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Cannabis and cognitive functions: A prospective study*

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Psychological tests measuring intelligence, memory and other cognitive functions were given to 26 heavy cannabis users (mean duration of cannabis use 6.76 years; average daily intake 150 mg THC). Compared with a control group, the cannabis users were found to react slowly in perceptuo-motor tasks, but not to differ in intelligence or memory tests. The users suffered disability in personal, social and vocational areas and indicated higher psychoticism and neuroticism scores.

Key words: cannabis; cognitive functions; memory; intelligence; India

Introduction

One of the major questions related to the effect of cannabis use on psychosocial health pertains to the effect of such use on the intellectual, memory and other cognitive functions; especially the effect of long-term, heavy use. 'The question of whether or not enduring effects on memory and other aspects of intellectual functioning occur as a result of chronic use is a difficult one to answer' [1]. The NIMH Jamaican [2] and the NIDA [3 – 5] three-country studies did not support evidence of cognitive impairment. The Egyptian studies [6 – 9] as well as our own earlier work [10,11] on the other hand, did indicate some evidence of such impairment. The Egyptian study has been criticised on account of sampling and psychometric inadequacies, and although defended by its workers it is agreed that it would be desirable to replicate the work.

Two series of studies have earlier been reported from our centres [10]. In one study, 25 *charas* smokers and 25 *bhang* drinkers were studied and compared with normal controls. In the other series [11], 23 long-term heavy users drawn from a total of 131 such users were studied and compared with a matched sample of 11 non-user controls. Although the above series found evidence of impairment in cognitive functions with reference to the normal control group, yet it is difficult to say whether the lower intellectual and memory functioning was genuine or related to cannabis use. We have accordingly considered it desirable to conduct a prospective study.

We, in India, are in a comparatively advantageous position for research on the effect of long-term heavy cannabis use as there is demonstrably a sizeable number of such users and as the social sanctions, as opposed to legal sanction, against its use are considerably less than in Western countries. It can be argued that social sanctions against the use may be related to a number of apparent psychosocial consequences including the drifting of the users into a subculture, with its own consequences. In India, on the other hand, a large majority of cannabis users come from the main stream of the society, and are active thriving members of the society with social, occupational, marital,

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and familial responsibilities. Accordingly, the impairment, if any, cannot be explained on the basis of social alienation and relinquishing of responsibilities.

Subjects and methods

The study was conducted to evaluate the effect of long-term, heavy cannabis use on intelligence, memory and other cognitive functions and carried out on a sample of 26 long-term heavy cannabis users and 26 matched controls, a long-term heavy user being defined as a person regularly consuming cannabis for 5 years, 20 or more times per month, with a daily intake equivalent to 150 mg of Δ-9 THC.

In order to select the users, temples and other common gathering places (*Addas*) of users were visited. Key-informant and snow-ball techniques were used to identify suitable users. The controls were selected by individually matching them with the users in terms of age, education and occupation.

Users and controls were administered a set of psychological tests. For the users, abstinence for a minimum period of 12 h prior to testing was ensured by hospitalising them overnight, so as to minimise the risk of acute effects of cannabis confounding the results. The users were financially compensated to make up for the lost wages.

The following tests were administered:

(1) Pencil Tapping test: Each subject was provided with a pencil and asked to tap on a uniform sized paper as quickly as possible for 30 s. The total number of dots made gave an estimation of motor activity and speed.

(2) Time Perception test: Subjects were instructed as follows: 'Sit quitely. After some time, I shall ask you how much time has elapsed starting from this moment'. The time interval was always 2 min. The time period, in minutes, guessed by the subject to have elapsed, was scored.

(3) Reaction Time: A list of 20 words was read one by one to the subject. On hearing each word, he was asked to report as quickly as possible whatever ideas came to his mind. The time taken to start the response, after the stimulus word had been given, was noted. The mean time taken for 20 responses was taken as the subject's score on this test.

(4) Size-Estimation test: Each subject was shown the outline drawings of the shapes of the coins of 50 paise and 5 paise in four different sizes each. The subjects were asked to tell which of the four sizes was the correct size for each of the three coins. The number of incorrect responses (chose smaller or large size) was counted.

(5) Trail Making Test (Form A): It requires the subject to link serially the numbers 1 – 25 endorsed in small circles which are scattered haphazardly over the test sheet. The total time taken and errors committed were noted.

(6) Bender Visual-Motor Gestalt test (BVMG): Each subject was asked to reproduce all the nine designs of the BVMG test, one by one, on a standard size paper. The scoring was done by HAIN's method [12].

(7) Nahor and Benson test (NBT): As in BVMG here also the subject was asked to reproduce all the designs one by one on a standard size paper. The number of correct designs reproduced was the score of the subject [13].

