Cognitive and Motor Skills Differ in Sensitivity to Alcohol Impairment

by

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ABSTRACT

Research reviews have repeatedly concluded that cognitive and motor skills are not equally impaired by a moderate dose of alcohol, but they disagree on which type of task is more impaired. The difficulties in comparing the effect of alcohol on cognitive and motor skills encountered in reviews of the literature underscore the need for research specifically designed to address this question. This thesis presents the results of two experiments designed for this purpose. This research used a within subject design in which the same person performed a pursuit rotor (PR) motor skill task and a cognitive rapid information processing (RIP) task requiring no learned motor skill. The pair of tasks was performed in counterbalanced order within each group. Tests on the pair of tasks occurred at intervals as blood alcohol concentration (BAC) rose and declined. In the first study, twenty male social drinkers received either a moderate dose of alcohol (0.62 g/kg) or placebo and performed the tasks under standard conditions that provided no consequence for performance. On both tasks, the alcohol group was significantly more impaired than the placebo group. Impairment in PR performance tended to increase and decline in accord with the blood alcohol curve, whereas the degree of impairment on the RIP task was unrelated to the blood alcohol curve. The second study tested the consistency of these two profiles of impairment in different environmental contexts by manipulating reinforcement for task performance. Four groups of social drinkers (N = 56) performed the tasks in the context of different reinforcement conditions. Reinforcement (25 cents reward) per test score under alcohol that was comparable to a drinker's drug-free score was administered either for both tasks, or only the motor, or only the cognitive task, or neither task. Rewarding the performance of a task under alcohol reduced the degree of impairment displayed, but the two types of tasks continued to show consistently different profiles of impairment as BACs rose and declined. On the motor task, impairment increased and diminished in accord with rising and declining BAC, whereas the degree of impairment on the information-processing task was not related to these BACs. The results imply that the controversy over which type of task is more impaired by a moderate dose of alcohol may be resolved by a consideration of the position on the BAC curve when performance is tested. Practical implications

of the findings and their relevance to theories of acute behavioral tolerance to alcohol are also considered.

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INTRODUCTION

Mankind has used alcohol since history has been recorded. Its use is so widespread that it is incorporated in the religious and social activities of most cultures (McKim, 1991). In the Old Testament, alcohol was hailed as a source of happiness and joy and as a tonic with healing and medicinal properties (Psalms 104:15, Ecclesiastes 10:19, as cited in McKim, 1991). However, the use of alcohol is also associated with numerous harmful social and personal consequences as well as injuries and fatal accidents.

During the first half of the twentieth century, the temperance movement attempted to curb alcohol related problems by advocating abstinence, and experimenters began to investigate the effect of alcohol on basic processes, such as sensation and reaction time. The increasing incidence of accidents with the introduction of the automobile and machinery in industry gave impetus to a massive amount of research examining the effect of alcohol on mental and motor skill tasks. A major purpose of this work was to determine what types of activities are impaired by moderate doses of alcohol. Reviews of the accumulated findings have led to the suspicion that motor and cognitive processes may not be equally sensitive to disruption by alcohol and thus may contribute differently to the risk of accidents and other adverse consequences. However, these important possibilities cannot yet be evaluated because there appears to be no research designed specifically to compare the impairing effect of moderate blood alcohol levels on cognitive and motor skills. The question of whether a moderate dose of alcohol results in different profiles of impairment in cognitive and motor skill tasks remains unanswered. This thesis addresses this question.

Pharmacology of Alcohol

Alcohol, known as ethanol in pharmacology, is classified as a depressant drug. When taken orally, alcohol passes through the stomach and is absorbed into the blood from the upper intestine (McKim, 1991). Alcohol is soluble in both water and fat and diffuses easily through biological membranes, allowing for rapid absorption (Julien, 1998). However, the rate of absorption varies somewhat among individuals, with the time from last drink to maximal blood concentration ranging from 30-90 minutes (Hardman et al., 1996). Absorption is slowed by the amount and type of food in the stomach, resulting in a slower rising blood alcohol concentration (BAC) and lower

peak concentrations from a given dose. After absorption, alcohol is evenly distributed in body fluids and tissues and the blood brain barrier is freely permeable to alcohol (Julien, 1998).

The majority of alcohol metabolism occurs in the liver, however, a smaller degree of metabolism occurs in the stomach. The primary enzyme responsible for alcohol metabolism in both organs is alcohol dehydrogenase. Alcohol dehydrogenase acts in the first step of liver metabolism by converting alcohol to acetaldehyde. Aldehyde dehydrogenase acts in the second step to convert acetaldehyde to acetic acid, which is then ultimately broken down into carbon dioxide and water (Julien, 1998). To a lesser degree, another metabolic system in the liver known as the microsomal ethanol oxidizing system is also involved in ethanol decomposition. The activity of this system increases slightly at higher blood alcohol levels and when alcohol is consumed chronically (McKim, 1991). A much smaller amount of alcohol is excreted by way of the lungs and in the urine (Grilly, 1998). Individual differences in rates of metabolism have been noted, but in all cases, the clearance rates are a linear function of time, irrespective of the concentration of blood alcohol (e.g.,McKim, 1991).

Gender, age and prior drinking history have all been shown to contribute to variation in alcohol absorption and elimination. Research has indicated that women have lower levels of alcohol dehydrogenase enzymes in the stomach, which may have implications for risk of acute intoxication or complications of chronic consumption (Frezza et al., 1990). In addition, women tend to have a higher proportion of body fat than men. Because fat offers less of an opportunity for alcohol distribution, blood alcohol levels from a given dose tend to be higher in women than in men. These factors may also contribute noise when men and women are grouped together for comparison on a secondary variable in experimental studies. Like women, older individuals also have a higher body fat to muscle ratio as compared to younger individuals and this may contribute to higher blood alcohol levels (McKim, 1991). In addition, older individuals also have slower respiration, metabolism and excretion and this may alter drug absorption (Palfai & Jankiewicz, 1997). Finally, individuals who have a heavier drinking history may require greater amounts of alcohol before impairment is seen. A number of factors that might explain this have been investigated (i.e., a faster rate of alcohol elimination owing to higher levels of liver enzymes,

greater activity of the microsomal enzyme oxidation system, adaptation of cellular function as a result of prolonged exposure; McKim, 1991; Hardman et al., 1996). However, a full explanation of this difference in individuals with heavier drinking histories remains to be determined (Kalant, LeBlanc & Gibbins, 1971).

Unlike most drugs that exert their effects by interacting with some receptor site in brain tissue, there is no known receptor site for alcohol (e.g., McKim, 1991). In vitro investigations indicate that alcohol alters a host of cellular functions. Alcohol has been found to disturb the permeability of cell membranes by allowing greater motility of molecules embedded in them (Hunt, 1993). In addition, alcohol interferes with voltage-gated ion activity (e.g., influencing the inward movement of calcium ions into neurons), with receptor mediated ion channels (e.g., interaction with the GABA receptor complex to facilitate its binding; blockage of the NMDA receptor for glutamate at low concentrations), and with second messenger systems (e.g., stimulation of adenylate cyclase, which is involved in the production of the second messenger cAMP) (Hunt, 1993). However, reviews of these findings indicate that the effects of alcohol at the cellular level do not predict in vivo behavioral effects of the drug (Hunt, 1993).

Alcohol also has effects on many other types of tissues. Specifically, alcohol increases blood circulation to the skin, creating a flushing sensation that in turn increases the rate of loss of body heat when exposed to the cold (Grilly, 1998). In addition, moderate doses of alcohol may result in vasoconstriction in the heart and brain (Hardman et al., 1996). Alcohol also increases the production of acid and pepsin in the stomach, which may account for why some people's appetites are enhanced by alcohol (Grilly, 1998). Antidiuretic hormone from the hypothalamus is also inhibited. As a result, the kidneys fail to reabsorb water and there is a high water elimination rate (Grilly, 1998).

What Types of Activities are Impaired by Alcohol?

Jellinek & McFarland (1940) were among the first to review research on the effects of alcohol on human behavior. They were merely interested in determining whether or not certain activities were affected by a moderate dose of alcohol. Thus, they reviewed the results of research that had examined the effect of alcohol on a whole host of abilities and skills, including chronaxy,

reflexes, sensations, perception and attention, simple reaction time, muscular strength and coordination, dexterity, learning, memory, associative function, judgment, reasoning, intelligence, volition, emotion and personality. The reviewers were clearly ahead of their time in knowledge about alcohol methodology because they noted that the procedure for administering the drug was inadequate in most experiments. In many studies, the same amount of alcohol was given to all subjects; failing to standardize the dose on the basis of body weight meant that the resulting BACs were uncontrolled. The rate of absorption of alcohol and the peak BAC also depend on the amount of food in the stomach. Requiring a standard fast prior to the administration of the drug controls this. Generally, three to four hours of fasting after minimal high fat content food is best. However, few studies controlled fasting or stomach contents. As a result, some subjects would have faster rising BACs than others. Their BACs would differ when they were tested and they would have different peak BACs. Since the behavioral effect of the drug presumably depends on the BAC, the drug effect could be shown in some people but not others. Jellinek and McFarland also noted that time of testing after alcohol was administered varied widely among experiments. When tests are performed soon after alcohol is consumed, BACs may be rising, but when tests are performed much later, BACs could be declining and the drug effect may be much weaker.

In addition to inadequacies in the administration of the drug, the design of many studies was flawed by the lack of a placebo control group. Some experiments used subjects as their own control, administering alcohol on one occasion and placebo on another, but this too is problematic because familiarity with the alcohol treatment may allow an individual to detect the placebo and thus expectation of receiving alcohol may not be controlled. The authors noted that all of the studies claimed that alcohol reduced the efficiency of the functions and performances that were tested. However, the doses used in the experiments ranged widely; many were in the moderate range that would yield peak BACs of no more than 100 mg/100 ml, but some doses were extremely low (i.e., 10 ml, which is the equivalent of two teaspoons). In the absence of adequate control groups, it is impossible to know if these low dose effects reflect the expectations about alcohol on the part of the subjects or the experimenters. The numerous problems in the research reviewed by the authors led them to state that the conclusions about the effect of alcohol on human activities

could only be surmised, although they suggested that simple psychological functions may be less affected by alcohol than the complex ones, whether or not complex tasks were familiar (i.e., practiced previously) (Jellinek & McFarland, 1940).

Two decades later, Carpenter (1962) reviewed the effects of alcohol on various classes of behavioral and sensory functions. For his review, he created categories and placed the tasks in each experiment into these groups. His classifications included reaction time, motor skills, eye positional nystagmus, sensory phenomenon (i.e. critical flicker fusion, color perception, acuity) and mental functions. However, even though some more adequate experiments had been conducted by 1962, it was difficult to determine how alcohol affected performance of any given class of activities because the experiments using tasks within a given category differed in important respects, such as different doses of alcohol, different types of subjects (males vs. females, heavy vs. light drinkers) and time of testing relative to alcohol administration. In addition, some studies did not even report BACs, the dose given or the time after consuming alcohol that the tests were performed. Another difficulty Carpenter noted in the research concerned variations in the degree of practice on a given task prior to the test. If subjects are not trained on a task prior to the administration of alcohol, learning may be confounded with the effect of alcohol. In other words, improvement in performance due to learning may overwhelm the impairing effect of alcohol, so no drug effects are detected. While recognizing that the flaws in the experiments clouded the interpretation of the results, Carpenter noted that some studies reported that reaction time was slowed by BACs as low as 40 mg/100 ml. The impairment of motor skills had been observed at BACs as low as 20 mg/100 ml, and the onset of positional nystagmus had been reported at BACs of 38 mg/100 ml. The results for sensory phenomenon (primarily in the visual domain) revealed that onset of impairment was seen at BACs of 31 mg/100ml. The impairment of mental functions (tests of attention, mathematical capabilities, recognition of figures and naming of objects) tended to be observed at BACs that were higher than motor and sensory abilities. This led Carpenter to speculate that mental tasks may be less sensitive to disruption by moderate doses of alcohol than are sensory and motor tasks. However, different criterion measures (e.g., reaction time, errors, correct responses) were used to assess performance on tasks in different categories. Unless the metric is comparable, there

is no way of determining whether one type of task was more impaired than another. Overall, Carpenter was disappointed in the results of the experiments he reviewed. He stated that the important questions about the degree and direction of change at low and moderate BACs for each category of activity still had to be investigated.

A major difficulty of Carpenter's review involved the imposition of arbitrary task classifications based solely on apparent face validity of the tasks, and a possible overlap of skills within categories. For example, many different types of motor tasks have been used in experiments, including pursuit rotor and tracometer tasks as well as variations of hand-eye coordination tasks and visuo-motor tasks. Although each of these tasks may tap different components of motor skills, it is common for all types of motor tasks to be classified together. In addition, many tasks classified in the same category can have components of another category. For example, many cognitive tasks such as coding also require manual dexterity and skilled motor responses. As a result, it is not clear whether the behavioral effect of alcohol can be attributed to the cognitive or motor component of the task. Further, tasks within the same category also could differ in the amount of skill needed to perform the task. It may be that the degree of skill required by a task influences the impairing effect of alcohol. However, none of these possibilities are taken into account when grouping tasks together within a given category. Carpenter's creation of a task classification scheme helped to provide a simplifying overview of alcohol effects on types of tasks. Unfortunately, it also added more noise to already poor evidence. However, this review was important in that it appears to be the first to suggest that mental and motor skills may be differentially sensitive to alcohol's impairing effects.

Levine, Kramer & Levine (1975) presented one of the first reviews that aimed to specifically examine Carpenter's suggestion that mental, motor and sensory tasks may differ in sensitivity to moderate doses of alcohol. These authors also noted that the same flaws that had been identified in earlier reviews plagued much of the contemporary research. In addition, they recognized the difficulty of trying to compare the amount of impairment in different tasks without some consistent performance index. Variations in the type of task, dependent and independent measures made it impossible to generalize. Therefore, they set strict requirements for the inclusion

of an experiment in the review. A study had to have an adequate description of the task; the experimental and control populations had to be well defined; performance data had to be reported; and the dose and the time of testing had to be identified. The reviewers obtained 41 studies that met these criteria and they classified the tasks in these experiments into either a cognitive, sensory-perceptual or psychomotor domain. The reviewers used rating scales to determine the extent to which an ability from each category was required for task performance. In cases where tasks involved multiple abilities, the ability ranked highest in importance for performance determined the category for the task. Most of the studies were single dose studies whereby the experimenter administered the dose during a single, 15-minute time period before testing began. However, a smaller number of studies in which multiple doses of alcohol were administered, both before and during testing, were also included. The reviewers also examined the results in relation to the time of test following the administration of alcohol (i.e. within 30 minutes, from 31-59 minutes or after 60 minutes).

The various dependent measures of task performance were transformed to provide a common measure that was consistent across tasks. This measure of the "percent difference" between alcohol and control groups consisted of the difference between the scores for the experimental (alcohol) group and the control (no alcohol) group, divided by the control group's score and multiplied by 100. Positive values indicated superior performance by the alcohol group and negative values indicated that the alcohol group was inferior to the control group. These percent scores were used to compare the three categories of tasks. To this end, the median percent impairment on tests for a given task within a category was computed for all studies that administered the same dose (ranging from 0.1 g/kg to 1.0 g/kg). They noted that the relation between the median percent impairment and the dose appeared to differ as a function of task categories. However, they concluded that, overall, regardless of dose, psychomotor tasks were less impaired by alcohol than were cognitive tasks, and perceptual sensory tasks were most impaired. For all categories of tasks, the greatest impairment appeared to occur when an hour or more had elapsed between the beginning of drinking and the initiation of performance testing. In contrast, if testing occurred within the first 30 minutes after alcohol had been consumed, there seemed to be no

difference in alcohol's effects on the three task categories. Unfortunately, the conclusions of Levine et al. (1975) about the different impairing effect of alcohol on psychomotor, cognitive and perceptual-sensory tasks were not tested statistically, so it cannot be stated for certain that these differences were not due to chance. However, the review of research on moderate doses of alcohol is important because it calls attention to the possibility that the observed effect of alcohol on a given task is dependent on the time a task is tested relative to alcohol consumption. In addition, the review is of particular interest because it suggests that cognitive tasks are more impaired than motor skill tasks, an opinion that is opposite to Carpenter's proposal that mental functions are less impaired than motor skills.

In 1985, Mitchell reviewed 49 studies of alcohol impairment on behavioral skills involved in driving. He classified the tasks in these studies into categories of perception, divided attention and vigilance, sensorimotor coordination, information processing and judgment. From an inspection of the results of studies in each category, Mitchell stated that almost all behavioral skills were impaired above a BAC of 100 mg/100ml and there was no consistent evidence that BACs below 50 mg/100ml resulted in impairment in any of the skill categories. He also suggested that the degree of impairment in these categories of skills was dose-related, but not identical or strictly linear for all categories. His review also led him to conclude that alcohol related impairment was greatest for tasks requiring information processing and judgment, with impairment seen at BACs of 50 mg/100 ml and above. Simple perception was found to be more resistant to impairment, with only minor decrements in visual and hearing acuity at BACs between 100 and 150 mg/100 ml. Likewise, perception of rapid movements and simple reaction times showed only minimal decrements at BACs below 80 mg/100 ml. Mitchell also stated that simple motor skills (i.e., Romberg body sway test) were impaired at BACs of 100 mg/100 ml and above, whereas complex motor skills (e.g., pursuit rotor tracking task) showed performance decrements at somewhat lower BACs (65 mg/100 ml). However, these comparisons are clouded by the arbitrary classification of tasks within categories, and the fact that the effect of alcohol is based on different measures of performance on the various tasks. Without a common metric, differences in the effects of alcohol in each task category remain in doubt. Nevertheless, the conclusions from Mitchell's review are of

interest because they are the reverse of Carpenter's opinions that cognitive skills are less likely than sensory and motor skills to be impaired by moderate doses of alcohol. Moreover, Mitchell's view that BACs of about 50 mg/100 ml are required before tasks in any of the skill categories show impairment is at variance with the opinions expressed in the other reviews.

In the next decade, Holloway (1995) reviewed the results of 155 studies from 1985-1993 that examined the effects of low and moderate doses of alcohol on psychophysical activity as well as the performance of various tasks. He noted that many of the experiments continued to be flawed by the same problems noted in earlier reviews. Rather than attempting to categorize these tasks on the basis of the abilities involved, Holloway simply divided them into "automatic" (i.e., simple well-learned activities) or "controlled" (i.e., new learned complex tasks). The automatic category included tasks such as easy tracking, simple and choice reaction time, mental arithmetic, cancellation and concentrated attention. The controlled class included difficult tracking, divided attention tasks, information processing/decoding and eye hand coordination. He standardized the comparison of the effect of alcohol by counting the percent of studies in a category that reported impairment at a given BAC. These measures showed that 70-80% of studies of controlled tasks reported impairment at BACs of 40 mg/100 ml, as compared to only 33% of studies of automatic tasks. Thus, it appeared that tasks in the controlled category were more sensitive to alcohol's impairing effects than those in the automatic group. Holloway's review did not address the question of differences between cognitive and motor skills in sensitivity to alcohol impairment. Nonetheless, his review was important because it did raise the possibility that variables, in addition to the nature of the task, might also influence the intensity of alcohol's effects. Specifically, he suggested that environmental factors, such as performance feedback and incentives contingent on performance as well as subject characteristics (e.g., gender, age and drinking history), may affect the degree of alcohol impairment on a given task. Variations across studies in these subject characteristics mean that there are differences in alcohol absorption and elimination, which may influence the rate and degree of impairment on a given task. Thus, variations in environmental factors and subject characteristics may contribute to the conflicting findings reported in the reviews.

In summary, reviews of research testing the effect of moderate doses of alcohol on various types of tasks have been helpful in identifying inadequacies in the design and conduct of these experiments. However, even if individual experiments were adequate, it appears that reviews of such work are unlikely to provide any clear conclusions. The tasks in the experiments were not specifically chosen to distinguish between mental and motor skills. Moreover, there is no objective means of determining the adequacy of arbitrary, retrospective classifications of tasks. Even if tasks had been specifically selected to assess mental or motor skill, the intensity of the effect of alcohol on the tasks may have been altered by differences among experiments in the type of subjects, the BAC, and the environmental conditions when performance was tested. The problematic and inconsistent conclusions derived from the various reviews of this research reveal the need for research specifically designed to test the relative sensitivity of mental and motor skills to disruption by a moderate dose of alcohol when other factors are controlled. An experiment could test the performance of a given subject on a mental and a motor skill task at comparable BACs under identical environmental conditions. Such a within-subject design would control individual differences, the setting and the BAC at time of test. The results of such research could contribute importantly to determining the relative sensitivity of cognitive and motor performance to disruption by a moderate dose of alcohol.

There is another facet to the problem of assessing the effect of a moderate dose of alcohol on the performance of a task. This relates to the time after alcohol is administered that performance is tested. Previous reviews mentioned that this variation in timing meant that the effect of different BACs was being assessed within a given task category. This creates problems for comparing the results of experiments within and between categories. However, variations in this time factor may engage another important phenomenon that merits special attention because it may affect the behavioral effect of a given BAC.

