

## The Mediating Role of High State Anxiety on the Association Between Cannabis Use and Sustained Attention

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### ABSTRACT

Cannabis, a product derived from the *Cannabis sativa* plant, has become a subject of considerable scientific inquiry and public discussion due to its widespread use and its potential effects on cognitive abilities. Despite the increasing number of individuals using cannabis in India, there is a significant gap between the growing number of users and the scientific research focused on understanding the cognitive consequences of cannabis use. This study aimed to gain a comprehensive understanding of how cannabis use affects sustained attention and to investigate whether high state anxiety plays a role in this relationship among Indian cannabis users. To achieve this, the study used statistical T-tests to compare the average scores on the Digit Vigilance Test (DVT) between cannabis users and non-users. Additionally, the study conducted a mediational analysis to examine whether high state anxiety serves as a mediator in the link between cannabis use and sustained attention. The results of the study revealed that high state anxiety indeed has a notable direct effect ( $z=1.701$ ) on the relationship between cannabis usage and sustained attention. However, it's important to acknowledge that further investigations are necessary to establish the full extent of the mediation effect.

**Keywords:** *Indian Population, High State Anxiety, Cannabis Consumption, Sustained Attention, Mediation analysis, T test*

In recent years, India has experienced a substantial surge in its population, currently standing at an astonishing 1.417 billion. Projections from the United Nations suggest that India may soon surpass China in terms of population. While this burgeoning population brings the promise of fresh ideas, vitality, and dynamism, it also entails a significant responsibility. Concurrently, there has been a notable increase in the number of individuals engaging in the use of psychoactive substances.

The historical and cultural significance of marijuana within the Hindu culture has translated into the contemporary use of this substance by Indian adults for a range of purposes, including recreation, spiritual rituals, and pleasure. A 2019 study conducted by the All India Institutes of Medical Sciences reported that approximately 7.2 million Indians had consumed cannabis within the past year. Furthermore, an estimated 1.3 million Indians

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engage in daily consumption of Ganja and Charas, procured through illicit means. Cannabis, derived from the *Cannabis sativa* plant, has emerged as a focal point of both scientific investigation and public discourse due to its widespread use and potential impact on cognitive function. Among the various cognitive processes influenced by cannabis, one of particular interest is sustained attention, a vital aspect of daily functioning. Cannabis comprises a multitude of chemical compounds, with delta-9-tetrahydrocannabinol (THC) serving as its primary psychoactive constituent. THC predominantly exerts its effects through the endocannabinoid system, a complex network within the brain comprising receptors, endocannabinoids, and enzymes. This system plays a fundamental role in regulating diverse physiological and cognitive functions, including attention, often referred to as vigilance. Numerous neuropsychological and functional neuroimaging studies have consistently reported that chronic marijuana use is associated with impairments in crucial cognitive skills such as attention, memory, and learning (Block and Gonheim, 1993; Pope and Yorgelun-Todd, 1996; Fletcher et al., 1996; Pope et al., 2001; Solowij et al., 2002; Bolla et al., 2002). These studies have demonstrated decreased activation within the normal attention network, notably in the right prefrontal region, the dorsomedial prefrontal (DMP) region, and, particularly, the medial cerebellum among marijuana users (Chang, 2006).

Moreover, a recent study conducted by Moore and Davis in 2023 investigated the effects of THC, a prominent component of cannabis, on attention and cognitive performance. They employed the rodent Psychomotor Vigilance Test (rPVT), a translational paradigm designed to quantify and measure sustained attention in rodents. Their findings indicated that when THC was administered alone at higher doses, it led to a decline in accuracy and an increase in lapses in attention. While the literature addressing the intricate relationship between chronic cannabis use and sustained attention remains limited, existing research collectively points toward a negative impact of cannabis use on cognitive functions, including sustained attention. This underscores the significance of further exploration in this domain to elucidate the nuances of this relationship and its potential implications for individuals and society at large. While the consumption of cannabis significantly impacts cognitive functions, several mental and emotional states could also be responsible for changes in cognition including – sustained attention.

Sustained attention is a complex cognitive process that involves the capacity to be watchful over time, to withstand interruptions, and to keep one's attention on a single task or stimulus. It is a cornerstone of cognitive control and crucial for tasks that call for sustained concentration.

