Middle East Current Psychiatry

RESEARCH

Open Access

Cannabis use and effect of cannabis abstinence on cognitive functioning in young people — an observational case-control follow-up study from rehabilitation centre in Andhra Pradesh

Sripathi Santhosh Goud[1*], M. S. Radhika[2], Vishal Indla[1] and Nagasaritha Kolli[3]

Abstract

Background: Cannabis is the most commonly used illicit substance globally, in India particularly. In recent times, younger people started abusing cannabis, resulting in academic decline and psychological disorders. Research from developed countries had shown that abstinence from cannabis reverses cognitive decline in the young population to a certain extent. Studies on this topic have been very few in India. We intended to assess the effects of cannabis use and abstinence from cannabis on the cognitive functioning of young adults.

The study was an observational study including 50 consecutive young male patients, who got admitted to our rehabilitation centre with cannabis use disorder (group A). The Montreal Cognitive Assessment (MoCA) test was used to assess the baseline cognitive functioning of these patients initially after 1 week of abstinence and compared with 50 graduate students with no history of cannabis use (group B). The MoCA test was re-administered to group A subjects after 3 months of strict abstinence from cannabis use.

Results: There was a statistically significant difference between the baseline MoCA score of cannabis users and the controls ($P < 0.001$). Both the duration ($r = -0.296$, $P = 0.036$) and the quantity ($r = -0.491$, $P < 0.001$) of cannabis use had a negative correlation with the MoCA score. When the MoCA test was re-administered after 3 months of abstinence, we found a statistically significant improvement in cognitive functioning in cannabis users ($P < 0.001$), but the mean score was still less than the mean score of the control group (24.08 ± 2.66 vs 28.62 ± 0.85, $P < 0.001$) showing only partial improvement.

Conclusion: This study showed that cognitive deficits were seen in cannabis users as compared to nonusers. It also had shown that abstinence from cannabis had partially reversed the impairment, but still some deficits were remaining. There is an urgent need for primary prevention strategies at community level to decrease the prevalence of cannabis use.

Keywords: Cannabis use, Marijuana, Young adults, Cognitive functioning, Cognitive impairment

Background

Cannabis is the most commonly used illicit psychoactive substance globally. According to the report published by the Ministry of Social Justice and Empowerment, Government of India, in 2019, about 2.8% of the Indians

*Correspondence: dr.santhoshgoud@gmail.com

[1] Indlas VIMHANS Hospital, Vijayawada, Andhra Pradesh 520002, India
Full list of author information is available at the end of the article

reported having used any cannabis product within the past 12 months. About 0.66% of Indians needed help for their cannabis use problems [1]. Adolescents in particular have been found to consume high levels of cannabis, approximately between 12 and 16 years of age. This is an important factor from mental health and neurodevelopment point of view [2]. Tetrahydrocannabinol (THC), the active molecule in cannabis, has been shown to cause alterations to the structure of the brain in long-term use. Cannabis causes short-term and long-term alterations in several cognitive functions of the brain [3].

When people begin using cannabis as teenagers, the drug impairs thinking, memory, and learning functions. A study from New Zealand conducted at the Duke University showed that people who started smoking marijuana heavily in their teens and had an ongoing marijuana use disorder showed a decline of at least 8 intelligence quotient (IQ) points between the ages 13 and 38 [4]. It was not reversed in those who had quit marijuana as adults. Some studies have reported complete recovery of impairments after 4 weeks of abstinence, whereas other studies describe persisting cognitive deficits. These deficits are seen predominantly in the domains of attention, memory, and executive functions. Some studies indicated partial recovery of cognitive impairments in abstinent users [5–7].

Considering the increased number of cannabis users in India and changes in the attitude of young people towards cannabis due to its legalization in several Western countries, it is imperative to have a better knowledge of the effects of cannabis on cognitive function in young adults. This study aims to be a small step in this endeavour.

Methods

This study was an observational case-control follow-up study done in a rehabilitation centre in the state of Andhra Pradesh. Sampling was done using the purposive sampling method. The study comprised two groups of subjects. Those were 50 young people between the ages group 18–25 years with active cannabis use (group A) who got admitted to the rehabilitation centre and a comparison group consisting of 50 college students pursuing their graduation with no history of cannabis use (group B). Smoking was the sole method of consumption of cannabis in all these 50 patients. The Structured Clinical Interview for the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (SCID-5) was used to diagnose cannabis use disorder, and it was confirmed by urine drug screening.

