



An Exploration on the Effects of Marijuana on Eyewitness Memory

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Introduction

Extensive research has been conducted on the plethora of factors influencing eyewitness memory including stress (see Christiansen, 1992; Deffenbacher, 1983), retention interval (e.g., Flin, Bull, Boon, & Knox, 1992; Lipton, 1977), participation (e.g., Hosch & Cooper, 1982; Yuille, Davies, Gibling, Marxsen, & Porter, 1994), age (e.g., Parker, Haverfield, & Baker-Thomas, 1986; Yuille, 1988), cognitive and sensory deficits (e.g., Dent, 1986; Porter, Yuille, & Bent, 1995), and misleading and post-event information (e.g., Loftus, 1974; Loftus & Davies, 1984). Yet one variable that may exert great influence on the memories of numerous forensic witnesses has been virtually ignored by researchers—drug usage.

Several years ago, an archival police file review was conducted in a Canadian city to determine the characteristics of victims and witnesses to various types of crimes (Yuille, 1986). A serendipitous finding confirmed the popularly held view that drugs are an important factor in criminal activity and crime-reporting; suspects, victims, and/or witnesses are frequently under their influence. Unfortunately, it was impossible to obtain reliable estimates of the prevalence of drug usage in witnesses from this review because the police had recorded evidence of drug usage on an irregular basis. Even when drug usage was noted, there was no attempt to determine accurately the degree of intoxication. The law-enforcement officers were subsequently interviewed to gauge their beliefs regarding the prevalence of drugs in forensic settings. Based on their experience, the officers unanimously indicated that alcohol is extremely common and that marijuana use is also frequently evidenced in forensic contexts.

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In light of the widespread use of alcohol as a recreational drug (The Canadian Centre on Substance Abuse and the Addiction Research Foundation of Ontario [CCSA/ARF], 1994), it is not remarkable that it often surfaces in forensic arenas. The prevalence of marijuana in witnesses is best understood in terms of the demographics of certain types of criminal activities. Citizens between the ages of 16 and 24 years are most frequently the victims of assault, theft, and robbery (Solicitor General of Canada, 1983). These are crimes for which the victim is commonly the only witness (Yuille, 1986). Significantly, this is the same age range in which marijuana use is the highest (CCSA/ARF, 1994). A national survey conducted by the CCSA/ARF in 1990 found that 9% and 13% of Canadians between the ages of 15 to 19 and 20 to 24, respectively, were current marijuana users. In addition, 7% and 20%, respectively, indicated being former users of the drug. In support of these statistics, Glassner, Carpenter, and Berg (1986) found that 50% of students enrolled in Grades 7 through 12 (ages 12 to 18) reported having used marijuana and 33% reported having taken the drug in the past month (see also Johnston, O'Malley, & Bachman, 1985).

Recently, two empirical studies have reported the effects of alcohol on eyewitness memory (Read, Yuille, & Tollestrup, 1992; Yuille & Tollestrup, 1990). In the Yuille and Tollestrup (1990) study, intoxicated and sober volunteers witnessed a staged theft and were subsequently interviewed about the event. Some witnesses were interviewed immediately after the event and all were questioned one week later. Alcohol inhibited the amount of information recalled immediately after the event and both the accuracy and the amount of the information recalled one week later. The early interview helped to reduce the deteriorating effect of a one-week retention interval on the information recalled (quantitatively). The delayed interview also included a photograph recognition task (identifying the principal character in the staged event). For some witnesses, the thief's picture was included in the photospread, whereas for others it was absent. Alcohol had little effect on the ability of the witnesses to recognize the thief's photograph in the target-present lineup. However, when his picture was absent the formerly intoxicated witnesses had a much higher rate of false identifications than did their sober peers. This study demonstrated that alcohol exerts complex effects on eyewitness memory, which depends on the influence of retention interval and the type of memory test employed (see also Read et al., 1992).

