QUALITATIVE DIFFERENCES BETWEEN DRUGS DEMONSTRATED BY PSYCHOMOTOR TESTING.

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Summary: Laboratory testing can describe qualitative differences between drugs. Laboratory tests which have revealed such differences between alcohol, opiates and cannabis on human skills performance are described.

The studies indicate that methadone as used in a methadone maintenance programme is without effect on a test battery which was sensitive to alcohol (BAC 0.06 g%) and diazepam (15 mg). The interaction between alcohol and marijuana is described as being one of de-intensification, or a less than additive effect. Qualitative differences in the responses to alcohol and marijuana on a divided attention task and on tests of risk-taking behaviour are described. Laboratory testing therefore indicates that alcohol and marijuana show quite different responses to certain tests of human performance skills.

Laboratory tests are designed to examine the performance of driving related skills. Alcohol has been the dominant drug involved in these studies and almost without exception, all such laboratory tests are sensitive to alcohol; it is only a matter of dose. Alcohol however, differs from most other drugs in some important ways. It differs in the way the body handles and eliminates it and as far as we know, it differs also in its mode of action.

Most drugs act in a very selective manner on specific sites termed receptors, and these drugs can only act on those cells which bear the drug receptor. This is one reason why drugs can differ so much one from another in their actions. The nature of their activity depends on the function of the nerve cells which bear the drug receptors.

Alcohol does not seem to act with this degree of specificity. The current belief is that alcohol acts more as a physical agent on cell membranes and is likely to modify the function of any cell into which it comes into contact. This is possibly why alcohol in sufficient concentration, can be demonstrated to affect any test of psychomotor performance. In this paper I will describe how testing can demonstrate some qualitative differences between the psychomotor effects of alcohol, the opiates and cannabis. I will illustrate this by describing some recent data generated in my laboratory.

The opiates.

The effects of the opiates on skills performance and moods was reviewed recently (Chesher, 1989). The general effects of the opiates result from their action on specific opiate receptors and include the modulation of the perception of pain (analgesia); a modulation of mood states, in particular the production of both euphoric and dysphoric effects; a depression or respiration; suppression of the cough reflex; reduction of the motility of the gastrointestinal tract; constriction of the pupil of the eye; effects on endocrine functions; and the development of tolerance and physical dependence.

This list gives us a clue as to what dangers may ensue from opiate use and what psychomotor functions we should test. The properties which could exert some
adverse effect on driving related skills are those on mood, mental clouding and drowsiness. The effects on the eye could indicate some involvement of opiates on vision which may influence driving, and of course, the behavioural consequences of drug dependence could influence driving behaviour. Of particular importance is the phenomenon of tolerance. Tolerance to the effects of the opiates can develop very rapidly and to a phenomenal degree. The opiates are employed quite legally in therapy for a number of the properties outlined above. Opiates, (usually as heroin) are also used illicitly as recreational drugs.

The methadone maintenance programme.

Methadone, which acts on the same opiate receptors as morphine, is used in the treatment of heroin dependency, primarily because of its long duration of action and its cross-tolerance with heroin. Once a heroin user is established on methadone, one dose will maintain an effect for more than 24 hours. During this time, the methadone can prevent the development of the symptoms of the opiate withdrawal and can suppress the desire to take more heroin.

Even if more heroin is taken, the degree of cross tolerance between the two drugs means that a much higher dose of heroin is required to produce an effect. It is quite surprising that in spite of the increasingly widespread use of methadone maintenance programs, there has been remarkably little study of the possible effects of this therapy on human skills performance.

The study I will describe briefly now (Chesher et al 1989) was undertaken to examine the effects of methadone, as used in the methadone maintenance program, on human driving-related performance skills. The tests used were (i) A divided attention task (Southern California Research Institute) which consists of a compensatory tracking task and a peripheral search task. (ii) The Critical tracking task (Systems Technology Inc. California), and (iii) A vigilance task (The Mackworth clock).