Acute Behavioral Tolerance

Drug effects are typically seen to intensify during absorption while BAC increases. When absorption is complete, elimination processes reduce the BAC. Acute tolerance is characterized by a drug effect that diminishes at a faster rate than the declining BAC. Acute tolerance is identified

by a stronger behavioral reaction to a given BAC on the rising compared to the falling limb of the blood alcohol curve, with a rapid reduction in the reaction during declining BACs (Vogel-Sprott & Fillmore, 1993).

Acute tolerance was first observed by Mellanby (1919). He injected dogs with a dose of alcohol and examined their gait as they roamed freely in the laboratory. The BACs of the dogs were measured when they first displayed any impairment in their gait, and again when their gait returned to normal. These measures showed that the onset of impairment occurred at lower rising BACs than the offset of impairment. Mellanby concluded that the threshold for impairment during rising BACs was lower than the offset threshold when BACs were declining. This phenomenon characterizes acute tolerance. However, the important implications of his findings were not recognized at the time.

Two decades later, Goldberg (1943) examined acute tolerance in abstainers, moderate drinkers and heavy drinkers when they performed sensory, motor and psychological tasks. He attempted to identify the BAC threshold for the appearance of impaired performance by administering a mild dose of alcohol and then testing task performance. If no impairment was evident, additional alcohol was administered and the tests were repeated. This continued until the individual's performance was impaired, and the BAC at this time was used to identify the onset threshold. Later, when BAC had declined to this level, the tests were repeated. Goldberg found that the BACs associated with the onset of impairment was lowest for abstainers and highest for heavy drinkers. In addition, all groups showed less impairment at these BACs when the drug blood levels were declining.

Although Goldberg's results were consistent with acute tolerance, his procedure for identifying the BAC for the onset of impairment was confounded with the number of tests on the tasks under the drug. Thus heavy drinkers not only had more doses of alcohol, they also had more task practice that might have improved performance and reduced the degree of impairment they displayed as BAC was rising. The beneficial effect of practice may have also reduced the degree of impairment all groups subsequently displayed when they were tested at BACs during declining drug levels. Nonetheless, Goldberg's findings attracted the interest of investigators in the field of

alcoholism. The exceptional behavioral tolerance to alcohol shown by alcoholics is commonly attributed to the development of some physiological compensatory mechanism induced by repeated drug exposures (e.g., Kalant et al., 1971). In theory, this compensatory reaction counteracts the effect of alcohol when it is consumed, and contributes to alcoholics' withdrawal symptoms when the drug is abruptly withheld. Goldberg's finding that all groups of drinkers had lower BAC thresholds for the onset than the offset of behavioral impairment implied that the physiological compensatory reaction grows with time during a single dose and may account for acute tolerance. In addition, progressive strengthening of this compensatory reaction as doses are repeated may account for the greater behavioral tolerance shown by alcoholics. Thus, acute and chronic tolerance are often thought to have the same underlying compensatory mechanisms, and these types of tolerance are just of different magnitude brought about by different numbers of exposure to alcohol (e.g., Kalant et al. 1971).

A great deal of animal research has examined the development of behavioral tolerance to an acute dose of alcohol (Kalant et al., 1971). These experiments typically trained groups of animals to criterion on some motor task before alcohol or placebo was administered. Then the groups repeatedly performed the task at intervals while their BAC rose and declined. The results indicated that impairment on the task intensified until the peak BAC was reached. Thereafter, the reduction in impairment proceeded more quickly than the BAC declined.

Similar findings have been obtained in experiments using the same repeated test procedure to test the effect of a moderate dose of alcohol on social drinkers' performance of motor skills (e.g., Haubenreisser & Vogel-Sprott, 1983; Vogel-Sprott & Fillmore, 1993). The swift recovery of motor function during declining BACs is commonly considered to reflect the development of tolerance during an acute dose of alcohol. It has been attributed to a physiological compensatory reaction that is induced by the drug and counteracts its effects (e.g., Goldberg, 1943). Because BACs from a dose rise and then decline, and this compensatory reaction is assumed to grow with time under the dose, this physiological reaction might explain why the effects of a given BAC are weaker on the declining than on the rising limb of the blood alcohol curve.

Physiological compensatory responses to large doses of alcohol have been demonstrated experimentally. In vitro studies of cellular mechanisms during a constant dose of alcohol indicate that adaptation to the disordering effect of alcohol on cellular function occurs (i.e., Hunt, 1993). In addition, studies of chronic alcoholics have indicated that physiological changes account, at least in part, for their greater behavioral tolerance (i.e., increase in the expression of NMDA receptors; liver enzyme induction resulting in faster elimination rates; Hardman et al., 1996). However, whether physiological adaptation accounts for the tolerance seen to an acute dose remains to be determined.

In the 1970's and early 1980's, it became apparent that learning may also account for some of the compensatory reactions that are seen under alcohol. Many animal studies were conducted with the goal of determining whether learning under the drug or physiological adaptation to alcohol accounts for the lesser impairment seen in behavior after repeated doses in ethanol naïve animals (i.e., LeBlanc, Kalant & Gibbins, 1976; Wenger, Tiffany, Bombardier, Nicholls & Woods, 1981). LeBlanc et al. first trained animals drug-free to criterion to walk on a treadmill that moved continuously over a shock grid. Time off the treadmill resulted in an aversive foot shock and total time off the treadmill during a fixed time period was the dependent variable. Animals were then given a daily dose of alcohol for a period of approximately one month. A "learning" group practiced on the treadmill after receiving alcohol. A "physiological" group received alcohol after practicing on the treadmill. Every fourth day, the alcohol tolerance of the groups was tested by measuring their performance on the treadmill task under alcohol. These tests showed that the animals in the Learning group developed greater tolerance in fewer days (i.e., spent less time off the moving belt) than the Physiological group. However, both groups reached the same maximum level of tolerance by the end of the experiment. This led the authors to conclude that the intoxicated practice of the Learning group "behaviorally augmented" the physiological tolerance, speeding up the rate of tolerance development.

Wenger et al. (1981) challenged these findings by pointing out that the Physiological group in the LeBlanc et al. (1976) study that received alcohol after treadmill performance did have some intermittent practice under alcohol on each of the test days. This intermittent task practice under the

drug could have contributed to behavioral tolerance. This was demonstrated by repeating the LeBlanc et al. study and adding a group with no intermittent practice. This group performed the treadmill task the same number of times and received the same number of doses of alcohol, but had no practice under the drug until day 24 at the end of the experiment. The results showed that no significant behavioral tolerance was acquired in this group but the intermittent practice group developed tolerance during the course of the experiment. This led the authors to conclude that tolerance was contingent on learning and that physiological adaptation alone could not account for tolerance.

Unfortunately, these studies do not provide clear information about whether physiological adaptation occurs during the course of an acute dose. Animals were injected with large doses (ranging from 1.6 to 2.5 g/kg) over many repeated sessions, making it difficult to know whether the adaptation observed during the course of an acute dose is representative of the phenomenon of acute tolerance. Another difficulty is that the task paradigm itself is aversive. The sober behavior of the animal is negatively reinforced by the avoidance of the aversive shock when it stays on the treadmill. This rewarding property of the task may also have some physiological basis. Also, in both studies described above, testing under repeated doses was necessary before the behavioral tolerance was seen. Learning itself likely accounts for some physiological changes to the impairing effect of alcohol, making it difficult to disentangle the two sources of adaptation (Kalant, 1982). Given that physiological changes due to learning, alcohol exposure and rewarding properties of avoiding impairment are also likely to occur during the course of a single dose of alcohol, it is difficult to determine the relative contributions of each in determining what accounts for the onset and offset of impairment in a given task.

Whatever mechanism accounts for acute behavioral tolerance, the fairly clear and consistent evidence of this tolerance to an acute dose of alcohol in motor tasks performed by animals and humans has fostered the assumption that all types of tasks are characterized by increasing impairment as BAC rises to a peak and subsequent accelerated recovery as BAC declines. For example, Hiltunen (1997) examined the presence of acute tolerance in the cognitive and motor performance of light and moderate drinkers under doses of 0.5 and 1.0 g/kg on different

days. The cognitive task used was the Pauli task, which requires subjects to add numbers displayed on a computer screen and to type their answers on the computer keyboard. Thus, the cognitive task required some typing skill, and the potential involvement of this learned motor skill clouds the comparison between the cognitive and motor skill tasks used in the experiment. The motor skill task used was the pursuit rotor task. Performance was assessed at matched BACs on the ascending and the descending limbs of the alcohol curve (approximately 30 mg/100 ml under the low dose and approximately 75 mg/100 ml on the high dose). In the light drinker group, both doses impaired the performance of both of the tasks during the rising BAC and acute tolerance was shown on both tasks (i.e., less impairment on the declining than on the rising BAC). Moderate drinkers showed no change in performance under the low dose on both tasks so no acute tolerance (i.e., no recovery from impairment during declining BAC) could be observed. Under the high dose, moderate drinkers' performance on both of the tasks was impaired and acute tolerance was displayed. These results led the author to conclude that acute tolerance to alcohol "seems inevitable" when subjects consume a dose of alcohol that affects performance. If drinkers are accustomed to a dose, they may show little change in behavior and so no acute behavioral tolerance can be detected. This study reflects the general assumption that acute behavioral tolerance is a universal phenomenon that occurs in the performance of all tasks.

Unfortunately, the cognitive task used in Hiltunen's study could have involved some learned motor skill. This may be an important consideration because incidental observations in some recent research suggests that little change in impairment may occur during rising and declining BACs under a moderate dose of alcohol in cognitive tasks that require no motor skill (i.e., Mulvihill, Skilling, & Vogel-Sprott, 1997; Easdon & Vogel-Sprott, 2000; Fillmore, Carscadden & Vogel-Sprott, 1998; Fogarty, 1997). Some of these experiments used an information-processing task, and others used a stopping task that is designed to measure cognitive inhibitory control of behavior (Logan, 1994). No learned motor skills were required to perform these tasks because an individual just rested a finger on a button and either pressed it, or inhibited this response. All the experiments administered a moderate dose of alcohol (0.62 g/kg) and tests on the task were repeated at intervals as BAC rose and declined. Although the overall mean

impairment under the dose was of prime interest in these experiments, incidental observations indicated that there was little change in the degree of impairment across tests on each task, and no reduction in impairment was evident during declining BACs. The lack of some recovery from impairment in the cognitive tasks as BACs decline also appears inconsistent with the assumption that drug exposure during a dose induces a physiological compensatory reaction that strengthens with time. However, these observations are derived from experiments that were designed to address other questions about the effect of alcohol on cognitive performance. In addition, the studies were conducted by different experimenters who tested different samples of social drinkers who performed one of the tasks. Nonetheless, these results suggest that cognitive and motor skill tasks may show quite different patterns of impairment during the course of a moderate dose of alcohol. This possibility indicates that an adequate comparison of the sensitivity of cognitive and motor skill tasks to a dose of alcohol requires that a drinker perform both types of tasks at comparable BACs at intervals as BAC rises and declines.

Summary

This review of the literature reveals a long-standing suspicion that mental and motor activities may not be equally sensitive to the impairing effect of a moderate dose of alcohol, but there is no agreement on which type of activity is more sensitive. In the absence of research specifically designed to obtain this information, investigators have resorted to reviewing the results of different experiments with various tasks. Efforts to review this evidence have been thwarted, in part because numerous individual experiments have been seriously flawed and inadequately designed. The reviews themselves have created additional problems by their retrospective classification of tasks in experiments into arbitrary skill categories whose adequacy is unknown, and could therefore be questioned. For example, motor skills are required to perform some cognitive tasks, whereas other cognitive tasks require no motor skill. This distinction has been ignored in the classification of cognitive tasks in reviews. Yet it would seem that clear information about the effect of alcohol on cognitive performance can only be obtained with cognitive tasks that involve no learned motor skill. The difficulties in comparing the effect of alcohol on cognitive and motor skills encountered in reviews of the literature underscore the need for an experimental

approach. In addition to allowing the selection of a motor skill and a cognitive task that involves no motor skill, experiments can control for individual differences in sensitivity to a moderate dose of alcohol by a within-subject design in which a person performs a cognitive and motor task, at similar BACs as blood alcohol levels rise and decline. This procedure was adopted in the research presented in the thesis.

The first experiment examined the profile of impairment displayed in a cognitive and a motor skill task when they were performed at intervals after the administration of alcohol. A placebo group was also included to control for the expectation of receiving alcohol and practice effects. This experiment was conducted under standard conditions, where performance of the tasks had no consequences. Given that the majority of laboratory research is conducted without consequence for performance, it was important to verify the different task profiles under these conditions.

The second experiment aimed to verify the results of the initial study, and to test the generality of the different task profiles of impairment. This was tested by manipulating the consequences of task performance under alcohol. Specifically, reinforcing consequences for performance have been found to influence the degree of behavioral impairment displayed in motor skill tasks (Mann & Vogel-Sprott, 1981), and on cognitive tasks including the RIP task (Fillmore & Vogel-Sprott, 1997). The extent of impairment under the influence of alcohol is reduced when positive reinforcement in the form of money or verbal approval is associated with non-impaired performance. In motor skill tasks, the reinforcement effects strengthen as the task is performed under repeated doses. This may be due to gradually learning new motor skills to overcome the drug effect and maintain proficiency on the task (Zinatelli & Vogel-Sprott, 1993; Easdon & Vogel-Sprott, 1996). Support for this interpretation has been provided by showing that impairment in cognitive tasks requiring no motor skill is reduced by reinforcement the first time the task is performed under a moderate dose of alcohol (Fillmore & Vogel-Sprott, 1997). Although the evidence that reinforcing consequences reduce the intensity of alcohol impairment has been based solely on research in which drinkers perform only one task, the findings suggest that this reinforcement treatment also should reduce the impairment of a cognitive and a motor skill when a

drinker performs both tasks under a moderate dose of alcohol. If the different profiles of impairment shown on the two tasks remain evident whether performance is rewarded or not, this finding would strengthen the conclusion that these two types of tasks are generally differently sensitive to rising and declining BACs. The second study in this thesis was designed for this purpose.

STUDY ONE

Introduction

Study one compared the effect of a moderate dose of alcohol on a cognitive and a motor skill task when there were no consequences for performance. Participants performed the two tasks alone in a laboratory room in order to minimize any factors that might possibly affect task performance. Performance on the pair of tasks was tested six times, at intervals, during rising, peak and falling BAC. One group of social drinkers received a moderate dose of alcohol. A second group received a placebo to control for any effects of expecting alcohol. On the basis of other research, the dose of alcohol should impair performance of a cognitive and a motor skill task, as compared to a placebo. However, three hypotheses are of prime importance.

1) The intensity of impairment on a motor skill task should wax and wane in accord with rising and declining BACs.

2) The intensity of impairment on a cognitive task should not increase and decrease in accord with rising and declining BACs.

3) When standardized common measures of the impairment in cognitive and motor skills on tests under alcohol are compared, the tasks should differ in their patterns of impairment during rising, peak and declining BACs.

Method

Subjects

Twenty healthy male volunteers, aged 19 to 22, were selected from a subject pool of volunteers for Psychology experiments. Potential volunteers were informed that the study examined the effect of alcohol on the performance of computer tasks (Appendix A, Phone Script). Participants were all social drinkers who were not taking any medication. They fasted for four hours and abstained from alcohol for 24 hours prior to the treatment session. They received $20 for completing the experiment. Ethical approval for the research was obtained from the University Office of Human Research.

Apparatus and Materials

Pursuit Rotor (PR) Task

This is a computerized task requiring psychomotor coordination. The equipment consisted of a computer, monitor and mouse on a tabletop, 75 cm above the floor. The subjects sat in a chair directly in front of a computer screen that displayed a rectangular track (14 cm by 11.5 cm) and an on-screen target (diameter = 1.3 cm) that moved at 23 rpm clockwise around the track. The subject tracked the target by moving a computer mouse to control an on-screen circular cross-hair sight (diameter 1.3 cm). The subject was instructed to keep the sight on top of the rotating target as long as he could during a 50 second trial. One test consisted of three 50-second trials separated by a 20 second inter-trial interval.

The computer measured performance as a percentage of time on target during each trial and stored the tests scores on a computer disk. The computer task controlled the entire test procedure, so a subject could perform the task alone in the room.

Rapid Information Processing (RIP) Task

This is a self-paced computerized task that measures participants' rate of information processing. Participants sat in front of a computer screen while a fixed, pseudorandom sequence of 250 digits consisting of the numbers one to eight was presented on the computer monitor. The white digits were 11.5 cm by 6 cm in size and were presented one at a time, on a blue background. Participants were instructed to press the #1 key on the computer number pad whenever they saw

any three consecutive even digits or any three consecutive odd digits. Participants were told to try to attain the highest digit presentation rate possible during every test by responding to as many of the digit triads as they could, while minimizing their misses and errors. The entire 250-digit sequence contained eleven triads of even digits and ten triads of odd digits. The initial digit presentation rate was 90 digits per minute and each correct response to a triad increased the speed of digit presentation by decreasing the inter-stimulus interval (ISI) by 33 ms. A failure to respond to a triad (a miss) or a response to a non-triad (an error) slowed the presentation rate by increasing the ISI by 33 ms. The task assessed an individual's rate of information processing by adjusting the presentation rate of the digits according to his ability to detect and correctly respond to the triads.

The rate of information processing was measured by the mean number of digits presented per minute during a five-minute test, with greater digits per minute indicating faster information processing. The computer task controlled the entire test procedure so each subject could perform the task alone in the room.

Blood Alcohol Concentration

Blood alcohol concentrations (BACs) were determined from breath samples measured by a Smith and Wesson 900A stationary table model breathalyzer.

Drinking Habit Questionnaire

The Personal Drinking History Questionnaire (Vogel-Sprott, 1992) is shown in Appendix B. It was used to obtain four measures of a drinker's present typical drinking habits: frequency (number of drinking episodes per week); dose (ml of absolute alcohol per kg body weight typically consumed during a drinking occasion); duration (time span in hours of a typical drinking occasion); and history (total number of months that alcohol has been consumed on a regular basis). Two additional items asked about convictions for impaired driving and problems experienced due to drinking. These questions were used to screen out individuals who might have alcohol-related problems. No subjects reported any problems.

Beverage Strength Rating Scale

All participants rated the alcohol content of their beverages by comparing it with bottles of beer containing 5% alcohol or ounces of liquor containing 40% alcohol (Appendix C). Ratings

could be made in terms of zero to ten bottles of beer, or zero to ten ounces of liquor in 0.5 increments. Zero indicated that the drink contained no alcohol. These ratings were used as a procedural check to determine whether participants who received a placebo reported that their drink contained alcohol. The rating of each subject was converted to the equivalent of bottles of beer.

Exploratory Measures

Two rating scales were administered to explore the possibility that changes in the degree of impairment on the PR or RIP related to the perceived effects of alcohol, or to the expected effect of alcohol on the performance of each task.

Subjective High Assessment Scale (SHAS) This twelve item rating scale was originally developed by Schuckit (1980) to assess perceived symptoms of alcohol intoxication in groups of social drinkers who differed in family history of alcoholism (Appendix D). The SHAS is now commonly used for this purpose. Each item is rated individually, on a scale ranging from 0 (normal state) to 36 (maximum alcohol effect). A single administration of the SHAS yields 12 item scores for a subject.

Despite the widespread use of the SHAS, the research literature appears to contain no information on the psychometric properties of the scale. In addition, little is known about the extent to which the ratings on the SHAS reflect an alcohol effect or the effect of expecting alcohol. This was explored by comparing the item ratings of alcohol and placebo groups in the present study. The scale was completed three times, at intervals corresponding to rising, peak and falling BAC concentrations (i.e., at 35, 70 and 130 minutes after drinking commenced).

Expected Type of Effect Scale To explore the possibility that the expected effect of alcohol influenced task performance, subjects rated the expected effect of alcohol on their performance of each task (Fillmore & Vogel-Sprott, 1995; Appendix E). They rated how they expected two beers drank in 1 hour to affect their performance of each task on a 13 point scale that ranged in 5-point increments from -30 Extremely Impair to +30 Extremely Enhance with 0 indicating that No Effect was expected.

Procedure

The study was conducted as two experiments, each containing ten subjects who were randomly assigned to either an alcohol (A) or a placebo (P) group. The experiments were separated in time by about two months.

Practice Session

Participants were provided with a general explanation of the nature of the study before they provided informed consent (Appendix F). They were seated in front of a computer while the experimenter explained the RIP task. To ensure that they were familiar with the task and understood the requirements, they performed a one-minute and a three-minute test while the experimenter remained in the room.

The participant was then seated in front of a second computer in the same room while the experimenter explained the PR task. Participants were told that they were required to move a sight so that it stays on top of a rotating target. They were told that the sight would appear as a circle with cross hairs on the screen and that moving the computer mouse controlled the sight on the screen. Participants performed one-50 second practice trial while the experimenter remained in the room to make sure the task requirements were understood.

The participant was then left alone to perform one test on the PR. Then the experimenter returned and asked the subject to perform a test on the RIP task. When this test ended, each subject completed the Drinking Habit Questionnaire. This pattern of practice (i.e., one test on the PR and one test on the RIP) was repeated four more times, with three-minute rest breaks between each task. When the practice session concluded, subjects were weighed and informed about the four hour fast from food and 24-hour abstention from alcohol and medications that were required for the next session. Subjects were given a menu to help them to select appropriate foods for consumption prior to fasting. This information and a copy of the menu are in Appendix G.