On the other hand, anxiety is an emotional condition marked by a raised level of arousal and alertness. Physical reactions like accelerated breathing, tightened muscles, and elevated heart rate are frequently present. Anxiety can have both beneficial and detrimental effects on attention. On one hand, mild anxiety can improve focus and attention by preparing the person to react to potential threats. Conversely, persistent or excessive anxiety can result in impairments in sustained attention. Anxiety can lead to attentional biases, where individuals become hyper-aware of potential threats in their environment. This heightened vigilance towards potential dangers can cause a shift in attention away from the task at hand, resulting in reduced sustained attention. High levels of anxiety are associated with impairments in cognitive control, which is essential for maintaining attention.

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Anxious individuals may struggle to filter out irrelevant information and may be more susceptible to distractions, which can hinder their ability to sustain attention.

Several studies have been conducted to investigate the effect of anxiety on sustained attention. For example, Derakshan and Eysenck (2009) discovered that people with high levels of trait anxiety had lower sustained attention than people with low levels of trait anxiety. Trait anxiety is a stable personality trait that is characterized by a proclivity to experience anxiety. State anxiety can be defined as a transitory emotional state consisting of feelings of apprehension, nervousness, and physiological sequelae such as an increased heart rate or respiration (Spielberger 1979).

The relationship between anxiety and attention is a complex and multifaceted one, with anxiety having the potential to significantly impact various aspects of attention. A study conducted by Deitlam and Jones in 2015 uncovered those participants in the study who experienced state anxiety performed worse on sustained attention tasks, with higher anxiety levels associated with worse attentional impairments. Anxiety appears to decrease active attention, as measured by the longest span of digits before an error is made. Passive attention was affected adversely by intense anxiety, however -This effect was less clear when anxiety was not intense.

The independent examination of the influence of cannabis and state anxiety on sustained attention and attentional control has undergone relatively limited exploration in the existing body of literature. Moreover, the interrelationship among these three variables has yet to be subject to systematic investigation. Despite the increasing prevalence of cannabis usage within the Indian population, there exists a notable disparity between the surge in users and the corresponding research efforts addressing cannabis-related cognitive impacts. This incongruity is particularly salient in the context of India, where there has been a notable relaxation of legal restrictions governing cannabis use, leading to an upsurge in its prevalence. Given this evolving landscape, it becomes imperative to undertake comprehensive research endeavors that elucidate the cognitive consequences of cannabis utilization and allied mental states. In addition to the limited body of research establishing a connection between the aforementioned variables, coupled with the scarcity of cannabis-related investigations within the Indian context, the detrimental influence of cannabis on cognitive function has encountered challenges from multiple studies, notably exemplified by Lyons and Toomey in their 2004 research, titled 'The Neuropsychological Consequences of Regular Cannabis Use,' which indicates an absence of marked long-term residual effects of marijuana use on cognitive abilities. (Lyons and Toomey, 2004).

Furthermore, an additional layer of complexity emerges from the study conducted by Potvin and Bergua in 2013, revealing beneficial effects of mild to moderate state anxiety on verbal reasoning and general cognitive functioning (Potvin and Bergua, 2013).

In light of these conflicting findings, while there exists considerable evidence highlighting the negative consequences of cannabis use on cognitive functions, a subset of studies have made us question about the same. Concurrently, the recognition of the favorable effects of mild state anxiety on cognitive domains, such as working memory, prompts us to inquire about its potential impact on the cognitive domain of sustained attention. The presence of these inconclusive and contradictory findings persuades us to explore more in this domain,

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To address the gaps in existing literature and contribute valuable insights to the field, this study endeavors to elucidate the mediating role of state anxiety in the association between cannabis use and sustained attention.

### **MATERIALS AND METHODS**

#### *Objectives of the study*

- Objective 1: To determine if regular cannabis use has a negative impact on the cognitive facet of sustained attention, within the Indian population.
- Objective 2: To understand if high state anxiety mediates the relationship between cannabis use and sustained attention.

#### *Hypothesis of the study*

- Hypothesis 1: There is no significant difference in the sustained attention scores between the cannabis consuming group and the control group.
- Hypothesis 2: The associative relationship between cannabis consumption and sustained attention scores is mediated by high state anxiety.

