

MARIJUANA AND JOB PERFORMANCE: COMPARING THE MAJOR STREAMS OF RESEARCH

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Though some estimate that marijuana use has cost U.S. companies billions of dollars in lost productivity, the relationship between use of marijuana and job performance is far from clear. In this paper, I review studies on this topic from four different methodological perspectives and discuss models to account for their apparently contradictory findings. This discussion suggests hypotheses for future research addressing possible reasons for inconsistencies in past findings.

Introduction

How does the use of marijuana affect peoples' performance at their jobs? The answers to this question vary widely. On one hand, some estimate that use of marijuana and other illegal drugs costs approximately \$100 billion per year in lost productivity to American companies (Bompey 1988; Segal 1990). On the other hand, some argue that marijuana's effects are currently unknown and that its use may have no negative effect at all on job performance (Crow and Hartman 1992). The question is likely to become more important in the future since nearly 60% of Americans have used marijuana and recent surveys indicate that its use may be increasing among high school students (Johnston, O'Malley, and Bechman 1994; Swann 1995), who will, in due course, be entering the labor force.

Debates on the effects of marijuana on job performance are often a waste of time because the "data" on which they are based are highly suspect. For example, Crow and Hartman (1992:923-925) critically evaluate the questionable claim that drug use costs \$100 billion annually and discuss ways such claims become "common knowledge" through the interaction of the media and politically motivated "experts." Some have expressed the concern that the sensitive political nature of this question has inhibited research on this topic and that there may be too little research to provide the basis for an objective discussion to replace the current "public debate" on this issue (Kleiman 1989:6-7).

The author's own investigation suggests more optimism about the possibility of an objective and informed discussion of this topic. Methodologically sound

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studies have been conducted on the topic from a variety of research perspectives and disciplines including cognitive and social psychology, economics, and anthropology in a diverse range of cultural contexts.

Searches of *The Business Periodicals Index*, the indices of the major research journals in the management field including *Academy of Management Journal*, *Administrative Science Quarterly*, *Journal of Management*, *Journal of Management Studies*, *Strategic Management Journal*, and several electronic business databases revealed only a few studies conducted within the last decade which provide data on the relationship between marijuana use and job performance and no detailed literature review and discussion of the relationship between these two variables.

A search of the Index Medicus database, however, revealed a great deal of research which, if interpreted with appropriate caution, provides information relevant to the role of marijuana in the workplace. Much of this work was done by medical researchers and addressed the effects of marijuana on mental and physical health so its relevance to job performance may not be immediately apparent. Many of the tasks subjects performed in these studies, however, seem to have direct relevance to skills required for effective performance at many jobs.

More than 200 research studies were initially screened to select the set of slightly more than 100 studies to be reviewed in this paper. The author himself made the judgments about which studies should be included in this review and developed the overall framework for discussing and integrating the contributions of different research methodologies to this question which is embodied in Tables 1 and 2.

The principle criterion for screening studies was whether the dependent variables were clearly related to job performance. This led to the exclusion of studies dealing only with marijuana's possible effects on physical or mental health and on violent or criminal behavior. Literature reviews on the health consequences of marijuana (e.g. Doblin and Kleiman 1995; Grinspoon and Bakalar 1993, 1995; Husain and Khan 1985) do not provide consistent evidence that recreational use of marijuana produces any long-term health consequences that might have negative effects on job performance. Further, it is possible to draw meaningful conclusions from the literature on the effects of marijuana on job performance without discussing the literature on the health effects of marijuana.

Studies of the effects of marijuana on violent behavior, socially deviant behaviors, and criminal conduct have also been excluded though these topics have been addressed in earlier research (e.g. Halikas, Weller, Morse, and Hoffman 1983). Since deviant behavior would not always reduce job productivity, and since problem behaviors which lead to termination, disciplinary actions by supervisors, or absenteeism are already examined in research on pre-employment drug testing, it is possible to discuss marijuana's effects on job performance without including these studies.

Since marijuana has long been the subject of intense public debate, a researcher's private opinions about the morality of marijuana use may affect his or her selection of studies and discussion of the results. Therefore, special care had to be exercised in selecting the final set of studies. First, the review was

restricted almost entirely to articles published in refereed journals and research monographs. While peer review is certainly not a guarantee of high-quality research, it provides a useful initial screen. Second, the decision about whether to include a study was made after having identified the independent and dependent variables but before examining the study's findings in order to minimize the chances that knowledge of the findings would influence the decision on inclusion. Finally, the typology was discussed and refined with colleagues before summarizing the research results in each category.

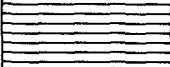
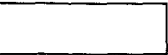
Table 1

Categories of Research Related to the Effect of Marijuana on Job Performance

Methodology	Definition of Use	Definition of Performance	Findings (Methodological Concerns)
Controlled experiments	Acute intoxication	Performance at job-related tasks	Intoxication reduces quality of performance at tasks requiring ability to learn and remember information. Effect sizes are small. Not shown to reduce motivation. (External validity.)
Survey research	Self-reports of frequency of use	Wages, hours worked	Reported use negatively related to learning, memory, and hours worked but positively related to wages and other measures of achievement in young men. Pattern of relationships different for young women. (Causality.)
Pre-employment drug testing	Testing "dirty" or self-reports	Absences, accidents, discipline, turnover	Those who test positive for marijuana use prior to employment have significantly higher rates of performance problems. Effect sizes are small. (Sample selection bias.)
Anthropological field studies	Self-reports confirmed by observation	Pay, work output	Level of use is positively related to some measures of job performance but overall, no significant differences between users and non-users. (Control for observer biases.)

Table 1 deals with the research methodologies used to examine marijuana use and performance.

Table 2
Volume of research
Summarized by research streams & topics covered

	Attention, learning, memory	Psycho-motor skills	Motivation	Job Performance
Controlled experiments				
Survey research				
Pre-employment drug testing				
Anthropological field research				
Key				
Large number of studies	Moderate num- ber of studies	Small number of studies	Few studies/ large number of subjects	Not addressed
				

The author identified four major streams of research related to the question of the effects of marijuana use on job performance: 1) Controlled experiments, 2) Survey research, 3) Pre-employment drug testing, and 4) Anthropological field research. Each stream represents a distinct approach to inquiry with its own strengths and weaknesses. As the table shows, each stream has a different way of defining marijuana use, uses a different definition of performance, and embodies a different set of assumptions about research. As would be expected, the results of each stream are not always supportive of each other.