Treatment Session

This session occurred within approximately one to ten days of the practice session. The tasks were performed in the same room as the practice session and the subject drank his beverages and gave breath samples in an adjacent room.

A breath sample to verify a zero BAC was obtained before subjects performed a test on the RIP and PR tasks. These tests provided drug-free baseline measures against which to compare treatment effects. The order in which the tasks were performed was counterbalanced within groups assigned to receive alcohol or placebo. After the baseline test on each task, subjects completed the Expected Type of Effect Scale.

Alcohol Group Participants in the A group received 0.62 g/kg of absolute alcohol divided equally into two drinks containing one part alcohol and two parts carbonated mix. Each drink was finished in one minute and the drinks were served four minutes apart.

Placebo Group Participants in this group received two placebo drinks, equivalent in volume to that received by the alcohol subjects. Each placebo drink consisted of the carbonated mixer with 5 ml of alcohol floated on top of the drink. Each drink was served in a glass that had been sprayed with an alcohol mist to provide a strong alcoholic scent as the drinks were consumed. Each drink was finished in one minute and the drinks were served four minutes apart.

The schedule of events during the treatment session is shown in Table 1. One minute after the second drink was consumed, participants returned to the computer room and completed the first of six sets of tests on the two tasks alone in the test room. These tests commenced at 7, 25, 45, 60, 95 and 115 minutes after drinking began. A test on the pair of tasks required about ten minutes to complete. Their BACs were measured at 19, 39, 59, 75, 90, 110 and 130 minutes. The Subjective High Assessment Scale was also administered at minutes 35, 70 and 130. The experimenter only entered the room after each task had been completed to prompt the subject to move in front of the next task or to obtain breath samples to measure BACs.

Table 1. Treatment Session Schedule of Events

Time	Schedule
-15	Verify Zero BAC
-10	Drug Free Baseline Test 1 and Expectancy Questionnaire for RIP and PR
0-1	Drink 1
5-6	Drink 2
7-17	Test 1
19	BAC 1
25-35	Test 2
35-39	SHAS QUESTIONNAIRE
39	BAC 2
45-55	Test 3
59	BAC 3
60-70	Test 4
71-75	SHAS QUESTIONNAIRE
75	BAC 4
90	BAC 5
95-105	Test 5
110	BAC 6
115-125	Test 6
130	BAC 7
131	SHAS QUESTIONNAIRE AND BEVERAGE RATING

After all six tests had been completed, participants were paid and completed the beverage strength rating scale. They were then debriefed about the nature of the study. The information read to subjects during the treatment session is shown in Appendix H.

Criterion Measures

The treatment effect was measured by subtracting a participant's drug-free baseline score on a task from his score on each of his six treatment tests on the task. This produced six change scores for an individual on each task. A negative change score indicated impairment (i.e., a decrease in the rate of processing or a reduction in percentage of time on target). A positive change score indicated improvement (i.e., an increase in the rate of processing or percentage of time on target).

In order to compare the profiles of performance under alcohol shown by the two tasks, z score transformations of the distribution of change scores on the tests of each task were performed to standardize their metric.

Data Analyses

Treatment effects on each task were tested separately by a 2 (group) by 2 (experiment) by 6 (tests) analysis of variance of change scores. Treatment effects could also be tested by analyzing subjects' six treatment test scores for each task in a covariance analysis (ANCOVA), using their baseline scores as a covariate. Both analyses were performed and yielded similar conclusions. Because the ANCOVA produces adjusted group means and change scores provide a more direct indication of treatment effects, the analyses of change scores are reported in the text and the ANCOVAs are shown in an Appendix.

In order to directly compare the two task profiles of impairment during the dose, the z scores were analysed using a 2 (task) by 2 (group) by 6 (test) ANOVA.

Results

The raw data for each subject can be viewed in Appendix I (Tables 1-7).

Procedural Checks

Subject Drinking Characteristics

A one-way analysis of variance of each drinking habit measure obtained no significant differences between groups assigned to receive alcohol or placebo: dose [$F(1,18) = 0.98$, $p = .33$]; weekly frequency of drinking [$F(1,18) = <0.01$, $p = .96$]; duration of typical drinking occasion [$F(1,18) = 0.87$; $p = .36$] and months of regular drinking [$F(1,18) = 1.21$, $p = .29$]. These analyses can be viewed in Appendix J (Tables 1-4). The entire sample (N = 20) reported a mean of 1.32 (SD = 0.98) drinking episodes per week, with an average dose per occasion of 1.12 ml/kg (SD=0.49). For a 70 kg male, this dose would be equivalent to approximately 4.60 bottles of beer. They reported drinking occasions had a mean duration of 3.98 hours (SD=2.27). These drinking history characteristics are within the range of norms for male, social-drinking university students (Vogel-Sprott, 1992). Participants also reported drinking regularly for an average of 43.05 months (SD=32.55).

Drug-Free Baseline

The drug-free baseline performance of groups assigned to receive alcohol or placebo was compared, separately for each task, using a one-way ANOVA (Appendix K). No significant effect of group was found for either the PR task [$F(1,18) = 0.10$, $p = 0.75$] or the RIP task [$F(1,18) = 0.26$, $p = .62$]. The mean (SD) percentage of time on target on the PR task for both the A and P groups combined was 48.20 (11.88). The mean (SD) number of digits processed per minute on the RIP task for both the A and P groups combined was 111.40 (16.09).

Beverage Strength Ratings

No subject in group P rated the alcohol content of his placebo to be zero, so the placebo appeared to be credible. The mean (SD) rating of placebo subjects was 2.10 (1.05) 5% alcohol bottles of beer. The mean rating (SD) of subjects in group A was 5.15 (2.25), and this was higher than the ratings of subjects in group P [$t = 3.44$, 9 df, $p < .01$].

Blood Alcohol Measures

BACs were measured seven times during the treatment session. Measures from one subject were lost due to equipment failure, thus a one-way ANOVA of BACs at 7 time intervals was based on nine of the ten subjects who received alcohol. This analysis is in Appendix L and shows that the BACs differed significantly over the time intervals [$F(6,48) = 4.89$, $p < .01$]. The mean and standard deviation of BAC measures at each of the seven intervals are shown in Table 2.

As the rise and decline in BAC tends to be linear, the midpoint BAC during the ten-minute period of each test on the two tasks can be estimated by interpolation, using the BAC means shown in Table 2. This is shown in Table 3. Tests 1-3 occurred while BAC was rising, test 4 occurred at the peak BAC and tests 5 and 6 occurred while the BAC was falling.

Table 2. Mean (SD) BAC values at each of the seven time intervals

BAC Measurement	Minutes After Drinking Commenced	Mean (SD) BAC (mg/100 ml)
1	19	45.00 (17.14)
2	39	55.56 (16.48)
3	59	68.33 (9.68)
4	75	68.89 (6.00)
5	90	67.78 (9.39)
6	110	62.78 (8.70)
7	130	58.33 (11.46)

Table 3: Midpoint BACs in the A group during each test on the two tasks

Test	Time	Midpoint BAC (mg/100 ml)
1	7-17	28
2	25-35	51
3	45-55	63
4	60-70	68
5	95-105	66
6	115-125	61

Treatment Effects

PR Task

The change in percentage of time on target shown by the 2 groups on the 6 treatment tests of each experiment was analysed by a 2 (experiment) by 2 (group) by 6 (test) ANOVA (Table 4). The analysis obtained no significant main effect of experiments [$F(1,16) = 3.92$, $p = .07$], or any

interactions involving experiments [ps > .49]. Thus the findings from both experiments were consistent.

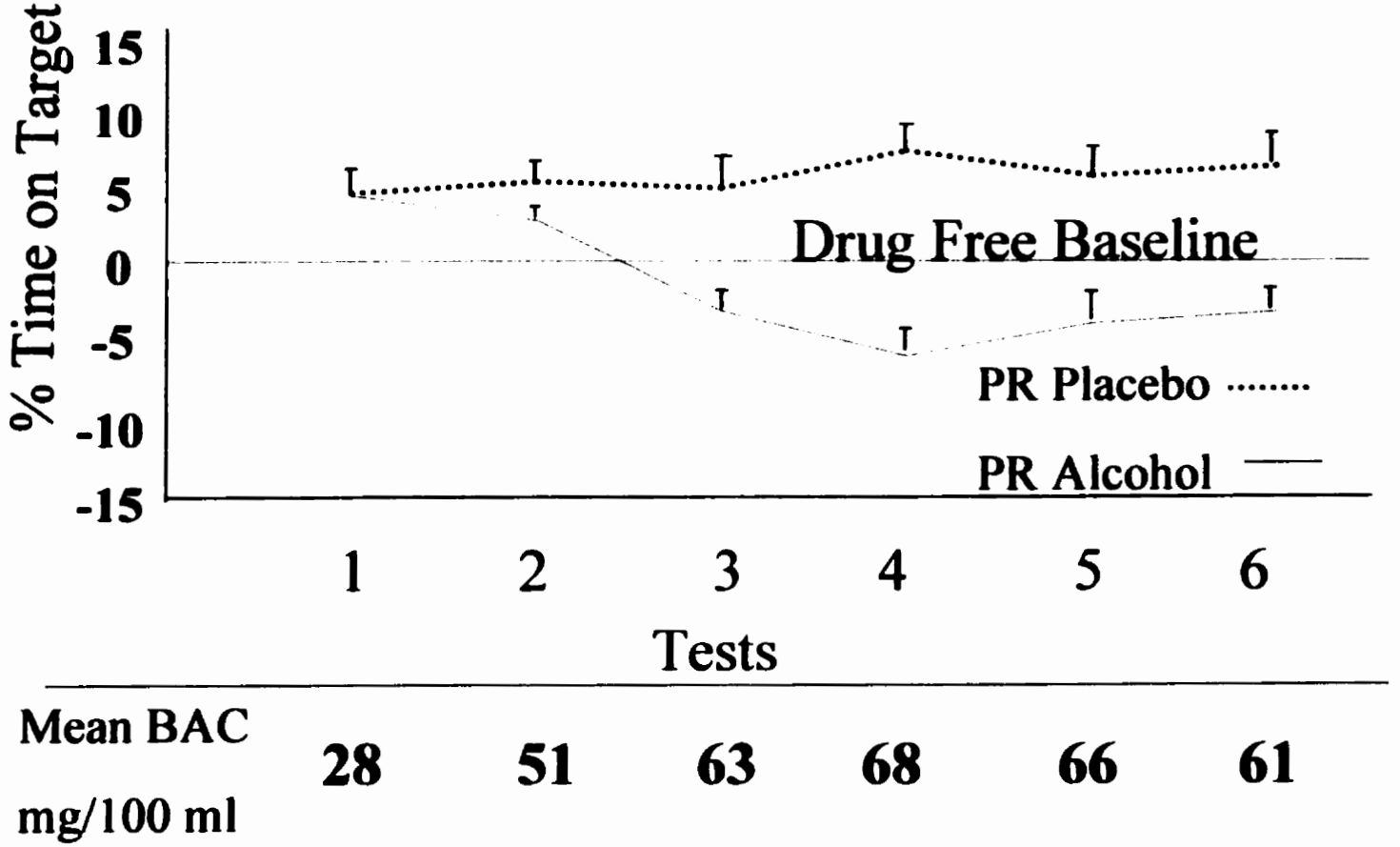
The significant group by tests interaction [F(5,80) = 8.66, p = <.01] is pertinent to the experimental hypothesis and indicates that the change in performance on the treatment tests differed between A and P groups. The mean change on each test in each group is illustrated in Figure 1. The figure illustrates that the performance of the A group tends to show less impairment both when BAC is rising on tests 1-3, and when BAC is falling on tests 5 and 6, as compared to when BAC is at its peak on test 4. In contrast, the P group appears to show a fairly stable level of performance.

Table 4. Variance Analysis of Change in Percentage of Time on Target in Two Experiments, Two Groups and Six Tests

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	1	1484.03	12.81	<.01
Experiment (E)	1	453.7	3.92	.07
G x E	1	44.00	0.38	.55
Residual	16	115.83		
Within Subjects				
Tests (T)	5	56.56	4.29	<.01
T x G	5	114.16	8.66	<.01
T x E	5	11.81	0.90	.49
T x G x E	5	10.92	0.83	.53
Residual	80	13.18		

Conclusions from the analysis of the change scores were checked by a 2 (experiment) by 2 (group) by 6 (test) ANCOVA of the actual percentage of total time on target scores on treatment tests, using participants' drug-free baseline scores as a covariate. The ANCOVA (Appendix M; Table 1) confirmed the conclusions from the ANOVA of change scores by showing a significant

Figure 1: Mean Change in Pursuit Rotor Performance Over Six Tests in Alcohol and Placebo Groups



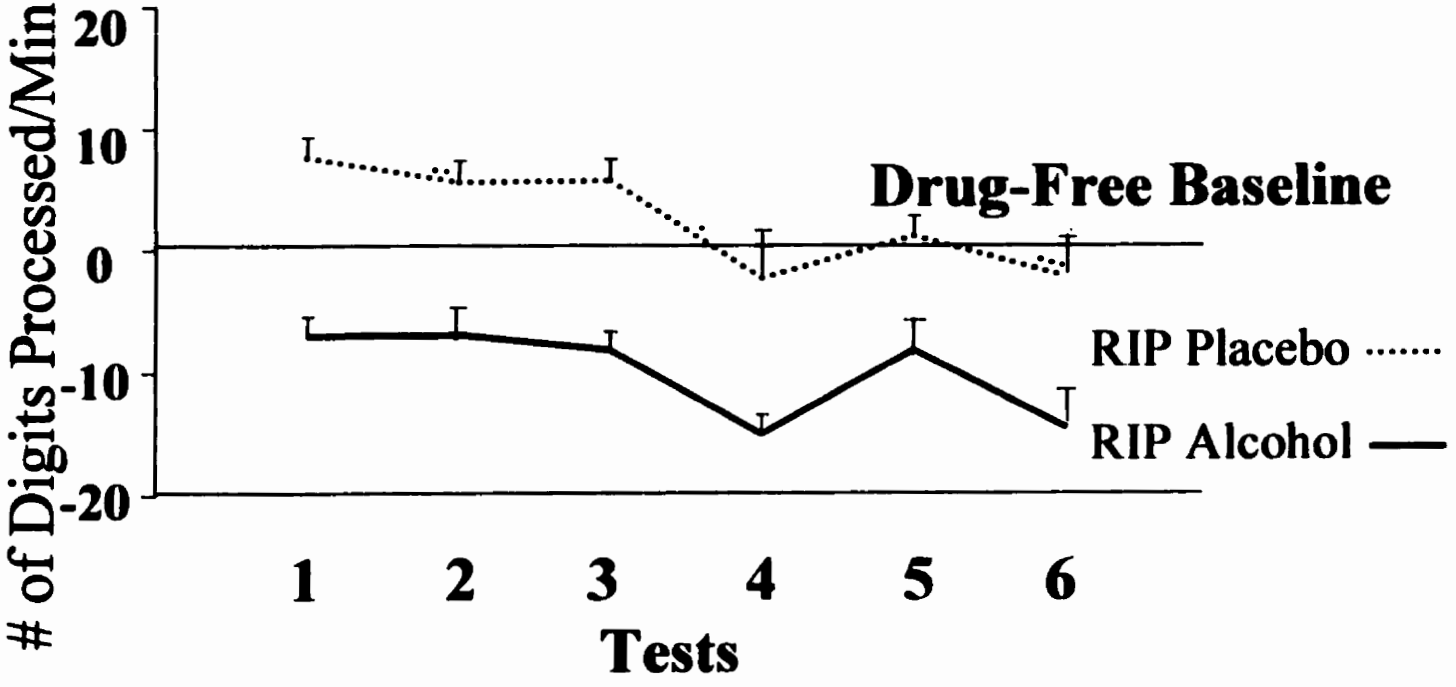
main effect of group [$F(1,15) = 15.53$, $p = <.01$], tests [$F(5,80) = 4.29$, $p = <.01$] and a test by group interaction [$F(5,80) = 8.66$, $p = <.01$]. The adjusted mean of percentage of total time on target scores on treatment tests for each group (Appendix M; Table 2) show that the A group tended to perform most poorly at the peak BAC (test 4) and there appeared to be some recovery as BAC declined (tests 5 and 6). The performance of the P group seemed to show little change over tests.

Rapid Information Processing Task

The change in digits processed per minute shown by the 2 groups on 6 tests in each experiment was analysed by a 2 (experiment) by 2 (group) 6 (test) ANOVA (Table 5). The analysis obtained no significant main effect of experiments, [$F(1,16) = .51$, $p = .49$], or any interactions involving experiments [$ps > .17$]. Thus, the findings from both experiments were consistent.

A significant effect of group was obtained [$F(1,16) = 15.01$, $p = <.01$]. The mean change in digits per minute on the treatment tests by group A was -9.90 ($SD = 10.03$) whereas the change in the P group was +2.60 digits per minute ($SD = 11.19$). The significant main effect of tests [$F(5,80) = 4.56$, $p = <.01$] and the non-significant group by test interaction [$F(5,80) = 0.24$, $p = .94$] indicates that the change in performance over tests did not differ between the groups. The mean change under alcohol or placebo is illustrated in Figure 2, and indicated that alcohol impaired information processing, but that both groups tended to show some decrement in performance on the fourth and sixth tests.

Figure 2: Mean Change in Rapid Information Processing Task Performance Over Six Tests in Alcohol and Placebo Groups



Mean BAC mg/100 ml	28	51	63	68	66	61

Table 5. Variance Analysis of Mean Change in Number of Digits Processed Per Minute in Two Experiments, Two Groups and Six Tests

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	1	4682.00	15.01	<.01
Experiment (E)	1	157.64	0.51	.49
G x E	1	633.97	2.03	.17
Residual	16	311.96		
Within Subjects				
Tests (T)	5	306.99	4.56	<.01
T x G	5	16.41	0.24	.94
T x E	5	81.97	1.22	.31
T x G x E	5	23.87	0.35	.88
Residual	80	63.38		

Conclusions from the analysis of the change scores were checked by a 2 (experiment) by 2 (group) by 6 (test) ANCOVA of the number of digits processed per minute on the treatment tests, using participants' drug-free baseline scores as a covariate. The ANCOVA (Appendix M; Table 3) confirmed the conclusions from the ANOVA of change scores by showing a significant main effect of group [$F(1,15) = 15.59$, $p = <.01$], tests [$F(5,80) = 4.56$, $p = <.01$] and a non-significant test by group interaction [$F(5,80) = 0.24$, $p = .94$]. The adjusted mean number of digits processed per minute for each group (Appendix M; Table 4) show that the A group appeared to perform more poorly on all tests in comparison to the P group. However, both groups tended to show poorer performance on tests 4 and 6.

Two Task Profiles of Impairment

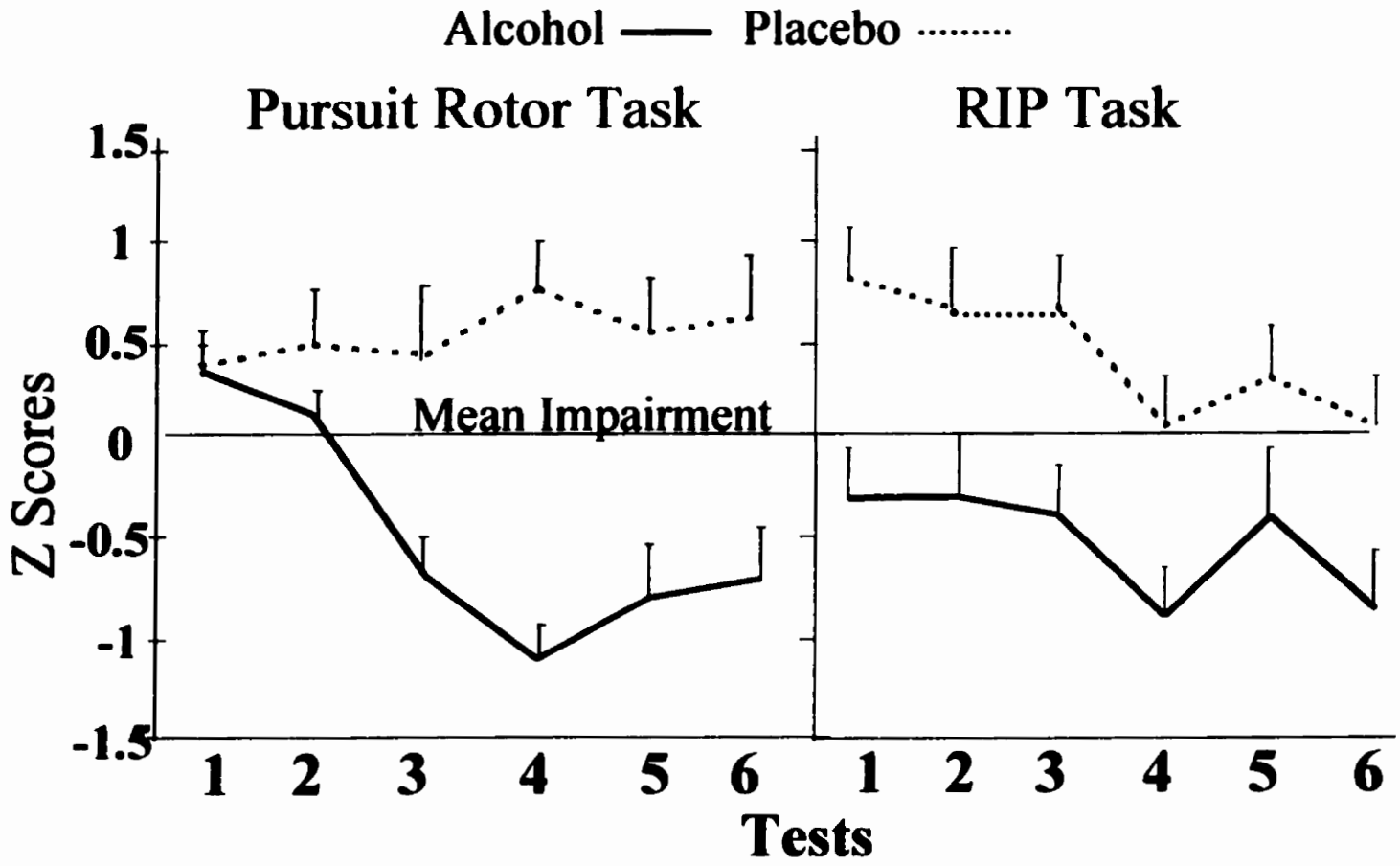
The change scores obtained on the tests of each task under alcohol were converted to z scores in order to directly compare their profiles of impairment. A 2 (task) by 2 (group) by 6 (test) ANOVA of z scores was then carried out. This analysis (Table 6) yielded a significant tests by task

by group interaction [F(5,180) = 4.14, p = <.01], indicating that the pattern of performance across tests significantly differed in the RIP and PR groups as a function of alcohol or placebo treatment (Figure 3). A z score of zero on these graphs represents the overall mean change in performance on each task. Therefore, for each task, a z score above zero indicates less impairment than the overall mean impairment and a z score below zero indicates greater impairment. The left half of this figure indicates that in the PR task, performance in the A group tended to become more and less impaired in accord with rising and declining BAC whereas performance in the P group appeared to hover above the mean impairment. The right half of this figure presents a different picture for the RIP task. Changes in performance in the A and P groups seemed to show a similar trend over the six tests and both groups tended to perform somewhat more poorly on the final test, where the declining BAC in the A group was lowest. Thus, the impairment in RIP performance under alcohol did not appear to be related to rising and declining BACs under the dose.

