ORIGINAL RESEARCH

Exploring the association of legalisation status of cannabis with problematic cannabis use and impulsivity in the USA

Louise Destrée BPsych (Hons)[1], Danielle Amiet BPsych (Hons)[1], Adrian Carter PhD[1], Rico Lee PhD[1], Valentina Lorenzetti PhD[1], Rebecca Segrave PhD[1], George Youssef PhD[2], Nadia Solowij PhD[3], Murat Yücel PhD[1]

[1]Brain & Mental Health Laboratory, Monash Institute of Cognitive & Clinical Neuroscience, and School of Psychological Sciences, Monash University, Melbourne, Victoria, Australia; [2]Cognitive Neuroscience Unit, School of Psychology, Deakin University, Geelong, Victoria, Australia; [3]School of Psychology and Illawarra Health and Medical Research Institute, University of Wollongong, New South Wales, Australia

Abstract

Background: There has been an increased trend towards the legalisation of medicinal and recreational cannabis use worldwide. This has been controversial as the long-term effects of frequent cannabis use on the brain are still poorly understood.

Methods: In this study, we investigated whether the legal status of cannabis in the United States of America (USA) is associated with problematic cannabis use and impulsivity in 329 frequent cannabis users. The data were collected in 2015 and were analysed in 2017. Ethical approval for this study was obtained from Monash University in 2015.

Results: The results indicated that participants' problematic cannabis use and impulsivity was not different whether they resided in states where cannabis is legal for medical and/or recreational use or prohibited.

Limitations: The present study is a cross-sectional design, making it difficult to infer causality and establish whether cannabis use is a cause, consequence, or correlate of altered impulsivity.

Conclusion: Our study supports the notion that frequent cannabis use is associated with impulsive behaviours, whilst, conversely, we did not find an association between US state legalisation and problematic cannabis use or impulsivity.

Keywords: impulsivity, legal status of cannabis in the USA, problematic cannabis use.

Introduction

Following the Single Convention on Narcotic Drugs in 1961, recreational cannabis use was banned and its possession became criminalised.[1] Thereafter, cannabis-related crimes – including use and possession – increased dramatically in the USA and Europe, particularly amongst young people.[1] A decade later, concerns were raised regarding the detrimental effects of criminal records on young people.[2] Consequently, some US states decriminalised cannabis use in the 1970s and replaced imprisonment with fines.[2] To date, across the USA, cannabis has been legalised by 29 states for medical use and 8 states for both recreational and medical use. Yet, evidence suggests an association between frequent cannabis use and dependence, cognitive impairment, and vulnerability to psychotic illness.[3] Further evidence suggests that adolescent cannabis users are at a greater risk for adverse outcomes, including persistent cognitive impairment and increased risk of psychotic symptoms.[4] A primary public health concern has been to establish whether the legalisation of cannabis is likely to increase use amongst youth with concomitant negative consequences. Studies show mixed results; some have found higher rates of cannabis use in states that have legalised medicinal use,[5] whereas others have found no difference after law enactment in the USA.[6] MacCoun[7] compared cannabis use in the USA and Netherlands after the legalisation of cannabis and found that cannabis use amongst students aged 15–16 years was higher in the USA. Other countries in the EU that have not legalised cannabis either matched or exceeded the rate of students' cannabis use in the Netherlands.[7] These studies suggest that legalising cannabis for recreational and/ or medical purposes does not necessarily lead to an increase

Figure 1.   Legalisation status of cannabis use in the USA in 2015.

