5-2010

Neuropsychological Performance in Cannabis Users and Non-Users Following Motivation Manipulation

Michelle Stiles
University at Albany, State University of New York

Running Head: NEUROPSYCHOLOGICAL PERFORMANCE

Neuropsychological Performance in Cannabis Users and Non-Users Following Motivation Manipulation

Michelle Stiles

University at Albany

ABSTRACT

Background: Previous research has yielded conflicting results regarding the long term consequences of cannabis use on cognitive functioning. Although in the cannabis literature, there is a commonly held belief associated with cannabis use called, "amotivational syndrome" the authors were unable to find any studies of neuropsychological performance that attempted to manipulate motivation.

Methods: Fifty-five undergraduates (34 cannabis users and 21 non-users) participated in an extensive neuropsychological battery. The experimenter read a statement at the beginning of the battery designed to induce motivation. Group differences on test performance were calculated with a one-way analysis of variance (ANOVA) for tests that did not differ in gender, and a 2 x 2 ANOVA (user by gender) for tests that did differ in gender.

Results: Significant group differences were found on four measures in the battery. Rey Complex Figure (RCF) Copy yielded a significant negative effect for cannabis use. California Verbal Learning Test-II (CVLT-II) Short Delay Free Recall, CVLT-II Short Delay Forced Choice, and CVLT-II Long Delay Cued Recall yielded significant positive effect for cannabis use in males. The groups did not significantly differ ($p > .05$) on any other tests in the battery.

Neuropsychological Performance in Cannabis Users and Non-Users

Following Motivation Manipulation

Cannabis is by far, the most widely used illicit drug in the United States today, with 47.5 percent of college students reported trying it at least once in their lifetime as of 2008 (Levinthal, 2004). Opinions regarding the use of cannabis have been dramatically changing, most prominently displayed in the passage of medical marijuana laws in 14 states. These laws have been enforced most recently in a memorandum issued by Deputy Attorney General, David Ogden (Ogden, 2009). With these changes in society well under way, scientific researchers are actively trying to determine the long term effects of cannabis use.

The acute effects of cannabis use have been extensively studied, but less is known about the residual effects in the cognitive domain. One meta-analysis examined 15 studies of chronic cannabis users on eight cognitive domains (attention, abstraction/executive, forgetting/retrieval, learning, motor, perceptual motor, simple reaction time, verbal/language) and found small deficits in the domains of learning and forgetting/retrieval, with effect sizes of -.21 and -.27, respectively (Grant et al., 2003).

In the cannabis literature, a commonly held belief about frequent cannabis users called, "amotivational syndrome" has been observed. This is a belief that individuals who use cannabis experience a long term effect of seven major symptoms including loss of energy, loss of productivity, inability to concentrate, slovenliness, apathy, depression, and a continuation of use (Page, J.B., 1983). However, the authors were unable to find any studies of neuropsychological assessment in cannabis users that attempted to manipulate motivation. Therefore, neuropsychological deficits exhibited in users may have been related to motivational factors, rather than actual cognitive deficits caused by long term use of cannabis.

To measure a person's cognitive abilities accurately there needs to be adequate effort from that person. Therefore, if a person is not motivated during a neuropsychological test their score may not accurately reflect their true cognitive abilities. Patients with depression are an excellent example of a group that could be influenced by a lack of motivation when taking neuropsychological tests. Goal setting instructions were used in an experiment (Scheurich et al., 2008) to manipulate motivation in two groups, a clinically depressed group (n=66) and a matched control group (n=60). Half of each group was given the goal setting instructions and the other half of each group was given standard instructions. The participants basic cognitive functioning was assessed by a standard vocabulary test, the Block Design Test from the Wechsler Adult Intelligence Scale-Revised German Version, and the Self-Efficacy Scale. The effects of the goal setting instructions were measured by the German version of the Auditory Verbal Learning Test (AVLT), the Number Combination Test (ZVT), the Regensburg Word Fluency Test, and the Digit Symbol Test. Depressed patients who received goal setting instructions increased their cognitive performance, specifically on the ZVT (13%) and the AVLT (10%). These results support that the use of motivational instructions have an impact on performance, and further raises questions about the use of motivational instructions in all cognitive testing.

The purpose of this study was to examine the neuropsychological performance of cannabis users compared to non users, after inducing motivation by means of a motivational statement. It is possible that neuropsychological performance of cannabis users could be enhanced by a motivational statement, thus potentially accounting for the group differences between users and non-users that have been previously found.