Table 6. Z score analysis of the Two Tasks (RIP and PR), Two Groups (A and P) and Six Tests

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	1	61.10	25.58	<.01
Task (Ta)	1	4.41	<0.01	1.00
G x Ta	1	0.003	<0.01	.97
Residual	36	311.96		
Within Subjects				
Tests (T)	5	2.59	7.42	<.01
T x Ta	5	0.59	1.69	.14
T x G	5	0.98	2.81	.02
T x Ta x G	5	1.45	4.14	<.01
Residual	180	0.35		

Figure 3: Z Score Measures of Impairment Across Six Tests in Alcohol and Placebo Groups



Secondary Findings

SHAS Ratings

Each subject's twelve ratings of adjectives on the SHAS were obtained at three time points. A 2 (group) by 3 (time) analysis of scores on each adjective (Appendix N; Tables 1-12) was performed to identify the symptoms of intoxication due to alcohol, distinct from the expectation of receiving alcohol in the placebo group. The analyses of four items (confused, nauseated, terrible and great) obtained no significant group effects ($p>.05$). The groups significantly differed on the remaining eight adjectives: uncomfortable ($p = .03$); high ($p = <.01$); clumsy ($p = .01$); slurred speech ($p = .03$); effects of alcohol ($p = <.01$); feelings of floating ($p = .02$); dizzy ($p = .02$) and drunk ($p = <.01$). The analyses of four of these eight items also resulted in a group by time interaction: high ($p = .01$), effects of alcohol ($p = .04$), feelings of floating ($p = .01$) and drunk ($p = <.01$). The mean ratings of the eight items by the alcohol and placebo groups are shown in Appendix N (Tables 13A and B). An examination of the ratings that showed a main effect of group revealed that the A group reported a greater increase in these symptoms of intoxication than did the P group. The ratings of items that showed a group by time interaction indicated that the A group reported an increase in these symptoms on the second time point, corresponding to the peak BAC. In contrast, the ratings of the P group steadily declined over the three time points.

The results of the ratings of these eight items suggest that they are not equally sensitive to the BACs resulting from a moderate dose of alcohol. However, additional research providing a psychometric analysis of the items would be required to evaluate this possibility. The important new finding from this study is that only eight of the twelve SHAS items are affected by alcohol.

Expectancy Ratings

The mean rating of expected impairment for the PR task ($N = 20$) was -10.25 [slightly impaired ($SD=6.78$)] with a range of 0 (no impairment) to -20 (moderately impaired). The mean rating of expected impairment for the RIP task was -10.00 [slightly impaired ($SD = 9.60$)] with a range of 15 (half way between slightly and moderately enhanced) to -30 (extremely impaired).

Individuals' ratings of expected impairment on the two tasks were strongly correlated, 0.67 ($N = 20$). Thus, those who expected a higher amount of impairment on one task also expected a

higher amount of impairment on the other task, and vice versa. Although the pattern of impairment under the dose differed for each task, the degree of impairment a drinker expects on a task might relate to the degree of impairment actually displayed. This has been shown in previous research using the PR task (Fillmore & Vogel-Sprott, 1995) and the RIP task (Fillmore, et al. 1998). For each task, a linear regression on the total average change in performance was conducted, entering the group and expectancy ratings as predictors. A comparable analysis was also completed using the mean change on trials 3 and 4 (where BAC was rising and peaked) as the dependent variable. These analyses are presented in Appendix O (Tables 1-4). Significant effects of group were obtained for both PR and RIP task performance in both analyses [PR: $p < .01$; RIP: $p < .01$]. However, in no case did expectancies show a significant relationship to average overall change or change during rising and peak BAC [PR: $ps > .31$; RIP: $ps > .75$].

Discussion

This experiment examined the profile of impairment on PR and RIP tasks during the course of a moderate dose of alcohol when performance had no consequence. The results showed that the impairment in PR performance tended to track the blood alcohol curve. Maximal impairment was observed on the fourth test where the peak BAC occurred and the remaining tests tended to show diminishing impairment as BAC declined. In contrast, performance on the RIP task was impaired on the initial test and did not appear to recover as blood alcohol levels declined. Thus, motor skill performance was observed to deteriorate and recover as a function of rising and declining BACs, whereas impairment in cognitive skill exhibited no such tendency. These results can be attributed to a different sensitivity to alcohol of the tasks themselves, because the same subject performed both tasks at comparable BACs under the dose. Because motor skill was required to perform the PR task, and no learned motor skill was required for the cognitive RIP task, these different task profiles of impairment suggest that motor skill and cognitive abilities are affected differently by alcohol.

The PR pattern of an increase in impairment as BAC peaked, and a reduction in impairment as BAC declined are generally in line with the idea that the intensity of the drug effect depends on the BAC. In this respect, the pattern of impairment seen on the RIP task could be considered unusual. Although the performance of the alcohol group was impaired as compared to the placebo group, the group by test interaction was not significant. The change in RIP performance over tests as BAC rose and declined did not differ from the changes shown under placebo. Performance under both treatments was poorer on the final test.

Some recovery from impairment was observed in PR performance when BACs began to decline, although no such recovery was apparent in RIP task performance. However, the evidence from the RIP task is equivocal because the increasingly poorer RIP performance was seen in both the A and P groups as tests continued. This raises the possibility that some factor, like test fatigue, may have adversely affected RIP task performance and obscured any evidence of recovery during declining BACs. This possibility could be checked in future research by administering fewer tests under alcohol than in the present study.

Compared to the RIP task, the onset of impairment during rising BAC on the PR task was delayed. It is not clear what may be contributing to this delayed onset in impairment in PR performance, but stimulating effects of alcohol on motor behavior in animals have sometimes been observed at low BACs (Waller, Murphy, McBride, Lumeng & Li, 1986). If this stimulation tends to counteract the depressing effect of alcohol, it might mask the onset of impairment during low BACs. Physical activity was involved in this study because drinkers walked back and forth between rooms to perform the tasks, receive drinks and provide BAC breath samples. This activity might also have provided motor stimulation that delayed the onset of impairment in PR performance. Future research in which drinkers remain sedentary could examine this possibility.

This experiment provides the first clear demonstration that a cognitive and motor skill task differ in the pattern of impairment under a moderate dose of alcohol. Although the findings are new and require replication, the results suggest that the failure to consider where on the BAC curve performance is tested may have contributed to the controversy over the sensitivity of cognitive and motor skills to a moderate dose of alcohol

Another important question is whether the different profiles of impairment shown by these two tasks when performance has no consequence will continue to be evident when task performance has some environmental consequence. People engage in many different activities during social drinking occasions. Games of cards and darts are common examples. Card games are essentially cognitive tasks that involve little in the way of motor skills, whereas darts require learned motor skills. In this respect, they bear some resemblance to the cognitive and motor skill task used in the present research. Sometimes the drinking situation provides no particular consequences for winning or losing these games. But sometimes they are played for money, and winning performance has an advantageous consequence. Will the different profiles of impairment shown by the cognitive and motor skill tasks when performance has no consequence continue to be evident when some reward is associated for good performance under alcohol? This question has been virtually ignored in reviews of research on the sensitivity of different types of task to alcohol impairment, although Holloway (1995) has suggested that the consequence of performance might affect the sensitivity of different types of tasks to a moderate dose of alcohol.

The consequences of task performance under a moderate dose of alcohol have been found to influence the degree of behavioral impairment displayed in motor skill tasks (Mann & Vogel-Sprott, 1981) and on cognitive tasks including the RIP task (Fillmore & Vogel-Sprott, 1997). Impairment is reduced when positive reinforcement in the form of money or verbal approval is associated with non-impaired performance. In motor skill tasks, the reinforcement effects strengthen as the task is performed under repeated doses. This may be due to gradually learning new motor skills to overcome the drug effect and maintain proficiency on the task (Zinatelli & Vogel-Sprott, 1993; Easdon & Vogel-Sprott, 1996). This study tests the prediction that the reinforcement treatment also should reduce the impairment of a cognitive and a motor skill when a drinker performs both tasks under a moderate dose of alcohol. If the different profiles of impairment shown on the two tasks remain evident whether performance is rewarded or not, this finding would strengthen the conclusion that these two types of tasks are generally differently sensitive to rising and declining BACs. The second study in this thesis was designed for this purpose.

The secondary findings on symptoms of intoxication obtained with the SHAS rating scale showed that only eight of the twelve scale items were actually affected by alcohol. Thus the ratings on these eight items will be examined in study two to explore the possibility that the intensity of a drinker's symptoms of intoxication relate to the degree of impairment shown on the RIP and PR task.

The present study also explored the relationship between the amount of impairment a drinker expected and showed on each task. No significant relationships were obtained. Although other research has shown these expectancies predict the amount of impairment on the PR task (Fillmore & Vogel-Sprott, 1995) and on the RIP task (Fillmore, et al. 1998), subjects in those experiments performed one task only, whereas both tasks were performed by subjects in the present study. This procedural difference may have accounted for the lack of significant findings in the present study. However, the expected degree of impairment is not of primary interest in this thesis, and given the lack of any promising evidence for this factor, it will not be investigated in the second study.

STUDY TWO

Introduction

The purpose of study two was to verify the different, characteristic profiles of impairment seen in the cognitive and motor skill task in study one, and to demonstrate that these profiles generalize when the tasks are performed under different environmental conditions. The cognitive and motor skill tasks in this study were the same as those used in study one, and the testing procedure was almost identical. Groups of drinkers received a moderate dose of alcohol and performed both tasks. They were tested at intervals as BAC rose and declined. However, in study two, the environmental consequences of task performance differed in each group.

Different task profiles of impairment during rising and declining BACs were demonstrated in study one under standard laboratory conditions that provided no consequence for performance. In order to test the reproducibility of those findings, study two included an alcohol group that was also tested under these standard conditions.

Study two also tested the profiles of impairment shown in each task when non-impaired performance was either reinforced by money and verbal approval, or had no consequence. In the present study, reinforcement ($_R$) of performance on the rapid information processing task (RIP) is designated R_R, whereas reinforcement of the pursuit rotor task (PR) is labeled as P_R. When performance of the tasks had no consequences ($_N$), the treatments are identified as R_N and P_N, respectively.

On the basis of prior research (Mann & Vogel-Sprott, 1981; Fillmore & Vogel-Sprott, 1997), the impairing effect of a moderate dose of alcohol on the performance of a task should be less when reinforcement is provided for performance that matches drug-free levels than when reinforcement is not provided. Thus, less impairment under the dose of alcohol should be shown in the RIP task by drinkers under the R_R treatment than under the R_N treatment. Similarly less impairment on the PR task should be displayed by drinkers under the P_R than the P_N treatment.

Although environmental reinforcement may reduce the amount of impairment on each task under the dose of alcohol, this treatment was not predicted to alter the pattern of impairment seen on each task in the first study. That is, the variation in impairment should accord with rising and

declining BAC when the PR task is performed, but this pattern should not be evident in the performance of the RIP task. Thus, the profile of impairment on each task should not differ in groups receiving reinforcement or no reinforcement, even though the degree of impaired performance differs in these groups.

Because a drinker performs both tasks, and reinforcement can be manipulated independently on each task, the second study also provides a unique opportunity to test the effect of alcohol on one task when it is performed in the context of reinforcement for the other task. In this respect, reinforcement for one task becomes the context in which the other task is performed. Is the amount or the pattern of impairment during rising and declining BACs altered on a cognitive (or a motor skill) task when good performance on a motor skill (or a cognitive task) is rewarded? It appears that no research has examined this sort of situation, although it could occur in social drinking situations whenever individuals engage in two activities such as playing cards and darts when money is at stake for winning one of the games. In the present study, the context effect for each task was tested by examining the profile of impairment shown on a given task when the opportunity for reinforcement was present or absent for the performance of the other task. Although there is no basis for predicting whether or how the reinforcement context might affect the amount of impairment shown on each task, the proposal that the two tasks display different, characteristic patterns of impairment during rising and declining BACs predicts that these task profiles of impairment should continue to be evident under these conditions.

In summary, study two involved four treatment groups who performed both tasks. The 2 x 2 experimental design is illustrated below.

		RIP (R) Task	
		Reinforced (R)	Not Reinforced (N)
PR (P) Task	Reinforced (R)	P_RR_R	P_RR_N
	Not Reinforced (N)	P_NR_R	P_NR_N

The groups are used to test the following four hypotheses:

(1) The replication of the patterns of impairment shown on each task when performance had no consequences was tested by comparing Group A in study one with the P_NR_N group in study two. Comparing task performance in these two groups tests the between-study consistency of the two task profiles of impairment.

(2) The hypothesis that reinforcement reduces impairment is tested separately for each task. The main effect of reinforcement on the motor skill task is tested by comparing the impairment on this task in groups P_RR_R plus P_RR_N to groups P_NR_R plus P_NR_N Reinforcing the cognitive task is tested by comparing the impairment on this task in groups P_RR_R plus P_NR_R to groups P_RR_N plus P_NR_N

(3) The context effects are also tested separately for each task. The impairment on the motor skill shown by groups with reinforcement on the cognitive task (P_RR_R plus P_NR_R) is compared to motor skill performance in those groups with no consequence for cognitive performance (P_RR_N plus P_NR_N). The impairment on the cognitive task shown by groups with reinforcement on the pursuit rotor (P_RR_R plus P_RR_N) is compared to RIP task performance in those groups with no consequence for motor skill performance (P_NR_R plus P_NR_N).

(4) The prediction that the different profiles of impairment shown on the cognitive and motor skill task remain consistent regardless of the consequences of performance is tested by comparing standardized measures of change on each task from all groups

Method

Subjects

Fifty-six healthy men, aged 19 to 23, were selected from a subject pool of student volunteers for Psychology experiments. Potential participants were informed that the study examined the effect of alcohol on the performance of computer tasks. Participants were all social drinkers who were not taking any medication. They fasted for four hours and abstained from alcohol for 24 hours prior to the treatment session. Participants were randomly assigned to one of four groups (n = 14) and received $20 for completing the experiment.

Data from nine subjects were not included owing to equipment failure or illness. The most common problem was that the BACs of six subjects either rose so swiftly or declined so slowly that behavioral measures could not be obtained on each limb of the curve.

Ethical approval for the research was obtained from the University Office of Human Research.

Apparatus and Materials

Tasks

The same two tasks, the pursuit rotor (PR) and the rapid information processing (RIP) task, were used in the second study.

Blood Alcohol Concentration

Participants had their blood alcohol concentrations (BACs) determined from breath samples that were measured by either a CMI Intoxilyzer Model S-D2 hand held breathalyzer (n = 17) or a Smith and Wesson 900A table model breathalyzer (n = 39). The portable, hand held Intoxilyzer was initially used to measure subjects' breath samples in the test room. However, due to equipment difficulties, the remaining subjects were tested with the Smith and Wesson stationary table model breathalyzer located in an adjacent room.

Drinking Habit Questionnaire

The Personal Drinking History Questionnaire (Vogel-Sprott, 1992) is shown in Appendix B.

Exploratory Measure

Subjective High Assessment Scale (SHAS; Schuckit, 1980) This scale (Appendix D) was administered to measure the perceived effects of alcohol. However, on the basis of findings from study one, only the eight scale items that were sensitive to the alcohol effect were examined. These were: uncomfortable; high; slurred speech; effects of alcohol; clumsy; drunk; feelings of floating; and dizzy.

The scale was completed four times, at baseline before any alcohol was consumed and also at three intervals corresponding to rising, peak and falling BAC concentrations (i.e., at 35, 71 and 126 minutes after drinking commenced). The baseline ratings were used to assess any group differences in ratings prior to alcohol treatment. The ratings on the eight adjectives for each subject were summed together to form a single composite rating for each of the four time points. The maximum composite score on the eight items at each time point is 288. These scores were used to explore the possibility that changes in subjective ratings of intoxication during rising, peak and declining BACs coincided with the changes in impairment on either task during the course of the dose.

Procedure

Practice Session

This session was identical to the practice session in study one. The procedures and instructions are detailed in Appendix G.

Treatment Session

The procedure and instructions to subjects are detailed in Appendix P. This session occurred within approximately one to ten days of the practice session. When subjects arrived at the testing room, a breath sample to verify a zero BAC was obtained. Subjects then completed the SHAS and performed a baseline test on both tasks. The task order was counterbalanced within groups and the tasks were performed in the same room as the practice session.

After the drug-free baseline test on each task, all participants received 0.62 g/kg of absolute alcohol divided equally into two drinks containing one part alcohol and two parts carbonated mix.

Each drink was finished in one minute and the drinks were served five minutes apart. The subjects drank their beverages in the same room with the computer tasks.

The schedule of events during the treatment session is shown in Table 7. In contrast to study one, where six tests were performed after alcohol was consumed, study two administered five tests. Fourteen minutes after the second drink was consumed, participants completed the first of five sets of tests on the two tasks alone in the test room. These tests commenced at 20, 40, 60, 95 and 115 minutes after drinking began and a test on the pair of tasks required about ten minutes to complete. Their BACs were measured at 19, 35, 55, 71, 90, and 126 minutes. The SHAS was also administered at minutes 35, 71 and 126.

Table 7. Treatment Session Schedule of Events

Time	Schedule
-15	Verify Zero BAC and SHAS Questionnaire
-10	Drug Free Baseline Trials on Each Task
0-1	Drink 1
5-6	Drink 2
19	BAC 1
20-30	Test 1
35	BAC 2 and SHAS Questionnaire
40-50	Test 2
55	BAC 3
60-70	Test 3
71	BAC 4 and SHAS Questionnaire
90	BAC 5
95-105	Test 4
115-125	Test 5
126	BAC 6 and SHAS Questionnaire and Debrief

Groups

The four groups received treatments that varied only with respect to whether or not reinforcement was administered for maintaining a sober level of performance on a task. The reinforcement was 25 cents and was administered for each test on a task if a subject's performance was within three digits of their drug-free baseline score on the RIP task and/or within three percent

of their baseline average percentage of time on target on the PR. The four treatment groups were: (1) Both tasks reinforced [$P_R R_R$] (2) PR not reinforced, RIP task reinforced [$P_N R_R$] (3) PR reinforced, RIP task not reinforced [$P_R R_N$] and (4) Neither task reinforced [$P_N R_N$]. The treatment of this latter group is identical to that administered to Group A in study one.

With the exception of group $P_N R_N$, all the other groups received information about monetary reward. This was introduced just before the drug-free baseline was performed. Subjects were informed that they could earn bonus money if they performed as well on all tests (including the baseline test) during the current session as they had on the practice session of the other day. Telling subjects that they had an opportunity for reinforcement on the drug-free baseline test served to ensure that subjects' treatment on this test was exactly the same as their treatment on the tests performed under alcohol, with the only difference being any effect of alcohol on performance. They also were given a "tally sheet" (Appendix P) that they could use to keep track of the number of tests on which they received reinforcement. Group $P_R R_R$ was told that they could get these bonuses for their performance on each of the two tasks. Group $P_N R_R$ was only told that they could get these bonuses for their RIP task performances, whereas group $P_R R_N$ was told only that they could get these bonuses for their PR performances. Participants in these latter two groups were told that while they only had a chance to earn bonus money for one task, they should also try to perform their best on the other task. All groups received reinforcement for their drug-free baseline tests on their respective task(s), irrespective of their performance.

Participants performed all tests alone in the room. The experimenter only entered the room after each task had been completed to check the subject's score and give him reinforcement if necessary and to prompt the subject to move in front of the next task. After all tests had been completed, participants were paid and were then debriefed. The debriefing information is given in Appendix H.

Criterion Measures

The treatment effect was measured by subtracting a participant's drug-free baseline score on a task from his score on each of his five tests on the task under alcohol. This produced five change scores for an individual on each task. A negative change score on a test indicated

impairment (i.e., a decrease in the rate of processing or a reduction in percentage of time on target). A positive change score indicated improvement (i.e., an increase in the rate of processing or percentage of time on target).

In order to compare the profiles of performance under alcohol shown by the two tasks, z score transforms of the change scores on the tests of each task were performed to standardize their metric.

Data Analyses

The impairment on tests during rising and declining BAC was examined separately for each task, using change scores. The reproducibility and generalizability of the results from the first study were key questions. To examine reproducibility, change scores from each task in the P_NR_N group were compared with the change scores for each task from the alcohol group in the first study. Subjects in the first study performed each task on six occasions under alcohol (at minutes 7, 25, 45, 60, 95 and 115) and subjects in the second study performed each task on five occasions (at minutes 20, 40, 60, 95 and 115). For the purposes of these analyses, the first test in study one was deleted, and a 5(test) by 2(study) ANOVA was then carried out on the change scores for each task.

The effects of reinforcement and context on impairment were tested separately for each task by a 2 (reinforcement – whether or not the task in question was reinforced) by 2 (context – whether or not the other task was reinforced) by 5 (test) ANOVA of change scores. The conclusions from this analysis were confirmed by a 2 (reinforcement – whether or not the task in question was reinforced) by 2 (context – whether or not the other task was reinforced) by 5 (test) covariance analysis (ANCOVA) of the subjects' five actual test scores on each task, using their baseline scores as the covariate.

In order to directly compare the two task profiles of impairment during the dose, the z scores were analysed using a 2 (task) by 2 (PR reinforced or not) by 2 (RIP reinforced or not) by 5 (test) ANOVA.

Results

The raw data for each subject can be viewed in Appendix Q (Tables 1-5).

Procedural Checks

Subject Characteristics

A one-way analysis of variance of each drinking habit measure obtained no significant differences between the four groups: dose [$F(3,52) = 1.30$, $p = .29$]; weekly frequency of drinking [$F(3,52) = 0.77$, $p = .51$]; duration of typical drinking occasion [$F(3,50) = 2.07$; $p = .12$] and months of regular drinking [$F(3,52) = 0.33$, $p = .80$]. These analyses can be viewed in Appendix R (Tables 1-4). The entire sample (N=56) reported a mean of 1.43 (SD=1.08) drinking episodes per week, with an average dose per occasion of 1.21 ml/kg (SD=0.58). For a 70 kg male, this dose would be equivalent to approximately 4.97 bottles of beer. The reported drinking occasions had a mean duration of 3.98 hours (SD=1.78). These drinking history characteristics are within the range of norms for male, social-drinking university students (Vogel-Sprott, 1992). Participants also reported drinking regularly for an average of 48.50 months (SD=21.61).

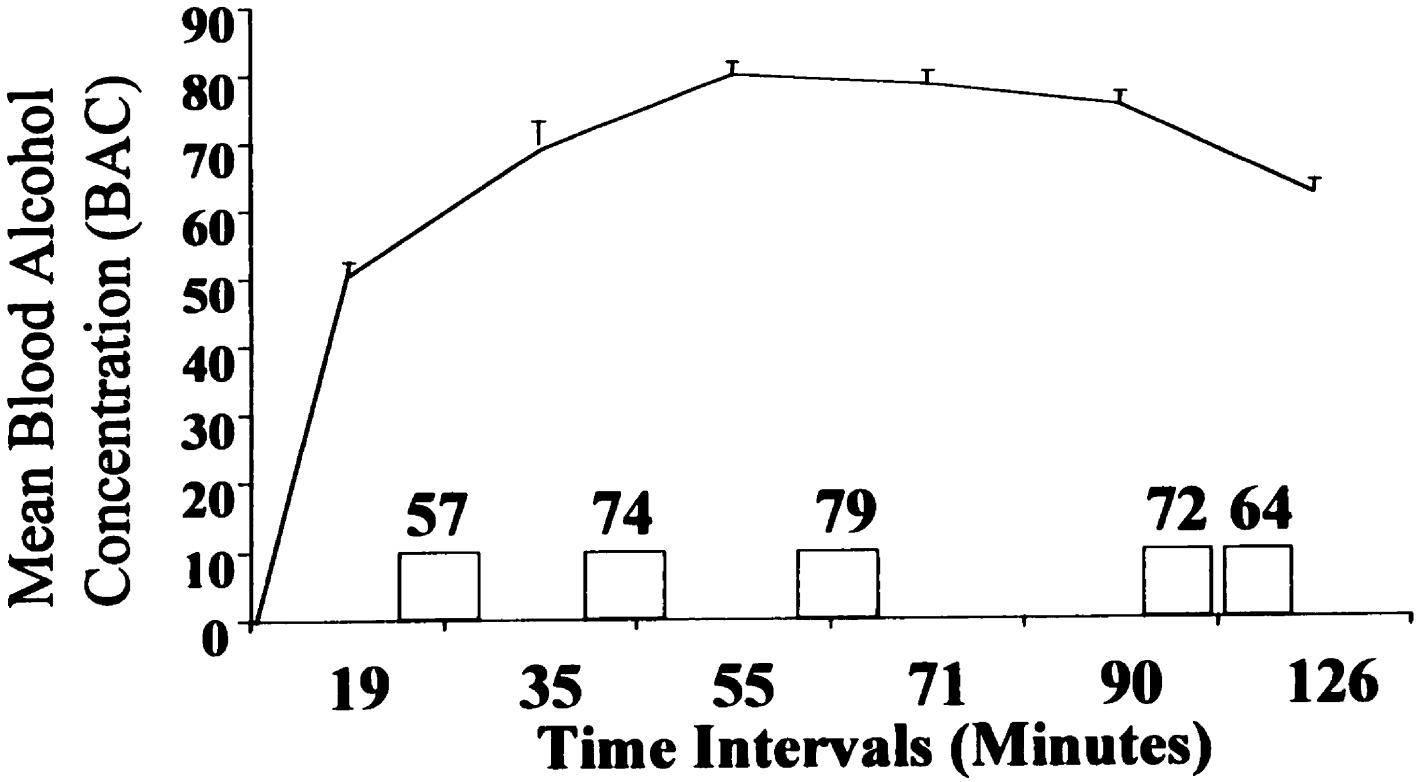
Drug-Free Baseline

The drug-free baseline performance of the groups was compared, separately for each task, using a one-way ANOVA (Appendix S). No significant effect of group was found for either the PR task [$F(3,52) = 1.26$, $p = 0.30$] or the RIP task [$F(3,52) = 0.55$, $p = .65$]. The overall (N = 56) mean (SD) percentage of time on target on the baseline test for the PR task was 46.88 (10.06). The overall mean (SD) number of digits processed per minute on the RIP task was 110.86 (15.83).

Blood Alcohol Measures

BACs were measured six times during the treatment session. A six (BAC test) by 4 (group) ANOVA indicated that the BACs differed significantly over the time intervals [$F(5,260) = 56.20$, $p = <.01$] and that there were no significant group differences in BAC [$F(3,52) = 0.94$, $p = 0.43$] (Appendix T; Table 1). Appendix T (Tables 2 and 3) show the mean (SD) BACs for each of the six tests, and the estimated mean BAC during the time that performance on the pair of tasks was tested. This information is also illustrated in Figure 4.

Figure 4. Mean (SEM) BAC at Intervals After Drinking. Closed Squares Indicate Test Periods and Show Estimated BACs



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Treatment Effects

Reproducibility

PR Task

The consistency of the profile of impairment when PR performance had no consequence in the first study (Group A) and in the second study ($P_N R_N$) was tested by a 5 (test) by 2 (study) ANOVA of change scores. In accord with the hypothesis, the analysis (Table 8) obtained a significant main effect of tests [$F(4,88) = 13.94$, $p = <.01$] and no significant main effect of study or interactions with study (ps >.13). The profile of impairment reproduced over tests by the groups from the two studies is shown in Table 9. This indicates that performance tended to become gradually more impaired as BAC rose; the most impairment appeared to be seen around the peak BAC and performance tended to improve as BAC declined.

Table 8. PR Reproducibility Analysis – Data from Study One (Group A; n = 10) and Study Two (Group $P_N R_N$, n = 14) when Performance had no Consequence

Source	df	Mean Square	F	P
Between Subjects				
Study (S)	1	412.45	2.53	.13
Residual	22	163.29		
Within Subjects				
Tests (T)	4	253.96	13.94	<.01
T x S	4	10.93	0.65	.63
Residual	88	16.92		

Table 9. Profile of PR Impairment Shown by Groups in Two Studies (N = 24) When Performance Had no Consequence

	Tests During Rising and Declining BACs				
Mean Change Scores (SEM)	1	2	3	4	5
Study One (Group A)	2.70 (0.98)	-3.07 (1.16)	-5.93 (1.76)	-3.80 (2.36)	-3.17 (1.89)
Study Two ($P_N R_N$)	-1.48 (1.32)	-6.14 (1.85)	-9.12 (1.97)	-9.74 (2.66)	-5.60 (2.16)

RIP Task

The consistency of the profile of impairment on the RIP task was also tested using Group A (study one) and group $P_N R_N$ (study two). A 5 (test) by 2 (study) ANOVA of change scores is shown in Table 10. In accord with the hypothesis, the main effect of tests was significant [$F(4.88) = 2.85$, $p = .03$] and there was no significant main effect of study or interactions with study (ps >.23). The profile of impairment reproduced over tests by the groups in the two studies is shown in Table 11.

Table 10. RIP Reproducibility Analysis – Data from Study One (Group A; n = 10) and Study Two (Group $P_N R_N$, n = 14) when Performance had no Consequence

Source	df	Mean Square	F	P
Between Subjects				
Study (S)	1	830.91	1.54	.23
Residual	22	540.88		
Within Subjects				
Tests (T)	4	197.03	2.85	.03
T x S	4	67.26	0.97	.43
Residual	88	69.08		

Table 11. Profile of RIP Impairment Shown by Groups in Two Studies (N = 24) When Performance Had no Consequence

	Tests During Rising and Declining BACs				
Mean Change Scores (SEM)	1	2	3	4	5
Study One (Group A)	-6.83 (3.40)	-8.10 (2.80)	-14.89 (2.72)	-8.20 (3.47)	-14.37 (3.79)
Study Two ($P_N R_N$)	-0.50 (3.13)	-7.58 (3.41)	-5.77 (3.10)	-4.78 (3.84)	-7.08 (5.17)

The means for the five RIP tests performed by the two groups occurred at fairly similar BACs. However, Group A had performed a total of six tests whereas the $P_N R_N$ group only performed five tests. The reduction of tests in group $P_N R_N$ aimed to lessen possible test fatigue that may have obscured a recovery from impairment during declining BACs in Group A. However, the groups' pattern of RIP impairment is consistent. Impairment tended to fluctuate in a pattern that was inconsistent with rising and declining BAC and the intensity of impairment did not appear to reduce on the final test at the lowest declining BAC.

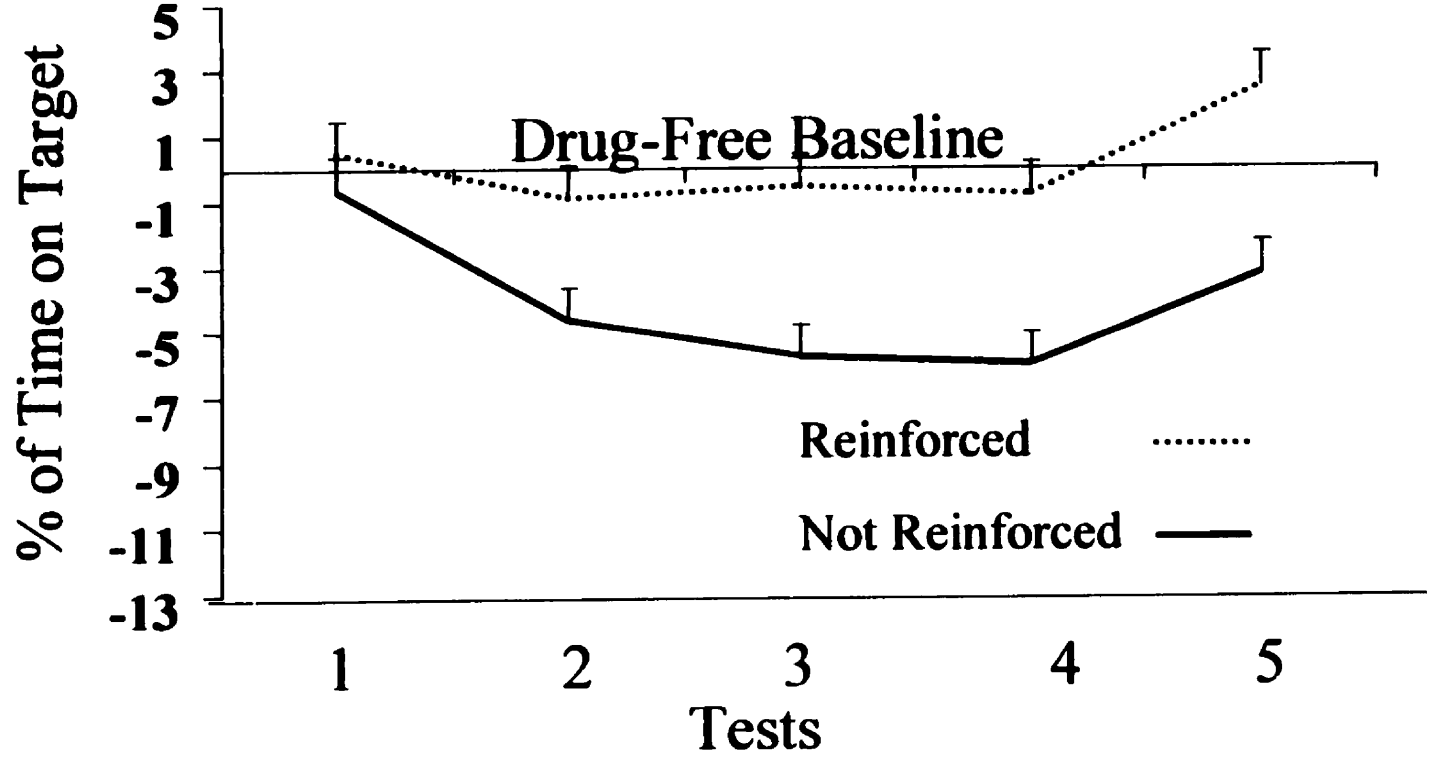
Generalizability

PR Task

The ANOVA (Table 12) of the change in percentage of time on target as a function of the 2 (reinforcement conditions) by 2 (context conditions) by 5 (tests) obtained a significant tests by reinforcement interaction [$F(4,208) = 3.20$, $p = .01$]. Main effects of tests [$F(4,208) = 9.48$, $p = <.01$] and reinforcement [$F(1,52) = 8.08$, $p = .01$] were also evident.

The tests by reinforcement interaction is illustrated in Figure 5. When PR performance was reinforced, there was a tendency for less impairment to be seen on all tests as compared with no reinforcement. Moreover, the generality of the profile of impairment was confirmed. Figure 5 shows that the same pattern was seen with and without reinforcement. Performance tended to track the BAC curve with poorest performance being observed around the peak BAC and improvement as BAC declined.

Figure 5. Mean Change in Pursuit Rotor Performance as a Function of Whether or Not Performance was Reinforced Across Five Tests



The analysis (Table 12) yielded no significant interactions with context (ps >.14). The main effect of context was somewhat stronger [$F(1,52) = 3.38$, $p = .07$] but failed to reach $p = .05$. Thus the analysis provided little support for the possibility that impairment on the PR task was affected when it was performed in the context of reinforcement for the RIP task.

Table 12. Variance Analysis of Change in Percentage of Time on Target as a Function of 2 reinforcement conditions and 2 contexts across 5 tests

Source	df	Mean Square	F	p
Between Subjects				
Reinforcement (R)	1	1234.51	8.08	.01
Context (C)	1	516.99	3.38	.07
R x C	1	267.05	1.75	.19
Residual	52	152.88		
Within Subjects				
Tests (T)	4	143.67	9.48	<.01
T x R	4	48.55	3.20	.01
T x C	4	25.63	1.69	.15
T x R x C	4	26.81	1.77	.14
Residual	208	15.16		

Results from the analysis of the change scores were checked by a 2 (reinforcement) by 2 (context) by 5 (test) ANCOVA of the actual percentage of total time on target scores on treatment tests, using participants' drug-free baseline scores as a covariate (Appendix U; Table 1). The ANCOVA confirmed the conclusions from the ANOVA of change scores. The adjusted mean of percentage of total time on target scores on treatment tests for each group can also be seen in Appendix U (Table 2).

RIP Task

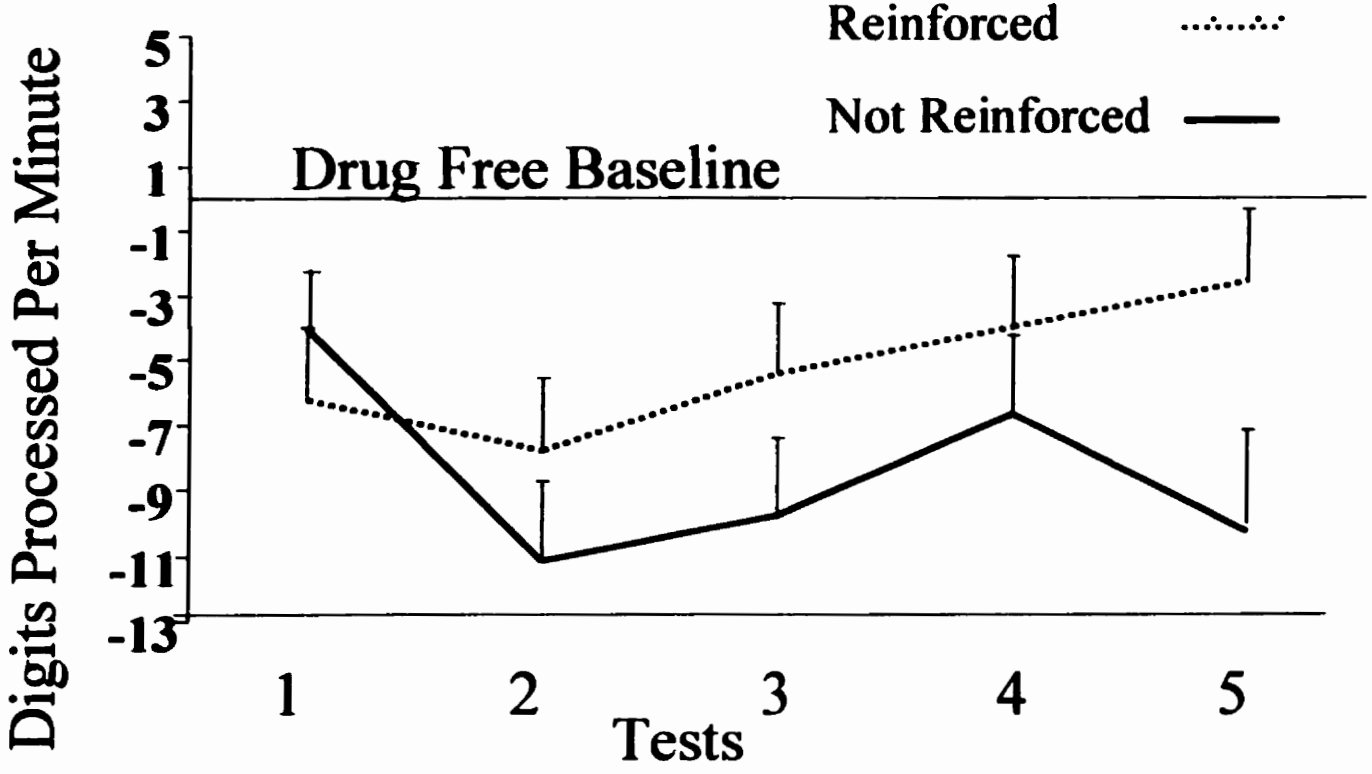
The ANOVA (Table 13) of the change in number of digits processed per minute as a function of the 2 (reinforcement conditions) by 2 (context conditions) by 5 (tests) obtained a significant tests by reinforcement interaction [$F(4,208) = 2.73$, $p = .03$]. There was also a significant main effect of tests [$F(4,208) = 2.81$, $p = .03$].

Table 13. Variance Analysis of Mean Change in Number of Digits Processed Per Minute as a Function of 2 reinforcement conditions and 2 contexts across 5 tests

Source	df	Mean Square	F	p
Between Subjects				
Reinforcement (R)	1	708.70	1.35	.25
Context (C)	1	1471.37	2.81	.10
R x C	1	253.42	0.48	.49
Residual	52	523.38		
Within Subjects				
Tests (T)	4	181.81	2.81	.03
T x R	4	177.09	2.73	.03
T x C	4	26.37	0.41	.80
T x R x C	4	56.30	0.87	.48
Residual	208	64.83		

The tests by reinforcement interaction is illustrated in Figure 6 and indicates that RIP performance across tests was less impaired when reinforcement was provided than when it was absent. This accords with the predicted influence of reinforcement. However, Figure 6 indicates that the test by reinforcement interaction arose because this reinforcement effect appeared to strengthen as tests were repeated. Thus, the difference in the degree of impairment between the groups seemed to be greatest on the final test. These results do not support the prediction that the profile of impairment on the RIP is consistent whether reinforcement is present or absent.

Figure 6. Mean Change in RIP Task Performance as a Function of Whether or Not Performance was Reinforced Across Five Tests



However, both groups showed that their impairment tended to be less at the peak BAC (test 3) than on test 2 at a lower rising BAC. In addition, impairment did not appear to increase and decrease systematically in either group as BACs rose to a peak and declined. This accords with the hypothesis that performance on the RIP task is not consistent with changing BACs.

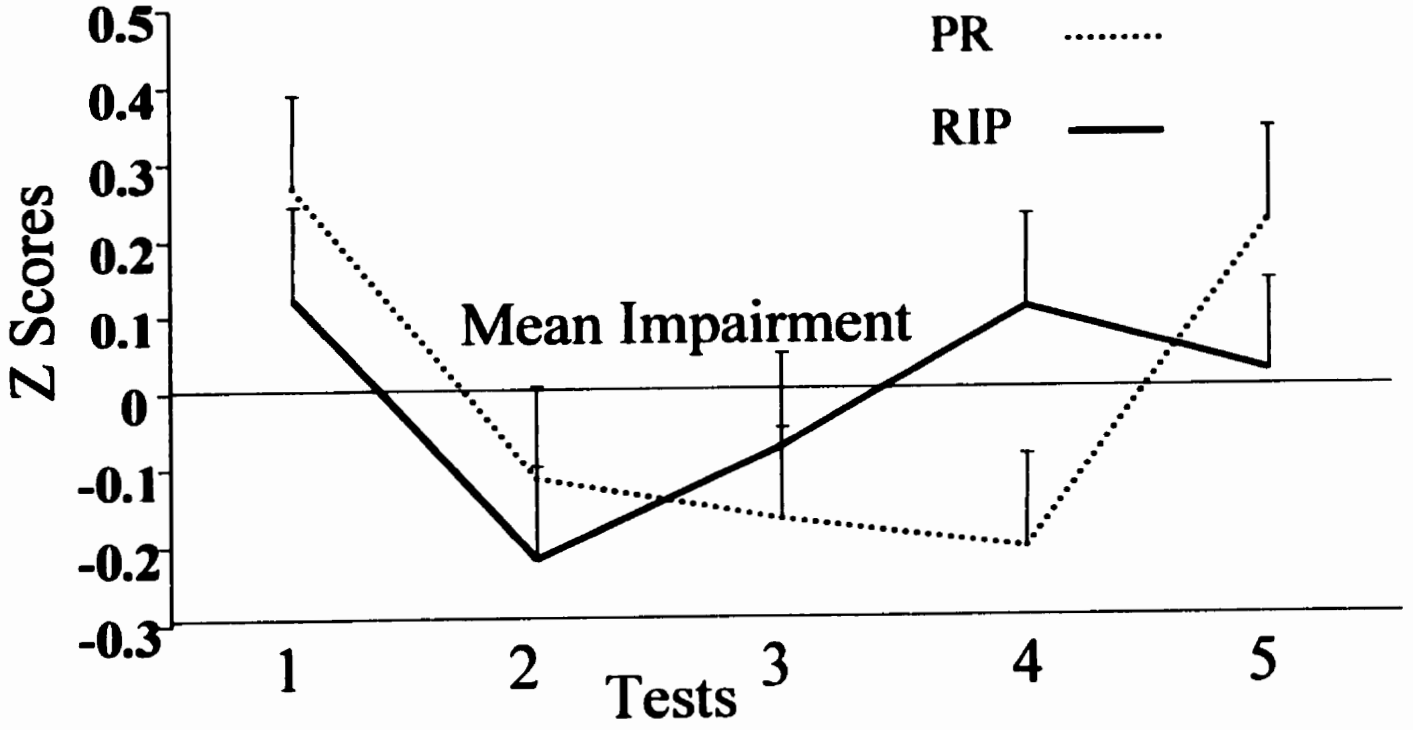
The analysis (Table 13) yielded no significant interactions with context (ps >.48). The main effect of context was somewhat stronger [$F(1,52) = 2.81$, $p = .10$] but failed to reach $p = .05$. Thus the analysis provided little support for the possibility that impairment on the RIP task is affected when it is performed in the context of reinforcement for the PR task.

Results from the analysis of the change scores were checked by a 2 (reinforcement) by 2 (context) by 5 (test) ANCOVA of the actual number of digits processed per minute on treatment tests, using participants' drug-free baseline scores as a covariate. The ANCOVA (Appendix U: Table 3) confirmed the conclusions from the ANOVA of change scores. The adjusted mean of number of digits processed per minute on treatment tests for each group can be seen in Appendix U (Table 4).

Two Task Profiles of Impairment

The change scores obtained on the tests of each task under alcohol were converted to z scores in order to directly compare their profiles of impairment during the rising and declining BACs. A 2 (task) by 2 (PR reinforced or not) by 2 (RIP task reinforced or not) by 5 (test) ANOVA of z scores is presented in Table 14. The difference between the tasks in the pattern of impairment over tests was of prime interest, and this was indicated by the significant task by tests interaction [$F(4,208) = 4.37$, $p = <.01$]. Figure 7 plots the mean z scores on PR and RIP performance on each test for the entire sample. A z score of zero on these graphs represents the overall mean change in performance on each task. Therefore, for each task, a z score above zero indicates less impairment than the overall mean impairment and a z score below zero indicates greater impairment. In accord with the findings from measures of change scores, PR performance tended to become more impaired as blood alcohol rose. The greatest amounts of impairment appeared to be seen on tests when drug blood levels were around the peak, and recovery (i.e., less impairment) seemed to be evident when BACs were declining. The RIP task revealed a different pattern. Test 2 appeared to

Figure 7. Mean Z scores on RIP and PR Tests for the Entire Sample (N = 56).



show an increase in impairment above the overall mean amount of impairment, but this test occurred during rising BACs before the peak was reached. Performance impairment on the remaining tests then seemed to fluctuate below and above the mean impairment in a manner that was not consistent with the peak and declining BAC. Thus, the degree of impairment on the RIP task did not appear to be related to the BAC.

The analysis (Table 14) also detected significant context effects for both the RIP and PR tasks. Specifically, reinforcing the RIP task led to different patterns of performance on the RIP and PR tasks across tests [$\underline{F}(4,208) = 2.62$, $\underline{p} = .04$]. In accord with the analysis of change scores, the z scores (Figure 8A) showed that when the performance on the RIP task was reinforced (groups P_RR_R plus P_NR_R), less impairment appeared to be seen regardless of whether the PR was reinforced. The pattern of impairment over tests also differed when the RIP task was reinforced (groups P_RR_R plus P_NR_R) compared to no reinforcement (groups P_RR_N plus P_NR_N). However, neither pattern accorded with the changes in BAC on the tests.

The z scores (Figure 8B) show that PR performance was also affected by reinforcement for the RIP task. Less impairment tended to be seen on the PR task when the RIP task was reinforced (groups P_RR_R plus P_NR_R), than when the RIP task was not reinforced (groups P_RR_N plus P_NR_N), irrespective of whether the PR was reinforced. However, the important aspect of these findings is that the pattern of impairment on the PR task is similar, whether or not the PR was performed in the context of reinforcement for the RIP task.

The effects of reinforcing the PR task also differentially affected the overall impairment shown on each task [$\underline{F}(1,52) = 14.20$, $\underline{p} = <.01$]. This can be seen in Figure 9, where the mean z scores on each test of the RIP and PR task are plotted as a function of the presence or absence of reinforcement for the PR task. Figure 9A shows that when the PR was reinforced, less impairment on the PR was displayed regardless of whether the RIP task was reinforced (groups P_RR_R plus P_RR_N). In contrast, Figure 9B shows that RIP performance was more impaired when it was performed in the context of reinforcement on the PR task (P_RR_R plus P_RR_N). Less impairment on the RIP task was shown when the PR task was not reinforced (groups P_NR_R plus P_NR_N).

Figure 8. Mean Z Scores on 5 tests of the RIP and PR Task as a Function of Whether or Not the RIP Task was Reinforced (RF ..... Not RF ——)

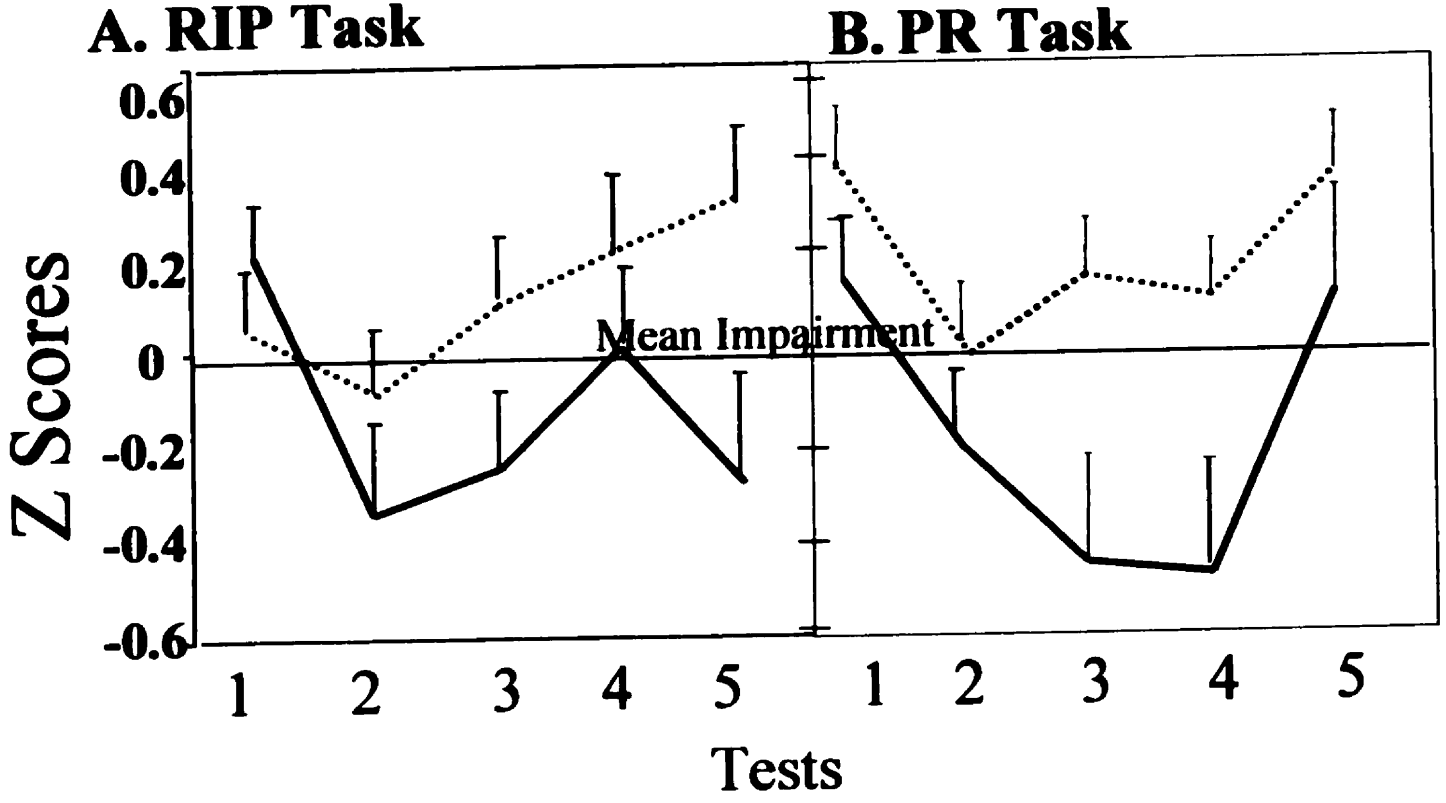
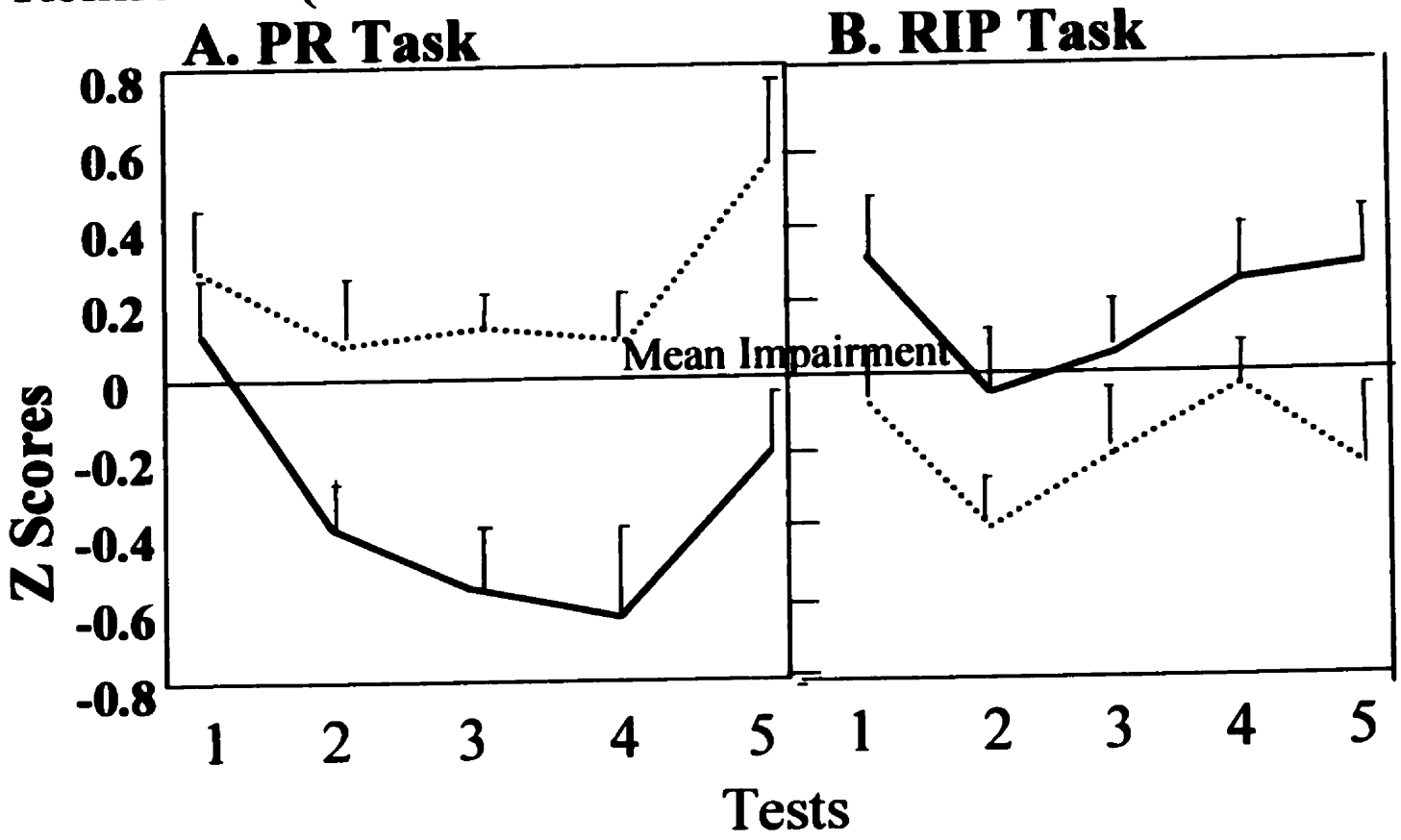


Figure 9. Mean Z Scores on 5 tests of the RIP and PR Task as a Function of Whether or Not the PR Task was Reinforced (RF ..... Not RF ——)



It is important to note that the context effects obtained in the z score analysis failed to reach significance when the tasks were analysed separately using either change scores or actual test scores. It is not clear why the z scores detected these context effects. For example, it might be due to a greater power and precision afforded by the use of the entire data or the equalised distribution of the z score measures. Therefore, these context findings await replication in future research.

Table 14. Variance Analysis of Z Scores of RIP and PR Tasks as a Function of Reinforcement, Context and Tests.

Source	df	Mean Square	F	p
Between Subjects				
PR Reinforced or Not ($P_{R\ vs.\ N}$)	1	13.98	3.48	.07
RIP Reinforced or Not ($R_{R\ vs.\ N}$)	1	1.87	0.46	.50
$P_{R\ vs.\ N}$ x $R_{R\ vs.\ N}$	1	0.55	0.14	.71
Residual	52	4.02		
Within Subjects				
Tests (T)	4	2.72	6.56	<.01
T x $R_{R\ vs.\ N}$	4	.85	2.05	.09
T x $P_{R\ vs.\ N}$	4	.57	1.36	.25
T x $R_{R\ vs.\ N}$ x $P_{R\ vs.\ N}$	4	.59	1.41	.23
Residual (T)	208	.42		
Task (Ta)	1	0.01	<0.01	.95
Ta x $R_{R\ vs.\ N}$	1	0.62	0.28	.60
Ta x $P_{R\ vs.\ N}$	1	31.63	14.20	<.01
Ta x $R_{R\ vs.\ N}$ x $P_{R\ vs.\ N}$	1	6.30	2.83	.10
Residual (Ta)	52	2.23		
T x Ta	4	1.24	4.37	<.01
T x Ta x $R_{R\ vs.\ N}$	4	0.75	2.62	.04
T x Ta x $P_{R\ vs.\ N}$	4	0.56	1.96	.10
T x Ta x $P_{R\ vs.\ N}$ x $R_{R\ vs.\ N}$	4	0.29	1.03	.39
Residual (T x Ta)	208	0.29		

Incidental Observations

Owing to the failure of the portable breathalyser, 37 of the subjects in the study had to walk back and forth to provide breath samples to the stationary breathalyser located in an adjacent room. The possibility that the additional physical stimulation of this activity affected the performance of each task was explored by separate 2 (activity) by 2 (reinforcement) by 2 (context) by 5 (test) ANOVAs of the change scores. These analyses are shown in Appendix V (Tables 1 and 2).

The analysis of the impairment on the PR task showed that the activity factor did not interact with the factors of interest in the experiment (tests, reinforcement and context), ps > .30. However, the main effect of activity approached significance ($p = .06$). The mean amount of impairment shown by the group with and without the activity of walking from room to room is presented in Appendix V (Table 3) and shows the activity group tended to display less impairment on the PR task as compared to the group with less activity.

The analysis of the RIP task obtained no significant main effect of activity ($p = .77$) or interactions with tests, reinforcement or context (ps > .13). The mean impairment of the two groups on the RIP task is shown in Appendix V (Table 4).

Secondary Findings

SHAS Ratings

To determine whether the groups differed at baseline in their SHAS intoxication ratings, the eight SHAS adjectives for each person on the drug-free baseline test were summed and a one-way ANOVA was performed (Appendix W; Table 1). This analysis indicated that the four groups did not differ in their baseline ratings of symptom intoxication [$F(3,52) = 0.40$, $p = .76$]. The overall (N = 56) mean (SD) baseline summed rating was 2.88 (4.80).

The summed ratings for a subject were obtained at each of the three time intervals (rising, peak and declining BAC), and his summed baseline score was subtracted from each of these ratings. This produced three measures of the change in self-reported symptoms of intoxication for each subject and served to control for any individual differences prior to treatment. A positive

score meant an increase in subjective intoxication from sober baseline, and a negative score meant a decrease in these symptoms.

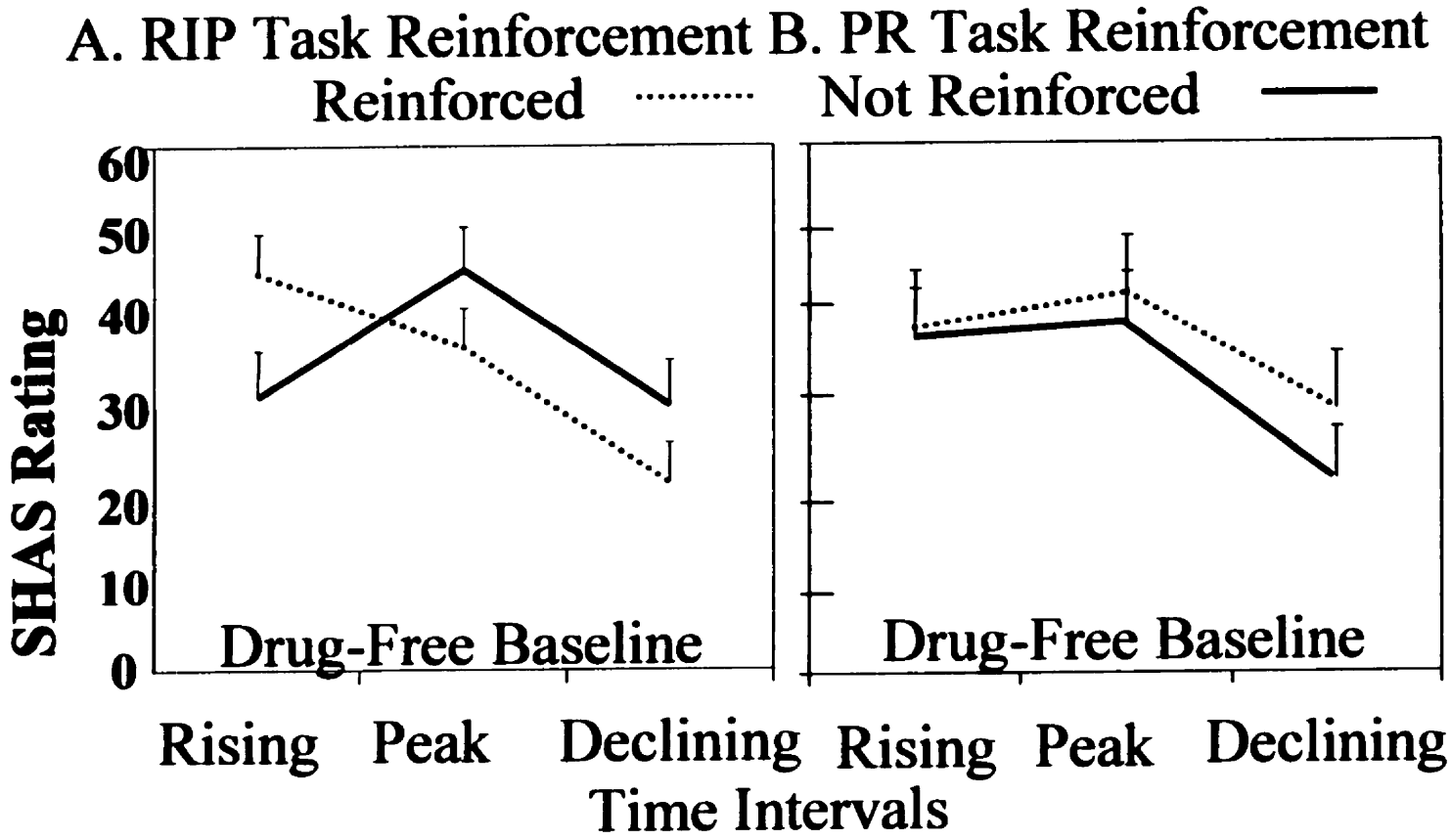
To determine whether the change in ratings across time differed when either task was reinforced, a 2 (PR reinforced or not) by 2 (RIP task reinforced or not) by 3 (time) ANOVA of the change scores was carried out (Appendix W; Table 2). This analysis obtained a two-way interaction between reinforcing the RIP task and time [$F(2,104) = 4.61$, $p = .01$] as well as a main effect of time [$F(2,104) = 7.10$, $p = <.01$]. The interaction effect, seen in Figure 10A, shows that when RIP task performance was not reinforced, the ratings of subjective intoxication appeared to be highest around the peak blood alcohol level. In contrast, when RIP task performance was reinforced, the ratings of intoxication tended to be highest when BAC was rising and progressively decreased as BAC peaked and declined.

It is interesting to note that the ratings of subjective intoxication across time did not differ, whether or not the PR task was reinforced [$F(2,104) = 0.30$, $p = .74$] (Figure 10B). In both cases, the subjective effects tended to be slightly greater at peak BACs as compared to rising BACs and the ratings diminished as BACs declined.

In sum, the changes in intoxication ratings appeared to be similar to the pattern of impairment on the PR, as slightly higher ratings occurred at the peak BAC compared to the rise, and intoxication ratings tended to drop off considerably as BACs declined. Reinforcement on the PR task seemed to reduce the overall intensity of impairment in performance, but symptom ratings appeared insensitive to this variation in motor skill impairment because the intoxication ratings seemed to be unchanged across reinforcement conditions.

The intoxication ratings of groups with or without reinforcement on the RIP task differed considerably. When the RIP task was reinforced, cognitive impairment and ratings of intoxication tended to diminish steadily over time as BAC rose and declined. However, when there was no consequence for performance, the ratings of intoxication did not tend to accord with changes in impairment on the RIP task. Maximum ratings under this condition were seemed to occur at the peak BAC, and these changes in ratings of intoxication seemed to more closely resemble those obtained from groups performing the PR.

Figure 10. Mean Change From Sober Baseline in SHAS Ratings Under Alcohol Over Time as a Function of:



These results lead to the suspicion that symptoms of intoxication during a dose of alcohol may generally accord with changes in impairment of a motor skill and a reinforced cognitive task. However, the unknown psychometric properties of the SHAS make it difficult to know whether these are reliable findings. Future research is required to evaluate this possibility.

Discussion

This experiment examined the profile of impairment on PR and RIP tasks during the course of a moderate dose of alcohol when participants' performance was reinforced for the maintenance of their sober standard, and when there was no reinforcement. The first study had indicated that when no consequence was provided for performing the PR and RIP tasks, motor skill impairment tended to track the BAC curve and cognitive impairment was unrelated to rising and declining BAC. Study two replicated this finding and extended the investigation by examining these two task profiles of impairment when a sober standard of performance was reinforced on one or both tasks, or neither task. In accord with the hypothesis, the impairment shown on each task was reduced when that task was reinforced. In the PR task, the characteristic pattern of maximal impairment around the peak BAC and lesser impairment during declining BACs was seen whether or not performance was reinforced. In the RIP task, the pattern of impairment remained unrelated to BACs irrespective of reinforcement, but the impairment pattern differed when reinforcement was present or absent. In general, reinforcement caused a gradual reduction in impairment as tests were repeated. In contrast, when RIP performance had no consequences, the degree of impairment on tests fluctuated in a fashion that did not accord with changes in BAC and no recovery was seen during falling BAC.

The separate analyses of each task did not reveal any significant effect of context (presence or absence of reinforcement for the other task). However, significant context effects were detected when scores on the tasks were converted to standardized z scores, enabling the direct comparison of the tasks. PR performance was less impaired, irrespective of reinforcement, when it was performed in the context of reinforcement for the RIP task. Conversely, RIP performance was more impaired (regardless of reinforcement) when it was performed in the context of reinforcement on the PR task. These findings suggest that the degree of impairment in a cognitive or a motor skill task might alter when it is performed in the context of reinforcement for the other task. These intriguing reinforcement context effects should be interpreted with caution because they were only seen in the standardized score analysis and await replication. However, these findings are

potentially important because they raise the possibility that reinforcement context may interact with alcohol to differently alter the degree of impairment in cognitive and motor skills.

Additional observations suggested that the amount of impairment under alcohol displayed by each task might be affected by different factors, specifically test fatigue and physical activity. The possibility that cognitive fatigue accumulated as tests were performed on the RIP task was suggested by the results of the first study, where both tasks were performed with no consequence. Under these conditions, a drinker's performance of the RIP task showed no reduction in impairment during declining BACs, even though this reduction was evident in his motor skill performance. This raised the possibility that test fatigue might have masked any recovery from impairment that was occurring. However, when fewer tests with no consequence for performance were administered in the second study, impairment on the RIP task also showed no reduction in impairment during declining BACs. This study did not include a placebo group, so it is not possible to discount the possibility that some RIP test fatigue was still present. Nonetheless, this seems unlikely because reinforcing RIP task performance caused a progressive reduction in impairment as tests were repeated. This evidence suggests that a continuation or intensification of impairment during early declining BACs may characterize performance on cognitive tasks when performance has no consequence.

Incidental observations suggested that drinkers who engaged in greater physical activity under alcohol showed less impairment in a motor skill than those who remained more sedentary. This physical activity did not alter the profile of impairment on the PR task, but the effect of activity appeared to be specific to motor skills because it did not seem to affect the pattern or the amount of impairment displayed on the RIP tasks. These novel observations are potentially important. If they are confirmed in future research, they would identify physical activity as a protective factor in reducing the impairing effect of alcohol on motor skills.

DISCUSSION

The controversy over the different sensitivity of cognitive and motor skill tasks to the impairing effect of alcohol has continued for almost a century. However, this thesis appears to be the first to conduct research designed specifically to test this question, using a within-subjects design. Two experiments measured the impairment shown on a motor skill and a cognitive task under a moderate dose of alcohol when a social drinker performed both tasks at comparable rising and declining BACs. The motor skill was represented by a pursuit rotor task (PR) and cognitive performance was exemplified by a Rapid Information Processing (RIP) task that required no learned motor skill. The pattern of impairment shown by each task was assessed under two conditions: when the performance of different groups of drinkers had no consequence and also when reinforcement for a sober standard of performance on either one or both tasks was provided. The results showed that reinforcing the performance of a task tended to diminish the amount of impairment displayed over tests under the dose, as compared to when no consequence was provided for performance. However, different profiles of impairment were consistently shown on each task. Performance on the PR task tended to track the changes in BAC. That is, impairment increased as BAC rose, the most impairment occurred around the peak BAC and impairment diminished as BAC declined. In contrast, performance on the RIP task showed no particular relation to the changes in BAC. The results of this research pointed to the conclusion that motor skills are typically impaired and recover as a function of rising and declining BACs, whereas no such pattern of BAC-related impairment is shown in cognitive performance.

These results are consistent with the longstanding suspicion that cognitive and motor tasks are not equally sensitive to a moderate dose of alcohol. But they cast new light on the controversy over which task is more impaired by showing that discrepant conclusions may arise if only particular BACs are taken into account. For example, if sensitivity were judged on the basis of which type of task showed the most impairment during low rising or declining BACs, the results of this study would indicate that information processing in the RIP task was more sensitive because it showed impairment at a lower rising BAC than did the PR motor skill task. However, if sensitivity

were assessed by which task showed regular increasing impairment as BAC rose to a peak, the PR task would be considered more sensitive to alcohol.

As the above example suggests, past opinions about the degree to which a moderate dose of alcohol impairs different types of tasks has been based on the assumption that impairment can be assessed equally well by measuring the lowest BAC at which impairment is shown, or the degree of impairment as BAC rises to a peak, or other measures, such as the degree of impairment shown during a dose, irrespective of the number of tests, or the time after alcohol is administered that impairment is seen. This thesis shows that single measures of this sort cannot answer the question of which type of task is more impaired by a moderate dose of alcohol because the difference between cognitive and motor skill tasks in their sensitivity to alcohol depends on where on the BAC curve the tests occur. If conclusions about task differences in sensitivity to alcohol impairment are based only on particular BACs, inconsistent claims about cognitive or motor tasks being generally more impaired by a moderate dose of alcohol are likely to continue.

The thesis research also demonstrated that an environmental factor, reinforcement for a sober standard of performance, complicates the measurement of the amount of impairment in cognitive and motor skills. Reinforcement was shown to reduce the impairment over tests on the RIP and PR tasks. This evidence accords with the suggestion that the consequence of performance under alcohol may affect the amount of impairment displayed (Holloway, 1995) and raises the possibility that the results of studies assessing the degree of impairment on tasks under alcohol can be misleading unless the consequences of performance are considered and held constant over tasks.

Acute Behavioral Tolerance

The evidence in this thesis also bears on the assumption that acute behavioral tolerance is a well-established phenomenon (Hiltunen, 1996; Moskowitz, Burns, Fiorentino, Smiley & Zador, 2000). In theory, the intensity of the drug effect depends on the drug blood level, and acute tolerance occurs because physiological adaptation to the drug grows with time under a dose and increasingly counteracts the drug effect. Acute tolerance is identified by showing that the drug effect at a given BAC is stronger during rising than declining blood alcohol levels, or by showing that the intensity of the drug effect diminishes more quickly than BACs decline.

Although this thesis research was not designed to measure acute tolerance, the profile of impairment on the PR task could be compatible with the occurrence of acute tolerance because impairment waxed and waned in accord with rising and declining BACs. This pattern of impairment has also been demonstrated in a variety of other motor skill tasks where acute tolerance has been measured and confirmed (e.g., Vogel-Sprott & Barrett, 1984; Lee, 1984; Vogel-Sprott & Fillmore, 1993).

If a general physiological adaptive mechanism accounts for acute behavioral tolerance, this adaptation should be constant for an individual and so the same pattern of impairment should be evident in the person's performance of other tasks during the course of the same dose. This is widely assumed to be the case, "subjects exhibit less impairment on a descending than on a rising alcohol curve" (Moskowitz et al., 2000). However, the present research showed that the pattern of impairment on the RIP and PR tasks differed when the same drinker performed both tasks at comparable rising and declining BACs. The intensity of impairment on the RIP task varied unpredictably with the changes in BACs. Moreover, if increasing adaptation to the drug effects were contributing to the reduction in impairment on the PR task during declining BACs, some such recovery from impairment also should have been shown on the RIP task. However, the results showed that the reduction in impairment on the RIP task appeared to depend on the presence of environmental reinforcement for performance, rather than drug adaptation. When performance had no consequence, there was no consistent pattern of increase in, and recovery from impairment that accorded with BACs. When performance was rewarded, impairment generally reduced as tests were repeated and BACs rose, peaked and declined. These findings raise the possibility that cognitive activities, unlike motor skills, are degraded as a function of time when no incentive is provided for unimpaired performance.

Research Implications

This thesis confirmed the reproducibility and generality of different cognitive and motor task profiles of performance under a moderate dose of alcohol in male social drinkers. However, it is important for future research to continue to test the generality of these task profiles. The consistently different profiles of impairment shown by these two tasks during the course of a

moderate dose of alcohol raises the question of whether these profiles also characterize other cognitive and motor skill tasks. The PR and the RIP tasks in this research were selected as prototypical examples of a motor skill and a cognitive task that required no learned motor skill. Although other research in which social drinkers perform other motor tasks at intervals under a moderate dose of alcohol tend to be consistent with the BAC-related profile of impairment in the PR, the profile of impairment demonstrated in the cognitive RIP task is a new finding. Little research on the effect of alcohol on cognitive performance has used tasks that excluded learned motor skill and no experiments appear to have investigated their profiles of impairment. Future research is required to determine whether the profile seen on the RIP task under alcohol is also exhibited in other cognitive tasks involving no learned motor response. This appears to be a promising pursuit because some incidental observations on the effect of alcohol on a cognitive task measuring inhibitory control suggest that impairment on this task also appears to be inconsistent with rising and declining BACs (Mulvihill et al., 1997; Easdon & Vogel-Sprott, 2000).

This thesis research used a sample of male social drinkers because previous research examining the effects of alcohol on cognitive and motor skills had also primarily used male social drinkers. Future research using the within-subject design of the present experiments could also determine whether the two task profiles of impairment are exhibited in different populations of drinkers (i.e., female social drinkers, heavier drinkers) and with higher doses of alcohol. Different reinforcement schedules is also an important question that merits examination. The finding that immediate reinforcement of a sober standard of performance reduces the impairing effect of alcohol on motor and cognitive skill tasks is consistent with the results of other research (Mann & Vogel-Sprott, 1981; Fillmore & Vogel-Sprott, 1997). However, task profiles of impairment under other schedules of reinforcement that may occur in drinking situations (i.e., delayed reward) is an important question for future research. In addition, research using this design and obtaining matching BACs on rising and declining limbs could add clear information about acute tolerance and contribute to an understanding of its occurrence.

The findings on the RIP task raise the intriguing question of what factor(s) or mechanism(s) might contribute to this pattern of impairment in cognitive performance. Answers to

this question await further research. However, observations obtained during the course of the experiments in this thesis suggested some possible factors, such as test fatigue, time under the dose and incentive for good performance that may affect the profile of impairment in cognitive performance.

Further insight into the mechanisms underlying the different task sensitivities may also come from research using functional brain imaging. Since the RIP task relies primarily on cognitive performance and the PR task also engages learned motor skill, it is possible that functional brain differences may account for the variant patterns of impairment between the tasks shown at particular BACs. Brain imaging studies of RIP and PR task performance both drug-free and under alcohol would provide insight into this possibility. Some research has examined drug-free PR performance in healthy volunteers using positron emission tomography (PET) (Grafton et al., 1992; Grafton, Woods & Tyszka, 1994). Grafton et al. (1992) imaged six subject's brains during their performance of four 80 second trials, each separated by 10-15 minutes. The dependent measure, percentage of time on target, ranged from 15-30 on trial 1 to 50-80 on trial 4, indicating that subjects learned over trials. A comparison of the areas of increasing cerebral blood flow across the four PET scans revealed an increase in the left motor cortex, the left supplementary motor cortex and the left pulvinar thalamus. Grafton et al. (1994), using a similar practice design had subjects return a second day to perform the task again. Changes in regional cerebral blood flow were seen bilaterally in the putamen and parietal cortex and in the left premotor cortex. To date, no brain imaging research has examined PR performance under alcohol and it remains to be determined what areas will be activated and/or what differences will be seen compared to drug-free activation. In addition, no brain imaging studies appear to have investigated brain areas and their activation when the RIP task is performed. However, Vogel-Sprott, Easdon, Fillmore, Finn & Justus (2000) describe studies that have used event-related functional magnetic resonance imaging (fMRI) to examine performance on a stopping task that assesses cognitive inhibition and activation. The task required no learned motor skill and subjects performed the task both drug-free and under a moderate dose of alcohol (0.56 g/kg). Drug-free inhibition was associated with strong activation of the connections between frontal and striatum areas, consistent with theories of response inhibition.

Alcohol decreased the strength of the connections between these two areas. Alcohol also decreased activation, compared to drug-free performance, in the cerebellum, the head of the caudate, the inferior and middle frontal gyrus and the cingulate gyrus. Some areas in the middle temporal gyrus also increased in activation after the consumption of alcohol. RIP task performance (drug-free and/or under alcohol) might also involve frontal activation as well as some motor areas, and also potentially the anterior cingulate, which is thought to be involved in performance and error monitoring (MacDonald, Cohen, Stenger & Carter, 2000). However, the specific brain areas and their interactions involved during RIP task performance remain to be determined. The research design of experiments in this thesis, coupled with fMRI, would allow the examination of the functional and structural differences in brain activation during RIP and PR performance at particular BACs. Such information may help to clarify and understand the different sensitivity of cognitive and motor skills to moderate BACs.

Practical Implications

A great deal of interest in the impairing effect of a moderate dose of alcohol on cognitive and motor skills is prompted by the notion that the type of task that is more vulnerable to impairment at moderate alcohol levels might make a greater contribution to the risk of alcohol-related accidents. The evidence in this thesis shows that the impairment of cognitive and motor skill tasks differ under alcohol and that they are differently sensitive to rising and declining BACs, rather than a moderate dose in general. The findings also provide information on what BACs might generate greater risk of impairment in these two types of tasks when a moderate dose of alcohol is consumed. During rising BACs, cognitive skills may be impaired before motor skills; during declining BACs, motor skills may recover before cognitive skills. An environmental factor, reinforcement for a sober standard of performance, appears to reduce the amount of impairment seen during the course of the dose on these tasks. This protective effect of reinforcement may have important implications for reducing the risk of alcohol-related accidents owing to impaired performance.

The practical implications and application of this research might also be illustrated by an analogy to activities that may occur in a social drinking situation. Card playing and dart throwing

are good examples. Card playing involves information-processing ability and little learned motor skill (somewhat similar to the RIP) and accurate dart throwing involves a great deal of learned, hand-eye coordination and motor skill (similar to the PR). If the findings from the current thesis are applied to a social drinking situation where both games are played, several predictions can be made about the pattern and intensity of impairment displayed on each game under a moderate dose of alcohol. Dart throwing should be most impaired when the game is played during peak BACs, and much less impaired during rising and declining BACs. In contrast, the degree to which performance on the card game is impaired is likely to be to unrelated to the rising or declining BACs. If darts and cards were each played for money, drinkers may display less impairment on both games (as compared to when no money was at stake). However, the different pattern of impairment with respect to BACs should continue to be evident in each game. Evidence in the second study suggested that performing one task under alcohol in the context of reinforcement for another task may affect the degree of impairment on both tasks. While this finding is new and awaits replication, the results suggest that if only one of the games were played for money, the intensity of impairment on both darts and cards may be altered.

Conclusions

For almost a century, reviews of research on the effect of a moderate dose of alcohol on cognitive and motor skills have generated conflicting conclusions about the difference between these types of tasks in their sensitivity to impairment. This thesis appears to be the first to address this controversy experimentally, by a within-subject comparison of performance on both types of tasks at comparable rising and declining BACs under a moderate dose of alcohol. The results clearly demonstrate that a motor skill and a cognitive task requiring no learned motor skill are differently sensitive to the impairing effects of these rising and declining BACs. Impairment on a motor skill increases and decreases in accord with these changes in BAC, whereas the impairment of cognitive performance bears no consistent relation to the rise and decline in BAC. Thus the degree of impairment observed in each type of task depends on the BAC where performance is tested. This new information suggests that inconsistent conclusions about which type of task is

more sensitive to alcohol may be due, in part, to the focus on the effect of a moderate dose of alcohol in general, without regard to the BAC when a task is performed.

