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Identifying Types of Drug Intoxication: Laboratory Evaluation of a Subject-Examination Procedure

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16. Abstract

The Los Angeles Police Department (LAPD) has developed a rating procedure for use in detecting drug-impaired drivers. The purpose of the rating procedure is to determine whether the driver is impaired and to identify the responsible drug class (e.g., stimulant, depressant, etc.). As part of a research effort designed to provide data regarding the validity of the LAPD Drugged Driver Detection program, a laboratory evaluation sponsored jointly by NHTSA and the National Institute on Drug Abuse (NIDA), was recently completed by the Johns Hopkins University. The experimental procedure involved the administration of specific drug dose conditions to volunteer subjects who were then rated independently by each of four LAPD Drug Recognition Experts. The drugs administered were:

- o Marijuana (2 dose levels)
- o Depressants
  - Diazepam (Valium(R); 2 dose levels)
  - Secobarbital (1 dose level)
- o Stimulants
  - d-Amphetamine (2 dose levels)

The results can be summarized as follows:

- o For certain drug-dose combinations most subjects were rated as intoxicated, but for other combinations most were not.
- o Subjects rated as intoxicated had almost always received a drug and raters were quite accurate in specifying which drug had been given to the subjects they rated as intoxicated.
- o Subjects who did not receive a drug were almost always rated as not intoxicated.

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Introduction

The present study was undertaken to provide information concerning the validity of subject examination procedures for identifying and differentiating types of drug intoxication. The study was undertaken at the initiative of the National Highway Traffic Safety Administration and the National Institute on Drug Abuse to gain controlled experimental data concerning examination procedures which are currently being promoted and used in field situations (law enforcement, military, industry) as a technique for detecting drug-intoxicated individuals and for identifying the type of drug producing the intoxication. The particular examination procedures tested were derived from those developed and used by the Los Angeles Police Department in their Drug Recognition Program. The present study consisted of a laboratory simulation assessment of this approach to recognition and identification of drug intoxication. In a clinical research laboratory volunteers were administered various drugs/doses under double-blind conditions and were then independently examined and evaluated for signs of drug intoxication by each of four trained and experienced raters.

METHODS

General Procedure

Eight drug dose conditions were administered under double blind conditions to 80 volunteer subjects who were then evaluated independently by each of four raters trained in a standardized procedure for recognizing and differentiating types of drug-produced intoxication. Each rater was allowed a 20 minute evaluation period to decide presence or absence, and type of drug intoxication.

The present report focuses upon the global evaluations of drug intoxication provided by the raters. In addition, extensive additional data were collected concerning drug effects on subjective, behavioral, and biological indices; the procedures for collecting these additional data, and their results, will be reported separately, as will a more detailed analysis of the sensitivity of specific elements in the present rating procedure.

Subjects

Participants were 80 normal, healthy adult male volunteers between 18 and 35 years of age (mean 23.7), weighing between 54 and 100 kg (mean 71.8), and who reported using marijuana within the past year. Volunteers were recruited from the community through advertisements placed in local newspapers, at local college campuses, and announced on radio and television. Volunteers were paid $80 for their participation.

Prior to participation, volunteers visited the laboratory for a two hour screening and training period for which they were paid $20. During this visit subjects were given a physical examination (including ECG and a urinalysis screen for evidence of drug abuse), interviewed about their drug use history (types, quantities, and patterns of drug use), and trained on the psychomotor tasks and subjective effect questionnaires used in the study. Volunteers found to be without significant medical or psychiatric disturbances, to be without substantial patterns of illicit drug abuse, to be taking no medication, and showing adequate performance on the psychomotor tasks and questionnaires were accepted for participation. Accepted subjects provided their written informed consent to research participation and were given an appointment for their experimental session. At this time subjects were instructed to take no drugs other than alcohol or marijuana for at least two weeks prior to the study and to consume no alcohol or marihuana for at least 24 hours prior to the study; subjects were informed that compliance with these instructions would be verified by a urinalysis test on their study day which would determine their eligibility to participate.

Instructions/Information to Subjects

Subjects were informed that they would be receiving two oral doses of medication and would be smoking marijuana plant material; they were informed that any or all doses might be inactive placebo or that they might receive marijuana, a sedative, a major or minor tranquilizer, or a stimulant. Subjects were informed that they would be examined individually by four raters who worked for the Los Angeles Police Department and who would attempt to identify the type of drug the subject had received. Subjects were instructed to cooperate with the raters, to answer their questions, and not to try to trick or mislead the raters; in addition, subjects were told not to volunteer information to the raters identifying the drug which the subjects themselves believed they had received.

