extremely important. This study take place in Wuhan, China, it applied with a school-based health intervention program named "Cognitive-Motivation-Emotional Intelligence-Resistance Skills" (CMER), this program is developed to enhance cognition upon drug use, and to decrease the motivation of drug use, and to improve emotional adjusting and drug resistance skills [23]. The study uses open question surveys to measure participants' attitudes toward drugs, levels of knowledge about the drug types, addiction of drug use, impact of using drugs, and their motivation to initiate drug use [23]. The experiment put the subjects into two groups, a control group (407 participants) which received the CMER program, and an intervention group (391 participants). The result showed a high degree of comparability between groups before the intervention, the control group had a deeper understanding of the drug and the drug use after the CMER program and showed a lower interest in using the substance [23] Therefore, the CMER program can be a method to educate adolescents to decrease the

chance of letting adolescents involving in drug abuse behaviors. The weakness of this study is that it didn't provide a long-term period to examine how long the program would be effective.

3. LIMITATIONS AND FUTURE IMPLICATIONS

This study has several methodological limitations that require future studies. First, there is no clear causal relationship between substance use and cognitive development. Even though several studies reveal the correlations between drug use and some cognitive effects such as memory, attention, executive function, processing speed, etc, there is still no explicit causation of the cognitive impacts. Future studies should not only focus on the correlations between substance use and cognitive impacts, but also the causation of those impacts. Second, the studies are lack variables. Each study only reveals limited aspects of the impacts. It does not conclude all the potential factors in one research. Some studies only include significant factors such as socioeconomic status, and others only test the impacts such as memory and executive functioning. Third, it is hard to control all the variables. Some adolescents with drug abuse often receive less education. It is ambiguous to determine which factors affect the intelligence quotient. For future research, more restricted control groups are needed. Intelligence needs to study for an extended time. The longer period of research time also helps to study if the impairment is reversible. Fourth, it has been found that adolescent drug abuse may change the brain structure of individuals. In this study, we mainly focus on the cognitive development of adolescents. However, how the brain regions of adolescents change needs to be further explored in future research

Finally, most importantly, the article is only focused on the cognitive impacts among adolescents. In Erickson's psychosocial theory, development is a lifelong process. The impacts for adulthood, and mature are not included. In his theory, young adulthood is essential to intimacy and isolation. Substance use might have some impacts on the formation of intimate relationships. Adulthood is critical of generativity. Substance use might influence the next generation or other problems related to generativity. It might impacts the next generation genetically and environmentally. It might also influence the quantity of generativity. Future research may focus on the lifelong effects of substance use in various aspects.

4. CONCLUSION

Adolescents using substances mainly because of family environment and peer pressure. The studies showed clear impacts of adolescents using substances.

Several studies show positive correlations between emotional intelligence, academic achievement, cognitive performance, and substance use. However, there are contradictory results on intelligence quotient effects. More studies are needed for the causal relationship between marijuana use and neuropsychological decline. Furthermore, there are different types of therapies focusing on adolescents substance abuse, mainly based on the family therapist and educational prevention.

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