#### *Research Design and Procedure*

Quantitative, Exploratory study using the statistical tools of T- Test and Mediation analysis. Individuals known to the author, who indulge in cannabis were approached to be a part of the study, they were screened for the study based on the inclusion and exclusion criteria stated below (Depending upon their CUDT- R scores and STAI-Y Short form scores). The control group was approached as per convenience. They were also screened as per the parameters mentioned above. If the participants met the inclusion criteria for the study the NIMHANS digit vigilance Test was administered on them, T test was used to find a difference in sustained attention functioning in the Cannabis group and The Non-Cannabis group, a mediation analysis on Jamovi was further carried out in order to explore the mediational role of high state anxiety in the associative relationship between cannabis usage and sustained attention.

#### *Sampling:*

Purposive sampling was used, 60 participants were selected to be a part of the study based upon the following filtering criteria-

#### **Inclusion Criteria for the Cannabis group**

1. Age- 18- 35
2. No bar on gender
3. Individuals who consume cannabis, either ingest it or smoke it.
4. Individuals who score more than 8 on the CUDIT scale.
5. Individuals who score within the range of 1 to 3 and 15 or more than 15 in the STAI-Y Short Version Form, for the low state anxiety group and high state anxiety group, respectively.
6. Individuals with no co-morbid psychiatric illnesses.

#### **Exclusion Criteria for Cannabis consuming group -**

1. Individuals below the age of 18 or above the age of 35
2. Individuals who do not consume cannabis and who do not use CBD oil.
3. Individuals with a CUDIT score in the range of 0 to 4
4. Individuals with comorbid psychiatric illnesses

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### Inclusion Criteria for the control Group

1. An individual between the age ranges of 18-35.
2. No bar on gender.
3. Individual does not consume cannabis or any other substance
4. Individuals scoring in the range of 1-3 and 15 or more than 15 in the STAIY Short version Form.
5. Absence of psychiatric and neurological conditions.

### Exclusion Criteria for the control Group

1. Individuals below the age of 18 and above the age of 35.
2. Individuals who score in the range of 0-4 on the CUDIT- R.
3. Presence of psychiatric disorders and neurological disorders.

### Tools Used

- **State-Trait Anxiety Questionnaire-** Form Y 1- 20 point Likert Scale, with separate forms to assess State anxiety and Trait anxiety. Several reliability and validity tests on the STAI have been conducted, providing sufficient evidence that the STAI is an appropriate and adequate measure for studying anxiety in research and clinical settings (Sesti, 2000). A high degree of internal consistency was observed for each of the 40 items, in both forms- with Cronbach's alpha value of 0.73 to 0.89 while Cronbach's alpha for the total scores had a mean of 0.86. A Cronbach value of above 0.70 is considered to be good.
- **Nimhans Digit Cancellation Test for Sustained attention-** A test for sustained attention and vigilance, wherein the participants have to strike out the numbers- 6 and 9 from an extensive list of numbers given. The tests have high reliability and validity, even in the Indian Context.
- **CUDIT-R** – It is a Self Report Questionnaire, with 8 items, used to classify participants who consume cannabis into categories. Loflin and Babson in 2018, tried to establish the reliability of the questionnaire. A confirmatory Factor analysis reflected a modest internal consistency, with the Cronbach alpha value being 0.73.

### Statistical Tools used –

- **Shapiro Wilk Test**– This was done in order to ascertain the normality of the distribution
- **T- Test-** Was done in order to ascertain the difference in the mean of the DVT scores in the cannabis group and the control group.
- **Mediational Analysis**– Mediational analysis was used in order to ascertain the mediating role of high state anxiety on the relationship between cannabis use and sustained attention.
- **Descriptive Statistics (Mean and Standard Deviation)-** The mean was used in order to ascertain the mean scores of the four groups and ascertain the difference between them. The standard deviation was used in order to ascertain was used to measure the extent to which individual scores deviate from the mean for each variable.

### Ethical Considerations

- The anonymity of the research participants was be preserved.

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- No information related to the name or identity of the participants was taken into account.
- Participants did not have to divulge information related to where they procure their substances from.
- The research followed the Nuremberg code of ethical principles. Informed consent was taken from all the participants and the research participants were permitted to exit from the research anytime they wished to
- The codes of Helinski were followed during the conduction of the research.
- Participants with a CUDIT-R score higher than 8 were given reference for rehabilitation.

