A driving simulator study on driving performance and traffic safety after multiple drug use, consisting of MDMA (Ecstasy) and various other psychoactive compounds.

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Abstract
A group of young people who had indicated that they regularly visit parties of the *dance party* type, using MDMA and other drugs including alcohol, were tested in a driving simulator, early in the morning shortly after having visited a party, under the influence of MDMA and possibly various other drugs. The participants were first tested before the party under the influence of MDMA alone and also tested sober, i.e. on a control night at a comparable time. The latter is reported elsewhere in this volume. After the party, at their wish, they were picked up at the party, brought to the test facility again and tested. In the simulator they again completed a test ride that included driving in an urban environment and on a motorway. Performance was assessed in terms of lateral control (swerving), longitudinal control (speed, headway) and decision making (response to braking manoeuvres of leading cars, gap acceptance while crossing a junction). In addition to performance participants' self-reports of performance and experienced effects were collected. Results indicate that basic vehicle control is only moderately affected. There are, however, indications that more so than under the influence of MDMA alone, after the party subjects accept higher levels of risk.

Introduction

This paper is a companion of the paper by De Waard, Brookhuis & Pernot in this volume (1). That paper reports on the effects of MDMA alone on driving behaviour in general and more specifically on decision making in a driving simulator. The present paper reports on the effects of multiple drug use, MDMA and a possible variety of other compounds, on driving behaviour in a simulator. The driving test was performed in the simulator of the Centre for Environmental and Traffic Psychology, University of Groningen (2). While engaging in mega-dance or house-party festivities, (mainly young) people use a variety of drugs that keep them in the right mood and (subjective) condition to participate. Multiple drug use seems to be common for that reason, among which MDMA is one of the candidates. MDMA, or ecstasy, is a popular dance drug, having socially facilitating and euphoric effects (e.g., 3,4,5,6,7). On the basis of other studies (e.g. 5,6), the effects of MDMA on behaviour in traffic that can be expected are not so much on the control level of performance (e.g. lane-keeping), but more on risk-taking, and judgement of more complex situations (see 6,8). In the study of De Waard, Brookhuis & Pernot (1) this expectation is confirmed, results indicating that basic vehicle control is only moderately affected, while there are indications that under the influence of MDMA alone, subjects accept higher levels of risk. In the present study the results are reported of a simulator driving test of subjects after visiting a festivity. Whereas the subjects were instructed to use only MDMA before the festivity, during the festivity they

were allowed to do as usual and use anything they liked. Subjects were encouraged to behave as they would normally do. Notwithstanding the variety in psychoactive compounds that could potentially be encountered in that case, the capability to drive a motor vehicle after such a festivity is of major interest. There is reason to believe that at least part of the visitors of such festivities drive a motor vehicle afterwards (see also the results of the alter-study (1)).

Method

Twenty-three subjects who had indicated that they use ecstasy regularly were asked to participate in the experiment. Subjects were included on the basis of solicitation through social workers and a snowball effect within the groups, after consulting the project's medical doctor. They were requested to participate in a simulator experiment on the evening they already had the intention to use ecstasy and visit some kind of festivity afterwards. The implication of this procedure is that MDMA was not provided by us, but a sample of subjects was selected from the population of regular users, however, under strict instruction. Subjects bought ecstasy for their own purpose (and mailed an extra pill to the laboratory for substance analysis), and used it in a self-determined dosage. After the first test (1), they were transported to the festivity of their choice where they would act as usual and picked up again after some time, at their choice. Arriving at the institute again, they repeated the test rides in the simulator, driving through built-up areas and over a motorway. During the rides primary task performance (longitudinal and lateral vehicle control) was measured, as well as self-reports on activation, effort and driving quality. Gap acceptance, the ability to follow speed changes of a lead car (9) and responses to braking manoeuvres (10) were also determined.

Subjects came to the institute four times. During the first visit the procedure was explained, intake questionnaires on usual habits were completed, an informed consent was signed and a full-dress practice ride was completed in the simulator. A medical checklist was completed and submitted to the project's medical doctor who judged whether participation could be approved. During the night of testing two rides were made, one approximately one hour after ingestion of MDMA, and one after the party when subjects normally would go home (or to an after-party). Between the first and second ride subjects were allowed to take any active substance in any combination and dosage they would normally take too. On a separate evening a control test ride was completed at the same hour as the first MDMA ride, but on that day no drugs were allowed. The test rides are summarised in Table 1. The order of the MDMA/multiple-drug and control rides was balanced across subjects.

Table 1: Regime and simulator tests in four conditions.

Condition	Experimental/Control	Time of day	MDMA	Other drugs
Practice	(control)	Day	No	No
MDMA	Experimental	Night: 1 hr. after taking MDMA	Yes	No
Multiple-drug	Experimental	After the party: 04:00 – 08:00 AM	Yes	Allowed
Control	Control	Night: same time as MDMA ride	No	No

The protocol of the study had been approved by the Ethical Committee of the Department of Psychology. In this paper the effects found in the multiple drug ride are reported. The effects found in the MDMA condition are reported elsewhere in these proceedings (1)

Results

Twenty three subjects were invited for the practice session. One subject became simulator sick during that ride, and accordingly could not participate any further. After conferring with the medical doctor one other subject was excluded from the test, and after the practice and control ride yet another subject withdrew by her own initiative from the experiment. As a result a total of 15 male and 5 female subjects completed all experimental and control rides of the experiment.

