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Personality differences in monozygotic twins discordant for cannabis use

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ABSTRACT

Aims To explore the association between cannabis and personality scores when genetic background and shared environment are controlled for. **Design** The co-twin control design. This design provides a powerful method for controlling for the effects of potentially confounding familial factors that may act to predispose subjects both to cannabis use and a particular personality profile. **Participants** 118 monozygotic twin pairs discordant for cannabis use. **Measurements** Data on personality and cannabis use were obtained through a questionnaire survey. The Dutch Sensation Seeking List was used to assess various aspects of sensation seeking. The Amsterdamse Biografische Vragenlijst assessed extraversion, neuroticism, somatic complaints and test attitude. **Findings** The affected twins scored higher on all scales than their unaffected co-twins, especially on experience seeking ($P = 0.004$), total sensation seeking score ($P = 0.004$) and neuroticism ($P = 0.039$). Differences were also observed when items on drug use were removed from the experience seeking scale ($P = 0.037$) and total sensation seeking score ($P = 0.009$) although these differences were no longer significant after Bonferoni correction ($P < 0.005$). **Conclusions** Cannabis use is associated with a higher score on personality scales. This result was obtained in a sample of monozygotic twins discordant for cannabis use. Thus, at least part of the association between cannabis use and experience seeking cannot be attributed to underlying genetic or shared environmental factors that influence both personality and cannabis use and must be explained by unique environmental influences.

Keywords Cannabis, discordant twins, experience seeking, genetic factors, monozygotic, neuroticism, personality, sensation seeking, shared environment.

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INTRODUCTION

In the Netherlands, the term 'soft drugs' is used for substances that are readily available such as the psychedelic mushrooms and cannabis products like hash and marijuana and are regarded as distinctly less harmful than hard drugs such as cocaine and heroin (as defined in the Dutch Opium Act).

The soft drug most commonly used in the Netherlands is cannabis, with the prevalence of lifetime use at 12–21% [1–3]. The lifetime prevalence of hallucinogenic mushrooms is 2.6% in the Dutch population [2].

Cannabis use is associated with increased risk for the subsequent use of more harmful drugs such as cocaine and heroin [1,4–7], just like alcohol and tobacco use appear to act as a gateway to cannabis use [7]. These associations may reflect correlated risks, such as genetic risk factors that influence the liability to use any drug or environmental risk factors like social availability of drugs, or these associations may reflect a causal influence of cannabis on subsequent hard drug use, e.g. pharmacological effects of cannabis increase the liability to use hard drugs [4,8,9].

Differences between cannabis users and non-users are not limited to substance use alone. Compared to non-users, cannabis users score higher on novelty seeking [10] and sensation seeking [11], develop more often a psychosis or psychotic symptoms [12,13] and show more suicidal behaviour [9].

A possible hypothesis to explain the association between cannabis use and personality traits is that genetic and/or shared environmental factors influence both the risk of cannabis use and certain personality traits. The individual variation in cannabis use is

influenced by genetic factors with heritability estimates ranging from 0.17 to 0.72 [14–17], and studies have indeed shown that the association between cannabis use and personality traits is at least partly explained by common genetic factors [10,18]. However, these common genetic factors do not explain all variances in cannabis use. The present paper intends to shed more light into the mechanism underlying the association between cannabis use and personality by determining whether this association still exists when controlling for influences of genes and shared environment. To this aim we use a powerful method, namely the discordant co-twin design, which studies discordant monozygotic (MZ) twin pairs by comparing the personality score of the affected twin, who has used cannabis, to that of his or her non-affected co-twin, who has never used cannabis. In this design, genetic and common environmental influences are controlled for because MZ twins share all their genetic material and their (early) home environment. If the association between cannabis use and personality traits is solely explained by genes and/or shared environmental factors, then the twins who initiated cannabis use should have the same personality score as their co-twins who did not initiate cannabis use. In contrast, if the association is to some extent causal or explained by environmental factors for which twin pairs are discordant, we would expect to find significantly different scores in the cannabis users compared to their unaffected MZ co-twins.

METHODS

Subjects

The data used for this study are obtained from an ongoing twin family study on health and lifestyle of the Netherlands Twin Register (NTR) [19,20]. Since 1991 questionnaires have been sent out every 2–3 years to Dutch twins and their families. For this study we focused on the data from the 2000 survey, which was completed by 4609 twins [21] of which 3890 remained after selecting only twins aged 21 years and older. We excluded participants under the age of 21 years to decrease the risk of misclassification since differences within twin pairs in substance use may change rapidly at a young age. Within this sample, the prevalence of cannabis use (ever used) was 24.4% (31.9% for men and 22.2% for women). Using only complete twin pairs, that is those twin pairs with data available for both members of the twin pair, resulted in a sample of 516 MZ female pairs and 195 MZ male pairs. For most pairs, both members of the pair had never used cannabis: 370 female pairs (72%) and 120 male pairs (61%). In some pairs, both twins had used cannabis: 64 female pairs (12%) and 39 male pairs (20%). The remaining pairs, 82 female twin pairs (16%) and 36 male twin pairs (18%), were discordant for cannabis use. Zygosity was based on DNA tests ($n = 32$ pairs) or on questions concerning similarity ($n = 86$ pairs). Agreement between zygosity based on questionnaire data and zygosity based on DNA is 97% in the total sample. The twins were on average 29.70 years old (SD = 8.92, range from 21 to 67 years).