Cannabis is legal for recreational and/or medical use
Cannabis is prohibited
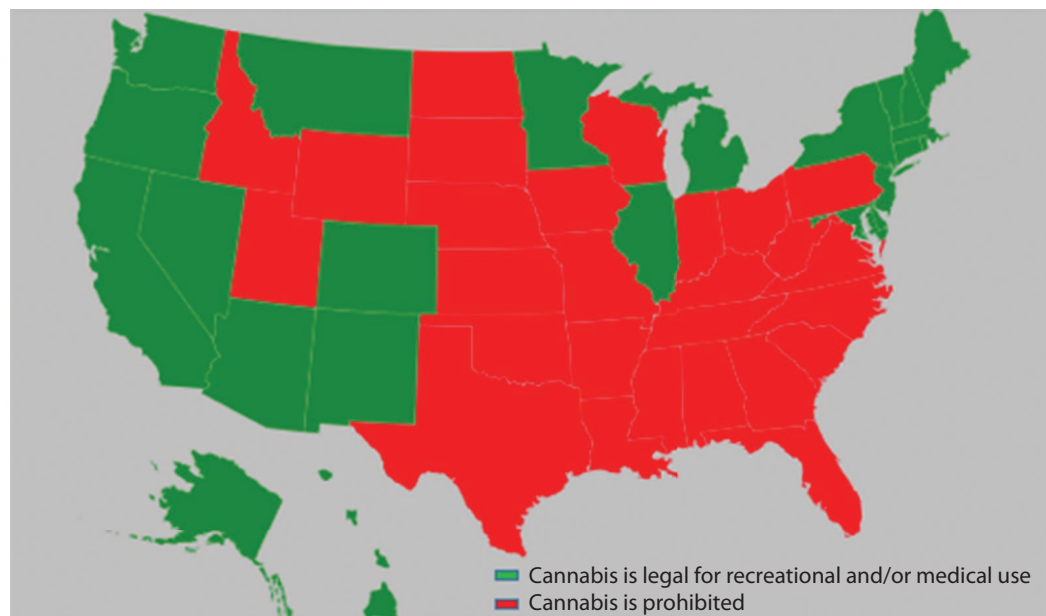
in cannabis use. Other studies show that cannabis use affects regulatory networks of the brain and is associated with impulsivity.[8] For example, it was demonstrated that cannabis increased impulsivity immediately after administration[9]; changes in impulsivity due to cannabis consumption may interfere with individuals' self-regulation, leading to risky or problematic behaviours.[10] As the cannabis landscape evolves and governments are increasingly turning towards legalisation, the public health concerns around cannabis use warrant further research. In the present study, we investigated whether there was an association between legalisation status and either problematic cannabis use or impulsivity in frequent cannabis users and whether the legal status of cannabis in the USA moderates the association between impulsivity and problematic use.

Methods

Ethical approval for this study was obtained from Monash University Human Research Ethics Committee (project number: CF15/1235 – 2015000576). 329 frequent cannabis users were recruited online via the Amazon Mechanical Turk (https:// www.mturk.com/) in 2015, and gave informed consent prior to commencing the questionnaire. All participants were US residents and frequent cannabis use was defined as having used cannabis once or more per week for the past 12 months (mean consumption: 3.93, s.d.: 2.34 times per week). Participants indicated that they had no history of diagnosed alcohol or other illicit substance disorders and that they had not used illicit substances other than cannabis once a month or more across the past 12 months. The sample consisted of 196 males and 133 females. The majority were Caucasian (82%) (see Table 1 for descriptive statistics.)

The Cannabis Use Problems Identification Test (CUPIT) was used to assess problematic cannabis use. It is a 16-item self-report scale with two subscales: 'Impaired Control' over cannabis use and 'Problems' caused by or as a consequence of cannabis use.[11] About 95% of participants met criteria for being at risk of developing a cannabis use disorder, as indicated by scores above 12. About 73% of participants met criteria for cannabis use disorder as indicated by scores above 20.[11] The Barratt Impulsiveness Scale was used to assess how often individuals perform different behaviours. US state legalisation status was obtained in 2015, and individuals were classified into two groups: states where cannabis use was legal for recreational and/or medical purposes (n=158) and states where cannabis was prohibited (n=171) (see Figure 1).