### RESULTS

*Table 1: shows the Mean, Standard deviation, and Normality scores using the Shapiro-Wilk test of the variable Sustained Attention amongst the cannabis group.*

#### Normality Statistics

	A
N	30
Mean	18.7
Median	18.0
Standard deviation	8.74
Shapiro-Wilk W	0.974
Shapiro-Wilk p	0.662

*Note- W= Shapiro- Wilk test of Normality*

The data consisted of 30 samples consisting of 18 men and 12 women. Shapiro-Wilk test of normality was run to check if the data met the assumptions of normality (Table 2). The test indicated that Sustained Attention Scores For the Cannabis group (W- 0.974, P< 0.05) met the assumptions of normality.

*Table 2: shows the Mean, Standard deviation, and Normality scores using the Shapiro-Wilk test of the variable Sustained Attention amongst the non-cannabis group*

#### Normality Statistic

	A
N	30
Mean	3.73
Median	4.00
Standard deviation	2.27
Shapiro-Wilk W	0.946
Shapiro-Wilk p	0.129

*Note- W= Shapiro- Wilk test of Normality*

The data consisted of 30 samples consisting of 16 men and 14 women. Shapiro-Wilk test of normality was run to check if the data met the assumptions of normality (Table 3). The test indicated that Sustained Attention Scores for the Cannabis group (W- 0.946, P< 0.05) met the assumptions of normality.

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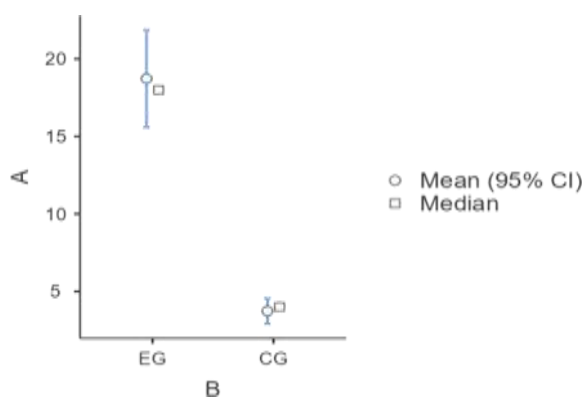
**Table 3:** shows a significant difference in DVT scores amongst participants with high state anxiety between the cannabis and non-cannabis group

		Statistic	Df	p
A	Student's t	9.10 <sup>a</sup>	58.0	< .001

Note. H<sub>a</sub>  $\mu$  EG  $\neq$   $\mu$  CG

### Interpretation of the results in table 3:

Individuals with high state anxiety using cannabis reported a higher number of errors while performing the sustained attention task (M=18.7, SD= 8.74) than the control group-consisting of non-cannabis users in general,  $t(60)=9.10$   $p<.001$ .



**Figure 1**

B=Experimental Group and non-Experimental Group

A= Scores of sustained Attention

In the context of participants exhibiting high state anxiety, the level of sustained attention observed within the cannabis group was four times lower compared to the sustained attention exhibited by the control group, hence the first hypothesis is rejected.

**Table 4: Correlation and mediation between High state anxiety and sustained attention**  
Mediation Estimates

Effect	Estimate	SE	Z	p
Indirect	0.0103	0.0394	0.262	0.793
Direct	0.6720	0.3952	1.701	0.089
Total	0.6823	0.3946	1.729	0.084

### Interpretation of the Results in Table 4:

The sample consisted of 30 participants, and there was a significant correlation between the variables – of cannabis usage and sustained attention,  $p<0.672$ , the direct effect of the mediating Variable, state anxiety was significant  $z =0.262$ , while the indirect effect is  $z= 0.262$ , therefore indicating a significant mediating relationship between the variables.

Accordingly, drawing from the aforementioned results, we would fail to accept hypothesis one while we fail to reject hypothesis 2.

## DISCUSSION

This study aimed to comprehensively understand the multifaceted impact of cannabis use on sustained attention while delving into the potential mediating influence of high state anxiety

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among Indian cannabis users. The objective was to explore the relationship between cannabis use and sustained attention and elucidate the potential role of anxiety in mediating this relationship. The findings of this study have critical implications for future studies. The Shapiro-Wilk Normality test was employed to assess the normality of the sample data. The results of this test confirmed that the data exhibited a normal distribution across the normal probability curve. Consequently, parametric testing was utilized, ensuring the robustness of the statistical analyses. The study conducted T-tests to explore the potential differences in mean Digit Vigilance Test (DVT) scores between cannabis users and non-users. The results of these tests revealed a significant disparity in the mean DVT scores, thereby pointing toward the rejection of the first hypothesis. This finding has profound implications, as it suggests that cannabis usage indeed has a negative impact on the cognitive domain of sustained attention.

These results align with existing research in the field. A notable study by Solowij (2010), conducted in Brazil, underscores the detrimental effects of cannabis use on cognitive function. This research highlights that cannabis use impairs memory, attention, inhibitory control, executive functions, and decision-making abilities, both during the acute intoxication period and persisting for extended durations, ranging from hours to weeks, or even more after the last use of cannabis (Solowij, 2010)

In light of the findings of the present study, it becomes evident that long-term and intense cannabis use can have a deleterious impact on attentional control, particularly sustained attention. This observation extends and reinforces the previously established conclusions regarding the negative cognitive consequences of cannabis use. The present study contributes to the growing body of evidence emphasizing the multifaceted detriments associated with cannabis use, especially in the cognitive domain. However, a study conducted in 2006 by Jager, Brink, and Ramsay reported that cannabis users exhibited comparable performance levels in both working memory tasks and selective attention tasks when compared to non-users. Additionally, the study found no significant differences in the overall patterns of brain activity within regions associated with these cognitive functions among cannabis users and controls (Jager et al., 2006). It is crucial to note that this prior investigation primarily involved participants engaging in moderate cannabis use, in contrast to the present study's focus on individuals with a history of heavy and intense cannabis consumption. This distinction in usage levels is pivotal, as it suggests that the impact of cannabis on cognitive functions may differ significantly based on the extent of consumption, shedding light on the dose-response relationship between cannabis use and cognition.

While existing research has convincingly demonstrated the adverse effects of cannabis use in isolation on cognitive function, there remains a dearth of comprehensive exploration into the combined influence of various mental states, particularly high state anxiety, and cannabis use on cognition. The present study fills this gap by examining the mediating role of high state anxiety on the relationship between cannabis usage and sustained attention. As detailed in Table 3, the findings indicate a noteworthy direct influence of high state anxiety ( $z=0.262$ ) on the relationship between cannabis usage and sustained attention. Specifically, individuals who are both cannabis users and experience high state anxiety tend to exhibit a higher frequency of errors in sustained attention tasks, implying a potentially collaborative impact of anxiety and cannabis on cognitive performance.



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While our current research delves into a less-explored area, it is not without its limitations. One notable limitation stems from the challenge of accessing a sizeable population of cannabis users, resulting in a relatively smaller sample size for this study. Additionally, there was a considerable imbalance in the number of participants allocated to the high state anxiety group, which included 60 individuals, in contrast to the low state anxiety group, which comprised 23 participants. This uneven distribution could have influenced our findings.

Another limitation to consider is that our study did not take into account the concurrent use of tobacco and alcohol. These substances are often used in conjunction with cannabis, and their combined effects on cognitive function were not thoroughly examined in our research. This is an important consideration, as the use of multiple substances may have contributed to the cognitive outcomes observed in our study.

### CONCLUSION

Based on the results generated by this study, it can be concluded that cannabis essentially has negative consequence on the domain of sustained attention and mental states such as high state anxiety along with the usage of cannabis can further exacerbate the deficiencies in sustained attention. Several noteworthy implications and avenues for future research emerge from these findings –

1. The mediating role of trait anxiety on the association between cannabis use and sustained attention can be explored.
2. The impact of varying levels of cannabis intoxication and their differential influence on multiple cognitive domains can be explored.
3. Further studies can include the component of Tobacco usage in their studies and explore how the various variables impact each other.
4. The relationship between other mental states such as high depressive symptoms along with cannabis usage could be explored. The collaborative impact of the two could be studied on the cognitive domain sustained attention.
5. The relationship between poly substance abuse, cannabis and cognitive function can be further studied.

Overall, this study explains the cognitive impact of cannabis use amongst the young Indians and how other factors such as high state anxiety may further alleviate the cognitive problems.

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### **Conflict of Interest**

The author(s) declared no conflict of interest.

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