Variables

The use of cannabis was assessed in a survey on lifestyle, health and personality. Subjects were asked to indicate at what age they used the drugs and substances listed below for the first time. The instruction they were given was 'The list below gives a number of drugs and other substances people may use (cigarettes, alcohol, etc.). If you have ever used any of the substances listed below, please indicate the age at which you used them for the first time.'. Items in the list were as follows: a) Smoked your first cigarette, b) Regularly smoked cigarettes, c) Tried an alcoholic drink, d) Regularly drank alcohol, e) Experimented with soft drugs (e.g. hash, marijuana, magic mushrooms, etc.), f) Regularly used soft drugs, g) Experimented with 'party drugs' (e.g. MDMA, a synthetic, psychoactive drug. Street names for MDMA include ecstasy or XTC), h) Regularly used 'party drugs', i) Experimented with hard drugs (e.g. cocaine, LSD, pep pills, speed, etc.), j) Regularly used hard drugs. The answer categories for each of these items from the list were: first use at 11 years or younger, at the age of 12–13, at the age of 14–15, at the age of 16–17, at the age of 18 or older, or never used. The variable 'experimented with soft drugs' was recoded into ever used cannabis or never used cannabis.

The Dutch Sensation Seeking List [22] was used to assess various aspects of sensation seeking; thrill adventure seeking, experience seeking, boredom susceptibility and disinhibition. Since the subscale experience seeking contains two items on drug use, we performed the analyses of the total score and the experience seeking subscale both with and without those items. Extraversion, neuroticism, somatic complaints and test attitude of the Amsterdamse Biografische Vragenlijst (ABV) [23] were used. The ABV is a 107 item self-report personality scale similar in content to the Eysenck Personality Questionnaire [24]. The scale has demonstrated good reliability and external validity [23].

Data analyses

Twin pairs were selected for this study if a MZ twin had used cannabis (=affected twin) and the co-twin had never used cannabis (=unaffected twin). The affected twin was compared to the unaffected co-twin on sensation seeking and other personality traits using paired-samples *t*-tests. A Bonferroni correction was applied by dividing the overall significance level $\alpha = 0.05$ by the number of

Table 1 Prevalence (%) of other substance use in affected twins and their unaffected co-twins. Differences between affected twins and their unaffected co-twin are tested with the McNemar test for paired samples (*P*-value in last column).

	Affected twin	*Unaffected twin*	*P-value*
Ever tried soft drugs	100.0	0.0	
Ever smoked a cigarette	89.9	72.0	0.000
Smoked regularly	60.9	41.7	0.000
Ever tried alcohol	100.0	100.0	–
Used alcohol regularly	88.6	79.0	0.043
Used soft drugs regularly	13.0	0.0	0.000
Tried party drugs (like XTC)	7.6	1.7	0.039
Used party drugs regularly	5.1	0.9	0.125
Tried hard drugs (like cocaine)	6.8	0.0	0.008
Used hard drugs regularly	5.1	0.0	0.031

XTC = ecstasy.

Table 2 Mean (standard deviation) of affected twins and their unaffected co-twins for the SBL subscales (thrill seeking, experience seeking, boredom susceptibility and disinhibition) and the ABV subscales (extraversion, neuroticism, somatic complaints, test attitude). Differences between affected twins and their unaffected co-twin are tested with paired *t*-test (*P*-value in last column).

	Affected twin	*Unaffected twin*	*P-value*
Thrill seeking	36.2 (9.9)	35.8 (9.7)	0.636
Experience seeking	36.0 (9.1)	33.8 (7.9)	0.004*
Experience seeking without drugs items	32.9 (8.6)	31.4 (7.6)	0.037*
Boredom susceptibility	36.6 (7.3)	34.5 (8.0)	0.010
Disinhibition	32.0 (7.6)	30.6 (8.0)	0.084
Sensation seeking—total	11.1 (1.9)	10.6 (1.9)	0.004**
Sensation seeking—total without drugs items	11.2 (2.0)	10.8 (1.9)	0.009*
Extraversion	61.9 (14.7)	61.0 (15.7)	0.589
Neuroticism	52.4 (24.5)	48.0 (21.0)	0.039*
Somatic complaints	17.9 (4.6)	17.7 (5.0)	0.772
Test attitude	35.9 (8.6)	36.9 (8.9)	0.252

*$P < 0.05$; **$P < 0.005$ (significance level after Bonferoni correction). SBL = Spannings Behoefte Lijst [Sensation Seeking Questionnaire]; ABV=Amsterdamse Biografische Vragenlijst.

comparisons (0.05/11 = 0.005). The co-twin control design is a special sort of case-control study. This design provides a rigorous test of the hypothesis that cannabis use is still associated with personality scores after controlling for family environment and genetic influences. For MZ twin pairs raised together (as our sample was), aspects of the home and family environment do not differ and members of each pair are genetically identical. This design is likely to achieve a more rigorous control of potentially confounding covariates than reliance on statistical control of observed covariates assessed in non-related individuals.