The present study represents the first research specifically addressing the effects of marijuana on witness memory. Marijuana has been shown to have profound effects on memory (for reviews see Darley & Tinklenberg, 1974; Murray, 1986; Reed, 1975). The majority of the findings in the literature support the conclusion that marijuana adversely affects the storage phase of memory (e.g., Darley, Tinklenberg, Roth, Hollister, & Atkinson, 1973; Dornbush, 1974; Wetzel, Janowsky, & Clopton, 1982). An excepting study, in which prose materials were employed, indicated that the drug impairs both the storage and retrieval phases of remembering (Miller, Cornett, Brightwell, McFarland, Drew, & Wikler, 1977a). Miller, McFarland, Cornett, and Brightwell (1977c) examined the effect of marijuana on memory by presenting intoxicated subjects with lists of repeated or nonrepeated words ensued by immedi-

ate free recall, delayed free recall, and recognition tasks. Results indicated that marijuana decreased immediate and subsequent free-recall ability but only slightly impaired recognition memory. One previous study also indicated that marijuana exerts a less significant effect on recognition than on recall (Miller & Cornett, 1978). Because Yuille and Tollestrup (1990) have found differential effects of alcohol on target-present and target-absent photospreads, both were included in the present study to examine marijuana's effect on recognition ability.

The Yuille and Tollestrup (1990) study exhibited the powerful effect that immediate recall opportunity can exert on subsequent recall, with or without the presence of alcohol. Because a limited amount of marijuana restricted the number of experimental conditions that could be employed, we elected to interview each subject twice—immediately following the event and again after a one-week interval.

Because most of the studies examining the influence of marijuana on memory have employed verbal materials as the to-be-remembered stimuli, there are probably limitations in generalizing to more complex, eyewitness situations (see Yuille & Wells, 1991; Yuille, 1993). Consequently, the present study was intended to be exploratory in nature, precluding the formulation of specific hypotheses. Nonetheless, the findings from this study should assist in determining whether witnesses under the influence of marijuana can still be considered reliable, especially in forensic settings.

Method

Participants

Subjects consisted of 52 male volunteers between the ages of 19 to 41 ($M = 23$) recruited through campus advertisements, which indicated that they would be paid \$5 for their participation. Subjects had to be at least 19 years of age, which is the legal drinking age of British Columbia, and have had previous experience with marijuana. Previous marijuana use was required to (a) avoid the possibility of an allergy or other adverse reaction and (b) to be more representative of the forensic population of interest—crime witnesses who use marijuana.

In addition, to ensure subject safety and avoid possible confounds related to nonexperimental memory effects, participants were excluded if they were (a) polysubstance drug abusers (i.e., if they regularly used minor or major tranquilizers, barbiturates, and amphetamines); (b) had an alcohol problem; (c) had serious physical and mental health problems within the last year; (d) had respiratory problems, seizures, epilepsy, myasthenia, and/or heart-related problems; (e) did not have normal or corrected-to-normal vision; (f) had drug-related allergies, and/or other similar complicating factors. These exclusion criteria were assessed via a medical questionnaire.¹ It is important to note that collaboration information, such as medical files and/or blood/urine toxicology,

¹For a copy of the medical questionnaire used for subject screening, contact the first author at the Dept. of Psychology, University of British Columbia, 2136 West Mall, Vancouver, BC, V6T 1Z4.

was not collected in support of the above self-reported information, which may have led to a more heterogeneous population than was desired. Those subjects who met the study criteria were randomly assigned to one of two groups. The marijuana-experimental and the placebo groups consisted of 25 subjects between the ages of 19 and 39 ($M = 23$ and $SD = 4.7$) and 27 subjects between the ages of 19 and 41 ($M = 23$ and $SD = 4.9$), respectively.

Materials

Marijuana cigarettes were obtained from an American government research agency. Following the guidelines of previous research (e.g., Miller, Cornett, & Wikler, 1979; Perez-Reyes, Owens, & Di Guiseppi, 1981), a dosage level was employed (in the experimental condition) that would induce intoxication without risking an adverse reaction. The experimental subjects smoked 907-mg cigarettes with a 10.4% moisture content and 1.24% tetrahydrocannabinol (THC) content. The control subjects received cigarettes of similar size (840 mg with a 12.7% moisture content) with the THC removed (0.004% THC).