The association between legalisation status and problematic cannabis use (i.e. 'Impaired Control' and 'Problems') and impulsivity were examined using a series of one-way analyses of variance (ANOVA). To examine whether the relationship between impulsivity and problematic cannabis use was moderated by legalisation status, we used multiple regressions. Problematic cannabis use was regressed on impulsivity, legalisation status, the interaction between impulsivity and legalisation status, and a vector of control variables (age, gender, and ethnicity [defined by 'Caucasian' or 'other']). Statistical analyses were performed using IBM SPSS Statistics version 23.

Results

A series of ANOVA found no association between state legalisation status and CUPIT 'Impaired Control' subscale, CUPIT 'Problems' subscale, or impulsivity (see Figure 2). The three ANOVA analyses were replicated using a subset of the sample that comprised only the 73% of individuals who met criteria for a

Table 1.   Demographic and clinical characteristics of participants.

Variable	Total (n=329)	Cannabis legal for medical and/or recreational use (n=158)	Cannabis is prohibited (n=171)
Gender (%)	M: 196 (59.6%) F: 133 (40.4%)	M: 101 (63.9%) F: 57 (36.1%)	M: 95 (55.6%) F: 76 (44.4%)
Age – Mean (SD)	M: 25.83 (3.27) F: 26.12 (3.31)	25.67 (3.24)	26.20 (3.32)
Ethnicity (%)			
Caucasian	n=270 (82.1%)	n=126 (79.7%)	n=144 (84.2%)
Other	n=59 (17.9%)	n=32 (20.3%)	n=27 (15.8%)
CUPIT 'Impaired Control' – Mean (SD)	24.54 (9.15)	24.56 (9.17)	24.53 (9.16)
CUPIT 'Problems' – Mean (SD)	3.03 (3.04)	3.30 (3.33)	2.77 (2.72)
BIS-11 – Mean (SD)	59.21 (11.60)	59.88 (10.87)	58.60 (12.25)

BIS-11, Barratt Impulsiveness Scale; CUPIT, The Cannabis Use Problems Identification Test; F, female; M, male; SD, standard deviation.

Figure 2.   CUPIT and Barrat Impulsivity Scale scores for both groups; cannabis legal for recreational and/or medical purposes and cannabis is prohibited.

Error Bars: 95% CI
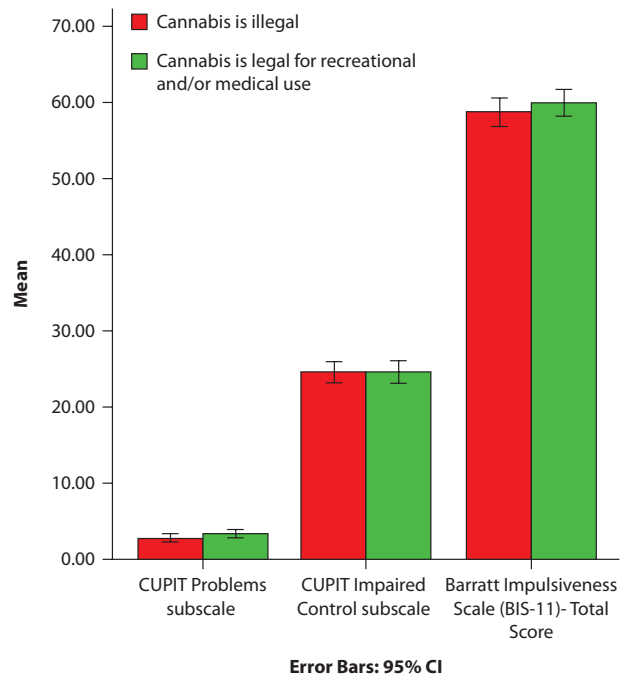
cannabis use disorder; however, again there was no association between state legalisation status and any of the three outcome variables. Two linear multiple regression models (Table 2) were then used to examine whether the relationship between impulsivity and problematic cannabis use was moderated by legalisation status. Specifically, these models regressed the outcome variables (i.e. 'Impaired Control' and 'Problems') on impulsivity, legalisation status, the interaction between impulsivity and legalisation status, and a vector of control variables. These models were found to explain 8% and 17% of the variance in problematic cannabis use when using 'Impaired Control' and 'Problems' subscales as the dependent variables, respectively. Results from the regression models found that after adjustment, impulsivity predicted 'Impaired Control' (β=0.24, p=0.001) as well as 'Problems' (β=0.34, p<0.001). However, the interaction between impulsivity and legalisation status was not significant in both models suggesting that the relationship between impulsivity and problematic cannabis use was not different depending on legalisation status.

