

Evaluation of Driving Skills after Brief Exposure to Nitrous Oxide

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SUMMARY

The driving skills of 10 dental students were evaluated on three occasions on a driving simulator after exposure to air and 50% and 70% nitrous oxide in oxygen. Errors increased after exposure to nitrous oxide and were statistically significant during the middle of the test period. Driving after short exposure to nitrous oxide appears inadvisable.

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Impairment of driving skills after general anaesthesia or the ingestion of alcohol is well recognized^{1,2} but no records of quantitative testing of driving ability have been published.³ Recent studies^{4,5} have shown subtle impairment of ability of persons taking barbiturates, benzodiazepines, phenothiazines and tricyclic antidepressants in small therapeutic doses. There appear to be no data regarding impairment after short exposure to nitrous oxide as administered during 'relative analgesia' in dentistry. The purpose of this study was to investigate impairment in skills on a driving simulator shortly after a 15-minute exposure to 50% or 70% nitrous oxide in oxygen, and to compare performance with that after exposure to air.

SUBJECTS AND METHODS

Ten adult male dental students, having given informed consent, were tested during part of their instruction on the use of nitrous oxide in dentistry. The students all held current driving licences and drove regularly. One week before commencing the experiment they were familiarized with the driving simulator by an experienced driving instructor (J.L.). The simulator consisted of a driving console with ignition, steering, hand and foot brakes, clutch, accelerator and signals (AETNA Drivotrainer System, Drivex Corp., Mountview, California, USA). The controls were linked to a central display panel at the rear of the room where inappropriate driving could be assessed.

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Errors were assessed by a single examiner (J.L.) and scored as present or absent. A recorder noted the score on computer sheets. The examiner was unaware of the mixture administered to the subject.

The students, arranged in a random order according to a table of random numbers, received air, or 50% or 70% nitrous oxide in oxygen. On two further occasions, separated by weekly intervals, the students were exposed to different mixtures. The order of administration of the mixtures to each subject was randomized. The gases were administered in the supine position through a Quantiflex machine situated behind the subject's head and they were unaware of the mixture used. After a 15-minute exposure oxygen was given for 2 minutes and the subjects kept in the dental surgery until Romberg's sign was negative, the time necessary for this being recorded. They were then accompanied 200 metres to the driving simulator and the total time from exposure until the commencement of the driving test was noted.

Subjects then had to take a driving test and perform appropriate driving manoeuvres in response to a film based on the Ministry of Transport (UK) driving test. Twenty-nine events arose in the film over a period of 21 minutes. Each event required appropriate steering, braking, acceleration or use of the indicators or the clutch. These functions were assessed separately and several penalty marks could be obtained. The results were transferred to computer punch-cards and analysed using the *Statistical Package for the Social Sciences*.⁶ Statistical analysis was carried out on the differences in score for each individual: (i) between the varying concentrations inhaled, i.e. 0-50%, 0-70% and 50-70% N₂O; and (ii) on the order of driving irrespective of concentration inhaled, using the paired Student's *t* test where

$$t = \frac{\bar{x} \text{ differences } (\sqrt{N})}{\text{SD differences}}$$

A probability value of $P < 0.05$ was selected as the level of statistical significance.

RESULTS

The mean times after gas administration until Romberg's sign became negative and until the driving test are shown in Table I. Recovery after nitrous oxide was rapid. The mean time until commencement of driving was similar after each inhalation session.

Driving errors were made by all subjects at each driving session. In Table II are listed the errors committed at the first, second and third driving tests. Significantly more mistakes ($t = 7.32$; $P < 0.001$) were made at the second attempt than at the first, and at the third attempt compared with the first ($t = -2.40$; $P < 0.02$). In contrast,

TABLE I. RECOVERY TIME (IN MINUTES) TO WALKING (ROMBERG'S SIGN NEGATIVE) UNTIL DRIVING

Time to {	Walking Driving	Air		50% N ₂ O/O ₂		70% N ₂ O/O ₂	
		Mean	SD	Mean	SD	Mean	SD
		0,1	0,4	1,6	0,8	1,3	6,8
		11,5	3,3	9,5	2,3	9,0	4,0

the number of mistakes made at the third attempt was significantly less than at the second attempt ($t = 3,91$; $P < 0,001$). This finding was independent of the nature of the gas that had been inhaled, and is an indication of the effect of experience in the test situation. Subjects concentrated hard during the first test, but less hard during the second, thereby committing more errors. On realizing this, the third attempt was accompanied by increased concentration.

TABLE II. DIFFERENCE IN ERROR SCORES AFTER 3 DRIVING TESTS AT WEEKLY INTERVALS (NEGATIVE VALUES INDICATE AN INCREASE IN ERRORS AND POSITIVE, A DECREASE)

Subject	Differences		
	Tests 1 - 2	Tests 2 - 3	Tests 1 - 3
1	- 8	- 2	-10
2	- 8	+ 9	+ 1
3	- 7	+12	+ 5
4	- 6	+ 3	- 3
5	-17	+ 6	-11
6	-11	+ 5	- 4
7	-13	+ 6	- 7
8	- 6	+ 1	- 5
9	- 4	+ 6	+ 2
10	- 9	+ 4	-13
Mean	- 8,9	+ 3,9	- 4,5
SD	3,8	4,0	5,9

Table III lists the differences in error scores arranged according to the gaseous mixtures that had been inhaled. After the inhalation of 50% N₂O/O₂ more driving errors were committed than after the inhalation of air, a difference significant at the 5% level ($t = -2,05$). Likewise there were more errors after inhalation of 70% N₂O/O₂ than after air inhalation, although this was not significant ($t = -1,32$). The mean error scores after inhalation of 50% and 70% N₂O/O₂ were almost identical ($t = 0,36$).

It is known that after alcohol ingestion a driver's attention may not be appropriately divided between various happenings on the road, and that reactions to unexpected situations may lead to accidents. Boredom and familiarity may enhance these errors. We attempted to simulate this by choosing a fairly long test film and by using the same film at each test session. To study the effect of time the error scores after each 5-minute interval of the 20-minute test drive were assessed. The mean differences are listed in Table IV. No discernible pattern of error-making in relation to time was noted.

TABLE III. DIFFERENCES IN ERROR SCORES AFTER INHALATION OF VARIOUS MIXTURES AT WEEKLY INTERVALS (NEGATIVE VALUES INDICATE AN INCREASE IN ERRORS AND POSITIVE, A DECREASE)

Subject	Differences		
	Air — 50% N ₂ O/O ₂	50 - 70% N ₂ O/O ₂	Air — 70% N ₂ O/O ₂
1	- 8	- 2	-10
2	+ 8	+ 1	+ 9
3	- 5	- 7	-12
4	- 6	+ 3	- 3
5	-11	- 6	-17
6	- 6	- 5	-11
7	-16	+ 6	-10
8	- 1	+ 6	+ 5
9	- 4	+ 6	+ 2
10	- 4	+ 4	+ 8
Mean	- 4,5	+ 0,6	- 3,9
SD	6,9	5,2	9,3

TABLE IV. DIFFERENCES IN ERROR SCORES AT 5-MINUTE INTERVALS (NEGATIVE VALUES INDICATE AN INCREASE IN ERRORS AND POSITIVE, A DECREASE)

	Differences					
	Air — 50% N ₂ O/O ₂		50 - 70% N ₂ O/O ₂		Air — 70% N ₂ O/O ₂	
	Mean	SD	Mean	SD	Mean	SD
First 5 min	0,7	2,5	-0,9	1,7	-0,2	2,4
Second 5 min	-2,2	3,29	1,5	3,1	0,3	2,36
Third 5 min	-1,9	3,03	-0,8	2,0	-2,7	3,6
Final 5 min	-1,1	3,2	0,6	3,1	-0,6	3,2

The type of driving error made is listed in Table V. The commonest error committed was signalling followed by incorrect use of the foot brake. Emergency situations concern instances in the test film when immediate braking was necessary to avoid collision with a person or with another vehicle. The sign test was applied to these errors. Significantly more errors in the use of gears were noted after inhalation of 50% N₂O/O₂ ($P < 0,01$). More important, the number of incorrect reactions to emergency situations was greater after inhalation of both 50% N₂O/O₂ ($P < 0,05$) and 70% N₂O/O₂ ($P < 0,01$) than after air inhalation.

DISCUSSION

The test used proved easy to operate and all the subjects remarked that they had enjoyed the experiment and that they felt that their driving had improved as a result of the tests. No subject felt that his driving ability might be impaired.

Under the test conditions used, it was clear that increasing experience played a significant role in the errors committed. However, randomization of the inhalation mixtures in the three tests probably compensated for this.

At the present time no evidence appears to exist to equate errors made on the driving simulator with actual

TABLE V. DETAILS OF NUMBER OF DRIVING ERRORS MADE AFTER INHALATION OF GAS MIXTURE

Driving technique	Gas mixture inhaled					Total
	Air	50% N ₂ O/O ₂	70% N ₂ O/O ₂			
Stalling	4 (24%)	6 (35%)	7 (41%)			17
Use of hand brake	18 (28%)	26 (40%)	21 (32%)			65
Use of foot brake	36 (31%)	42 (36%)	39 (33%)			117
Use of gears and clutch	10 (18%)	29 (54%)	15 (28%)			54
Turning	13 (22%)	20 (35%)	25 (43%)			58
Signalling	46 (31%)	48 (32%)	56 (37%)			150
Emergency situations	4 (18%)	5 (23%)	13 (59%)			22

driving ability on the road. This is compensated for in the experimental design through the use of each subject as his own control after initial familiarization with the simulator. Thus increases or decreases in error-making after inhalation of the nitrous oxide mixtures were analysed. Significant numbers of errors in technical driving ability were noted and we believe it is reasonable to assume that actual driving ability would be even more adversely affected. On the road more distractions are present and allowance has to be made for the bad driving of other drivers. Particularly worrying was the subjects' decreased ability to cope with emergency situations.

The ability of 4 subjects to apparently improve their driving ability after 70% N₂O/O₂ inhalation (Table III) suggests that, unlike alcohol, more intense concentration may overcome the effects of nitrous oxide.

From our findings that some impairment of driving skills occurred up to 30 minutes after nitrous oxide

inhalation, it would appear that caution in driving should be exercised after a short exposure. Further experimentation is necessary to determine: (i) the effects of prolonged exposure on driving ability, and (ii) the period after which it would be safe to drive.

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