To attain a high degree of realism, the memory stimulus employed in this study was a complex event designed to be involving for the participants and meaningful in the context in which it occurred. After ingesting the drug or a placebo, participants were interrupted by a confederate. The confederate (an actor) represented himself as a graduate student who had detected the odor of marijuana in the building. He became incensed at the use of the drug for any purposes in the Psychology Department. He argued vehemently with the experimenter and threatened to telephone the police. The experimenter then produced a document that demonstrated police approval for the research. The intruder expressed his condemnation for the study and subsequently exited the room.

The use of a confederate permitted the exploration of the possible effects of the drug on eyewitness recognition memory. An eight-person photospread was generated for the identification task. The target-present photospread included a picture of the intruder plus seven photographs of men of similar appearance (foils). For the target-absent photospread the intruder's photograph was replaced by the photograph of an eighth foil.

A Marijuana Effect Scale was designed to measure each participant's subjective opinion regarding the impact of the cigarette he had ingested. They were asked to rate the effect of the marijuana cigarette on a 9-point scale (1 = no effect; 5 = moderate effect; 9 = strongest effect ever felt from marijuana).

Procedure

Subjects were instructed not to drink alcohol or ingest and drugs during the 48 hours preceding the experiment. They were informed that they would be smoking a marijuana cigarette and then performing a memory task involving a slide presentation.

Upon arriving at the laboratory each person signed a consent form. Subjects were then seated and provided a marijuana cigarette ($n = 25$) or placebo ciga-

rette ($n = 27$). Each participant inhaled from the cigarette and retained the smoke for 18 seconds. He then exhaled and paused for 15 seconds. This procedure was repeated until the cigarette had burned to a line 1 centimeter from its end. Participants were tested in groups of eight.

Five minutes after the smoking occurred, all participants completed the Marijuana Effect Scale and then experienced the event described above. The brief interval between the event and memory test was intended to ensure that the effects of the drug would be maximal. As noted by Gieringer (1988), the effects of marijuana are greatest in the first few minutes after smoking and decline slowly over a period of hours. The experimenter prepared a slide projector for the fictitious memory task but was interrupted by the intruder who proceeded to exhibit the behaviors described above. As previously mentioned, the situation was designed to be provocative and involving. Indeed, following the confederate's insolent departure many of the participants voiced concern about the police learning of their participation in the study.

With the culmination of the staged event, participants were informed that it had been staged and would be the focus of the memory study. They were asked to rate their level of anxiety both during and after the event. These ratings were indicated through the use of a 7-point scale (1 = relaxed; 7 = very tense). Each participant was individually interviewed on audiotape concerning his memory for the staged event. Participants were then asked not to discuss the event with other participants during the next week (to minimize memory contamination). The participants returned for a second interview one week after the event. Both interviews followed the Step-Wise Interview procedure (see Yuille, Hunter, Joffe, & Zaparniuk, 1993) in which a free narrative is followed by open, general questions intended to clarify and elaborate the freely recalled material. At the culmination of the second interview, each participant viewed the prepared photospread. The target-present photospread was shown to a random sample of 24 subjects (12 experimental) and the target-absent to 28 participants (13 experimental). Each participant attempted to identify the confederate or rejected the photospread and then rated his confidence in his choice on a 7-point scale (1 = a guess \rightarrow 7 = very confident).

Scoring

After all interviews were completed, the audiotapes of the eyewitness accounts were transcribed. The transcriptions were subjected to an evaluation procedure based on the protocol developed by the first author (see Yuille & McEwan, 1985; Yuille & Cutshall, 1986). The reports were partitioned into single units of information. Each detail was assigned one point if it related a specific piece of information (e.g., "The man who shouted had on a red shirt" contains one action detail and one descriptive detail). Information that was vague or nonspecific was given one-half point (e.g., "The man was tall"). A detail was considered unclassifiable if it relayed subjective information and was hence unclassifiable (e.g., "I felt very nervous at that point"). Fewer than 5% of the total details were unclassifiable. Unclassifiable details were not included in any subsequent analyses.

The accuracy scores of the eyewitness accounts were based on the percentage of correct details over the total number of correct and incorrect details reported.