Discussion

These data indicate that there is a positive association between problematic cannabis use and impulsivity in frequent cannabis users. This finding is in accord with other studies showing an association between problematic cannabis use and impulsivity.[9] A strong body of research shows that cannabis use is linked with impulsivity, and studies suggest that impulsivity is an important factor related to the early stages of addiction processes, such as drug experimentation.[10] Our results also show that legalisation status in the USA is not associated with problematic cannabis use and impulsivity. The current findings go beyond prior studies to suggest that, at this point in time, the legalisation status of cannabis has not shown an association with cannabis use amongst frequent users, a finding supported by a growing body of literature.[6] Although the detrimental health effects of frequent cannabis use are well established,[3] our findings suggest that legalisation status does not worsen these effects. It is too early to conclude that the legal status

Table 2.   Multiple regression analysis for variables predicting problematic cannabis use.

Variable	b	95% Confidence interval	*p*-value	Standardised *β*
Regression 1: Impaired Control subscale as DV				
BIS-11 total score	0.19	0.08; 0.30	0.001*	0.24
Legal *vs* Illegal	−0.95	−11.22; 9.32	0.86	−0.05
BIS-11 × Legalisation	0.01	−0.16; 0.18	0.90	0.04
Ethnicity	1.38	−1.16; 3.92	0.29	0.06
Age	0.08	−0.22; 0.38	0.60	0.03
Gender	−1.90	−3.89; 0.07	0.06	−0.10
R-squared	0.08			
N	329			
Regression 2: CUPIT Problems subscale as DV				
BIS-11 total score	0.09	0.06; 0.12	<0.001*	0.34
Legal *vs* Illegal	−1.14	−4.36; 2.09	0.49	−0.19
BIS-11 × Legalisation	0.03	−0.03; 0.08	0.36	0.26
Ethnicity	0.48	−0.31; 1.29	0.23	0.06
Age	−0.03	−0.12; 0.07	0.60	−0.03
Gender	−0.59	−1.21; 0.04	0.07	−0.10
R-squared	0.17			
N	329			

*$p<0.05$.
DV, dependent variable.

of cannabis in the USA has had no effects on problematic cannabis use or cannabis-related harms, especially in states with liberal definitions of cannabis use.[2]

Limitations of the study

Our study has several limitations. First, it uses cross-sectional data, making it difficult to infer causality and establish whether cannabis use is a cause, consequence, or correlate of altered impulsivity. Future research would benefit from a longitudinal design to track over the long term whether there is an association between legalisation status of cannabis and problem use and impulsivity. A second limitation is the small sample size, which restricted our ability to investigate those using cannabis for recreational purposes only compared with both recreational and medical purposes. A third limitation is the recruitment design that relied on online self-report data, which may lead to biases. For instance, participants may not have reported their cannabis use or impulsivity accurately due to memory impairments, which

are common in frequent cannabis users.[12,13] Notwithstanding, all participants were informed that their responses would remain anonymous and confidential, encouraging genuine responses. Furthermore, studies have reported that using self-reports are relatively valid tools to measure cannabis use, even compared to more objective measures such as urine tests.[14,15] Nonetheless, it should be noted that we cannot exclude the influence of biases on the accuracy of this study's results.