Three groups of volunteers from the methadone programs in Sydney were chosen to represent various stages of progress by clients within the program. These were (i) those beginning on the program; (ii) those receiving an increase in dosage of 10 mg methadone; and (iii) those who have been stabilized on a dose of methadone for a period of at least six months.

The study also investigated the interaction with methadone of alcohol and diazepam. Methadone clients in the stabilized group were given alcohol (mean peak BAC 0.064 g%) and on another occasion, diazepam (15 mg). Two control groups were employed; a group of opiate-free ex-users of heroin and a group of non-opiate users. A total of 96 volunteers were used.

On days 1 and 2, all subjects after practice on the tests, completed the test battery twice, before and after the methadone clients had received their daily dose of methadone. On day 3 all clients from the control groups and the stabilized methadone groups received alcohol and on day 4, diazepam. The test battery was sensitive to the effects of alcohol and diazepam. There was however, no evidence for an effect of the acute dose of methadone on any of the experimental groups on the methadone program. Although alcohol and diazepam significantly impaired the performance on the test battery, there was no
difference in the intensity of this effect between the groups. The impairment
produced in the methadone group was no different from that of the controls.
The result of this testing indicates that methadone maintenance clients should
not be considered as impaired in their ability to drive a motor vehicle. These
results are in agreement with those of a similar study by Moskowitz and
Robinson, (1987) and Robinson and Moskowitz (1987). I would now like to turn
to another drug, cannabis and examine what can be learned from the laboratory
testing of its effects on human performance skills.

Testing cannabis.

The effects of cannabis on psychomotor skills have been reviewed recently by
Moskowitz (1985) who concluded "...that marijuana seriously impairs psychomotor
performance required for driving." Among the skills for which a marijuana-
induced impairment can be demonstrated are those involving coordination such as
body sway and hand steadiness, tests of tracking skills, of perception,
vigilance and those tasks which require the division of attention. Laboratory
testing has indeed demonstrated that marijuana has a potential to cause road
crashes.

I would now like to describe some of the qualitative differences in the effects
of cannabis and alcohol on psychomotor skills as they have been revealed in
some of our recent studies.

First I would like to describe a study of the interaction between alcohol and
marijuana. For this we used a between-subject design involving 320 volunteers,
who on arrival at the laboratory were assigned to one of 16 treatment groups.
These groups represented all of the possible combinations of four dosage
conditions of each drug (Table 1).

The test battery comprised simple and complex reaction time measures, (with
increasing demands on information processing), pursuit tracking, spatial
ability (a mental rotation task) and forward digit span. All tests were
presented by Apple//e microcomputers. Subjects were tested before (T1), at
estimated peak of effects for both drugs (T2), and three hours after peak of
drug effect (T3).

A summary performance measure (SPM) for the entire battery was calculated using
scores derived from the five tests. The data were analyzed using linear
regression using the SPM as the dependent variable and dose as the regressor.
Regression analysis showed a strong dose-dependent effect for alcohol and
marijuana (THC) towards poorer performance, that for alcohol being greater than
that for marijuana. At T1, the slope of the alcohol regression was 0.14; i.e.
there was an average deficit of 0.14 SPM units per 0.25 g/kg unit increase in
alcohol dose, and for marijuana, an average deficit of 0.05 SPM for each 2.5 mg
increase in THC dose.

Therefore on this test battery, and at the doses employed, the statistically
significant difference between the slope of the dose response curves for
alcohol and THC reflect a lesser effect of THC than for alcohol. However, the
interesting finding of this study is the description of the interaction between
these two drugs. On the performance measure the effect of the two drugs when
taken together was less than would be expected by simple addition: an effect
which we describe as a de-intensification. This is demonstrated in table 1.
Table 1

Difference from double placebo for performance measures in arbitrary units at time T2 - time T1. The expected score, if the two drugs had additive effects, is in parenthesis.