Table 2 deals with four broad categories of dependent variables related to job performance. In defining these categories and assigning studies to each, the author attempted to adopt a conservative approach and select from a very broad range of dependent variables only those which were most directly related to job performance or to factors which were clearly job-related. The resulting categories are ones that are commonly discussed in personnel and human resource texts and are included in aptitude tests like the General Aptitude Test Battery (GATB).

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The first category of job-related dependent variables is Attention, Learning, and Memory, which deals with the relationship between marijuana and performance at tasks requiring people to learn, remember, and use information. These are skills which seem relevant to all jobs, though much more important in some jobs than in others. The second is Psychomotor Skills such as reaction time and hand-eye coordination, skills which are not important in some kinds of work but very important in others. The third is Motivation to achieve or to perform well. The fourth is actual Job Performance measured in terms of pay, absences, or other measures of productivity on the job.

Next, the research in each methodological perspective will be discussed separately and the findings on each of the four topics will be summarized. Each section concludes with a discussion of the strengths and weaknesses of each approach to research. Understanding the limitations of different methods of inquiry will be useful in explaining the apparently contradictory findings.

Controlled Experiments

Nearly all of the controlled experiments follow the same basic procedure. Subjects are given marijuana (orally or in smoked form) or THC (the active ingredient in marijuana), and its effects on their performance in a variety of tasks are assessed. In this review the results of all studies are combined regardless of the means by which marijuana or THC are administered. Though Casswell and Marks (1973a) have argued that marijuana's effects differ by means of administration, the author's own reading of the literature suggests that the differences in effects are not sufficient to warrant separate treatment. The period of administration varies from a single administration to controlled administration over 98 days (see Murray 1986; and Pope, Gruber, and Yurgelun-Todd 1995 for further discussions of these studies).

These experiments allow us to assess the effects of acute intoxication on performance at tasks constructed to test basic skills or abilities. Several of these basic skills and abilities are relevant to the performance at a wide variety of jobs, so it seems that this research should be relevant in estimating the effects of marijuana intoxication on performance at specific jobs requiring these skills.

Attention, Learning, and Memory

Because marijuana intoxication is commonly believed to make people inattentive, slow, and forgetful, a number of experiments have addressed this question (Abel 1970, 1971; Casswell and Marks 1973a and b; Chait 1990; Chait, Fishman, and Schuster 1985; Dittrich, Battig, and von Zepplin 1973; Dornbush, Clare, Zaks, Crown, Volavka, and Fink 1972; Evans, Martz, Brown, Rodda, Kiplinger, Lemberger, and Forney 1973; Jones and Benowitz 1976; Melges, Tinklenberg, Hollister, and Gillespie 1970a and b; Meyer, Pillard, Shapiro, and Mirin 1971; Miller, Drew, and Kiplinger 1972).

The tasks used to assess attentiveness, learning, and memory in these experiments are typically laboratory tasks which have little apparent similarity to job-related tasks but which do test certain basic cognitive skills. For example some experiments have used the Goal-Directed Serial Alternation (GDSA) task (Melges et al. 1970a and b; Meyer et al. 1971) in which subjects are assigned a

number between 106 and 114 and required to mentally perform sequential additions and subtractions while holding the results of the previous operation in mind. Thus, this task tests attention, memory, and ability to perform complex cognitive tasks. The tasks used in these experiments vary widely but all are designed to test basic cognitive skills and few bear any surface similarity to job-related tasks. Other more innovative measures have also been used including some involving EEG readings but these are even less similar to job-related tasks and so will not be discussed in detail here.

Most experiments have shown that marijuana intoxication reduces subjects' attention or concentration on tasks, their speed at learning new material and their short-term memory. Abel (1970) showed that smoking marijuana reduced subjects' ability to recall written material from a book they read twice at their own speed after smoking and, in a later experiment (Abel 1971), that smoking marijuana reduced subjects' ability to recall words from lists they previously read. Dornbush's (1974) results using a similar research design replicated those of Abel. Miller et al. (1972) found that marijuana affected memory for narrative material but not performance on another memory task (the Stroop Color-Word Test). Several of these studies showed that subjects who had smoked marijuana tended to produce more irrelevant material to "fill in" gaps in their recollections. Casswell and Marks (1973a) and Melges et al. (1970a and b) found that smoking marijuana reduced subjects' performance at the GDSA task discussed above though Evans et al. (1973) found that low doses of marijuana did not influence performance at a task similar to the GDSA. Dittrich et al. (1973) found that subjects showed less ability to recall lists of two-syllable nouns after using marijuana than after using a placebo. Chait (1990) and Chait et al. (1985) have shown that some negative effects persist, but with diminished intensity, over periods of 24 hours.

Experiments on the effects of marijuana on the ability to recall material already in long-term memory have shown no overall differences attributable to marijuana intoxication (Darley, Tinklenberg, Roth, Vernon, and Koppel 1977; Parker, Birnbaum, Weingartner, Hartley, Stillman, and Wyatt 1980). One study which explored both short-term and long-term memory showed that intoxicated subjects required more trials to learn word lists but that they recalled more of the material they had learned when tested three days later than subjects who were not intoxicated while learning the lists (Rickles, Cohen, Whitaker, and McIntyre 1973).

