A driving simulator study on the effects of MDMA (Ecstasy) on driving performance and traffic safety

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Abstract
A group of young people who had indicated that they regularly use MDMA were tested in an advanced driving simulator, shortly after the use of MDMA, just before going to a party. The participants were also tested sober, i.e. on a control night at a comparable time. In the simulator they 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 on performance and experienced effects were collected. Results indicate that basic vehicle control is only moderately affected. There are, however, indications that under the influence of MDMA subjects accept higher levels of risk.

Introduction
MDMA, or ecstasy, is a popular dance drug. MDMA is mainly used for its socially facilitating and euphoric effects (e.g., 1). Documented effects on cognitive performance are in terms of a reduced accuracy in performance (2), and lack of concentration (3). There are also indications that basal cognitive performance, such as visual-spatial performance, is not affected (4, 5).
So far, the effects of MDMA on car driving performance have only been documented with respect to above mentioned skills that are related to car driving, and in the form of case studies. Schifano (6) gave some examples of extreme driving behaviour leading to traffic accidents after dance parties involving (amongst others) MDMA use.
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. The present paper reports on the effects of MDMA on driving behaviour in general and more specifically on decision making. The study was performed in the advanced simulator of the Centre for Environmental and Traffic Psychology, University of Groningen (7).

Method
Via a streetcorner worker and by making use of the snowball effect, twenty-three subjects who had indicated that they use ecstasy regularly were asked to participate in the experiment. Subjects were asked if they were willing to participate in a simulator experiment on the evening they already had the intention to use ecstasy. MDMA was accordingly not provided, but a sample of subjects was taken from the population of users. Subjects bought ecstasy for their own purpose (and mailed an extra pill to the laboratory for substance analysis), and used

MDMA in a self-determined dosage. They made 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 (8) and response to braking manoeuvres (9) were also determined

Subjects came to the institute four times. During the first visit the procedure was explained, an informed consent was signed and a first practice ride was completed in the simulator. A medical checklist was filled in and submitted to a medical doctor who judged whether participation could be approved. During the night of a party 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 psycho-active substance in a 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/multi-drug and control rides was balanced over subjects.

Table 1: simulator tests

Condition	experimental/ control	Time of day	MDMA	Other drugs
practice	(control)	day	No	No
MDMA	experimental	night: 1 hr. after taking MDMA	Yes	No
multi-drug	experimental	night: morning after the party	Yes	Allowed
Control	control	night: same time as D1-ride	No	No

The experiment had been approved by the Ethical Committee of the Department of Psychology. In this paper effects found in the MDMA ride are reported. The effects found in the multi-drug condition are reported elsewhere in these proceedings (10)

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 on her own demand 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 these 20 subjects was 27 years (sd 4.5), they had an average mileage of 17 000 km/year (sd 14 000). 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 (sd 45, range 2-150). On average they had driven a car 8 times (sd 14, range 0-50) under the influence of ecstasy. Experience with other drugs, and with the combination of MDMA with other drugs is listed in table 2.

Table 2: Proportion of subjects (N=20) that had experience with other drugs, and with the combination of MDMA with other drugs

Drug	Experience with drug	Experience with combination MDMA-drug
Alcohol	100 %	80 %
amphetamine (speed)	80 %	65 %

cocaine	75 %	35 %
crack	10 %	5 %
heroine	10 %	0 %
LSD	85 %	35 %
marihuana	100 %	85 %
mushrooms	85 %	20 %
tobacco	90 %	75 %
nitrous oxide	15 %	
MDEA	10 %	5 %
GHB	15 %	5 %
Other	≤ 5 %	≤ 5%

From table 2 it can be seen that drug experience was wide, and that most subjects had experience with combining MDMA with other drugs.

Before the MDMA ride subjects had taken on average 1.0 pill (sd 0.33). Analyses (at the time of writing 16 pills had been analysed) showed an average dose of 56 mg MDMA (sd 22, range 25-98 mg).

simulator test ride results
Under the influence of MDMA subjects drove faster, but only in the built-up area with a speed limit of 50 km/h (see table 3). Speed variance increased under the influence of MDMA as well, both in the city and on the motorway ($F(1,19) = 4.84$, $p = 0.040$). Lateral control was not affected.

Table 3: speed data

SPEED (sd) in km/h	city	motorway	ANOVA (city + motorway)	ANOVA (city)
Control	55.1 (8.3)	116.4 (13.7)	$F(1,19) < 1$, NS	$F(1,19) = 12.3$,
MDMA	57.6 (9.9)	114.7 (11.0)		$p = 0.002$

The ultimate indicator of driving safely is the absence of crashes. Although crashes are relatively rare in real traffic, they happen more frequently in a simulator even though subjects had been instructed to drive safely and avoid accidents. On the motorway section where lead cars braked suddenly, sometimes 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.

Judgement does not seem to be impaired, i.e. as far as gap acceptance behaviour is concerned (table 4). The smaller gap between cars that is accepted while turning left under the influence of MDMA is not significantly different from the control condition.

The same applied to self-reports on effort and driving quality. Although invested effort as indicated on the Rating Scale Mental Effort (11) increases from 40.2 to 47.6 under the influence of MDMA, the effect is not significant ($F(1,19) = 2.15$, NS). After the use of ecstasy self-judged driving quality deteriorates 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)

Table 4: gap acceptance

	Gap 1 (s); crossing	Gap 2 (s); left turn	ANOVA (drug)
Control	6.6 (0.9)	7.2 (1.2)	$F(1,19) = 1.38$, NS
MDMA	6.6 (1.2)	6.7 (1.2)	

Discussion

Effects of MDMA on the control level of driving performance are moderate, only a higher driving speed in the urban environment was found. This effect on speed may also be explained as an indication for higher risk-taking under the influence of ecstasy. Other indications for higher risk taking were found in a trend to accept a smaller gap between cars, and twice as many crashes that were measured in the MDMA condition compared with the control condition. Extreme driving behaviour under the influence of ecstasy, as reported by Schifano (6), was not found in the present study. His findings may be strongly related to the effects of taking multiple drugs, which is very common. See also Brookhuis et al. (10), for their report on the multi-drug condition in this experiment.

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References

1. Parrott AC, Stuart M. Ecstasy (MDMA), Amfetamine, and LSD: comparative mood profiles in recreational polydrug users. Human Psychopharmacology 1997; 12; 501-504.
2. Morgan MJ. Recreational use of “ecstasy” (MDMA) is associated with elevated impulsivity. Neuropsychopharmacology 1998; 19; 4; 252-264.
3. Vollenweider FX, Gamma A, Liechti M, Huber,T. Psychological and cardiovascular effects and short-term sequelae of MDMA (“ecstasy”) in MDMA-naïve healthy volunteers. Neuropsychopharmacology 1998; 19; 4; 241-251.
4. Parrot AC, Larsky J. Ecstasy (MDMA) effects upon mood and cognition: before, during and after a Saturday night dance. Psychopharmacology 1998; 139; 161-268.
5. Krystal JH, Price LH, Opsahl C, Ricaurte GA, Heninger GR. Chronic 3,4-Methylenedioxymethamphetamine (MDMA) use: effects on mood and neuropsychological function? American Journal of Drug and Alcohol Abuse 1992; 18; 331-341.
6. Schifano F. Dangerous driving and MDMA (“Ecstasy”) abuse. Journal of Serotonin Research 1995; 1: 53-57.
7. Van Wolffelaar PC, Van Winsum W. Traffic simulation and driving simulation –an integrated approach. In Proceedings of the Driving Simulator Conference (DSC’95); 1995. Toulouse, France: Teknea.
8. Brookhuis KA, De Waard D, Mulder LJM. Measuring driving performance by car-following in traffic. Ergonomics 1994; 37; 427-434.
9. Brookhuis KA, De Vries G, De Waard D. The effects of mobile telephoning on driving performance. Accident Analysis and Prevention, 1991; 23, 309-316.
10. Brookhuis, KA, De Waard D, Pernot, LMC. A driving simulator study on driving performance and traffic safety after multiple drug use, consisting of MDMA (Ecstasy) and various other psychoactive compounds. ICADTS 2000.

11. Zijlstra FRH. Efficiency in work behavior. A design approach for modern tools. PhD thesis, Delft University of Technology, 1993. Delft, The Netherlands: Delft University Press.