All statistical analyses were performed with the Statistical Package for the Social Sciences (SPSS) version 11.5 for Windows.

RESULTS

Descriptives

Most of the twins who used cannabis experimented for the first time at an age of 18 years or older (65%). Only 2% started at the age of 12–13 years old, 11% experimented at the age of 14–15, and 22% were 16–17 years old at the time of their first use. Of the 118 twins who tried cannabis, 15 subjects (13%) also reported to have used cannabis on a regular basis at some point in their lives. The prevalence of other substance use, both licit (smoking and alcohol use) and illicit (party drugs and hard drugs), was higher in the affected than in the unaffected co-twins (Table 1).

Personality

When comparing the twins on the subscales of the sensation seeking questionnaire, the affected twins scored higher on all scales (Table 2). The differences between the average scores for thrill seeking, boredom susceptibility and disinhibition were small and not significant. After Bonferoni correction, the affected twins still scored significantly higher than the unaffected twins on the experience seeking scale and the total sensation seeking score. However, the experience seeking scale contains two items

on drug use. When analyses were repeated without those items, both the score on experience seeking and the total sensation seeking score were still higher in affected twins compared to their unaffected co-twins, but not significant after Bonferoni correction ($P = 0.037$ and $P = 0.009$, respectively).

Affected twins also scored higher than their co-twins on all scales of the ABV except test-attitude. The largest difference was found for neuroticism scores. This difference was not significant after Bonferroni correction ($P = 0.039$).

DISCUSSION

The current study explored the differences in personality scores in MZ twin pairs discordant for cannabis use. The twin pairs selected in this study are genetically identical and shared their home and family environment. Our use of the co-twin control method provides a powerful tool for controlling for the effects of potentially confounding familial factors (either genetic or environmental) that may act to predispose persons both to cannabis use and a particular pattern of personality scores.

The twins who used cannabis had more often used other substances, both legal (alcohol and tobacco) and illegal (party drugs and hard drugs), compared to their MZ co-twins who never used cannabis. This is in accordance with previous research (also using the co-twin control methodology), which showed that rates of lifetime party drugs use and life time hard drugs use were elevated in twins who used cannabis before the age of 18 compared to their co-twins who did not use cannabis before the age of 18 [1,6].

The affected twins scored significantly higher on neuroticism, experience seeking and sensation seeking (total score) than their unaffected co-twins. Differences were also observed when items on drug use were removed from the experience seeking scale and total sensation seeking score although the significance of the results was reduced. Several studies have found an association between personality scores and cannabis use [9,11–13]. Pedersen [11] demonstrated that different subdimensions of sensation seeking were strong predictors of future drug use in a sample of 553 adolescents aged 16–18 years. For example, experience seeking predicted cannabis use in boys. However, epidemiological studies with unrelated subjects do not correct for common genetic factors that influence both personality and cannabis use. With the present study we demonstrated that the differences in personality scores between twins who used cannabis and their unaffected co-twins cannot solely be explained by genetic influences and/or a shared environment. A remaining question to be addressed by future research is the mechanism leading to these differences in personality scores between genetically identical users and non-users. Differences in cannabis use may lead to personality differences or, vice versa, personality differences may lead to differences in cannabis use. Alternative explanations are also possible, such as the existence of a third unique environmental factor that is influenced directly or indirectly, e.g. through an effect on genetic make-up, both personality and cannabis use. The possible causal pathways underlying the relationship between personality traits and cannabis use has not received much attention but two papers have specifically explored the causal relationship between cannabis use and psychotic symptoms [25,26]. Results of these studies were not in agreement; while Fergusson *et al.* [26] concluded that cannabis use causes psychotic symptoms, the results by Ferdinand *et al.* [25] pointed to a common vulnerability underlying both cannabis use and psychosis or a bi-directional causal relationship. The pathways causing cannabis use to be associated with personality and psychological disorders therefore still remain to be determined.

A potential limitation of the present study is that participation in the survey study of the NTR is voluntary and therefore may present a selection bias. However, the prevalence of ever having used cannabis in our sample (25.4%) is comparable to the prevalence of cannabis use in a similar age group within the Dutch population as reported for 2001 by the Netherlands National Drug Monitor [27]. A second potential limitation is that self-report data are obtained and it is possible that such reports may be biased in some way. Still, research has shown acceptable reliability and validity for self-reported age of onset of cannabis use [28,29].

In conclusion, our MZ discordant comparison shows that individual-specific environmental factors play a role in the association between cannabis use and personality, in particular sensation seeking.

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