Written informed consent was taken from the subjects from both the study and control groups and from the caregivers wherever required. Subjects with a history of head injury and seizures, those who were suffering from substance-induced psychosis or any other psychological disorders, or those who were already taking treatment for their substance use were excluded from the study. After obtaining the Indlas VIMHANS Hospital institutional ethics committee's approval, the study was conducted from June 2021 to December 2021.

A semi-structured pro forma was used to collect the socio-demographic data. The Montreal Cognitive Assessment (MoCA) test was used to assess cognitive functioning. It was developed by Dr. Ziad Nasreddine and colleagues in 2005 for the assessment of cognitive functions [8]. The MoCA test consists of 13 items measuring seven cognitive domains: executive functioning; visuospatial abilities; attention, concentration, and working memory; language; abstract reasoning; memory; and orientation with a maximum score of 30. It is a one-page test that can be administered in 10 min. Its reliability was adequate, with a coefficient alpha of 0.75 [9], and its sensitivity and specificity in detecting mild cognitive impairment were found to be 86% [10]. The following ranges may be used to grade the severity of cognitive impairment: 18–25 = mild cognitive impairment, 10–17= moderate cognitive impairment, and less than 10 = severe cognitive impairment. The study was done in 2 steps.

Step 1

The cognitive functioning of subjects from group A was assessed by using Montreal Cognitive Assessment (MoCA) test after an initial period of 1 week of abstinence. These scores were compared with the MoCA scores of group B.

We have chosen this 1-week abstinence period, as assessing cognitive functioning under cannabis intoxication and immediate withdrawal period may not give proper test results due to the acute effects of cannabis on attention and concentration.

Step 2

The cognitive functioning of patients from group A was reassessed after the completion of 3 months of treatment in our rehabilitation centre by repeating the MoCA test. The patients were completely abstinent from any kind of psychoactive substance during this period. All these patients attended a daily routine programme of ground activities for 60 min, breathing exercises for 10 min, Jacobson's progressive muscle relaxation (JPMR) exercise for 20 min, yoga and meditation for 30 min, and daily counselling sessions. JPMR is a non-pharmacological method of relaxation, teaching the patients to monitor the tension in specific muscle groups by first tensing and then relaxing each muscle group. It is widely used to reduce the anxiety and increase self-esteem and thus helps patients in dealing with stressful conditions more

confidently. No special medications were given, or cognitive remedial techniques were taught to improve their cognitive functioning.

The effect of cannabis use on cognitive functioning was assessed by comparing scores of group A (at 1st week of treatment) and group B.

The effect of abstinence from cannabis use on cognitive functioning was assessed by comparing scores of group A in the 1st week and after the 3rd month.

Statistical analysis

Data entry and analysis were performed using Microsoft Excel (2019) and MedCalc version 20.109 (Ostend, Belgium).

Descriptive statistics

Continuous variables were reported as means with standard deviations (SD), and categorical variables were reported as numbers with the percentage of the total.

Inferential statistics

Karl Pearson's correlation coefficient was used to calculate the relationship between duration, the quantity of cannabis use, and the initial MoCA score of cannabis users.

The *Z*-test of difference between two means was used to compare mean scores of MoCA between cannabis use and nonuser groups. Paired *t*-test was used to compare the initial MoCA score with the score after 3 months of abstinence from cannabis.

For all analyses, the probability level considered to indicate statistical significance was set at $P < 0.05$.

Results

In our study, all the subjects in both groups were men. The mean age of the subjects in cannabis use was 21.02 ± 1.85. Two-thirds of the subjects were graduates ($n = 39$, 78%), from nuclear family ($n = 38$, 76%), and practising Hinduism ($n = 38$, 76%). Nearly half of the subjects were from a middle-class socio-economic background ($n = 23$, 46%). More than half of the subjects ($n = 28$, 56%) were consuming 50–100 g of cannabis per day on average. The mean duration of cannabis use was 3 ± 1.63 years, with the majority of the subjects consuming for the past 2–4 years ($n = 33$, 66%). Among other substances used, tobacco was the most commonly consumed substance ($n = 30$, 60%) followed by alcohol ($n = 26$, 52%), whereas 12 (24%) subjects reported using illicit drugs. Only 4 (8%) subjects reported cannabis as their single drug of abuse. The mean MoCA score, in the beginning, was 21.8 ± 2.04. This score increased to 24.08 ± 2.66 when examined after 3 months of abstinence (Table 1).

Table 1 Sociodemographic data of study subjects

Variable	Group A (%) $N = 50$ (100%)	Group B (%) $N = 50$ (100%)
Age in years	(Mean ± SD) 21.02 ± 1.85	(Mean ± SD) 19.62 ± 1.10
18–20	19 (38%)	39 (78%)
> 20 years	31 (62%)	11 (22%)
Education		
Up to intermediate	4 (2)	0
Graduation	39 (78)	50 (100)
Post graduation	07 (48.75)	0
Type of living		
Nuclear	38 (76)	25 (50)
Joint	12 (24)	25 (50)
Socio-economic status		
Upper	18 (36)	19 (38)
Middle	23 (46)	23 (46)
Lower	09 (18)	08 (16)
Religion		
Hindu	38 (76)	36 (72)
Muslim	10 (20)	12 (24)
Christian	02 (04)	02 (04)
On-going medicolegal cases		
Yes	11 (22)	-
No	39 (78)	-

SD standard deviation

Among the cannabis nonuser group, the mean age of the subjects was 19.62 ± 1.10. All the subjects were perusing graduation ($n = 50$,100%). Half of the subjects ($n = 25$, 50%) were from a nuclear family, and the other half ($n = 25$, 50%) were from a joint family. Two-thirds of the subjects ($n = 38$, 76%) belonged to the Hindu religion. Nearly half of the subjects ($n = 23$, 46%) were from a middle socioeconomic background. One-third of the subjects ($n = 16$, 32%) reported using tobacco, and another one-third ($n = 18$, 36%) reported using alcohol. The mean MoCA score was 28.62 ± 0.85 (Tables 1 and 2).

There was a statistically significant difference between MoCA scores of cannabis users and the control group ($P < 0.001$) (Table 3). When checked after 3 months of abstinence, MoCA score was increased to a statistically significant level in users group ($P < 0.001$), but the mean score was still less than mean score of the control group (24.08 ± 2.66 vs 28.62 ± 0.85, $P < 0.001$) (Tables 4 and 5).

We found a statistically significant relationship between duration ($r = -0.296$, $P = 0.036$) and quantity of cannabis use ($r = -0.491$, $P < 0.001$) and a decrease in cognitive functioning (Table 6).

Table 2 Substance use pattern of study subjects

Variable	Group A (%) $N = 50$ (100%)	Group B (%) $N = 50$ (100%)
Average cannabis use per day (in grams)		
< 50	20 (40)	-
50–100	28 (56)	-
> 100	02 (04)	-
Duration of cannabis use (in years)	(**Mean ± SD**) 3 ± 1.63	
< 2	08 (16)	-
2–4	33 (66)	-
> 4	09 (18)	-
Other substance use		
Tobacco	30 (60)	16 (32)
Alcohol	26 (52)	18 (36)
Lysergic acid	03 (06)	-
Cocaine	01 (02)	-
MDMA	03 (06)	-
Methamphetamine	01 (02)	-
Solvents	02 (04)	-
Benzodiazepines	01 (02)	-
Magic mushrooms	01 (02)	-
Nil	04 (8)	16 (32)

SD standard deviation, *MDMA-3-4* methylenedioxymethamphetamine

Table 3 Comparison of MoCA scores between cannabis users and nonusers using *Z*-test

Variable	Group A	Group B	*p*-Value
MoCA score **(mean ± SD)**	21.8 ± 2.04	28.62 ± 0.85	< 0.001*

MoCA Montreal Cognitive Assessment test, *SD* standard deviation, *$P < 0.05$

Table 4 Comparison of MoCA score in cannabis user's baseline versus after 3 months of abstinence using paired *t*-test

Variable	Initial MoCA score	MOCA score after 3 months of abstinence	*p*-Value
MoCA score **(mean ± SD)**	21.8 ± 2.04	24.08 ± 2.66	< 0.001*

MoCA Montreal Cognitive Assessment test, *SD* standard deviation, *$P < 0.05$

Table 5 Comparison of MoCA score in cannabis users after 3 months of abstinence with base line score of nonusers using *Z*-test