Psychomotor Skills

Since psychomotor skills are important in a large number of jobs, and since driving performance is central to the performance at a variety of jobs, research results on the effects of marijuana on driving performance are relevant to the discussion of its effects on job performance. Some of the experiments previously cited in connection with the effects of marijuana on attention, learning, and memory also included tests of psychomotor and driving performance. A few additional studies have also been identified (Brief, Silverton, Saccuzzo, and Janowsky 1981; Bech, Rafaelsen, and Rafaelsen 1973; Clark, Hughes, and Nakashima 1970; Hansteen, Miller, Lonero, Reid, and Jones 1976; Jones and Stone 1970; Kaplan 1973; Klonoff 1974; Kvalseth 1977; Manno, Kiplinger,

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Haine, Bennett, and Forney 1970; Manno, Kiplinger, Scholz, Forney, and Haine 1971; MacAvoy and Marks 1975; Mathew, Wilson, Humphreys, Lowe, and Weithe 1993; Melges 1976; Moskowitz, Shea, and Burns 1974; Moskowitz, Zeidman, and Sharma 1976; Rafaelsen, Beech, Christiansen, Christrup, Nyobe, and Rafaelsen 1973; Robbe, and O'Hanlon 1993; Roth, Tinklenberg, Whitaker, Darley, Kopell, and Hollister 1973; Vachon, Sulkowski, and Rich 1974; Wilson, Ellinwood, Mathew, and Johnson 1994).

Research dealing with psychomotor performance covers a wide range of tasks testing hand-eye coordination, reaction time, spatial and temporal judgments, etc. Marijuana intoxication has been shown to cause a greater rate of errors in estimates of distance (Bech et al. 1973) and estimates of time which could affect judgments in driving and operating machinery (Hollister and Gillespie 1970; Jones and Stone 1970; Melges et al. 1971; Vachon et al. 1974). It also affects visual tracking (MacAvoy and Marks 1975; Melges 1976; Roth et al. 1973) and visual information processing (Brief et al. 1981; Casswell and Marks 1973b) as well as reducing reaction time and coordination of movements important for operating industrial machinery as well as driving (Kvalseth 1977; Manno et al. 1970; Manno et al. 1971; Moskowitz et al. 1974). In general, these experiments suggest that acute marijuana intoxication impairs performance, particularly at more complex tasks.

The effects of marijuana intoxication on performance in driving simulators and controlled driving tests are somewhat more ambiguous, suggesting that in situations more similar to actual driving situations (or to actual work situations) users may be able to "suppress the marijuana high" (Murray 1986:34). Crancer, Dille, Deloy, Wallace, and Haykin (1969) found that marijuana intoxication reduced the accuracy of speedometer readings but did not affect use of the brakes, accelerator, or steering. Though Hansteen et al. (1976) showed decrements in driving skills for high doses of marijuana, Robbe and Hanlon (1993) found that in a controlled driving protocol, including driving in high-density urban traffic, higher doses impaired performance slightly but that the only significant effect of lower doses was that they caused drivers to drive more slowly, a trait which would not necessarily produce less safe driving.

Motivation

Experiments on the motivational effects of marijuana intoxication bear on the claim that marijuana leads to an amotivational syndrome (McGlothlin and West 1968). Some have claimed that this syndrome reduces effort and leads to poorer performance at jobs and school work (Hendin, Pollinger, and Ulman 1981; Margolis and Popkin 1980; Miranne 1979).

Research has dealt with the effects of intoxication on the psychological phenomenon of "depersonalization." Mathew et al. (1993) define depersonalization as "an alteration in the perception or experience of the self in which the usual sense of one's own reality is temporarily lost or changed" and discuss the fact that this psychological state is associated with fatigue, depression, schizophrenia, and other conditions which could negatively affect worker motivation (Mathew et al. 1993:431). Both Melges et al. (1970b) and Mathew et al. (1993) used scales developed by Dixon (1963) and found that marijuana intoxication caused

increased levels of depersonalization. Mathew et al. (1993:433-435) found that depersonalization increases to a maximum approximately 30 minutes after smoking marijuana and returns to baseline within two hours.

These experiments show that ingestion of marijuana produces measurable psychological effects which are sometimes associated with mental illness but not that the depersonalization measured in these studies was associated with lower productivity, since neither of the studies included measures of the behavioral consequences of the depersonalization. Castillo (1990) has shown that depersonalization can be produced by meditation in otherwise healthy and productive individuals and this suggests that depersonalization by itself is not evidence of reduced motivation to work or productivity.

Job Performance

The experiments which deal most directly with work performance involve administration of marijuana to subjects and the measurement of performance in controlled settings over periods as long as 94 days (Cohen 1976) and 98 days (Kagel et al. 1976). Mendelson, Babour, Kuehnle, Rossi, Bernstein, Mello, and Greenberg (1976a) and Cohen (1976) found no differences between the performance of subjects given marijuana and those who were not.

The Kagel et al. (1980) piece deserves special mention because it represents the contribution of experimental economics and specifically the "microeconomy" to the study of this topic. In this experiment, subjects spent 98 days in a controlled environment in which they could do work in exchange for symbolic currency which could be exchanged for items of value. Subjects used marijuana within this controlled environment and this allowed researchers to assess the relationship between use and productivity measured in terms of output per hour worked. They found no significant relationship between hours worked and marijuana use. However, marijuana use was associated with a statistically significant increase in subjects' output per hour (1980:386-387). Overall, this experiment does not support the claim that marijuana reduces work productivity. Further, it raises the interesting possibility that marijuana use may, in some circumstances, be associated with higher productivity.

In summary, the controlled experimental research supports the conclusion that marijuana intoxication does have negative effects on attention, short-term memory, learning, and some psychomotor skills in controlled settings and that the effects appear to be dose-related. The evidence from controlled experiments does not support the conclusion that marijuana use reduces motivation. However, the results of these experiments do not tell us about the magnitude of marijuana's effects in the field because the artificial conditions of the laboratory will influence the magnitude of the effects observed in the experiments. It is difficult to be sure how these results relate to actual job settings in which those who use marijuana are probably not continuously in a state of acute intoxication.