Raters

Four raters, who were experienced staff of the Los Angeles Police Department's Drug Recognition Program, participated; two of these were instructors in that program. The Drug Recognition Program trains staff in a standardized subject examination procedure intended to permit recognition of drug-produced intoxication and to permit identification of the pharmacological drug class producing that intoxication. The four raters had 13, 3, 4, and 5 years experience with the Program.

Instructions/Information to Raters

Raters were instructed to indicate estimated drug classes even if they were not as confident as they would normally be in a field situation. Raters were informed that drugs were being administered orally and by smoking, and that all subjects, as part of the blinding procedure, would receive dosing by both routes and by no other route. In particular, raters were informed that all subjects would smoke some marijuana plant material which might or might not contain active drug, and that they should reach their conclusions based upon observed drug effects and should not be misled by superficial cues such as the smell of marijuana. Raters were informed that there was no alcohol, PCP, or LSD administered, that no drug combinations were administered, and that some subjects received no active drug. Raters were also informed of the general characteristics of the subjects -- normal healthy volunteers, with some history of prior drug use but without patterns of clinically significiant drug abuse.

Setting

The study was conducted in a hospital laboratory setting consisting of a suite of offices and lounge areas within the Behavioral Pharmacology Research Unit at the Francis Scott Key Medical Center of the Johns Hopkins University School of Medicine. Each rater was assigned to a private

examination room. Raters had no contact with subjects prior to their examination period, and raters had no contact with one another throughout the period of subject examinations. Subjects were escorted among the raters on a prearranged schedule by research staff who were blind to drug conditions and to the results of the ratings, and who had no information about subjects' performance in individual ratings. These procedures were intended to maximize the independence of each rating.

Drug Administration

Subjects were randomly assigned among drug conditions according to the latin square design described below. The following eight drug conditions were studied: d-amphetamine, 15 or 30 mg orally; diazepam, 15 or 30 mg orally; secobarbital, 300 mg orally; marijuana, 12 puffs of 1.3% or 2.8% THC; or placebo. For d-amphetamine, diazepam, and secobarbital these doses are approximately three to six times the typically recommended therapeutic dose. The marijuana doses were selected on the basis of pretesting as being in the middle to upper range of doses typically achieved by occasional marihuana users in the community.

To allow for differing speeds of absorption, drug doses were administered at three separate times. To maintain the double-blind procedure a dummy medication procedure was used in which each subject received a dosage on each of the three occasions, with at least two of the three occasions being placebo only (for subjects assigned to the placebo condition all three occasions were placebo). Drug administrations occurred at 2 hours (d-amphetamine), 1 hour (diazepam and secobarbital), or 20 minutes (marijuana) prior to the start of the experimental rating period.

All oral doses were prepared in identically appearing opaque gelatin capsules with lactose filler and were dispensed directly into the subject's mouth by a nurse who then watched the subject drink water and examined the subject's mouth to insure drug ingestion.

Marijuana smoking began 20 minutes prior to, and ended approximately 10 minutes prior to, the beginning of the rating period. The marijuana cigarettes, including the placebo cigarettes, were indistinguishable in appearance; they were machine-rolled cigarettes provided by the National Institute on Drug Abuse. In an effort to control and standardize the biological exposure to marijuana smoke a standardized puffing procedure was used. Subjects smoked exactly 12 puffs -- 6 from each of two successive cigarettes. Subjects were signaled when to inhale and to exhale each puff, with 10 seconds being allotted to inhaling and holding each inhalation, and 25 seconds elapsing between exhalation and the next inhalation. To corroborate marijuana exposure, heart rate and breath carbon monoxide concentration were recorded before and after the smoking period.

Subjects who were cigarette smokers were not allowed to smoke from the time of the second oral dosing (one hour prior to the start of the rating period) until completion of the ratings.

Rating Procedure

For purposes of this experimental evaluation it was necessary to use a rating procedure somewhat different from that used by the raters in their field situations. The time available for each rating/evaluation was limited to 20 minutes; this is in contrast to approximately one hour which is used in the field. Certain elements of the evaluation which are important in the law enforcement context -- e.g., searching the subject for physical evidence, examination for evidence of route of drug administration, conducting a breath alcohol test -- were eliminated as irrelevant in this experimental context. For purposes of this experiment the raters produced a modified version of their usual evaluation procedure, which they estimated would be compatible with the time and procedural constraints of the study. This experiment was the first experience of the raters with using this modified evaluation procedure. A copy of the rating/evaluation form is shown in Figure 1.