Variable	MoCA score ofgroup A after 3 months of abstinence	MoCA score of group B	*p*-Value
MoCA score **(mean ± SD)**	24.08 ± 2.66	28.62 ± 0.85	< 0.001*

MoCA Montreal Cognitive Assessment test, *SD* standard deviation, *$P < 0.05$

Table 6 Relationship between cannabis use and MoCA score Pearson correlation test

Variable	*r*-value	*p*-value
Duration of cannabis use	−0.296	0.036*
Quantity of cannabis use	−0.491	< 0.001*

*P-value < 0.05

Discussion

Cannabis use was highly comorbid with other substance use disorders. Illicit drug usage is 10 times more common in males than females, and there is a huge gap related to treatment for substance use between genders. This could be the reason for the representation of only male patients in our study.

Cannabis use and other substance use disorders

The National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) survey had shown that around half of those with cannabis use in the past year also met diagnostic criteria for alcohol and nicotine use disorders [11]. Among illicit drugs, cocaine, sedatives, stimulants, club drugs, and opioid use disorders were common in those who use cannabis [12].

In our study, alcohol use and nicotine use were seen in 52% and 60%, respectively. Other substance use was seen in a negligible percentage of subjects. Though cannabis along with alcohol and nicotine can act as a gateway drug, availability and affordability also play a significant role in the presence of other substances of abuse. Exposure to other illicit drugs has been low in Andhra Pradesh with the exception of cannabis. This might explain the low incidence of other illicit drug use in our study sample.

Relationship between cannabis use and cognitive functioning

There was a statistically significant difference between the mean MoCA scores of cannabis users and the comparison group ($P < 0.001$). The majority of the past studies have suggested a significant cognitive decline in cannabis abusers compared to non-abusers and healthy controls [13–16]. Bassiony et al. in their case-control study on 1682 adolescents found that adolescents who use cannabis frequently had impairment in cognitive functions, and their total MoCA score was less than the controls [17]. Bartholomew et al. reported prospective memory impairments associated with cannabis use in young adults [18]. In India, Wig and Varma reported cognitive disturbances such as poor attention span and memory deficits in bhang users [19]. Mendhiratta et al. in their study reported delayed reaction time, poor concentration, and poor time estimation in long-term cannabis users [20].

We found a statistically significant negative correlation between duration ($r = -0.296$, $P = 0.036$) and quantity of cannabis use ($r = -0.491$, $P < 0.001$) and cognitive functioning in our study subjects. Studies have proven that cannabis-related cognitive impairment depends upon duration and dosages of use [21]. Adolescents who start using cannabis at an early age generally use a very high amount of cannabis. Cannabis use during critical developmental periods in the still-maturing brain may induce persistent alterations in brain structure and brain function. Studies have also proved that cannabis use can alter the pruning process in adolescents resulting in long-term consequences [22]. Structural imaging studies showed abnormalities in hippocampal volumes and grey matter density in temporal lobes of cannabis users relative to controls [23].

Effect of abstinence on the improvement of cognitive function

Wallace et al. reported improvement in cognitive functions after 2 weeks of monitored abstinence [24]. Rabin et al. [25] in their study found that cannabis-related cognitive impairment is state dependant, and they are reversible with a sustained period of abstinence [26]. Other studies done on chronic cannabis abusers also found significant improvement in cognitive functions after a period of more than 1 month of abstinence [26, 27].

In our study, we reassessed the cognitive functioning after abstinence period of 3 months from cannabis use and found a statistically significant difference in MoCA score ($P < 0.001$). Though there was a significant improvement in the mean MoCA score in cannabis users after 3 months of abstinence, this score was still lower than the MoCA score of the control group, with a statistical significant difference between these scores (24.08 ± 2.66 vs 28.62 ± 0.85, $P < 0.001$). This clearly denotes that cannabis use has long-term effects on cognitive functions, and abstinence improves these functions up to some extent only. This can be explained by findings of the previous studies which found that the structural changes induced by chronic cannabis use particularly in the hippocampus and amygdale were persistent even after a prolonged period of abstinence resulting in long-term effects on cognitive functioning [23].