Results

Manipulation Check

As predicted, participants in the experimental group provided significantly higher ratings on the Marijuana Effect Scale than did the control subjects (averaging rating of 5.9 [$SD = 1.5$] vs. 2.6 [$SD = 1.2$]), $t(50) = 8.79, p < .001$, indicating that the marijuana had exerted its intended effect. A trend was found that suggested participants reported higher anxiety levels during the staged incident ($M = 2.8$ and $SD = 1.1$) than following it ($M = 2.5$ and $SD = 1.1$), $t(51) = 1.93, p < .06$. The relatively small difference in ratings is likely attributable to residual anxiety (stemming from the confederate's outburst) remaining after the event had ended. This would explain why both measures were highly correlated ($r = .45, p < .001$). Thus, this suggests that the event had been anxiety-provoking and involving.

Number of Details Recalled

Table 1 provides summary data concerning the amount and accuracy of information reported in both recall trials by the experimental and control subjects. The amount recalled was subjected to a 2×2 analysis of variance (ANOVA) with drug condition and time of recall as factors. A significant interaction effect was found, $F(1, 50) = 5.38, p < .05$, and followed up with two Bonferroni-corrected t-tests, one on each of the recall times. The marijuana-experimental group recalled significantly less information ($M = 56.2$ and $SD = 9.9$) than did the cigarette-placebo group ($M = 74.3$ and $SD = 22.4$) immediately following the experiment, $t(50) = -3.72, p < .001$. However, after one week there was no difference in the amount recalled as a function of the drug, $t(50) = -1.36, p > .10$, with the intoxicated participants recalling a mean of 69.1 details ($SD = 16.7$) compared to 77.6 details ($SD = 27.1$) by the control group. Significant main effects of both drug and time of recall were also obtained. However, these must be interpreted with caution in light of the above interaction effect. Nevertheless, marijuana had a strong negative effect on the amount of information recalled overall ($F(1, 50) = 6.45, p < .05$); intoxicated participants recalled a mean of 62.6 details ($SD = 15.1$) compared to 76.0 ($SD = 24.7$) details by participants in the placebo condition. Thus, the control subjects recalled significant (21%) more details than did those in the experimental group, $F(1, 50) = 13.78, p < .01$. In addition, results indicate that more information was recalled in the second interview ($M = 73.5$ and $SD = 22.9$) than in the first ($M = 65.6$ and $SD = 19.6$), $F(1, 50) = 15.46, p < .01$. Intoxicated participants exhibited a greater increase in the amount of information recalled from the first interview to the second (23%) than did the placebo group (4%). (Table 1.)

TABLE 1
Mean Number and Percentage Correct of Details
as a Function of Interview and Marijuana

Condition	Total	Accuracy
Immediate		
Marijuana ^a	56.20	83.74
SD	9.93	7.38
Placebo ^b	74.30	86.72
SD	22.39	4.71
Delayed		
Marijuana	69.06	83.17
SD	16.70	6.76
Placebo	77.61	86.00
SD	27.11	5.04

^a*n* = 25.

^b*n* = 27.

Accuracy of Details Recalled

The accuracy scores of the testimonials were also subjected to a 2×2 ANOVA. There were no significant main or interactive effects (each $F[1, 50] < 3.07, p > .05$).

Photospread Identification

Table 2 provides a summary of the accuracy of the responses to the photospreads as well as the mean confidence ratings. The drug's effects on subsequent photospread choices were not significant; overall the control group made correct decisions 81% of the time compared to the 76% accuracy rate of the intoxicated participants, $\chi^2(1, 52) = .63, p > .05$. Similarly, the drug had little influence on subsequent confidence ratings, $F(1, 51) = .81, p > .10$. (Table 2.)

TABLE 2
Identification Accuracy and Mean Confidence Ratings

Identification	Confidence	SD	(%) ^a	<i>n</i>
Placebo				
Present, correct	6.10	1.10	83.3	10
Present, incorrect	6.00	1.41	16.7	2
Absent, correct	5.83	1.27	80.0	12
Absent, incorrect	4.67	1.15	20.0	3
Marijuana				
Present, correct	6.08	0.90	100.0	12
Present, incorrect	—	—	—	—
Absent, correct	6.86	1.22	53.8	7
Absent, incorrect	5.00	1.10	46.2	6

^aPercentage of each of the four conditions; target present/absent and marijuana/placebo.

However, a significant correlation existed between overall confidence ratings and overall accuracy ($r = .36, p < .01$). Accurate subjects reported higher levels of confidence in their decisions (6.15) than did inaccurate subjects (5.09). Interestingly, this effect was not present in the placebo condition, where both correct and incorrect identifications were given similar confidence rating (6.10 and 6.00, respectively). It should be noted that two of the photographs in the photospread were not selected by any witness. Thus, the functional size of the photospread was 6 rather than 8 (see Wells & Turtle, 1987).

Discussion

The presence of marijuana has frequently been ascertained by police in criminals, witnesses, and victims (Yuille, 1986). This investigation represents the first empirical study to test the effects of the drug on eyewitness memory. Our results may have important implications for law enforcement and courts, which occasionally must evaluate the evidence of people under the influence of marijuana.

These data suggest that marijuana exerts only a temporary negative effect on the amount of information the witnesses are able to remember and has little influence on recall accuracy or recognition. This finding contrasts with much of the previous research indicating that marijuana's detrimental effect occurs during the storage process. The evidence for the effect of marijuana on retrieval stems from the fact that participants who smoked placebo cigarettes recalled 21% more than intoxicated participants. The drug's transient effect on subject's retrieval while intoxicated is evidenced by the fact that in the second interview (when no longer intoxicated) subjects in the marijuana group recalled 23% more information than when they were under the drug's influence. Interestingly, this is consistent with the view that marijuana exerts greater negative effects on short-term than on long-term memory (e.g., Borg, Gershon, & Alpert, 1975; Brubaker, 1973; Miller, Cornett, & McFarland, 1977b; Miller et al., 1977c). Moreover, this suggests that once the immediate effects of marijuana dissipate, previously intoxicated individuals recall as much information as those who are initially sober.

One possible reason for the discrepancy between our findings and those of most previous studies is the utilization of a live scenario instead of more simplistic verbal stimuli. The long documented soporific effects of the drug (e.g., Tart, 1970) could perhaps restrict subjects' willingness and/or ability to perform tasks such as learning nonsense syllables or other verbal materials. Episodic memory, involving more "passive" encoding (i.e., attending to the angry man who has just barged into the room), may not suffer these same detrimental effects by marijuana. Further research investigating the drug's effects on memories for different stimuli is warranted.

Two explanations (not necessarily mutually exclusive) might account for the relatively small amount of information elicited in the interviews immediately after the incident. One possibility, previously alluded to, is that marijuana adversely affects the witness's retrieval processes. Alternatively, the somniferous effects of marijuana may have been causing participants to be less

resolved in their efforts to report all that they could recall about the incident. Indeed, it is extremely difficult to determine whether retrieval performance reflected ability or motivation to retrieve or report. The line dividing "unable" from "unwilling" is a fine one at best, and the only strategy of differentiating the two—self-report—is obviously rife with shortcomings. Yet self-report is often the only means to gather such information in forensic settings. Regardless of whether this is an ultimately answerable question, however, it remains out of the purview of the present study.

It is interesting to note how divergent these observed effects of marijuana are from the reported effects of alcohol. Marijuana's temporary and simple effect on the subjects' accounts is quite unlike alcohol, which seems to have permanent and complex consequences for human memory, affecting amount, accuracy, and recognition. For instance, in the Yuille and Tollestrup (1990) study, no improvement was found in amount or accuracy between a recall attempt immediately after the event and a subsequent (and presumably sober) attempt a week later.

Regarding recognition ability, Read et al. (1992) found that alcohol had quite complex effects, interacting with both arousal and presentation of a target-present lineup. Interestingly, the fact that the overall recalled information in the current study increased in the second recall opportunity is consistent with previous research on both subjects under the influence of alcohol (see Yuille & Tollestrup, 1990; Yuille et al., 1994, which found that immediate recall exhibits a powerful positive effect on subsequent recall, regardless of intoxication.