Methodological Issues

The great strength of laboratory research is that it allows the experimenter to manipulate the independent variables of interest (in this case, ingestion of marijuana) and to determine the effects of these manipulations on dependent

variables of interest (in this case, task performance) because the use of experimental control and random assignment to conditions allow the researcher to rule out third-variable causes. The great weakness of this method is that the results are always open to questions of external validity because the variables may not be operationalized in the laboratory in the same way that they occur in the field (in this case, acute intoxication as it is produced in the lab may not have the same effects as occasional recreational use of marijuana). More importantly, subjects' motivation to perform well at a laboratory task may be less than their motivation level in their jobs or careers. This may be especially true if there were no incentives or rewards for good performance. Since many of the effects of acute intoxication on performance may derive from marijuana's specific effects on attention span, subjects with greater motivation to pay attention and perform well at a task may be less affected by marijuana. This speculation is supported by the research which suggests that, at lower doses, users may be able to suppress the effects of marijuana intoxication on their behavior (Murray 1986:34) and that their behavior in actual driving conditions may be less affected by marijuana than their performance on driving simulators.

In attempting to apply the laboratory results to the field, it is important to develop a definition of acute intoxication which would allow us to determine whether an employee was intoxicated to a level which matches the level achieved in the controlled experiments. The existing literature provides no generally accepted definition of acute marijuana intoxication. The problem of developing a definition for marijuana is much greater than for alcohol. The effects of acute alcohol intoxication (slurred speech, poor coordination, etc.) are similar in most users and the severity of these effects is highly correlated with blood alcohol level. These statements do not appear to be true of marijuana. The effects appear to vary widely from user to user and there is no agreement on the blood level of THC which constitutes intoxication. If, however, we assume that all employees who smoke marijuana do so to the point of intoxication, it appears that the intoxication lasts approximately two hours. Thus, if a person smokes at work or performs work within two hours of smoking, the research on acute intoxication should be relevant in predicting the effects of marijuana on their job performance.

Survey Research

Though the studies in the next section deal with a variety of topics, they share a common methodology. In these studies, people were asked, through the use of surveys, about their past marijuana use and the information they provided was used to assess the relationship between frequency of use (also called chronic use, recreational use, and long-term use) of marijuana and other variables related to job performance. The discussion of this research uses the same categories used for discussing controlled experiments.

Attention, Learning, and Memory

Partly because of the relative ease of using this research method as opposed to controlled experiments, a number of studies have assessed the relationship between self-reported marijuana use and performance at attention, learning, and memory tasks similar to those used in the controlled experiments previously

discussed. In many studies, subjects provided information on past use at the same time they completed the performance tasks. While some have shown no significant differences attributable to long-term marijuana use (Bowman and Pihl 1973; Culver and King 1974; Mendelson et al. 1976; Satz et al. 1976; Weckowicz et al. 1977), the majority have shown significant negative relationships between history of use and performance on a variety of tasks (Agarwal, Sethi, and Gupta 1975; Block and Ghoneim 1993; Block, Farnham, and Braverman 1990; Carlin and Trupin 1977; Entin and Goldzung 1973; Gianutsos and Litwack 1976; Page, Fletcher, and True 1988; Rubin and Comitas 1975; Schwartz, Gruenwald, Klitzer, and Fedio 1989; Sethi, Trivedi, and Singh 1981; Varma, Malhotra, and Dang 1988; Wig and Varma 1977).

Psychomotor Performance

For the dependent variable of psychomotor performance, the results may be a bit different. The number of studies showing no differences (Bowman and Pihl 1973; Culver and King 1974; Grant et al. 1973; Mendelson et al. 1976b; Reed 1974; Rochford et al. 1977; Satz et al. 1976a and b; Weckowicz et al. 1977) is approximately the same as those showing negative relationships between marijuana use and performance (Block and Ghoneim 1993; Block et al. 1990; Carlin and Trupin 1977; Gianutsos and Litwack 1976; Mendhiratta, Varma, Dang, Malhotra, Das, and Nehra. 1988; Page et al. 1988; Rubin and Comitas 1975; Varma et al. 1988; Wig and Varma 1977). These studies suggest that marijuana use may have a stronger relationship to attention, learning, and memory tasks than to psychomotor tasks.

Nonetheless, the foregoing studies demonstrate that those who report having used more marijuana in their lives perform less well at some tests of attention, learning, and memory. They may also perform worse at tests of psychomotor performance, though the relationship may be less clear-cut. A future meta-analysis of the existing studies would probably show that the average effect size across studies is small but statistically significant for attention, learning, and memory tasks and close to statistical significance for psychomotor tasks.

Motivation

Several studies deal with the relationship between marijuana use and measures of achievement or achievement motivation (Brill and Christie 1974; Kupfer 1973; Mellinger 1978; Mellinger, Somers, Davidson, and Manheimer 1976; Miranne 1979). Though Kupfer (1973) found that marijuana users had indications of lower motivation, including lower grades, the remainder of the studies cited above show no overall differences in indicators of motivation and Mellinger (1978) found that marijuana users had higher grades while Miranne (1979:197) found that marijuana had no significant relationship to any of six measures of achievement or achievement orientation (including materialistic achievement orientation,

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educational aspirations, occupational aspirations, and grade point average) when other relevant variables were controlled for.

Job Performance

One set of studies deals directly with the relationship between marijuana use and two measures of job performance, wages and labor force participation. These studies make use of the National Longitudinal Survey of Youth, a survey begun in 1979 with 12,500 respondents who were then between the ages of 14 and 21. The research on the relationship between marijuana and wages is based on the 1984 and 1988 waves of data from these subjects. Kaestner (1994a and b) provides a summary of prior studies of this database and gives the results of his own cross-sectional and longitudinal analyses of the 1984 and 1988 waves. In Kaestner (1994a) he examines the relationship between reported marijuana use and wages which are one measure of performance. Categories of reported use were: 1) Lifetime use, 2) Use within the past 30 days, and 3) A dichotomous variable indicating heavy use. His results show that in 1984, men (aged 19-26 at that time) who had higher levels of lifetime marijuana use and higher levels of use within the last 30 days had significantly higher wages. These relationships were positive but not significant in 1988. In 1988, men (aged 23-30 at that time) who were classified as heavy users had higher wages than those who were not. For women, lifetime use was significantly related to wages in 1988. All relationships between measures of marijuana use and wages for men and women were positive in both 1984 and 1988 but none were statistically significant except those mentioned above (Kaestner 1994a:462).

Comparison of the 1984 and 1988 data reveals a negative, but not significant, relationship between marijuana use and wage increases for both men and women. The most conservative interpretation of these data seems to be that increases or decreases in marijuana use had no relationship to increases or decreases in wages between 1984 and 1988 (Kaestner 1994a:464).