The modified rating procedure consisted of three components. First was a brief interview concerning the subject's medical history and drug use history, and concerning recent eating, sleep and alcohol use. This interview component provided a basis for evaluating alertness and responsiveness, speech and conversation characteristics, and mood and attitude. Second was examination of objective physiological signs, including pulse rate, blood pressure, oral temperature, pupil size, pupil response to light and dark, nystagmus, smoothness of visual pursuit, perspiration and salivation. Third was a field sobriety test assessing psychomotor performance and ability to remember and follow instructions; this consisted of four elements: (1) standing steadiness and time perception: the subject is asked to stand with feet together and eyes closed and to hold that position until he thinks 30 seconds have elapsed; body sway and elapsed time are recorded; (2) one-foot balance: the subject is asked to stand on one foot while extending the other in front of him and looking at it and counting to 30; this is repeated for the other foot; the times at which the lifted foot is placed down are recorded; (3) hand-to-nose test: the subject is asked to stand with eyes closed and arms down at the side and to touch his nose with the index finger of the correct hand as the rater calls "left, right, left, right, right, left"; the location of touches is recorded; (4) line test: the subject is asked to stand heel to toe on a line marked on the floor, hands to his sides, and is instructed to take nine heel-to-toe steps down the line, turn, and take nine steps back, counting the steps aloud; occasions at which the subject steps off the line are recorded and the quality of divided attention performance is noted.

The rating procedure is designed to recognize and differentiate intoxication produced by the following drug classes: narcotics/analgesics (opiates, heroin, morphine, etc.), central nervous system depressants (barbiturates,

SUBJECT_____ OPINION UNDER INFLUENCE OF_____

DATE/TIME_____ TEST NOT COMPLETED_____

EYES: ____Bloodshot ____Glassy ____Blank stare ____Eyelids

PUPILS: ____Reaction to light slow ____Nystagmus_____

____Pinpointed ____horizontal

____Dilated ____vertical

Lack of smooth pursuit_____

Observation at max_____

SPEECH: ____Slow ____Repetitive ____Difficulty speaking clearly

____Sluggish ____Incoherent ____Thick or slurred

____Deliberate ____Fast

CONVERSATION: ____Confused ____Talkative

ATTITUDE: ____Disoriented ____Emotionally erratic ____Antagonistic

____Excited ____Agitated ____Bizarre

____Sedated ____Argumentative ____Stuporous

____Euphoric ____Irritable ____Other_____

VITAL SIGNS & MOTOR SYSTEM:

____Dry Mouth ____Motor movements poor

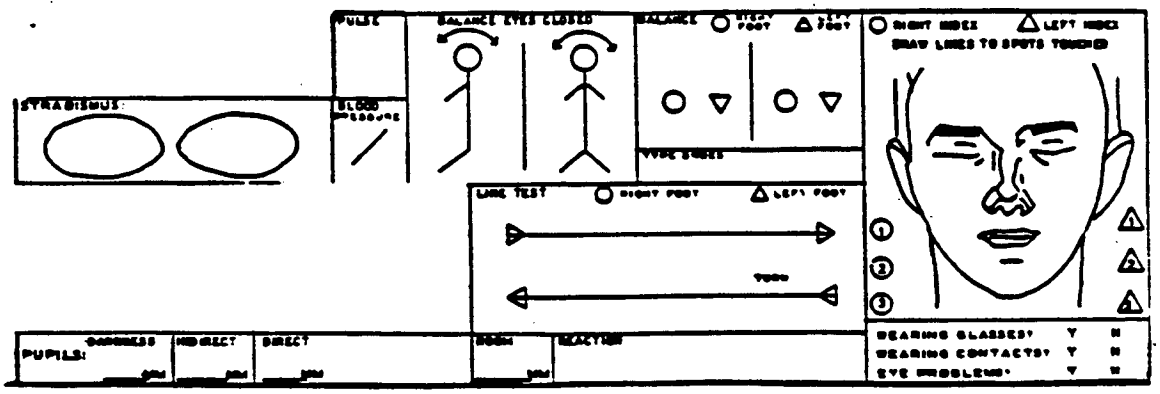
____Perspiring ____Appear drowsy

____Coordination poor (example_____)

____Nervous ____Rub or scratch face area

____Slow response and coordination ____Muscle tone ____rigid ____spasmodic

____Divided attention impairment ____Body temperature



COMMENTS_____

_____

Rater_____

FIGURE 1: Evaluation And Recording Form Used By Raters

tranquilizers, etc.), central nervous system stimulants (amphetamine, cocaine, etc.), phencyclidine (PCP), hallucinogens (LSD, psylocybin, etc.), marijuana, and inhalants (toluene, acetone, etc.). In the present study raters made one of the following five judgments: not intoxicated, opiate, sedative, stimulant, or marijuana.