Average age of the remaining 20 subjects was 25 years (sd 4.5), they had an average mileage of 17000 km/years (sd 14000). They had used ecstasy on average on 26 occasions the past 12 months (sd 27, range 2-100), and had used in this period an average of 40 pills (range 2-150). Additional use of other drugs, and with the combination of MDMA with other drugs is listed in table 2.

Table 2: Proportion of subjects (N=20) that indicated the use of other drugs, for each of the relevant conditions.

Additionally used ↓ Condition →	MDMA	Multiple-drug	Control
Ecstasy	--	70%	0%
Alcohol	30%	90%	15%
Marihuana	35%	80%	30%
Tobacco	45%	80%	45%
Amphetamine (speed)	0%	30%	0%
Caffeine	25%	25%	45%
Cocaine	0%	10%	0%
Mushrooms	0%	10%	0%
GHB	0%	10%	0%
LSD	0%	5%	0%
5-HTP	0%	5%	0%
Heroine	0%	0%	0%
Crack	0%	0%	0%
Nitrous oxide	5%	0%	0%

From table 2 it is clear that, notwithstanding the strict instructions, during the day of testing some of the subjects had used marihuana (7 subjects) and some consumed alcohol (6 subjects), according to their report much earlier and / or at diner. Breathalyser indication showed 0.00 % in all these six cases. The majority of the subjects (i.e. 14) used additional ecstasy during the festivity, while multiple drug use was very popular in the form of alcohol (18 subjects) and marihuana (16 subjects) too here. Breathalyser indication showed an average of 0.04 % across all these 18 cases (sd 0.39, range 0.00 - 1.09). All of the subjects used at least one extra drug during the festivity.

simulator test ride results

Among the control parameters of vehicle handling, lateral position control and keeping to the speed limits in the city environment were affected in the active drug conditions. Swerving, or standard deviation of lateral position, as a measure of vehicle control, was affected in the multiple drug condition, as compared to the other two conditions ($F(1,19) = 5.48, p < 0.031$).

In the multiple drug condition subjects drove faster than in the other two conditions, but on in the built-up area with a speed limit of 50 km/h (see table 3). Speed variance increased both under the influence of MDMA as in the multiple drug condition, both in the city and on the motorway (multiple drug $F(1,19) = 8.83, p < 0.008$).

Table 3: Speed differences in the city and on the motorway.

SPEED (+sd) in km/h	City (speed limit 50 km/h)	Motorway (speed limit 120 km/h)	ANOVA (city) Drugs-control
Control	55.1 (8.3)	116.4 (13.7)	
Multiple drugs	64.4 (10.7)	117.2 (13.3)	$F(1,19) = 20.4 p < 0.001$

Reaction time to braking manoeuvres of cars in front was not significantly affected in either of the two drug conditions as compared to the control condition. However, the ultimate indicator of safe driving is the absence of crashes. Although crashes are relatively rare in re traffic, they happened more frequently in the simulator even though subjects had been instructed to drive safely and avoid accidents. On the motorway section where lead cars braked suddenly, some accidents happened. During two of the twenty control rides crashes occurred, while under the influence of MDMA four times the simulator-car collided with another car, a 100% increase. In the multiple drug conditions even five out of twenty subject had a crash with the car in front, some of them quite serious. However, these low numbers turned out to be not significantly different from the control condition, though the result is perhaps relevant.

Contrary to the alter-study, judgement is impaired, i.e. as far as gap acceptance behaviour i concerned (table 4). The smaller gap between cars that is accepted while turning left under the influence of multiple drugs is significantly different from the control condition.

Table 4: Gap acceptance at two types of crossings.

	Gap 1 (sd); straight	Gap 2 (sd); left turn	ANOVA (drug)
Control	6.6 (0.9)	7.2 (1.2)	
Multiple drugs	6.1 (0.8)	6.5 (1.5)	$F(1,19) = 4.75, p < 0.032$

Similar effects apply to the self-reports on effort and driving quality. Although invested effo as indicated on the Rating Scale Mental Effort (13) increases from 40.2 to 47.6 under the influence of MDMA, the effect is not significant ($F(1,19) = 2.15$, NS). In the multiple drug condition the score increases even further, to 50.7, which is significant ($F(1,19) = 5.02, p < 0.037$). After the use of ecstasy self-judged driving quality (10) decreases from +16.5 (control) to +3.8 (on a scale from –100 to +100), but this effect is not significant ($F(1,19) = 2.26$, NS). After a visit to the party after more drugs, self-judgement of driving quality deteriorates to below zero, i.e. – 4.6, which is significant again ($F(1,19) = 5.13, p < 0.035$).

Discussion

The effects in the multiple drug condition on the control level of driving performance are moderate again, similar to the alter-study (1), although somewhat more pronounced. Subjec showed an increased variation in both lateral and longitudinal direction. The increases in speed in the urban area and the trend to accept smaller gaps are an indication for higher ris taking under the influence of ecstasy and multiple drugs thereafter. Another indication for higher risk taking was found in the number of crashes that were measured in the MDMA and

multiple drug conditions as compared with the control condition. Extreme driving behaviou under the influence of ecstasy, as reported by Schifano (8), was only occasionally found in the present study. The very high standard deviations for many of the metrics in the present stu as compared to other studies (e.g. 11,12), are an indication for this assertion. It seems, that looking at the data, taking into account the non-compliance with instructions as clear from table 2, the group of subjects is deviant from the normal population. For this reas it was decided to include an extra group of control subjects, which will be reported in due time.

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