<table>
<thead>
<tr>
<th>THC dose (mg)</th>
<th>0</th>
<th>2.5</th>
<th>5.0</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol dose</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g/kg</td>
<td></td>
<td></td>
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<td>0</td>
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<td>38</td>
</tr>
<tr>
<td>.25</td>
<td>24</td>
<td>25</td>
<td>14</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>(25)</td>
<td>(44)</td>
<td>(62)</td>
<td></td>
</tr>
<tr>
<td>.5</td>
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<td>59</td>
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<tr>
<td></td>
<td>(30)</td>
<td>(50)</td>
<td>(67)</td>
<td></td>
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<td>.75</td>
<td>65</td>
<td>51</td>
<td>50</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>(66)</td>
<td>(87)</td>
<td>(103)</td>
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</tbody>
</table>

The same de-intensification effect was also found in the effects of the drugs on heart rate.

Cannabis and alcohol on a divided attention task.

The divided attention task was the same as that described above for the methadone study. In this experiment (a within-subject design), each volunteer attended the laboratory on three occasions. On day one, all subjects completed the task three times for practice without taking any drug. On the second and third days, subjects were given a drink (placebo or alcohol to produce BAC approx.0.08g%) and marijuana to smoke (placebo or active with 15 mg THC). Active drugs were given in a balanced order of administration across the two days. Performance was recorded before and after the drug.

The results indicated an interesting difference in the manner in which the same volunteers performed the task after the different drugs. With alcohol there was a significant increase in the errors on the peripheral search component (p<0.05) but not in the compensatory tracking. However, with marijuana, the tracking task was significantly impaired (p<0.05) but not the peripheral search.

Cannabis, alcohol and risk-taking behaviour.

Finally, we attempted to examine the differences in the reported effects of alcohol and marijuana on risk taking behaviour. It has been frequently reported that under alcohol, drivers in closed course driving or in driving simulators are more willing than when sober to attempt an overtaking task, they tend to drive at a faster speed and make more gear shifts. (e.g. Dott, 1974). Using a between-subject design we have attempted to examine these differences in two laboratory based tests to measure what might be interpreted as risk-
taking. In both tasks the motivation is to accumulate a high score for a financial reward.

(i) A pursuit tracking task in which the volunteer can determine the speed at which the task runs. At faster speeds, the score accumulates more rapidly but if errors are made points are deducted.

(ii) A line length comparison test. Two vertical lines approximately 5 cm apart appear on the monitor and the task is to determine, as quickly as possible which line is longer. The response is recorded by pressing one of three buttons. Left, or right to indicate the position of the longer line. If the volunteer is uncertain, as some pairs of lines are very similar, the central (uncertain) button is to be pressed. Faster reaction times are rewarded with higher scores but marks deducted for errors. "Uncertain" responses by avoiding errors, can be considered as "cautious" responses. The same doses of alcohol and marijuana (or their respective placebo) as were used in the previous study were used. There were twenty volunteers allocated to each group; 80 Ss in all.

Differences in responding between alcohol and cannabis were apparent in these tests. First, the tracking task revealed that under both drug conditions when compared with the controls, the performance was impaired, with the stronger effects being recorded for alcohol (Alcohol p=0.002; THC p=0.04). There was a trend which approached significance (p=0.07) for the volunteers under alcohol to choose a faster speed than they did when sober. This trend was not apparent with marijuana.

The line length comparison test also revealed differences in the nature of the responses under the two drugs. Both drugs produced a significant increase in errors. Reaction times for correct responses were slower under THC (p=0.003), but not for alcohol. Reaction times for the "undecided" responses were faster under THC than for alcohol (p=0.03). Under alcohol, subjects made fewer undecided responses than did the control group (p=0.05).

In both these tests, the results are consistent with an interpretation that alcohol (but not marijuana) increases "risky" behaviours.

The results of these laboratory tests indicate that alcohol and marijuana are quite different drugs.

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**References**:


