Drug Induced Driver Impairment: The Development of a Roadside Testing Device

J Boyle
R Meadows
I Hindmarch
A Degia

Human Psychopharmacology Research Unit, School of Biomedical and Molecular Sciences, University of Surrey, Guildford, GU2 7XP, United Kingdom

Background
Drug induced impairment has become a major road safety problem. Latest results from the UK show that amongst all road users traces of illegal substances were present in 18% of fatalities. This is a six-fold increase when compared with previous studies carried out in 1989.

Although driving whilst impaired is a criminal offence it is a difficult one to enforce. There is no objective measure, which is available for use at the roadside and which can determine impairment due to drugs. Results from the first phase of the ROSITA\(^1\) project have urgently stated the need for an objective measure available for use at the roadside: reporting that roadside tests and the publicity made around them can have a deterrent effect as the subjective risk of being caught increases\(^2\). Further to this, it is suggested that roadside tests can save time and simplify the enforcement procedure and can save money by excluding drugs as a cause of impairment. Indeed, the need for an on-site test is so great that in some countries police officers have alarmingly suggested that they would rather use an imperfect device than wait for a more suitable one.

Historically, psychopharmacologists have developed a wide range of tests that they believe are sensitive and reliable measures of the pharmacodynamics of drugs in the context of driving. These tests work on the assumption that drug effects are reflected in changes in behaviour and include such measures as simulators, driving analogues, gymkhana type field tests, and psychometric test batteries\(^3\). It is, however, only the latter of these which offers the possibility of complying with the generic requirements of an objective, roadside, measure of impairment: portable and lightweight, simple to use and quick and accurate.

Methodology
In order to select sensitive psychometric tests, which met these requirements, analysis of iterative alprazolam (3mg/Day) data was performed. Alprazolam is a triazolobenzodiazepine derivative known for its impairing effect on cognitive function and psychomotor performance. It is also a known problem in driver impairment in the U.S: in 1993 the Drugs and Driving Committee reported on 102 individuals arrested for driving under the influence of alprazolam, stating that 30% of the cases had consumed over three times the dose normally given to those receiving chronic therapy.

Using a database of 23 subjects, and both pre and post dosing results, the response measures from a number of psychometrics were used as independent, potentially explanatory variables in an incremental stepwise logistic regression, to predict whether or not alprazolam had been administered before the psychometrics were carried out. This mirrored the roadside requirement of retrospective determination.
Akaike’s Information Criterion (AIC) was used at each step of the regression run to judge whether or not inclusion of a candidate explanatory variable produced an improved model or produced a better model than inclusion of another candidate explanatory variable. Sex and age-group of the subjects was also included as candidate variables.

Variables from four of the most commonly used psychometric tests were selected for inclusion within the logistic regression model. These tests all contained elements seen as essential for motor vehicle driving: at the Strategic, Tactical or Operational level.

**Compensatory Tracking Task (CTT)**
The compensatory tracking task is an interactive task of psychomotor function involving parallel information processing. Subjects are required to keep a cursor in alignment with a moving target whilst simultaneously responding to randomly presented visual stimuli in the periphery of the screen. The task yields two measures of performance: tracking accuracy, measured as the root mean square deviation of movements of the cursor from the tracking stimulus, and the mean reaction time to a peripheral stimulus.

**Choice Reaction Time (CRT)**
The Hicks CRT is used as an indicator of sensorimotor performance, assessing the ability to attend and respond to critical stimuli. Subjects are required to extinguish 1 of 6 equidistant red lights by pressing the associated response button as quickly as possible. Behind each red light is a corresponding green light, which is illuminated to indicate whether 1, 3 or all 6 or the red lights are potential stimuli. The mean reaction time is recorded for three components: recognition, motor and total.

**Rapid Visual Information Processing (RVIP)**
The RVIP assesses the performance of attentional mechanisms in remaining vigilant to periodically occurring events. Subjects are required to monitor a series of single digits (0-9) appearing on the screen at a rate of 100 digits every minute and respond to consecutive sequences of odd or even digits by pressing a button. At each assessment the duration of the task is 10 minutes. The response measures are the mean reaction time in milliseconds and the number of correct responses made.