Kaestner (1994b), using the same data set, examined the relationship between marijuana use and number of hours worked. Cross-sectional analyses for male respondents indicated significant negative relationships between lifetime use and current use of marijuana and hours worked in 1984 and in 1988. There was also a significant negative relationship between lifetime use of marijuana and hours worked in 1988 but not between current use and hours worked (Kaestner 1994b:148). For female respondents, the story is a bit different. Cross-sectional analyses showed that current use was not significantly related to hours worked in 1984 or 1988 and that no measures of lifetime use were related to hours worked in 1984 though lifetime use was negatively related to hours worked in 1988 (Kaestner 1994b:149). The longitudinal analysis using 1984 and 1988 data, however, was unable to detect any significant effects on changes in hours worked for either men or women, leading Kaestner to conclude there is no significant overall effect of marijuana use on labor force participation (Kaestner 1994b:141, 145).

There are two points of interest in the results of Kaestner's studies. First, the variability of the parameter estimates was large in general, leading Kaestner to argue that "marijuana use is a highly idiosyncratic experience that has different effects on different people" (1994b:145). Second, there is some suggestion from

the results that marijuana may have a different relationship to job performance for women than men.

In summary, these results provide no support for the claim that the use of marijuana makes people less productive at their jobs. Further, the results of the cross sectional analyses may be contradictory. How is it possible that the use of marijuana could simultaneously cause a reduction in hours worked and an increase in wages? Unless marijuana actually improves peoples' efficiency at the job, it would appear that the relationship between marijuana use and job performance, if any, is the result of a third-variable cause.

Methodological Issues

There are at least two great strengths of this type of survey research: First, it enables researchers to collect data from large numbers of individuals; more than could be accommodated in controlled experiments because of limitations in time and resources. Second, it allows researchers to assess the effects of lifetime use, a variable which could not be manipulated in controlled experiments because it would be ethically wrong to conduct such experiments on human beings.

One important weakness of this type of research, however, has to do with the measurement of drug use. People do not always accurately report their drug use. More importantly, there is evidence that the inaccuracies in their reports are not simply random but are biased in systematic ways which might affect the observed relationships between marijuana and performance. Self-reports of drug use tend to understate use and that the degree of understatement is a function of the perceived desirability of drug use, among other factors (Harrison 1995). Further, Schwenk (1985) has shown that cognitive processes may affect recollections of past behavior to make it more consistent with social norms. Thus, apparent relationships between lifetime drug use and performance may be partially due to biases in reporting of use.

There are at least three additional problems which must be taken into account in interpreting these results. First, few of the studies contained adequate controls for other drug use. Subjects who use marijuana may use other drugs and the effects of these other drugs may account for any apparent relationship between marijuana use and performance. Second, few studies adequately matched subjects with controls on relevant variables which might affect their performance. If, for example, marijuana users were less intelligent than non-users they should be matched with controls on this variable. Third, few of the studies relied on blinded evaluation. Often those who evaluated the subjects knew whether or not they were in the control group. This may have biased their evaluations. The last two problems are less common in the studies conducted since the mid-1980s.

Because of these weaknesses, these studies do not show that lifetime marijuana use makes people inattentive, slow, forgetful, clumsy, or unmotivated. They do, however, provide information which is a useful complement to the results of the controlled experiments.

Pre-employment Drug Testing

Some studies have assessed the relationship between testing positive for marijuana on a pre-employment drug screening and subsequent job performance

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measured in terms of problem measures like absenteeism, turnover, disciplinary actions, and accidents. Unlike most of the controlled experimental research, this research deals directly with applicants for employment so it is not as vulnerable to criticisms about external validity as is controlled experimental research. Further, the best of these studies (e.g., Zwerling et al 1990) use urine screens or other methods to confirm marijuana use, thus avoiding the potential problems of using self-report data which plague survey research on this topic. As noted in Table 2, studies using this methodology do not deal with attention, learning, memory, psychomotor skills, or motivation so the discussion will focus directly on job performance.

Job Performance

Studies have examined a variety of outcome measures. However, involuntary turnover and on-the-job accidents have received the greatest attention.

Turnover

McDaniel (1988) examined self-reports of marijuana use by over 10,000 successful applicants to the four military services and collected data on the number subsequently discharged for "failure to meet minimum behavioral requirements" (McDaniel 1988:719-720). Respondents indicated their lifetime frequency of use and the age at which they began using marijuana. They combined these into a pre-employment drug use measure which was significantly related to the probability of discharge for unsuitability. Military recruits who tested positive for marijuana were 33% more likely to be discharged for unsuitability. Though the results were statistically significant because of the large sample size, marijuana use explained less than one half of one percent of the variance of the probability of discharge for unsuitability (McDaniel 1988:721-722).

Blank and Fenton (1989) analyzed turnover data for 482 male Navy recruits who tested positive for marijuana when entering the service compared to a control group who did not. After 2 ½ years, 43% of those who had tested positive had separated from the Navy while only 19% of the control group had. In this study, those who had tested positive were given counseling and in some cases subjected to random drug tests during this period. Since they may have been discharged for positive test results, potential criterion contamination may have contributed to the high number of discharges in the marijuana positive group.

Parish (1989), in a study involving 180 new employees, found that those who tested positive for any illicit drug were 28% more likely to be terminated than those who did not. However, the results for those testing positive for marijuana alone were not significant.

Normand, Salyards, and Mahoney (1990) examined 5,465 applicants to the U.S. Postal Service, 6.3% of which tested positive for marijuana. They found no significant relationship between positive test results and future involuntary turnover.

In summary, the body of evidence suggests that those who test positive for marijuana on pre-employment drug screens are more likely to turn over than those who do not. Estimates of the magnitude of this relationship vary considerably but

the McDaniel and Blank and Fenton results suggest that marijuana users are one-third to twice as likely to separate from military service. The Normand et al. results suggest that the relationships may be much smaller in the Postal Service.