(8) Standard Progressive Matrices test (SPM): The test consists of 60 problems divided into five sets of 12. The problems which follow each set become progressively difficult. Each correct answer gets the score of one. The raw score is then converted to percentile rank or WAIS IQ equivalent [14,15].

(9) WAIS-R (Verbal Scale): The Indian adaptation of the WAIS-R Intelligence Scale (verbal) consists of four subtests: Information, Digit Span, Arithmetic, and Comprehension. Each correct answer would get one mark. The raw scores were added up separately for each subtest and their test scores were obtained according to the norms [16,17].

(10) Bhatia's Short Scale (BSS): This test has been standardized from the Bhatia's Battery of Performance Tests of Intelligence in which Koh's block design and Alexander's Pass Along test (APA) are administered [18,19]. The raw score is converted to the IQ according to the norms.

Table I. Perception and sensory motor functions of cannabis users and controls.

	Subtests	Pencil tapping test	Time perception test (s)	Reaction time test (s)	Nahor-Benson test	BVMG (Hain's score)	Trail making test	Size estimation test
Users (N = 26)	Mean ± S.D.	151.5 25.40	216.04 95.22	3.15 1.30	1.00 1.52	4.23 4.00	68.27 25.93	Correct 54 Incorrect 24
Controls (N = 26)	Mean ± S.D.	167.76 18.32	148.69 32.89	1.32 1.03	0.26 0.53	2.65 2.24	42.30 14.39	Correct 71 Incorrect 7
	t-Value	2.59*	3.34**	5.7**	2.38*	1.73 NS	4.37**	χ^2 = 11.62**

*Results significant at 0.05 level.
**Results significant at 0.01 level.

(11) PGI Memory Scale: This scale [20] was constructed and standardized in 1979. It contains 10 subtests: (1) Remote memory, (2) Recent memory, (3) Mental balance, (4) Attention concentration, (5) Delayed recall, (6) Immediate recall, (7) Retention for similar pairs, (8) Retention for dissimilar pairs, (9) Visual retention and (10) Recognition. The method of scoring adopted followed the norms given in the manual.

(12) The Hindi Psychoticism, Extraversion and Neuroticism Scale (PEN): This consists of 78 items. Each item is to be answered by Yes or No. All the items are scored on a scoring key and scored according to norms [21].

(13) The Disability Assessment Schedule: The schedule consists of 27 items. There are 9 items in each area of personal, social and vocational disability.

The users and the controls were compared with each other in terms of their performance on these psychometric tests.

Results

The mean age of the cannabis users and control subjects was 24.5 years (range 15–35 years). The majority in either group were single (6.1%); were Hindus (88.51%); had education up to middle (61.5%); and belonged to urban areas (96%). Users and controls were matched on age, occupation and education as well as on marital status, religion and urbanicity.

Table I compares the users and the controls on their performance on the psychometric tests. The mean score of the users was significantly lower on the pencil tapping test.

Table II. IQ of cannabis users and controls.

	Intelligence tests	WAIS-R (VIQ)	BB-SS (PIQ)	Raven's SPM (PIQ)
Users	Mean	103.08	93.08	84.6
	± S.D.	10.15	14.49	9.81
Controls	Mean	99.92	98.19	87.12
	± S.D.	11.08	14.38	9.58
	t-Value	1.05 NS	1.21 NS	0.91 NS

Table III. Percentile scores of PGI Memory Scale of cannabis users and controls

	Subsets of Memory Scale	Remote memory	Recent memory	Mental balance	Attention-concentration	Delayed recall	Immediate recall	Retention for similar pairs	Retention for dissimilar pairs	Visual retention	Recognition
Users	Mean	47.69	42.30	55.76	57.69	58.46	70.0	60.0	58.46	70.0	51.60
(N = 26)	± S.D.	6.51	13.94	27.15	29.43	24.11	25.29	22.80	26.63	21.90	23.03
Controls	Mean	50.0	50.0	54.61	52.30	62.30	81.53	64.61	66.15	71.53	61.53
(N = 26)	± S.D.			27.31	16.32	17.95	18.04	15.55	23.83	19.53	16.17
	t-Value	1.77	2.76**	0.14	0.80	0.63	1.85	0.83	1.08	0.26	1.73
		NS		NS	NS	NS	NS	NS	NS	NS	NS

*Significant at 0.05 level.
**Significant at 0.01 level.

The users again differed from the controls in the time perception tests, over-estimating the elapsed time of 120 s. The reaction time was significantly longer in the case of users. They gave a higher error score on the Nahor and Benson test as well as under trail making tests. The two groups did not differ significantly on the BVMG. A significantly higher proportion of the users estimated the given size incorrectly (Table II).

As regards the intellectual function, the two groups did not differ significantly on any one of the three measures of intelligence: WAIS-R measuring verbal intelligence; Bhatia's Short Scale; and Raven's Standard Progressive Matrices.