METHODS

Participants

Participants (n=55) were recruited from the Psychology 101 Research Pool of the University at Albany, State University of New York. The sample was predominantly Caucasian, with 38 Caucasian participants, 5 African American participants, 6 Hispanic/Latino participants, and 6 Asian participants. The first group (n=34) consisted of cannabis users defined as using cannabis at least 4 times per week for the last year. The users had an average age of 19.59 years (*SD* = 1.58), consisted of 24 males and 10 females. The second group (n=21) served as the control group, defined by use less than 6 times in their lifetime, and not within the past thirty days. The participants had an average age of 19.04 years (*SD* = 1.80), consisted of 13 males and 8 females. The two groups did not differ in intelligence ($p > .05$), as approximated by the NART-R. Both groups were read a statement by the experimenter at the beginning of the experiment which was designed to induce motivation.

Materials

Each participant completed an extensive battery of neuropsychological testing which was completed in one hour. Tests included in this battery are as follows: the California Verbal Learning Test-II (CVLT-II), the Digit Span subtest of the Weschsler Adult Intelligence Scale-III (WAIS-III), the Rey-Osterrieth Complex Figure Test (RCF), the Trail Making Test, the National

Adult Reading Test-Revised (NART-R), the Computerized Assessment of Response Bias (CARB), and the Word Memory Test (WMT).

The CVLT-II was used to measure verbal learning and memory. For this test, the experimenter read a list of words and then asked the participant to recall as many words as possible. This was repeated four times, then a list of different words, referred to as List B, was read to the participant as a distracter, and the participant was then asked to recall as many words as they could from this list. Then, the experimenter again asked the participant to recall as many words from the first list as they could, after which they were cued to which groups the words may fall in (ie: animals, transportation, vegetables, and furniture). Later to measure effort, the participants were asked to choose which word was on the original list (Forced Choice Task), choosing between either a distracter word, a List B word, or a word from the original list.

The WAIS-III Digit Span was used to assess attention and working memory. For this test, the examiner read a series of numbers increasing in length to the participant at a rate of one digit per second. The participant was then asked to repeat back the series of numbers in the same order (in the forward condition), and each set length is tested twice (i.e.: 3-4-9 and 5-2-8). If the participant is able to repeat back correctly, the first set of numbers, the examiner then presents the next longer set (i.e.: after the participant completes two 4-digit series, the examiner presents a 5-digit series). The process continues with sequentially longer sets of numbers until the participant is unable to complete both trials of a given set length, at which time the test is terminated. After this portion (the forward condition) is completed, the experimenter begins the second portion (the backward condition) of the Digit Span test. The second portion is identical to the first, except that the participant is now asked to repeat the digits back in reverse order (i.e.: if the examiner reads "2-3-4," the participant should respond "4-3-2").

The RCF was used to assess visuoperceptual organization and executive functioning. The test requires the participant to first copy a complex geometric figure as accurately as possible (Rey Copy), then draw the figure from memory as accurately as possibly immediately after (Rey Immediate), and then 30 minutes later draw the figure as accurately as possible again (Rey Delayed).

The Trail Making Test was used to evaluate visual scanning, numeric sequencing, visuomotor speed, mental flexibility, and multi-tasking. The test was broken into two parts, Part A and Part B, both beginning with a sample test demonstrating how to the task was to be completed. In Part A, the participant was asked to connect circles with numbers inside, ranging from 1 to 25, in order (e.g.: 1-2-3), as quickly as possible, without picking up their pen. Part B was the same, except that the participant was asked to alternate with letters of the alphabet in order (e.g.: 1-A-2-B-3-C). Both parts are timed.

The NART-R was used to estimate premorbid intelligence. For this test, the participant was asked to read a list of commonly mispronounced words aloud to the experimenter. Scores are determined by the number of accurately pronounced words.

The CARB was used to detect poor effort. This test was administered through a computer starting by showing the participant a number, then instructing them to then count backwards from 20 silently, and finally asking them to choose between two numbers, a distracter number and the number previously shown. The computer then provided feedback, highlighting the participant's choice in green, if it was correct, or red, if it was incorrect. This was repeated in blocks. The instructions were designed to mislead the participant into thinking that if they did well on the test the computer would allow them to go on to increasingly more difficult blocks, when in fact the opposite is true (i.e.: if they put forth inadequate effort the computer would administer another block).