These results have lead some to argue that pre-employment drug testing is not cost-effective (Wish 1990) and that it would be more cost-effective to use "impairment testing" in which the focus is on job impairment rather than drug use (Trice and Steels 1995). Whether the results justify screening applicants for marijuana use depends on the cost of turnover in a particular job and the relationship between turnover and marijuana use in that specific job. If the employing organization invests heavily in training employees for a certain job, turnover would be expensive and the use of pre-employment marijuana screens might be justified if marijuana use does predict turnover in that job.

Accidents

The second common dependent variable in these studies is workplace accidents. The study by Normand et al. (1990), cited above, examined workplace accidents in addition to turnover and found no significant relationship between positive results on a pre-employment drug screen for marijuana and number of accidents on the job.

In contrast, Crouch, Webb, Peterson, Buller, and Rollins (1989) showed that, among employees of a single company, Utah Power and Light, those who tested positive for marijuana, cocaine, and other drugs were five times more likely to have a reportable vehicle accident than a matched control group. Though their results were based on employees who used a variety of drugs, it is reasonable to assume that marijuana alone accounted for some increase in reportable vehicular accidents.

Zwerling, Ryan, and Orav (1990) conducted a study of the relationship between pre-employment urine tests for marijuana and adverse employment outcomes in over 2500 postal employees, 7.8% of whom tested positive for marijuana. The results of the screen were not used in the employment decision or given to employees or their supervisors. Thus, it is unlikely that the study's findings were biased by differential treatment of those with positive drug tests by their supervisors or others. Employees with a preemployment drug screen positive for marijuana had 55% more industrial accidents and 85% more injuries. All these results were statistically significant though, as the authors observed, the effect sizes were small (Zwerling et al. 1990:2643).

MacDonald (1995), used self-report data from a mail survey of 882 Canadian employees in a variety of jobs, 8.6 % of which admitted to using marijuana. He found a significant positive relationship between marijuana use and workplace accidents. Those who used marijuana were approximately 2 ½ times more likely to be involved in accidents than those who did not. MacDonald also found that alcohol use and legal drug use had stronger relationships to accidents than use of illicit drugs. He concluded, "Overall, the results indicated that illicit drug use does not appear to be a major cause of job injuries" (MacDonald 1995:882).

In summary, the relationship between tests for marijuana use and accidents is ambiguous. Some studies have found significant relationships between testing positive and subsequent injuries but others have not. Some studies (Crouch et al.

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1989; MacDonald 1990) have estimated that marijuana users may be several times as likely as non-users to experience accidents. Though these results are not conclusive, they support the use of pre-employment screens for marijuana in jobs where the costs of accidents may be very high or may involve loss of life (e.g. airline pilots).

Methodological Issues

There are problems with the use of pre-employment screening as a measure of the effects of marijuana in the workplace. First, a positive score on a urine test demonstrates only that the employee used marijuana at some time in the two to three weeks prior to the test. It does not provide any information on drug use during the period when the employee is in the job. Second, not all studies control for use of other drugs in addition to marijuana. Though some studies focus on those who tested positive only for marijuana, others include some who used marijuana and other drugs. In these studies, the relationship between marijuana and accidents may be contaminated by the effects of other drugs. Third, pre-employment drug screening may not identify all drug users but only those without the foresight or motivation to refrain from smoking marijuana for a sufficient time before the test. In many of these studies (e.g. Normand et al. 1990; Zwerling et al. 1990) the proportion of applicants or employees testing positive for marijuana is less than 9%, much smaller than the estimates of the proportion of the general population who use marijuana. This suggests that not all of the users are being identified, perhaps because some have the foresight and motivation to prepare for the drug test.

Employees without foresight or motivation may be expected to have a greater number of employment problems whether or not they use marijuana. Therefore, this method may bias results toward a negative relationship. Nonetheless, even if positive test results are merely a marker for carelessness it may be economically justified for employers to use them to screen out such employees.

This same logic does not, however, apply to attempts to reduce drug use in organizations or society as a whole. Unless marijuana actually causes performance declines, attempts to reduce its use may not have any economic benefits.

Anthropological Field Research

Three anthropological studies of marijuana use and its effects have been conducted; one in Costa Rica (Carter 1980), one in Greece (Stefanis et al. 1976), and one in Jamaica (Dreher 1982). These studies illustrate the strengths and potential weakness of this approach to inquiry. Researchers lived in or near the communities and observed the ways marijuana was "woven into the fabric of working-class life" (Dreher 1982:197) in each country. This approach to inquiry produces a more complex understanding of the role of marijuana in work life within a small population. It is impossible to capture the richness of the findings of these studies in a brief review so only their findings with respect to variables examined in experimental and survey research will be discussed here.

Attention, Learning, Memory, and Psychomotor Skills

The Costa Rican study did include tests of attention, learning, and memory as well as psychomotor skills. The author summarizes the results as follows:

"Although some users reported that marijuana was impairing their short-term memory processes, this was not confirmed by the neuropsychological battery. Lack of agreement between the test results and user perception may be attributable to the fact that users were reporting their acute reactions whereas the test battery was designed and administered to measure chronic effects. No hard data were obtained regarding the effect of marijuana use on driving ability. However, some of the user subjects did earn their living by driving trucks, buses, or taxis, and some preferred to drive while under the influence of the drug." (Carter 1980:202)

Motivation

Regarding the relationship between indices of motivation to achieve and level of marijuana consumption, Carter observed, "...The heaviest users had the highest incomes, the least unemployment, and the most stable job histories of the entire user group. They also more frequently reported that their preferred activity while intoxicated was to work. As with Jamaicans who used the drug primarily as a work adjunct, Costa Rican users did not usually report the "high" sought by American recreational users" (Carter 1980:202). Page (1983) and Page, Fletcher, and True (1988) found few differences in the symptoms of amotivational syndrome between cannabis users and nonusers in a Costa Rican sample, a result which is consistent with Carter's (1980) observations.

Job Performance

In the second of these studies, conducted among agricultural laborers in Jamaica (Dreher 1982), data were collected on earnings and other measures of performance. These performance measures showed no consistent differences between smokers of marijuana and non-smokers in job performance at low skill harvesting jobs but there was some evidence that non-users fared better than users (Dreher 1982:173-185). Dreher suggests the following explanation for this divergence.

"While there is little evidence to indicate that differences in worker productivity—measured in dollars and tons—can be successfully related to ganja (marijuana) use, there is strong indication that the attitudes of managerial staff toward ganja use do affect worker performance. If non-smokers are consistently selected on the basis of alleged reliability or manageability over smokers for the most lucrative jobs, it would be surprising if they failed to produce and earn more" (Dreher 1982:191). This suggests that relationships observed between marijuana and productivity as measured by wages may be influenced by cultural (and subcultural) attitudes toward marijuana use.

Dreher's study was criticized by Nahas (1985) on the grounds that sampling biases accounted for the failure to find any negative effects of marijuana on health or productivity and on the grounds that observer biases account for the positive motivational effects of marijuana observed.

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One interesting finding of both the Carter and Dreher studies is that the perception of the effects of marijuana on work performance is much different among the Jamaican and Costa Rican study participants than it is among people in the U.S. Members of the working class and agricultural laborers who used marijuana in both Costa Rica and Jamaica believed that it could facilitate work performance. One ganja user in Dreher's study remarked, "For the man that have the workin' spirit, it let him work more" (Dreher 1982:173). A later ethnographic study in Jamaica confirmed this perception (Broad and Feinberg 1995).

Similar attitudes are found in India, in which marijuana has a reputation as the "herb of concentration" dating back at least 3400 years to the Vedic scriptures. Among some subcultures it is seen as an aid to concentration in meditation and work (Aldrich 1977; Morningstar 1985:157). This belief seems incompatible with the common view in the U.S. that marijuana reduces concentration and motivation. However, among some subcultures of users, the belief that marijuana increases concentration is more common. Sussman et al. (1996) reported that 15% of a group of continuation students in the U.S. expressed this belief (which the authors call a myth).

The fact that members of different cultures and subcultures have radically different perceptions of marijuana's effects on performance suggests that these effects may be largely socially-mediated. It may be that perceived effects of marijuana vary from one country to the next *or* that members of the working class in each culture have different perceptions of marijuana's effects than do members of the middle class.

Methodological Issues

In anthropological field studies, researchers typically live with or near their subjects and collect a great deal of information on the way practices like marijuana use are integrated into their day-to-day life. However, in this process it is difficult to ensure that researchers' prior biases do not affect their collection or interpretation of information. For these reasons, it is safer to use this sort of research for hypothesis generation rather than hypothesis testing.

Summary and Future Research

The preceding pages summarize a large volume of research from different methodological perspectives on a bewildering variety of topics. All of it, however, deals with the question of how the independent variable, marijuana use, is related to the dependent variable, job-related performance. Given the methodological limitations of each approach and the inconsistent results, the research does not support the claim that the independent variable has any consistent effect on the dependent variable but it does raise several interesting questions for future research.

Despite the desirability of more research on this topic, CEOs and other executives who set human resources policies must decide whether to commit the resources necessary to monitor employees for marijuana use and take action to deal with employees who do use the drug. If marijuana is a direct cause of poor performance, then the costs associated with attempts to control use may improve performance enough to be justified on economic grounds. If marijuana is not a

cause but a correlate, however, reducing use may have no economic benefits at all.

Policy decisions are currently being made on the basis of the evidence presently available. Thus, policymakers must decide whether the existing evidence suggests that marijuana has a direct effect on job performance or whether the negative (and positive) relationships found between use and performance in past research are the result of spurious correlation.

In answering this question, it is helpful to review the most important findings from each stream of research. These are summarized below in the form of six points.

1. Individuals given marijuana in experimental settings perform worse on tasks measuring attention, learning, and psychomotor skills related to performance at many jobs.
2. Acute marijuana intoxication reduces performance in driving simulations but effects are not consistent in actual driving situations.
3. There was a significant positive relationship between some measures of self-reported marijuana use and wages among young adult men in the mid and late 1980s. The relationships are different for young women.
4. There was a significant negative relationship between some measures of self-reported marijuana use and labor force participation (hours worked) among young adult men in the mid and late 1980s. Relationships are different for young women.
5. Individuals who test positive for marijuana in pre-employment drug screens are more likely to experience turnover and employees who use marijuana are more likely to experience accidents which should reduce their overall productivity.
6. Though objective measures show no consistent relationship between marijuana use and motivation to work, the perceptions of its effects on motivation vary widely in different cultures and are in some cases diametrically opposed.

Any model purporting to explain the relationship between marijuana use and job performance must account for these six facts, which will be referred to by number in the discussion that follows. I will argue that the commonly-believed model of the relationship between marijuana use and job performance, which I will call the DIRECT CAUSE model, is less consistent with these facts than a model I will call the SPURIOUS CORRELATION model.

Many who argue that marijuana use reduces job performance are believers in the direct cause model. They make the implicit assumption that marijuana use produces changes in users which directly affect their performance at the job. It is difficult to reconcile the facts with this assumption. It seems unlikely marijuana

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would simultaneously increase wages (3) and decrease hours worked (4). If marijuana did have an effect on performance, it seems unlikely that those who work under the influence of marijuana in different cultures would have diametrically opposed views of its effects (6). It also seems unlikely that marijuana would produce different effects in men and women (3 and 4). Finally, the fact that effects seem more consistent in experiments and simulations than in real world settings (1 and 2) is not easily explained by this model.

The alternative or spurious correlation model is based on the assumption that marijuana does have subjective effects which may distract users but that these effects can be dismissed at dosages associated with recreational use, so that marijuana would have no direct effect on job productivity at all. Apparent effects would be spurious correlations produced by methodological limitations of different types of research. In the discussion which follows, I will not be attempting to prove that marijuana has no effects on job performance, which would amount to attempting to prove the null hypothesis. I will simply argue that the spurious correlation model of the effects of marijuana is more consistent with the six facts listed above than is the direct cause model.