Conclusion

Despite the above limitations, our study supports the notion that frequent cannabis use is associated with impulsive behaviours, whilst, conversely, we did not find an association between US state legalisation and problematic cannabis use or impulsivity. These findings contribute to the debate related to the benefits of legalising cannabis use and contribute to the debate over the link between problematic cannabis use and state legalisation status as well as impulsive behaviours.

References

1.   Room R, Fisher B, Hall W, Lenton S, Reuter P. *Cannabis Policy: Moving Beyond Stalemate*. USA (New York): Oxford University Press; 2010.

2.   Hall W, Weier M. Assessing the public health impacts of legalizing recreational cannabis use in the USA. *Clin Pharmacol Ther*. 2015;97(6):607–615. https://doi.org/10.1002/cpt.110

3.   Volkow ND, Baler RD, Compton WM, Weiss SR. Adverse health effects of marijuana use. *N Engl J Med*. 2014;370(23):2219–2227. https://doi.org/10.1056/NEJMra1402309

4.   Gruber SA, Dahlgren MK, Sagar KA, Gönenç A, Lukas SE. Worth the wait: effects of age of onset of marijuana use on white matter and impulsivity. *Psychopharmacology*. 2014;231(8):1455–1465. https://doi.org/10.1007/s00213-013-3326-z.

5.   Cerdá M, Wall M, Keyes KM, Galea S, Hasin D. Medical marijuana laws in 50 states: investigating the relationship between state legalization of medical marijuana and marijuana use, abuse and dependence. *Drug Alcohol Depend*. 2012;120(1):22–27. https://doi.org/10.1016/j.drugalcdep.2011.06.011

6.   Choo EK, Benz M, Zaller N, Warren O, Rising KL, McConnell KJ. The impact of state medical marijuana legislation on adolescent marijuana use. *J Adolesc Health*. 2014;55(2):160–166. https://doi.org/10.1016/j.jadohealth.2014.02.018

7.   MacCoun RJ. What can we learn from the Dutch cannabis coffeeshop system? *Addiction*. 2011;106(11):1899–1910. https://doi.org/10.1111/j.1360-0443.2011.03572.x

8.   Wrege J, Schmidt A, Walter A, et al. Effects of cannabis on impulsivity: a systematic review of neuroimaging findings. *Curr Pharm Des*. 2014;20(13):2126–2137. https://doi.org/10.2174/13816128113199990428

9.   McDonald J, Schleifer L, Richards JB, de Wit H. Effects of THC on behavioural measures of impulsivity in humans. *Neuropsychopharmacoogy*. 2003;28(7):1356. https://doi.org/10.1038/sj.npp.1300176

10. Ansell EB, Laws HB, Roche MJ, Sinha R. Effects of marijuana use on impulsivity and hostility in daily life. *Drug Alcohol Depend*. 2015;148:136–142. https://doi.org/10.1016/j.drugalcdep.2014.12.029

11. Bashford J, Flett R, Copeland J. The cannabis use problems identification test (CUPIT): development, reliability, concurrent and predictive validity among adolescents and adults. *Addiction*. 2010;105(4):615–625. https://doi.org/10.1111/j.1360-0443.2009.02859.x

12. Ranganathan M, D'Souza DC. The acute effects of cannabinoids on memory in humans: a review. *Psychopharmacology*. 2006;188(4):425–444. https://doi.org/10.1007/s00213-006-0508-y

13. Solowij N, Battisti R. The chronic effects of cannabis on memory in humans: a review. *Current Drug Abuse Rev*. 2008;1(1):81–98. https://doi.org/10.2174/1874473710801010081

14. Basurto FZ, Montes JMG, Cubos PF, Santed FS, Ríos FL, Moreno AM. Validity of the self-report on drug use by university students: correspondence between self-reported use and use detected in urine. *Psicothema*. 2009;21(2):213–219.

15. Mayet A, Esvan M, Marimoutou C, et al. The accuracy of self-reported data concerning recent cannabis use in the French armed forces. *Eur J Public Health*. 2012;23(2):328–332. https://doi.org/10.1093/eurpub/cks108