Experimental Design

The study was conducted over 10 experimental days in a two week period, with eight subjects participating each day; on each experimental day each of the eight drug conditions was received by exactly one subject. Subjects participated as two successive waves of four subjects each, with the second wave being scheduled 100 minutes behind the first.

The order in which subjects were evaluated by each rater was determined by balanced sets of 4 x 4 Latin squares; these were constructed so that across four experimental days each rater would evaluate each drug condition in each of the four possible sequential orders (first, second, third, fourth). Subjects were assigned to dose conditions, as determined by the Latin squares, sequentially as they arrived at the hospital.

RESULTS

The accuracy of raters' judgments of drug intoxication was examined in relation to the known drug doses which subjects had received. Table 1 presents these data in summary form. The table shows, for each of the eight experimental drug conditions, the number of occasions raters made each of the various possible intoxication judgments; for each drug condition there were 40 ratings (10 subjects x 4 raters). Two things are apparent in this tabulation: (1) on many occasions when an active drug was administered subjects were judged not to be intoxicated; and (2) when subjects were judged to be intoxicated the correct drug class was generally identified.

These accuracy data are more easily quantified and interpreted when the data in Table 1 are converted to percentages. These conversions have been done in two slightly different ways, which permit the examination of two different aspects of raters' judgmental accuracy -- specificity and sensitivity.

Specificity

Specificity refers to the proportion of cases judged as intoxicated by a particular drug class who had actually received that drug class. The specificity analysis addresses the question of "Given that a subject is judged to be intoxicated on drug class X, how likely is it that he had actually received drug class X?"

Table 2 presents specificity data; this is a transformation of the data in Table 1, with each entry being converted to a percentage of the column total. That is, entries show, for each category of intoxication judgment, the proportion of evaluation occasions in which the subject had actually received the various drug conditions. These data show the specificity of raters' intoxication judgments to be high -- with 80%, 97.5% and 92.7% of cases judged to be intoxicated on stimulants, marijuana, or depressants, respectively, actually having received those drug classes.

These data for judgments of stimulant, marijuana or depressant intoxication are shown graphically in Figure 2. Judgments of intoxication were most likely to occur with the higher dose levels of each drug class, and rarely occurred for inappropriate drug classes; the occasional errors of misidentification were scattered among other drug classes. On only two occasions were subjects who had received only placebo judged to be intoxicated -- on depressants in both cases. (In both of these cases subjects were judged not be sufficiently intoxicated to warrant arrest in a law enforcement field situation.)

Rater Judgements

Actual Drug Condition	NOT INTOXICATED	INTOXICATED BY: Opiate	Stimulant	Marijuana	Depressant	TOTAL
Placebo	38	0	0	0	2	40
d-Amphetamine 15	33	0	5	0	2	40
d-Amphetamine 30	29	0	11	0	0	40
Marijuana 1.3	27	0	0	11	2	40
Marijuana 2.8	9	0	2	28	1	40
Diazepam 15	19	0	2	0	19	40
Diazepam 30	6	1	0	1	32	40
Secobarbital 300	2	0	0	0	38	40
TOTAL	163	1	20	40	96	320

TABLE 1: Tabulation of the number of occasions various rater judgments (listed across the top) were made as a function of the actual drug conditions administered (listed vertically at left). Each row sums to 40 occasions (4 raters x 10 subjects per condition).

Actual Drug Condition	Rater Judgements: NOT INTOXICATED	INTOXICATED BY: Opiate	Stimulant	Marijuana	Depressant	TOTAL
Placebo	23.3	0	0	0	2.1	12.5
d-Amphetamine 15	20.2	0	25.0	0	2.1	12.5
d-Amphetamine 30	17.8	0	55.0	0	0	12.5
Marijuana 1.3	16.6	0	0	27.5	2.1	12.5
Marijuana 2.8	5.5	0	10.0	70.0	1.0	12.5
Diazepam 15	11.7	0	10.0	0	19.8	12.5
Diazepam 30	3.7	100	0	2.5	33.3	12.5
Secobarbital 300	1.2	0	0	0	39.6	12.5
TOTAL	100	100	100	100	100	100

TABLE 2: Transformation of Table 1 in which entries are converted to percentages to reflect the specificity accuracy of raters' judgments. Each column sums to 100%. Entries indicate, for each type of rater judgment listed across the top, the percentage of those judgment occasions that the subject had actually received each of the actual drug condition listed at the left.

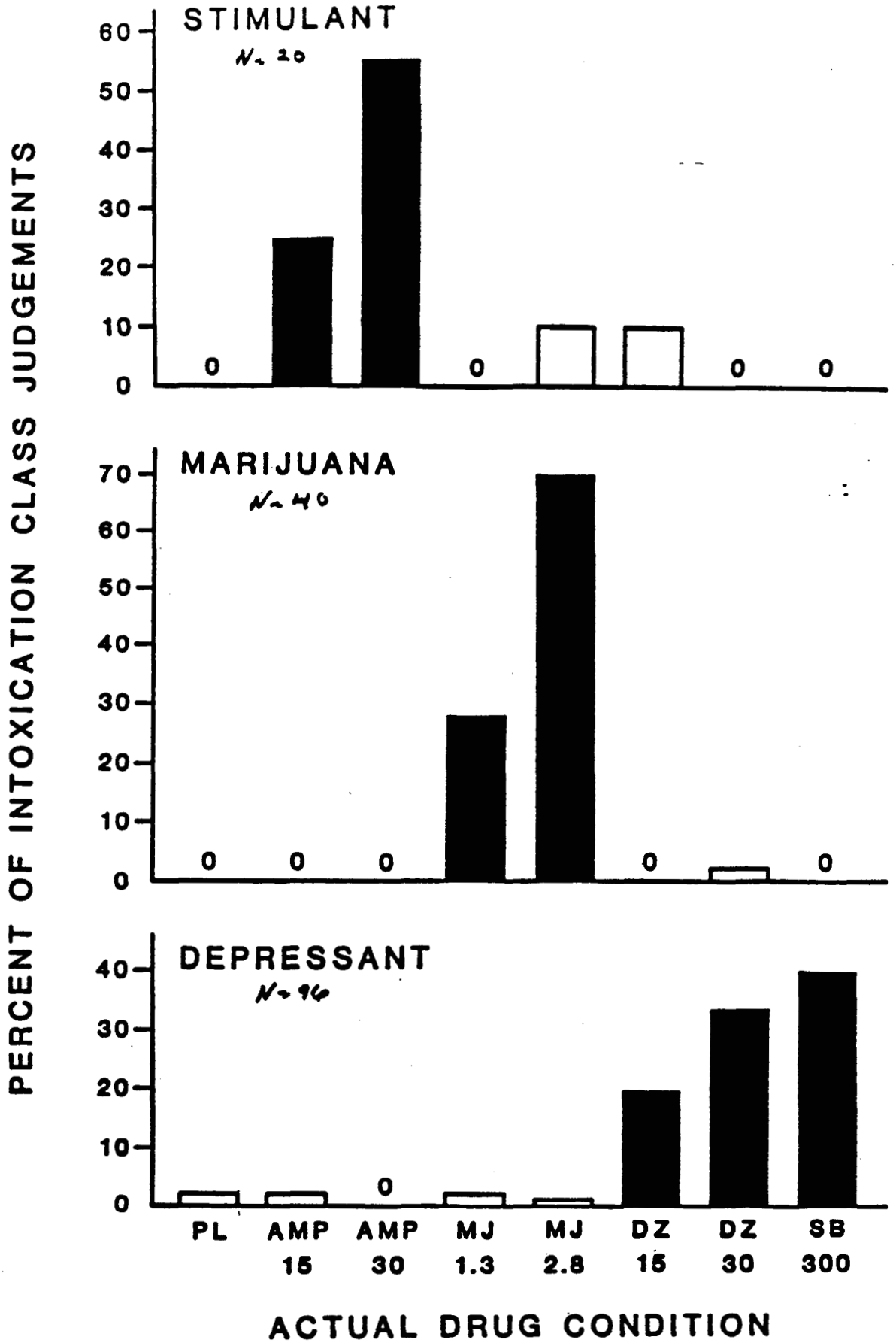


FIGURE 2: Each panel presents the data for occasions when a given type of intoxication judgment was made — stimulant intoxication, upper panel; marijuana intoxication, center panel; depressant intoxication, lower panel — and shows the percent of those occasions in which the subject had actually received each of the various experimental drug conditions shown on the horizontal. Bars corresponding to correct identifications are filled in.