Limitations of the study

The sample of subjects in our study represents an extreme end of the cannabis use spectrum, i.e. patients using higher quantities of cannabis for longer duration. This may not represent the cannabis users in the community. The subjects in the case group are also taking other substances of abuse which can also have effect on their cognitive functions and their performance on MoCA test. Sample size calculation was not done, and the sample size was small. So generalization of the study findings needs to be done carefully. Base level cognitive functioning of these subjects before they started using cannabis was not available. Initial MoCA score was low in cannabis user group, but the cause-effect relationship could not be established with the current study design. Though we have not used specific cognitive remedial techniques, effect of other activities like reading newspapers, participating in group counselling sessions, physical activities, yoga, and meditation on improvement in cognitive functions cannot be ruled out. Long-term cohort studies with good number of participants, a sample consisting of subjects with exclusive cannabis use and a rigid study design will yield much clear results in future.

Conclusions

Cannabis is perceived as a relatively safe recreational drug by young adults due to legalisation for recreational use across the world and its portrayal in popular culture. Our study clearly shows cognitive deficits in cannabis users compared to the nonusers. These cognitive deficits may affect their scholastic abilities, further worsening their prospective careers. Abstinence from cannabis use improves modest but reliable improvement of cognitive functions, but still some deficits are remaining. The impairments must be accounted for while formulating psychotherapy strategies for these patients. Cannabis use also leads to other mental health problems like psychosis, depression, and anxiety. However, the young adult population seems to be unaware of the risks with cannabis use. So, there is a need for primary prevention strategies at a community level like psycho educating the parents, teachers and students regarding the ill-effects of cannabis, thus reducing the prevalence of cannabis use.

Abbreviations

MoCA test: Montreal Cognitive Assessment test; THC: Tetrahydrocannabinol; IQ: Intelligence quotient; SCID-5: The Structured Clinical Interview for DSM-5; DSM5: The *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*; JPMR: Jacobson's progressive muscle relaxation.

Acknowledgements

Not applicable

Authors' contributions

SSG designed the study protocol, collected the data, and administered the tests. RMS and VI did literature review and manuscript proofreading. NK helped in statistics part. The authors read and approved the final manuscript.

Funding

No funding was received. The authors declare that the research was conducted in the absence of any commercial or financial relationships.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study was conducted with the approval of Indlas VIMHANS Hospital institutional ethics committee. Informed consent was taken from the subjects from both groups and from the caregivers wherever required.

Consent for publication
Not applicable

Competing interests
The authors declare that they have no competing interests.

Author details
[1]Indlas VIMHANS Hospital, Vijayawada, Andhra Pradesh 520002, India. [2]Antara Psychiatric Hospital and Rehabilitation Centre, Kolkata, India. [3]Department of Statistics, NRI General Hospital, Guntur, India.