The WMT was used to assess effort. For this test, the experimenter read a list of word pairs aloud two times, then read the participant two words and asked the participant to choose the word that was on the list, choosing between a distracter word or a word from the list.

Procedure

Each participant was given a phone screen to determine whether or not they were eligible for the study. Individuals were screened for the following criteria: (1) use of any other illicit drug (i.e.: hallucinogens, cocaine, stimulants, or opiates) more than 5 times in their life, (2) history of alcohol abuse (i.e.: consuming 2 or more drinks, 4 or more days per week for a period of one month or longer), (3) current DSM-IV Axis I disorder other than simple phobia or social phobia, (4) history of head injury with loss of consciousness requiring hospitalization, (5) current use of any psychoactive medication, or (6) a medical, psychiatric, or neurological condition that might affect cognitive function.

The day of the experiment a trained research assistant (who was blind to the participant's status) provided the participant with a consent form. Then, the experimenter administered a brief field sobriety test that is commonly used to asses intoxication by having the participant stand on one foot, with the other foot extended, for thirty seconds, to ensure that he or she was not under the influence of cannabis or alcohol. Participants who were unable to complete this test (i.e.: stumbling or lowering the raised foot during the thirty-second period) were asked to reschedule the experiment and reminded to abstain from cannabis or alcohol use for twenty-four hours prior to their appointment.

The experimenter then gathered some basic demographic data including, age, gender, race/ethnicity, years of education, and handedness. The participant was then read one of two statements which was determined prior to the assessment. The first statement was designed to encourage motivation in participants: "We are going to begin a series of tasks which measure different areas of cognition, like memory and attention. If you have any questions at any time, please feel free to ask me. It is very important that you do your best on these tasks, because this research will be used to support legislature on marijuana policy. As long as you give your very best effort on these tasks, we will be able to draw important conclusions from the results." The second statement was neutral, not designed to impact motivation: "We are going to begin a series of tasks which measure different areas of cognitions, like memory and attention. If you have any questions at any time, please feel free to ask me." All participants used in the analyses in this paper were read the statement designed to induce motivation.

The experimenter next administered a battery of neuropsychological tests, to the participant that collectively assessed various aspects of cognitive functioning, in addition to effort and motivation. Finally, the participants were asked to self-report how motivated they were to do their best during the experiment between 0 and 100 (i.e.: 0 being not motivated at all and 100 being the most motivated they had ever been). They were also asked to self-report their interest in marijuana legislature between 0 and 100 (i.e.: 0 being not interested at all and 100 being very interested).

RESULTS

Because the two groups were significantly different in gender distribution, a one-way analysis of variance (ANOVA) was performed to determine whether the two genders differed in performance on any of the neuropsychological or motivational measures. If the genders differed in performance on any of the measures, gender was included as a factor in the analysis.

There was no significant difference in performance between the two genders on Rey complex Figure Copy Task, so gender was not included in the analysis. To compare the performance of motivated non-users and motivated users, the author performed a one-way ANOVA. Significant group differences were identified on the Rey Complex Figure Copy Task ($F = 4.042$, $p = .049$), illustrating better performance by the non-users.

There was a significant difference in performance between the two genders on the CVLT-II Short Delay Free Recall, CVLT-II Short Delay Forced Choice, and CVLT-II Long Delay Cued Recall so gender was included in the analysis. To compare the performance of the two genders within each user group, the author performed a 2 x 2 ANOVA (user status by gender). A significant interaction would indicate that within each user group, the two genders performed significantly differently on the measure. There was a significant interaction on the CVLT-II Short Delay Free Recall ($F = 7.838$, $p = .007$), such that the male users performed significantly better than the male non-users, while the female users did not significantly differ from the female non-users. There was also a significant interaction on the CVLT-II Short Delay

Forced Choice (F = 4.790, p = .033), such that the male users performed significantly better than the male non-users, while the female users did not significantly differ from the female non-users. There was also a significant interaction on the CVLT-II Long Delay Cued Recall (F = 5.616, p = .022), such that the male users performed significantly better than the male non-users, while the female users did not significantly differ from the female non-users.

The two groups did not significantly differ ($p > .05$) on any other measures in the battery.