An overall summary of the specificity accuracy of raters' intoxication judgments is presented in Figure 3. Of the 320 rating occasions in this study there were 157 occasions when subjects were rated as being drug intoxicated. On 91.7% of those occasions the rater correctly identified the drug class that the subject had received. On 1.3% of occasions judged as drug intoxicated the subject had received no active drug -- i.e., a definite false positive error was committed. Finally, on an additional 7% of occasions the subject had received an active drug but the rater identified the incorrect drug class; these are identified in the figure as incorrect identifications but might also be considered a type of false positive error. Thus, the total false positive error rate (occasions that a rater identified a type of drug intoxication different from the drug class that individual had actually received) was 8.3%.

Sensitivity

Sensitivity refers to the proportion of cases who actually received a given drug class who are detected as being intoxicated by that drug class. The sensitivity analysis asks the question "Given that a subject has actually received drug class X, how likely is it that he will be detected as intoxicated on drug class X?"

Sensitivity data are presented in Table 3; this is a transformation of the data in Table 1, with each entry being converted to a percentage of the row total. That is, entries show, for each of the 8 experimental drug conditions, the proportion of evaluations receiving each of the various intoxication judgments. These data show that the likelihood of being judged intoxicated differed across different drug classes but was dose-dependent within each drug class. Judgments of drug intoxication were more likely at the higher doses of active drug than at the lower doses. For most drug conditions a substantial proportion of ratings reached the conclusion of "not intoxicated". As doses increased the proportion rated "not intoxicated" declined, the proportion rated as intoxicated on the appropriate drug class increased, and the proportion judged intoxicated on the incorrect drug class did not change. Sensitivity ranged from a low of 12.5% of low dose amphetamine ratings leading to a conclusion of drug intoxication to a high of 95% of secobarbital ratings leading to a conclusion of drug intoxication. These sensitivity data are presented graphically in Figure 4.

JUDGEMENTS OF DRUG INTOXICATION

N = 157

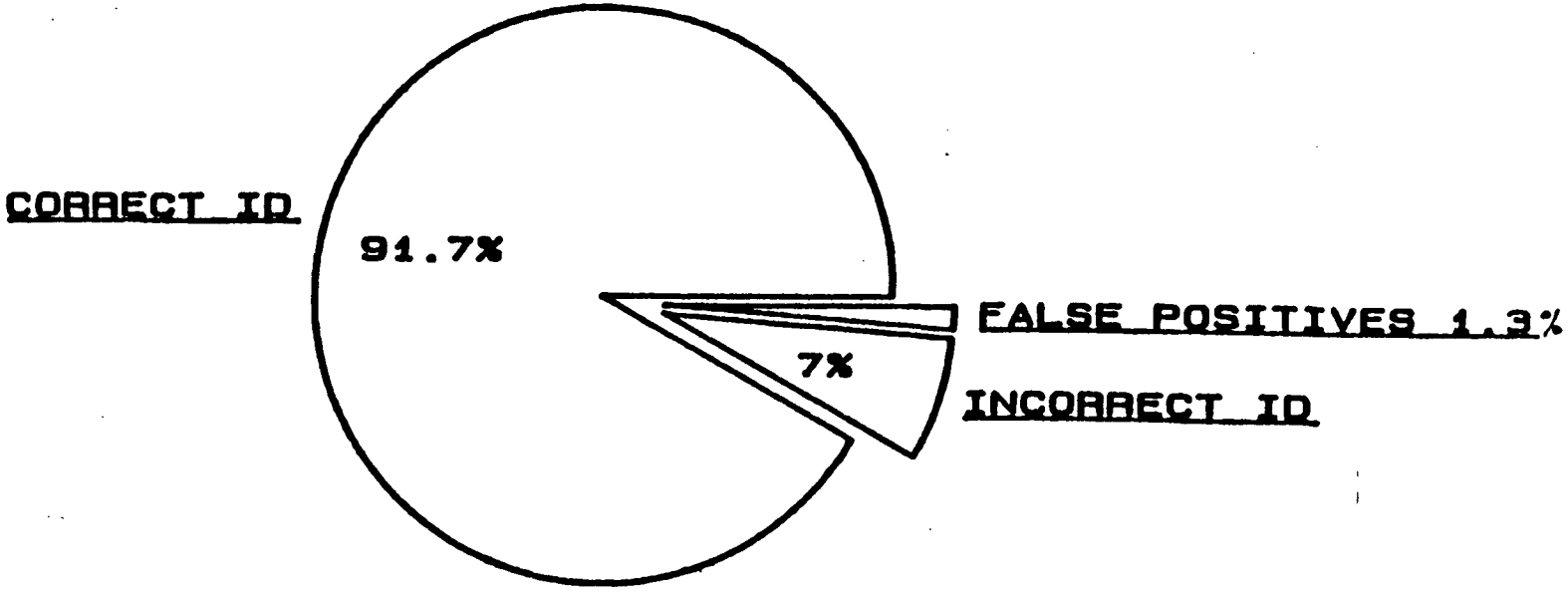


FIGURE 3: Accuracy of rater judgments is summarized for all 157 occasions when a judgment of drug intoxication was made. The correct drug class was identified on 91.7% of occasions. On 1.3% of occasions a definite false positive occurred, as the subject had received no active drug. On 7% of occasions, although the subject had received some active drug, the incorrect drug class was identified.