An elaborate battery of memory tests was administered to assess the functions of the users and the controls (Table III). The users and the controls did not differ significantly on the

Table IV. Personality and disability scores of cannabis users and controls.

		PEN inventory				Disability Assessment Schedule		
		Psychoticism	Extraversion	Neuroticism	Lie	Personal	Social	Vocational
Users	Mean	6.73	13.15	8.96	8.04	4.23	3.46	2.46
	± S.D.	3.32	2.62	4.29	2.24	2.32	2.16	2.16
Non-users	Mean	4.53	10.61	5.30	9.69	0.92	0.76	0.61
	± S.D.	2.15	3.12	2.93	2.89	1.0	0.99	0.85
	t-Value	2.85**	3.17**	3.66**	2.26*	6.62**	5.86**	4.20**

*Significant at 0.05 level.
**Significant at 0.01 level.

percentile scores on any one of the various subtests of memory, except that the users scored significantly lower on recent memory.

On the personality variables, the users gave significantly higher scores on psychoticism, neuroticism and extraversion and a lower score on social disability. As expected, the users gave a significantly higher score on the three measures of disability, namely personal, social and vocational.

Discussion

As compared to our earlier studies [10,11], the present study used a more comprehensive battery of psychological tests to measure the cognitive and personality variables. In addition, it also attempted to measure the disability of the users in several areas of functioning.

The present study replicates earlier findings of difference between users and controls in the pencil tapping test, time perception test, and size-estimation test. The users were slower in pencil tapping and tended to perceive the time as longer than elapsed. As regards the time perception tests, all subjects — controls and users — over-estimated the time of 120 s. However, the over-estimation was significantly greater in the users. The earlier study [10] also gave similar results in the sense that all over-estimated the time, but the users estimated it to be longer than the controls. With regard to over-estimating the time, an interesting point is sometimes conjectured, i.e. the so-called aphrodisiac effect of cannabis. As cannabis users tend to over-estimate the duration of sexual intercourse, they may feel that the drug contributed to their sexual potency.

In the size-estimation test, the proportion of incorrect estimations was much greater in the case of the users. This difference, although similar to that reported earlier [10] was more pronounced.

The present study failed to find a significant difference between users and controls on the BVMG, in contrast to both the earlier studies in which users were found to have a higher Hain's error score. Another similar test, namely the NBT was used in the present study which yielded a significantly higher error score in the case of the users.

An important way in which the present study has produced results different from those of both our previous studies pertains to the intellectual and the memory functions. The IQ as measured by each of the three tests, namely WAIS-R (verbal), BSS (performance), and SPM, failed to produce significant differences between users and controls whereas we had found earlier [11] that the users and the controls differed significantly on the Raven's Coloured Progressive Matrices as well as Malin's Intelligence Scale for Indian children, an adaptation of the corresponding Wechsler Scale.

For the memory functions, a more elaborate test was used, developed in our department [20] and widely researched and published. It measures memory functions in 10 different areas. By and large, the users and the controls did not differ significantly on the percentile ranking on each subtest, except in the case of the subtest for recent memory.

The present, more carefully conducted, research on cognitive functions indicates that the users and the controls did not differ significantly in terms of intelligence and memory. This is contrary to our earlier finding and more consistent with the NIMH Jamaican and other studies [2—5]. It appears that the differences, if any, between users and non-users in terms of cognitive functions pertain to perceptuo-motor tasks.

The point has been often emphasized that in our country and cannabis users, by and large, belong to the mainstream of society and do not form a socially deviant drug culture and are thus fully functioning members of society. The present study, however, finds that the users were significantly more disabled in each of the three areas, viz. personal, social and vocational functioning. It is possible that although in these areas the score was significantly higher than in controls it did not amount to a noticeable disability.

The present study has also tried to indirectly

look at the psychopathology of users. The bulk of research evidence has been against a higher incidence of independent psychiatric illnesses in the cannabis users. Most of the studies reporting psychopathology in cannabis users [22–24] which have indicated the so-called 'cannabis psychosis' have been faulted on research methodology. An earlier study [25] has also failed to lend support to an increased incidence of psychiatric illnesses in cannabis users.

All the same, the present study has found significantly higher psychoticism and neuroticism scores in the users. Our earlier study [10] also found a higher neuroticism score in the users. Psychoticism was studied for the first time in the present study. The users were significantly more extroverted than the controls. Surprisingly, the social desirability score (lie score) was significantly higher in non-users as compared to users.

To conclude, the present study indicates that impairment of cognitive functions, if any, associated with long-term, heavy cannabis use may concern perceptuo-motor tasks more than intelligence or memory. Furthermore, there is some suggestion that the users suffer disability in personal, social and vocational areas and show higher psychoticism and neuroticism, although these do not reach clinically significant levels.

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