The results of the experimental research seem consistent with the commonly-reported subjective effects of acute marijuana intoxication such as "experiencing vivid colors, sounds, and tastes" and "being easily distracted" (Stafford 1976:201-203). This suggests that marijuana makes sensory input more interesting and therefore more difficult to ignore. Thus, an intoxicated person would be more easily distracted when performing tasks requiring attention, learning, memory, and psychomotor skills in an experimental setting and would perform less effectively at them (1). If, however, the effects are weak, a person motivated to attend to work might be able to "dismiss" the drug's effects and work as effectively as they would without it. This may be particularly true for relatively repetitive and difficult tasks like agricultural labor. If workers have the ability to dismiss the effects of the drug while they are actually working or driving, this would explain the fact that marijuana has more consistent negative effects in driving simulations than in actual driving situations (2) and the fact that marijuana use did not reduce the productivity of agricultural laborers in the anthropological field studies (6).

If marijuana has no effect on performance, the positive relationship between marijuana use and wages among young men (3) and the negative relationship between marijuana use and hours worked (4) could be due to the fact that those who have higher wages and work fewer hours smoke more marijuana. In other words, these results are produced not by the effects of marijuana on wages and hours worked but the effects of greater amounts of money and free time on marijuana use among young men.

The spurious correlation model also has implications for the preemployment drug testing results. These studies show that positive tests on a preemployment marijuana screening are positively related to job-related problems which should translate into lower productivity, though the effect sizes are small (5). If, however, marijuana use has no overall effect on job performance, the relationships between pre-employment drug tests and subsequent job problems may be due to some third-variable cause such as selection bias (i.e. preemployment drug

screens tend to identify careless and thoughtless marijuana users rather than all marijuana users).

In the anthropological field research, use of marijuana was positively associated with some measures of performance and local folklore portrayed marijuana as a drug which could be used to increase productivity (6). If marijuana has no overall effect on performance, the popular association between use and performance may have to do with the cultural context in which it is used. In the Costa Rican and Jamaican studies, those who want to work are more likely to use marijuana so the high levels of productivity and use may both be caused by motivation to work hard.

This explanation also accounts for the difference in the relationship between reported marijuana use and wages between men and women (3) (4). If the common folklore in our culture suggests that marijuana smoking is more acceptable for young men than for young women (as was once believed about cigarette smoking), then young women who choose to use it may have personal characteristics which would account for the apparent differences in "effects" of marijuana on men and women.

White (1991) argued for the spurious correlation explanation (and against the direct cause model) in understanding marijuana and delinquency. His data show that some of the relationships between marijuana use and delinquency can be explained by other variables. The same appears to be true for the relationship between marijuana use and job performance. If so, policies aimed at limiting use cannot be justified on the grounds that they will have predictable effects on job productivity. If, as this review suggests, there is no clear causal relationship between marijuana use and job performance, it is not certain that any policy dealing with employee marijuana use will have any economic benefits at all.

Implications for Future Research

The direct cause model and the spurious correlation model make different predictions which could be tested in future research. There are at least three possible future studies which would help to determine which model is more plausible.

The first deals with the results of past experimental research on performance at various tasks dealing with job-related skills and abilities. If, as the direct effects model suggests, marijuana has effects which cannot be dismissed, then users' level of motivation to dismiss the effects should be irrelevant. The spurious correlation model, on the other hand, suggests that the effects of marijuana should disappear if users are motivated to dismiss them. This suggests the following hypothesis:

H1: The task performance of subjects motivated to perform well will be less affected by marijuana intoxication than the performance of subjects not motivated to perform well.

This hypothesis could be readily tested by comparing the performance of intoxicated subjects who are rewarded for performing well at a set of tasks similar to those used in past controlled experiments with intoxicated subjects who are paid the same amount regardless of their performance. Since the experimental research has generally been conducted by individuals with training in medicine

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rather than management, motivation to perform well at tasks has not been incorporated into previous experiments. If, however, the effects of marijuana intoxication can be dismissed, an experiment in which subjects were motivated to dismiss the effects should provide evidence of this ability. It would, however, be difficult to design incentives in laboratory experiments which would have the same effects as those used on the job. An alternative approach using survey research might involve asking respondents about their level of commitment to their jobs and their motivation to perform well. Negative relationships between marijuana use and job performance may be stronger for those who have low levels of commitment to their jobs.

The second study has to do with the relationship between attitudes and expectations about marijuana, marijuana use, and performance. The spurious correlation model suggests that these attitudes will be more important in explaining the relationship between marijuana and productivity than does the direct effects model. Collecting data on these attitudes in future survey research would help to address the question of whether beliefs about the effects of the drug account for any of the observed relationships between use and performance.

H2: Individuals' beliefs about the effects of marijuana and the beliefs of their co-workers will moderate the relationship between marijuana use and performance.

This hypothesis could be addressed in future field research by collecting information on respondents' attitudes and the attitudes of co-workers toward marijuana use as well as data on actual use. The relative importance of beliefs about use versus actual use could then be assessed.

The final study would attempt to address questions of causality in past survey research using the NLSY database. The positive relationship between marijuana use and wages would be explained within the direct cause model as a positive effect of marijuana on job productivity (though advocates of the direct cause model would strongly disagree that marijuana might improve job performance). The spurious correlation model, on the other hand, suggests that the positive relationship has another cause, possibly the fact that those who earn more money are likely to use more marijuana. This suggests the following hypothesis:

H3: Job performance (wages) predicts future marijuana use better than marijuana use predicts future job performance.

Data on marijuana use and wages would be collected from the 1988 and 1990 data in the NLSY and the relationships between these variables at these two times would be assessed. If we find a stronger relationship between 1988 wages and 1990 marijuana use than between 1988 marijuana use and 1990 wages, this would argue that differences in job performance (wages) lead to differences in marijuana use, rather than the reverse.

Needless to say, these three hypotheses do not exhaust the possibilities for future research on marijuana and work performance. A short list of topics would include: the effects of recreational use versus acute intoxication on the job, possible "hangover effects" on work performance, the effects of marijuana on different types of jobs requiring different physical and mental capabilities, and the differential effects of marijuana on employees of different cultural backgrounds and genders. Readers are encouraged to identify other topics that may

have escaped my notice. The relationship between job performance and marijuana use is much more complex and interesting than the discussions of the topic in popular news media would suggest.

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