Actual Drug Condition	Rater Judgements: NOT INTOXICATED	INTOXICATED BY: Opiate	Stimulant	Marijuana	Depressant	TOTAL
Placebo	95	0	0	0	5	100
d-Amphetamine 15	82.5	0	12.5	0	5	100
d-Amphetamine 30	72.5	0	27.5	0	0	100
Marijuana 1.3	67.5	0	0	27.5	5	100
Marijuana 2.8	22.5	0	5	70	2.5	100
Diazepam 15	47.5	0	5	0	47.5	100
Diazepam 30	15	2.5	0	2.5	80	100
Secobarbital 300	5	0	0	0	95	100
TOTAL	50.9	0.3	6.3	12.5	30.0	100

TABLE 3: Transformation of Table 1 in which entries are converted to percentages to reflect the sensitivity accuracy of raters' judgments. Each row sums to 100%. Entries indicate, for each actual drug condition listed at the left, the percentage of rating occasions that raters made each of the judgments listed across the top.

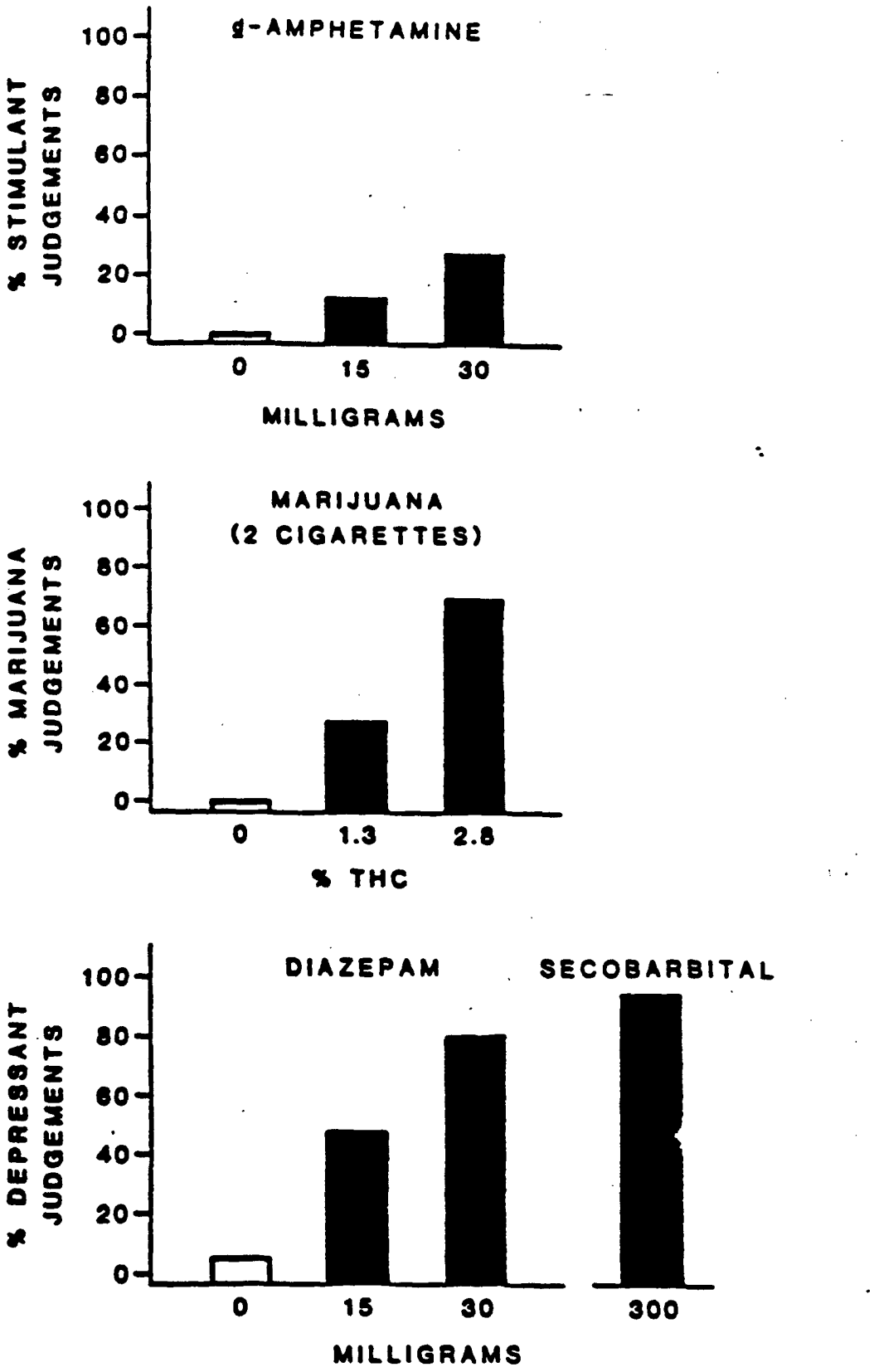


FIGURE 4: Each panel shows the percent of occasions on which raters made a drug-appropriate intoxication judgment for each of the three major drug classes as a function of the dose actually administered (shown on the horizontal). Dose-effect functions are shown for d-amphetamine (upper panel), marijuana (center panel), and diazepam (lower panel); results for secobarbital are included in the diazepam panel. Bars which represent correct identifications are filled in. Each bar is based on 40 rating occasions (4 raters x 10 subjects per dose condition). There was a single placebo group which constituted the 0 dose condition shown in all three panels.

CONCLUSIONS

This laboratory simulation study does not represent a direct test of the validity of these or related behavioral examination procedures for detecting and identifying drug intoxication in field situations. It does, however, provide valuable scientific information concerning the potential accuracy and utility of such procedures.

The procedures tested in this study showed a high degree of accuracy in correctly identifying the drug classes which had been administered to those subjects judged to be intoxicated. Of subjects judged to be intoxicated the correct drug class was identified on 91.7% of occasions. Overall, in 98.7% of instances of judged intoxication the subject had received some active drug. On 7% of occasions of judged intoxication the incorrect drug class was identified, and on 1.3% of occasions the subject had received no active drug -- for a total false positive rate of 8.3%. While these data indicate a relatively low rate of false positive errors, they also indicate a degree of fallibility of the evaluation procedure.