If the present results are replicated there may be some clear recommendations for law-enforcement personnel. Even when under the influence of marijuana, witnesses may provide testimonials that are quite accurate. If a witness who has recently consumed marijuana does not supply enough information, the witness can be reinterviewed at a later time when the probability that the amount of information elicited will increase. In addition, given the well-known beneficial effects of an early recall attempt on both sober (e.g., Yuille et al., 1994) and inebriated subjects (Yuille & Tollestrup, 1990), there may be a very good reason to conduct such an interview. However, research needs to be conducted to ascertain whether the retrieval practice effect holds for subjects under the influence of marijuana or if this effect is simply a reflection of the lowered motivational state produced by this drug.

Moreover, because the effects of marijuana decline slowly over a period of hours (Gieringer, 1988), future research should investigate at which point in time these memory effects dissipate. It may be that, although high at the time of the incident, witnesses may be able to provide full information by the time law-enforcement personnel are ready to question them. Finally, it is also important to note that marijuana did not appear to be a factor in witnesses choosing a perpetrator in a lineup, choosing a foil, or rejecting the lineup.

There are some limitations in applying the current findings to actual investigations. First, the issue of statistical power must be raised in light of the sample size (owing to restrictions on the marijuana supply). It is possible that some of the marijuana's effects were not evidenced because of low power to detect the effects. For example, on the confederate-identification task, participants who had ingested marijuana fared better in the target-present photo-

spread than did the placebo control group. In contrast, intoxicated participants showed much lower accuracy in the target-absent photospread, indicating a possible interaction effect that was not validated statistically. Future research should address this problem by employing larger samples if feasible.

Second, although the current study attained a degree of realism not usually seen in eyewitness studies, the event did not contain levels of stress associated with witnessing or being victimized in certain types of crime (e.g., sexual or physical assault). A potentially useful line of inquiry would be to vary the nature of the event to be remembered. For example, it would be appropriate to divide the subjects into participants and observers and vary the event's perceived consequences for the subjects. An accumulating body of evidence (e.g., Yuille, 1986; Tollestrup, Turtle, & Yuille, 1994) indicates that frequently the only witness to a violent crime is the victim of that crime. It therefore seems likely that when marijuana is involved in actual eyewitnesses, it will often be confounded by arousal and participative factors. Yuille et al. (1994) have found that these two variables can have complex effects on unintoxicated eyewitnesses' accounts. Read et al. (1992) similarly observed that stress shows complicated interactive effects on the testimonials of subjects who had been administered alcohol. The highly relevant question of whether or not marijuana interacts with stress and participation should be addressed in subsequent research.

Finally, the present study could be criticized on the grounds that subjects may have been polysubstance abusers. It may be that the specific memory effects of marijuana might best be studied by investigating these effects in a more homogeneous sample. Although the current study tried to control for possible memory confounds caused by such things as polysubstance abuse and medical complications, no collateral information was gathered to support the self-reported data. However, the fact that subjects were instructed that this information was needed for their own "safety" rather than for excluding possible confounds suggests that subjects had little motivation to lie and/or present themselves in an overly favorable light. Furthermore, cognitive, emotional, and behavioral heterogeneity is a fact of life in a forensic setting and should thus be studied.

It is apparent that before any definitive recommendations can be formulated, further research must be conducted. Marijuana users range from those who only consume it irregularly to those who partake of it daily. It is conceivable that chronic effects, proficiency at smoking the substance, or tolerance for the drug may influence eyewitness memory (or memory processes in general) in marijuana users. Equally necessary are studies examining the effects of different dosages of the drug. Similarly, concurrent usage of alcohol and marijuana is likely a common phenomenon in witnesses. Norton and Colliver (1988) found in a large-scale American survey that among individuals aged 18 to 25 years, 24% of men and 12% of women reported using alcohol and marijuana in combination. Studies of marijuana and alcohol in combination have found that their effects are additive for certain tasks (e.g., Chesher, 1986; Sutton, 1983), but again none have specifically addressed eyewitness memory. Future research should examine possible additive or interactive effects of simultaneous usage on witness memory.

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