Received: 20 May 2022 Accepted: 22 July 2022
Published online: 15 August 2022

References

1. Ambekar A, Agarwal A, Rao R, Mishra AK, Khandelwal SK, Chadda RK. National surveyon extent and pattern of substance use in India 2019. Magnitude of substance use in India (2019). Ministry of Social Justice and Empowerment Government of India. Available from: https://socialjustice.nic.in. (Accessed 21 Jan 2022)
2. Patton GC, Coffey C, Carlin JB, Degenhardt L, Lynskey M, Hall W (2002) Cannabis use and mental health in young people: cohort study. Br Med J 325:1195–1198
3. Battistella G, Fornari E, Annoni JM, Chtioui H, Dao K, Fabritius M et al (2014) Long-term effects of cannabis on brain structure. Neuropsychopharmacology. 39(9):2041–2048
4. Meier MH, Caspi A, Ambler A, Harrington H, Houts R, Keefe RSE et al (2012) Persistent cannabis users show neuropsychological decline from childhood to midlife. Proc Natl Acad Sci U S A 109(40):E2657–E2664
5. Bolla KI, Brown K, Eldreth D, Tate K, Cadet JL (2002) Dose-related neurocognitive effects of marijuana use. Neurology 59:1337–1343
6. Hunault CC, Mensinga TT, Bocker KB, Schipper CM, Kruidenier M, Leenders ME et al (2009) Cognitive and psychomotor effects in males after smoking a combination of tobacco and cannabis containing up to 69 mg delta-9-tetrahydrocannabinol (THC). Psychopharmacology 204:85–94
7. Solowij N, Stephens R, Roffman RA, Babor T (2002) Does marijuana use cause long-term cognitive deficits? JAMA. 287:2653–2654
8. Nasreddine ZS, Phillips NA, Bédirian V, Charbonneau S, Whitehead V, Collin I et al (2005) The Montreal cognitive assessment, MoCA: a brief screening tool for mild cognitive impairment. J Am Geriatr Soc 53(4):695–699
9. Bernstein IH, Lacritz L, Barlow CE, Weiner MF, DeFina LF (2011 Jan) Psychometric evaluation of the Montreal cognitive assessment (MoCA) in three diverse samples. Clin Neuropsychol 25(1):119–126
10. Ozer S, Young J, Champ C, Burk MA (2016) A systematic review of the diagnostic test accuracy of brief cognitive tests to detect amnestic mild cognitive impairment. Int J Geriatr Psychiatry 31(11):1139–1150
11. Stinson FS, Ruan WJ, Pickering R, Grant BF (2006) Cannabis use disorders in the USA: prevalence, correlates and co-morbidity. Psychol Med 36:1447–1460
12. Hayley AC, Stough C, Downey LA (2017) DSM-5 cannabis use disorder, substance use and DSM-5 specific substance-use disorders: evaluating comorbidity in a population-based sample. Eur Neuropsychopharmacol 27:732–743
13. Solowij N (1988) Cannabis and cognitive functioning. Cambridge University Press, Cambridge
14. Fletcher JM, Page JB, Francis DJ, Copeland K, Naus MJ, Davis CM et al (1996) Cognitive correlates of long-term cannabis use in Costa Rican men. Arch Gen Psychiatry 53:1051–1057
15. Pope HG, Yurgelun-Todd D (1996) The residual cognitive effects of heavy marijuana use. JAMA. 275:521–527
16. Lovell ME, Akhurst J, Padgett C, Garry MI, Matthews A (2020) Cognitive outcomes associated with long-term, regular, recreational cannabis use in adults: a meta-analysis. Exp Clin Psychopharmacol 28:471–494
17. Bassiony MM, Ammar HK, Khalil Y (2021) Cannabis use and cognitive impairment among male adolescents: a case-control study. Addict Disord Their Treat 20(4):416–422
18. Bartholomew J, Holroyd S, Heffernan TM (2010) Does cannabis use affect prospective memory in young adults? J Psychopharmacol 24:241–246
19. Wig NN, Varma VK (1977) Patterns of long-term heavy cannabis use in North India and its effects on cognitive functions: a preliminary report. Drug Alcohol Depend 2:211–219
20. Menhiratta SS, Wig NN, Verma SK (1978) Some psychological correlates of long-term heavy cannabis users. Br J Psychiatry 132:482–486
21. Dragt S, Nieman DH, Schultze-Lutter V, der Meer F, Becker HE, De Haan L et al (2010) Age of onset of cannabis use is associated with age of onset of high-risk symptoms for psychosis. Can J Psychiatr 55:165–171
22. Blest-Hopley G, Colizzi M, Giampietro V, Bhattacharyya S (2020) Is the adolescent brain at greater vulnerability to the effects of cannabis? A narrative review of the evidence. Front Psychiatry 11:S859
23. Ashtari M, Avants B, Cyckowski L, Cervellione KL, Roofeh D, Cook P et al (2011) Medial temporal structures and memory functions in adolescents with heavy cannabis use. J Psychiatr Res 45:1055–1066
24. Wallace AL, Wade NE, Lisdahl KM (2020) Impact of 2 weeks of monitored abstinence on cognition in adolescent and young adult cannabis users. J Int Neuropsychol Soc 26(8):776–784
25. Rabin RA, Barr MS, Goodman MS, Herman Y, Zakzanis KK, Kish SJ et al (2017) Effects of extended cannabis abstinence on cognitive outcomes in cannabis dependent patients with schizophrenia vs non-psychiatric controls. Neuropsychopharmacology. 42(11):2259–2271
26. Fried PA, Watkinson B, Gray R (2005) Neurocognitive consequences of marihuana - a comparison with pre-drug performance. Neurotoxicol Teratol 27:231–239
27. Pope HG, Gruber AJ, Hudson JI, Huestis MA, Yurgelun-Todd D (2002) Cognitive measures in long-term cannabis users. J Clin Pharm Ther 42:41S–47S

Publisher's Note