The sensitivity of this assessment procedure was directly related to the dose of drug administered. As dose increased, detection and identification of intoxication increased. As might be expected, many individuals who had received active drug -- especially one of the lower doses -- were judged not to be intoxicated. These might be viewed as cases which were "missed" by the raters; however, while it is known they received active drug, it is not known whether an objective behavioral intoxication resulted. Because these rating procedures were developed in a law enforcement context the raters indicate they have intentionally designed them to err, if at all, on the side of "missing" rather than on the side of "false positives".

The differences seen between different drug classes with respect to the proportion of cases detected as intoxicated may simply represent differences in the relative effective dose levels given of the different drugs. In particular, the relatively small proportion of amphetamine cases detected as intoxicated may be the consequence of our inability, due to medical safety considerations, to administer high doses of amphetamine experimentally. The graded dose-effect relationships observed suggest that higher doses of the drugs would have an even greater probability of detection as drug intoxication.

It should be noted that this study was the first occasion that the raters had ever used the specific modified evaluation procedure that they had developed in order to meet the time constraints of the study. It is possible that accuracy of judgments would have been different if the raters had been able to use their usual, longer evaluation procedure. It is also possible that the present brief evaluation procedure could achieve higher levels of accuracy after raters gain experience with it.

Certain limitations of the present study should be noted. First, it is unclear to what extent the subjects themselves, who were instructed to be cooperative, may have provided information aiding in drug identification. While subjects were told not to volunteer such information, raters were free to inquire how subjects felt, had they ever felt that way before, had they ever used drugs that made them feel that way, etc. In this experimental setting subjects may have been more revealing than would occur in a law enforcement field situation. Second, the present study provides no information about detection and identification of intoxication when multiple drugs have been taken by the same individual; such polydrug use, especially combinations with alcohol, is widespread in field situations.

It is anticipated that further analyses of the data from this study will provide information concerning which aspects of the subject examination procedure are most useful for detecting and identifying different types of drug intoxication. At present, the conclusion based upon these global judgment-of-intoxication data is that raters were able to perform quite well in accurately identifying the drug classes administered to subjects and did so with a relatively low rate of false positive errors.