DISCUSSION

The main findings of this study yielded significant group differences on four measures in the battery after motivation was manipulated. Only one (Rey Copy) of the four tests revealed a negative effect of cannabis use (non-users performed better than users). RCF Copy task is a measure of executive functioning and visuospatial organization. It is curious why this task shows a negative effect for cannabis use for two reasons. First, in this task the participant is asked to draw the complex figure exactly as it is shown. Therefore, one might assume that this deficit may influence later requests for the participant to draw the figure from memory at two different times (immediate recall and delayed recall). Yet the two groups did not significantly differ on either of those later tasks. The second reason that this finding is curious is because, it does not fall into the domains that Grant and his colleagues found deficits in cannabis users. It would be beneficial to further study this finding in a battery that included other measures of visuospatial organization and executive functioning to serve as comparative measures.

The positive effect of cannabis use on the other three tests is also quite interesting. The CVLT-II Short Delay Free Recall and the CVLT-II Long Delay Cued Recall are both measures of verbal memory. The motivated male users performed significantly better on both tests in comparison with the motivated male non-users. This result may be explained by the unequal number of males in the two groups (24 user males vs. 13 non-user males).

The positive effect of cannabis use on CVLT-II Forced Choice Task may be explained by the verbal content of the motivational statement. The Forced Choice Task is a measure of effort, which the author hypothesized to be increased as a result of the motivational statement. Considering the performance of the user males was better than that of the non-user males, although they received the same motivational statement, may imply that the statement influenced them differently. With the ongoing change in cannabis legislature as discussed earlier, it is possible that this statement could have been perceived as a change towards legalization (pro-cannabis legislature). Thus, users may have been more influenced to do well in hopes of personal gain, and in opposition non-users may have not have been influenced by the statement because there was no opportunity for personal gain.

This study had possible limitations regarding the participants. The participants were required to complete multiple research studies for credit and may not have been motivated to perform to the best of their abilities. Also, since all participants were university students, the enrollment process to be accepted into the university may have screened out any potential participants that are affected, or are more severely affected by “amotivational syndrome.”

Other limitations involve the testing scenario of the study. It is possible that performing neuropsychological tests in a small office, for a stranger, may not be a true representation of a participant’s true cognitive abilities if tested in a more natural environment. The length of the experiment is also quite lengthy (one hour with no breaks), therefore levels of effort may have fluctuated or diminished over the course of the experiment.

The last possible limitation of the study is the tactic used to induce motivation. The phrasing of the motivational statement clearly was not perceived equally by both groups, as it had more of an impact on the cannabis users than the non-users. A different tactic that may have influenced both groups more equally would have been a monetary incentive. For example, offering a certain amount of money for a certain score on the tests might equally motivate both groups to perform well.

The overall implication of this study supports that there is little effect of cannabis use on neuropsychological performance, as demonstrated by the lack of significant differences on all of the other measures in the battery including some in the domains that Grant and his colleagues found deficits in. Therefore, neuropsychological deficits exhibited in cannabis users may have been related to motivational factors, rather than actual cognitive deficits caused by long term use of cannabis. Furthermore, Grant's findings should be interpreted with caution if a simple motivational set of instructions is enough to wipe out the deficits he found in cannabis users. Replication of these findings in a study with greater power would strengthen the results and also help to understand the relevance of the executive functioning and visuospatial organization deficit found in this study.

REFERENCES

Grant, I., Gonzalez, R., Carey, C. L., Natarajan, L., Wolfson, T. (2003). Non-acute (residual) neurocognitive effects of cannabis use: a meta-analytic study. *Journal of the International Neuropsychological Society*, 9, 679-689.

Levinthal, C. F. (2004). *Drugs behavior and modern society*. Upper Saddle River, New Jersey: Allyn & Bacon.

Ogden, D. (19, October 2009). Memorandum for selected United States attorneys. *U.S. Department of Justice*. Retrieved from http://www.justice.gov/opa/documents/medical-marijuana.pdf

Page, J. B. (1983). The amotivational syndrome hypothesis and the Costa Rica study: Relationships between methods and results. *Journal of Psychoactive Drugs*, 15, 261-267.

Scheurich, A., Fellgiebel, A., Schermuly, I., Bauer, S., Wolfges, R., & Muller, M. J. (2008). Experimental evidence for a motivational origin of cognitive impairment in major depression. *Psychological Medicene , 38*, 237-246.