**Sternberg’s Short Term Memory Scanning Task (STM)**
The Sternberg test assesses high speed scanning and retrieval of information from short-term memory. Subjects memorise a random series of 2, 4 or 6 digits (the stimulus set), which are presented sequentially at a rate of 1.2 seconds per digit. One second after the final digit of the stimulus set is present, a visual warning appears followed by a series of 12 digit probes. Subjects indicate whether each probe digit was contained within the original stimulus set or not. The response measures are the mean reaction time and the number of correct/incorrect responses.

**Results and Analysis**
Individual test data showed that alprazolam (3 mg) significantly impaired cognitive functioning and psychomotor performance on all four psychometric tests selected.

Alprazolam impaired sensorimotor performance, significantly reducing tracking accuracy and increasing the time taken to respond to a peripheral stimuli (p < 0.0005 for both) on the CTT and significantly increasing recognition, motor and total reaction time (p < 0.0005) on the CRT test. Alprazolam also impaired attentional mechanisms: significantly reducing the number of correct responses (p < 0.0005) and increasing the time taken to respond (p < 0.0005) on the RVIP test. Data showed that alprazolam also affected short-term
memory, significantly reducing the number of correct responses made and increasing the time taken to respond \( p < 0.0005 \) during the STM test.

From the above variables entered, the logistic regression model selected the variables ‘correct responses’ (STM), ‘number of valid responses’ (RVIP), ‘tracking accuracy’ (CTT), ‘total reaction time’ (CRT) and ‘correct reaction time’ (STM) as having the strongest explanatory power. It was also found that using separate coefficients for men and women produced better AIC for ‘tracking accuracy’ (CTT), ‘total reaction time’ (TRT) and ‘correct reaction time’ (STM). Further to this, it was found that forcing the coefficient for men to zero, while leaving the coefficient for women for correct reaction time to be estimated, produced better AIC. Age however, had no noticeable effect on the model.

The linear predictor obtained in the final fit had an intercept estimate of -14.4271 (s.e. of 4.6789), a coefficient estimate for ‘correct responses’ (STM) of 0.1248 (s.e. of 0.0492), a coefficient estimated for ‘number of valid responses’ (RVIP) of –0.0690 (s.e. of 0.0223), a coefficient estimate for men for ‘tracking accuracy’ of 0.1726 (s.e. of 0.0593), a coefficient estimate for women for ‘tracking accuracy’ of 0.1005 (s.e. of 0.0364), a coefficient estimate for men for ‘total reaction time’ (CRT) of 0.00702 (s.e. of 0.00328), a coefficient estimate for women for ‘total reaction time’ (CRT) of 0.0183 (s.e. of 0.00467), and a coefficient estimate for women for time of –0.0118 (s.e. of 0.003384).

By varying the probability level for prediction it was possible to accurately predict 72% of those subjects in the alprazolam group (probability level 0.440). However at this probability level 21% of those in the placebo group were wrongly predicted as having taken the drug. At a probability level of 0.800 only 8% false positives were obtained with 50% of the alprazolam group correctly identified.

**Conclusion**

The results demonstrate that the tracking task, choice reaction test and RVIP are sensitive to drug use and that response measures can be used to predict whether or not a subject has taken a psychoactive drug. STM also displayed some sensitivity although STM reaction time was only sensitive for women. The model was able to predict, from a relatively small sample group, up to 70% of those who have taken a prescription drug. As the literature indicates that levels of this particular drug found in U.S. drug drivers is far in excess of the 3mg/day dose administered in this study, it is possible that the discriminatory power of this model is underestimated here.

Future directions are investigating this, as well as looking at issues of portability, comprehension, learning and numeracy/literacy. Any roadside test must not be dependent on comprehension and numeracy/literacy skills and must not contain learning effects. In this vein, the RVIP and STM fail as potential measures, despite their discriminatory power.

Of the tests contained within the database described here, the CTT offers the best potential for transferability from the research unit to the roadside. This test has now been programmed, along with the Sustained Attention task, a test that incorporates elements of the RVIP and STM without the comprehension or numeracy/literacy problems, on to a portable, ruggedised PDA. Fieldwork continues.
References