The results obtained in this thesis also have other broad implications. It is widely assumed that the intensity of the drug effect depends on the blood drug level. While this assumption accords with the profile of impairment shown in the motor skill task, it is at odds with the evidence showing that impairment on the cognitive task failed to wax and wane in accord with rising and declining BAC. Moreover, these results raise questions about the universality of acute behavioral tolerance to alcohol because a reduction in the intensity of the drug effect as BACs decline is prerequisite for the occurrence of acute tolerance, and this reduction was not consistently seen in the cognitive task.

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APPENDIX A

Phone Script

Hello, _____ I'm _____ and I am phoning from the University of Waterloo, Dept. of Psychology. I got your number from the subject pool and I'm calling to see if you would be interested in participating in an experiment that we are currently running.

In our lab we are measuring the effects of alcohol on computerised tasks that require responding to visual information on a computer screen. The experiment requires you to come in for two appointments. The first will take about 1 hour and 15 minutes and the second will take about 2 and a half-hours. In total, we need about 3 hours and 45 minutes of your time and we will pay you $20.00 at the end of the second session. This project has been reviewed and received ethics clearance through the University's Office of Research Ethics. We are selecting individuals whose body weights fall between a range of 130-200 pounds (50-90 kg) and are at least 19 years of age. During this experiment you will receive alcohol in the form of a mixed drink. Are you interested in participating? Have you ever participated in an alcohol study before or a study that involved any other drugs such as caffeine? What did you do in that study? What was the task?

A breathalyser machine will measure your breath samples in order to estimate your blood alcohol concentration at different times. We use moderate doses of alcohol, which will not make you sick. However, you must not drive after completing the experiment. If you need transportation home it will be provided for you. After the experiment you are advised to remain in the lab until your blood alcohol level returns to a safe level as determined by the researcher.

Although the doses of alcohol used in this experiment are not harmful, alcohol may have some physical effects. Certain existing medical conditions contraindicate participation in this study. Thus, it is important that you do not have any medical problems such as diabetes or epilepsy. Similarly, it is important that you are not taking any medication: this includes regular use of cold or allergy medications, aspirin or antihistamines, or over-the counter drugs such as "wake-up" pills.

As I mentioned, you will need to come to the lab on two separate occasions. On the first day, you practice the computer tasks. On the second day, you will be performing the same tasks after you receive your drinks. We will be asking you to fast for 4 hours before this second session and I can tell you more about that later. It is also important that you abstain from drinking alcohol for 24 hours prior to the second session. Would either the fast or abstinence from alcohol be a problem for you? What would be a good time for you to come in for the first appointment? Please meet me on the 4th floor of the Psychology Building by the elevators. Do you have any questions?

APPENDIX B

Personal Drinking History Questionnaire

Below are some questions that are primarily concerned with your personal drinking. Most ask you to answer according to what is most typical or usual for you. Please try to answer each question as honestly as possible.

1) Please estimate the number of years that you have been drinking alcohol. Estimate to the nearest month.

_____years _____months

2) How often, on average, do you drink alcohol? (Choose only **one**)

A) Only on special occasions, how many times per year? _____
B) Monthly, how often? _____
C) Weekly, how often? _____
D) Daily, how often? _____

3) What alcoholic beverage do you drink? _____

4) In terms of the beverage indicated in question 3, what is the **AVERAGE** quantity you drink in a single drinking occasion? (Choose only **one**)

A) WINE (estimate ounces) 1 2 3 4 5 6 7 8 9 10 or ____
B) BEER (bottles) 1 2 3 4 5 6 7 8 9 10 or ____
C) BEER (draft glasses) 1 2 3 4 5 6 7 8 9 10 or ____
D) LIQUOR (assume 1.5 ounces per drink and estimate the number of drinks) 1 2 3 4 5 6 7 8 9 10 or ____

5) How long does your typical drinking occasion last? (Choose only **one**)

A) _____ MINUTES
B) _____ HOURS
C) _____ DAYS

6) Have you ever been charged with impaired driving? YES NO

7) Have you ever experienced any problems related to your drinking? YES NO

8) Age ____ Weight _____ Height _____ Handedness: RIGHT LEFT

APPENDIX C

Beverage Strength Rating Scale

Regarding the alcohol you have consumed, rate the strength of its effect by comparing it to bottles of beer (5% alcohol by volume) OR fluid ounces of liquor (40% alcohol by volume). ONE STANDARD DRINK CONTAINS 1.5 OUNCES OF ALCOHOL.

OUNCES OF LIQUOR (40%) OR	BOTTLES OF BEER (5%)
Circle the total number of OUNCES	Circle the total number of BOTTLES
0	0
0.5	0.5
1.0	1.0
1.5	1.5
2.0	2.0
2.5	2.5
3.0	3.0
3.5	3.5
4.0	4.0
4.5	4.5
5.0	5.0
5.5	5.5
6.0	6.0
6.5	6.5
7.0	7.0
7.5	7.5
8.0	8.0
8.5	8.5
9.0	9.0
9.5	9.5
10.0	10.0

APPENDIX D

Subjective High Assessment Scale

These questions refer to how you are feeling right now.

Assume that before you drank the beverage your score was "Normal".

How do you feel right now?

Normal	|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|	Extremely Uncomfortable
Normal	|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|	Extremely High
Normal	|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|	Extremely Clumsy
Normal	|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|	Extremely Muddled/Confused
Normal	|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|	Extremely Slurred Speech
Normal	|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|	Extreme Effects of alcohol
Normal	|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|	Extreme Feelings of Floating
Normal	|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|	Extremely Dizzy
Normal	|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|	Extremely Nauseated
Normal	|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|	Extremely Drunk

Also rate these two items as above:

Normal	|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|	OVERALL, I Feel Terrible
Normal	|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|	OVERALL, I Feel Great

APPENDIX E

Expected Type of Effect Scale

On this scale, ranging from -30 (Extremely Impair) to 30 (Extremely Enhance), please indicate how you would expect your performance on our task to be affected if you drank two beers within an hour. Circle only one number.

-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
Extremely Impaired		Moderately Impaired		Slightly Impaired		No Effect		Slightly Enhanced		Moderately Enhanced		Extremely Enhanced

APPENDIX F

Consent Form

I, _____, age _____ hereby state that I have volunteered to consume a moderate dose of alcohol and to perform trials on a computer task. The purpose of this study is to examine the effects of alcohol on the ability to perform a task that requires responding to visual information on a computer screen. I understand that I will become familiar with the task and then perform the task under a moderate dose of alcohol. I also understand that this experiment will take about 3 hours and 45 minutes to complete. I am not currently taking any medication. I have abstained from alcohol for at least 24 hours and have fasted for 4 hours prior to this study to ensure that stomach contents do not affect the absorption of alcohol. I also understand that at the conclusion of the study, my blood alcohol level may be above zero and I am advised to remain in the lab until it returns to a safe level of .03%.

I understand that all records, tests and personal data are confidential, and will be used in research reports that do not disclose the identity of any individual.

I consent to what is proposed to be done. I agree of my own free will to participate in this experiment. The Consent is given freely and I understand that I am free to withdraw from the experiment at any time for any reason.

I understand that I shall receive a remuneration of $20 for taking part in this study.

This research is being conducted by Jennifer Fogarty under the supervision of the Principal investigator, Dr. M. Vogel-Sprott, who may be reached at the Department of Psychology, ext. 2666. This project has been reviewed and received ethics clearance through the Office of Human Research. If you have any questions or concerns about your participation, please call this office at 885-1211, extension 6005.

Signed this _____ day of _____, 19___.

_____
Participant's Name

_____
Participant's Signature

_____
Witness

*The experimenter signed the form as the witness

APPENDIX G

Instructions Read to Participants During the Practice Session

To ensure that each participant has the same understanding of the experiment, I will be reading information and instructions to you. While this is formal, it ensures that I remember to explain everything the same way to everyone.

First of all, I'd like to thank you for volunteering to participate in this study. I hope that you'll find it to be an interesting experience. It is very important that you are fully aware of the requirements for participation before we begin the study.

The total time required of you will be around 3 hours and 45 minutes. Today's session will take about 1 hour and 15 minutes to complete and will involve practising two computer tasks and getting familiar with the lab. During the second session you will perform the same two tasks after drinking. This will take about 2 hours and a half-hours.

The purpose of this study is to examine the effect that alcohol has on the performance of computerised tasks. The pay for participating in the experiment is $20, which you will receive at the end of the second session. Please remember that you have to come to both sessions to be paid: There is no partial payment.

As I told you on the phone, there are some instructions regarding fasting for the second session. I will give you more details about this at the end of this session.

Do you have any questions? If you agree with these conditions, please read and sign this consent form, then we can begin.

RIP Task Instructions

I'm going to tell you a bit about this first computer task before you begin. You will sit directly in front of the monitor and will have your finger resting on the #1 key on the number pad.

For each trial, the computer will display a sequence of digits one at a time at a fairly quick rate. Only the digits one through to eight will be presented. Your task is to press the #1 key whenever you see any three even digits or any three odd digits presented in succession. For example, if you saw 6 then 2 then 8, you would press the key. Similarly, if you saw 7 then 1 then 5, you would press the key.

The presentation rate, the speed at which the digits follow one another, depends on your performance. The presentation rate will increase when you make a correct response. Your goal is to try to achieve and maintain the highest digit presentation rate possible. Any questions?
Let's do a 1 min. trial so that you can see how the task works.

Work through the entire task and I'll answer all of your questions when you've finished. Now place your finger on the #1 key. Ready? Okay, with your other hand press the space bar to start the task. Go ahead.

APPENDIX G (Cont'd)

After test:

Any questions? Have you ever seen a task similar to this before? When? How much experience did you have with it?

You may have seen from this trial that the presentation rate increases when you make a correct response. The rate also decreases when you either miss a target--that is, fail to notice it, or make an incorrect response--respond to a non-target event e.g. 1-2-5 which is neither a three even digit sequence nor a three odd digit sequence.

Again, your goal is to achieve and maintain the highest presentation rate possible. This means maximising the number of targets you correctly identify and respond to and minimising your misses and incorrect responses. Are there any questions?

There are some other things you should know about the task. For one thing, no number will ever follow itself. For example, 4 followed by 4 would not occur. Also, it does not matter in what order the three odd or three even digits are presented. For example, you would press the key if you saw 2-8-6 or 4-6-2 or 2-4-6, etc. Note that these even digits were not in any particular order. Similarly, for the odd digits, you would press the key if you saw 7-3-1 or 1-3-5, etc. Any questions?

Now you can have another opportunity to get acquainted with the task. This trial will be three minutes. I'll stay here with you to make sure you have no problems. Just ignore me and please don't talk during the trial. Place your finger on the key and press the space bar to begin.

After test:

Do you have any other questions regarding the task requirements?

Pursuit Rotor Task Instructions

Now I am going to get you to practice on this second task, but I am going to tell you a bit about this computer tracking task before you see it. You will sit in front of the screen, as you are doing, and manipulate the mouse which you position directly in front of the shoulder of your preferred hand. Keep your forearm extended out over the table and keep the mouse in the center of the pad (DEMONSTRATE). The task requires that you move a sight so that it stays on a rotating target. The sight will appear as a circle with cross hairs on the screen. Moving the mouse controls the sight on the screen. So you just have to move the mouse, there is no need to push any buttons on the mouse itself. So that you see what I mean, let's try a practice trial. I will point out the track, sight and target just before the trial starts.

As the test is beginning:

There is the sight
There is the rotating target
Your job is to keep the sight on the rotating target as much as possible.

APPENDIX G (Cont'd)

SUBJECT DOES ONE 50 SECOND PRACTICE TRIAL

AFTER THE PURSUIT ROTOR FAMILIARIZATION TRIAL:

Have you ever seen a task like this before?

Now there are some other things about the task I would like to mention.

(1) As I said, there is no need to push any of the mouse buttons.
(2) You also want to keep the mouse straight (demonstrate how cross-hair is difficult to move when mouse is crooked)
(3) You want to keep the mouse in the centre of the pad so that your forearm is extended out over the table. This also reduces any interference from the mouse cord that can occur if you have it close to you (Demonstrate). So position the mouse in the centre of the pad before each trial
(4) The computer will beep 3 times to prompt you before a trial begins

When I start the task again, it will automatically run through three trials, giving you a 20 second rest between each trial. After you have completed the third trial, the screen will say Please Wait for Experimenter. I will always come into the room at the end of each of the trials on both of the tasks to tell you what to do. Just wait for me before you do anything else.

I will leave you alone so as not to distract you. Please hit Continue on the computer screen with the mouse as soon as you hear me shut the door. Remember that the computer will beep 3 times to warn you to begin and that you will perform three of these trials this time, with 20 second rest breaks in between. The computer will prompt you to begin again after the breaks. Do you have any questions before we begin? I'll see you at the end of the third trial.

Now I will get you to perform a five-minute trial on this task (RIP).

Remember that you press the #1 key when you see three even digits in a row or three odd digits in a row. It is important that you respond as quickly and accurately as possible and that you attempt to achieve the highest digit presentation rate possible. I will come back into the room when the trial is over and then you will have a short break. Press the space bar to begin the task when I close the door and I will see you at the end of this trial.

First break: Now you will have a short break. GIVE PDHQ. Please fill out this questionnaire and I will come back and tell you when to begin again. Just wait here until I come back in the room.

After 3-minute rest break:

Now you can go back and sit in front of the tracking task. Just like last time, you will perform three short trials, with brief rests in between and the computer will beep three times to prompt you to begin. Hit continue when I shut the door and I will come back when the task is finished. Just wait for me before doing anything else.

APPENDIX G (Cont'd)

OK, now you will perform a trial on the task with the numbers. Just come back and sit here and press the space bar to begin when I close the door. I will come back when the trial is finished and tell you what to do.

REPEAT 3 MORE TIMES, AT END OF PRACTICE SESSION:
Check to make sure each subject's last practice trial digit presentation rate on RIP is 80 or better.

IF NOT, SAY: For the experiment, we need people with a wide range of scores. Your score falls within the most popular range and we already have enough people from that category. Unfortunately, this means that we will not be able to use you in the experiment. However, we will be able to pay you $5 for your time.

Next Time Script

Our next appointment will be a drinking session. Because the amount of alcohol that a person receives depends on his weight, I will need to measure your weight now.

After subject is weighed:

It is very important that you take no medications and abstain from drinking alcohol for 24 hours before the next appointment. You should have a light meal and then fast for four hours before the experiment. For example, if your appointment was at 12:00 p.m., you would have your light meal before 8:00 and then fast until you come in for the experiment. It is very important that you eat this light meal, and not come on an empty stomach from the night before. Food in your stomach will affect the absorption of alcohol. It is very important to fast so that the alcohol absorption rate for everyone is basically the same. During the fast, do not drink tea or coffee, only water. For the light meal prior to the fast, you should avoid all dairy products such as milk and yoghurt as well as fried or greasy foods including anything with butter, mayonnaise, etc. After your light meal, eat nothing for 4 hours. I have a menu that may help you to choose the sorts of food to eat before your fast (give menu). Can we make the next appointment now?

During the drinking session, you perform the same two tasks at intervals with rest breaks between trials. These rest intervals will vary in length so you might want to bring some books or things to work on during the rests.

At the conclusion of the alcohol session, your blood alcohol level may be above zero, so for safety, we will invite you to remain in the lab until your blood alcohol level reaches a safe level. For safety, we caution you against driving or riding a bike after the experiment. You should make alternative transportation arrangements, and if you have any difficulties in this respect, we can arrange a ride for you.

APPENDIX G (Cont'd)

Menu: Given to subjects

Eat a light meal followed by 4 hours of fasting before you come in for the next session. Below is a list of suggested foods and a list of foods to avoid. In general, avoid all dairy products and all greasy, fried foods (eg. anything with butter). Thank you for your co-operation.

Suggested foods:

- breads, buns, muffins
- fruits, vegetables
- seafood (nothing packed in oil)
- meat or poultry (broiled, baked, or barbecued)
- hard or soft boiled eggs
-toast with jam (no butter)
- salad (no dressing)
- sandwiches (luncheon meats, with mustard only)
- soup (not creamed)
- pickles

Foods to avoid:

- all dairy products (eg., cheese, butter, yoghurt, ice-cream margarine or milk
- mayonnaise
- fried eggs
- fried hamburgers
- french fries, chips
- bacon
- donuts
- peanut butter

Next Appointment Time: _____

APPENDIX H

Session 2 Instructions

BRING SUBJECT TO BREATHALYSER ROOM

Before we begin, I need to ask you some questions. When did you last eat? What did you eat?

Now I would like you to practice giving a breath sample to the breathalyser so that you can become familiar with the procedure and to get an idea of how hard you have to blow into the machine. Try to blow a steady stream of air that you can maintain for at least 10 seconds. (Verify Zero BAC.)

After you drink, I will be asking you to provide some more breath samples. Each time you do, it will take a couple of minutes for the breathalyser machine to provide a reading, so I will not be able to give you your blood alcohol readings until the end of the experiment.

Timing is very important in this experiment. You will be asked to perform each of the tasks at specified times, and during the drinking session you will be asked to drink each of the drinks within a certain time period. Thanks for co-operating with this time schedule.

Move to computer room:

Let me explain to you what will happen in this session. Before you drink, you will complete one trial on each of the two computer tasks that you practiced last time. You will do the task with the numbers first. Remember that you press the #1 key when you see 3 even digits in a row or 3 odd digits in a row. It is important that you respond as quickly and accurately as possible and that you attempt to achieve the highest digit presentation rate possible. As soon as I close the door, press the space bar to begin the first trial. I will see you immediately after this task is finished.

When test is completed:

I have this questionnaire that asks you to rate how much of an impairing effect that you expect 2 beer drank in an hour will have on your performance on this task. Could you fill this out for me now?

Now I will set you up on the other task. Remember that the other task involves tracking the moving target with the sight, using the mouse. You will also do three short trials on this task, with breaks in between. As soon as I close the door, click CONTINUE to begin and I will see you immediately after you are done on this task

When test is completed:

Could you also rate how much of an impairing effect that you expect 2 beer drank in an hour will have on your performance on this task?

OR

APPENDIX H (Cont'd)

Let me explain to you what will happen in this session. Before you drink, you will complete one trial on each of the computer tasks that you practiced last time. You will do the task with moving target first. Remember that you track the moving target with the sight, using the mouse. As soon as I close the door, click CONTINUE to begin and I will see you immediately after you are done on this task.

When test is completed:

I have this questionnaire that asks you to rate how much of an impairing effect that you expect 2 beer drank in an hour will have on your performance on this task. Could you fill this out for me now?

Now I will set you up on the other task with the numbers. Remember that you press the #1 key when you see 3 even digits in a row or 3 odd digits in a row. It is important that you respond as quickly and accurately as possible and that you attempt to achieve the highest digit presentation rate possible. As soon as I close the door, press the space bar to begin the first trial. I will see you immediately after this task is finished.

When test is completed:

Could you also rate how much of an impairing effect that you expect 2 beer drank in an hour will have on your performance on this task?

Now come back to the other room. You will drink each of your three drinks in here, one at a time. Here is your first drink. You have 1 minute in which to drink it. I'll tell you when your time is up. You can start drinking now.

AFTER SUBJECT HAS FINISHED FIRST DRINK:

To get accurate readings from the breathalyser, its important that you rinse the alcohol residue from your mouth. Sip some water from this container, swish it around in your mouth, and then spit it out in this container. Do this a couple of times, but please do not drink any water. I will ask you to rinse again after your next drink, but first you will rest for a few minutes while I go and get your second drink.

AFTER REST:

Here is your second drink. You have 1 minute in which to drink it. I'll tell you when your time is up. You can start drinking now and rinse again when you are done.

Move back to computer room:

As you did a few minutes ago, you will perform this computer task and then the other computer task. I will come into the room after you finish on this one and set you up on the other task. Begin the task when I close the door.

APPENDIX H (Cont'd)

Bring subject back to breathalyser room after trial is completed and take his breath sample at minute 19.

You will now continue alternating between performing the two computer tasks and providing a breath sample. There will also be some short rest breaks. I will always be there to tell you what to do if this sounds confusing! At the end, I can tell you a little more about the experiment and give you your payment. **Any Questions??**

At minute 35, 70 and 130:

Now I would like you to rate how you feel at this time using this scale. Note that there are 12 sensations for you to rate. For each of these, you would mark 0 if you feel like you did before had any alcohol today and you should mark higher ratings as you experience a greater change from your pre-alcohol state.

APPENDIX H (Cont'd)

Debriefing

Here is the receipt form for your participation fee of $20. Please sign here (indicate).

Thank you for participating in our study. We are interested in how university students respond to information that is presented visually by computers. We are looking at the accuracy of responses and speed with which people react to the information. Drugs like alcohol, may affect responses to information in different ways. Alcohol is a depressant drug and may impair the ability to respond accurately and quickly. To examine its effects, we administered a mild amount of alcohol to test your performance. To understand how alcohol affects performance, we compare your performance under alcohol to your performance drug-free. Any differences between these conditions will help us understand how alcohol affects information processing and motor skills.

For participants who received alcohol: As mentioned before, we require that you remain in the lab area until your blood alcohol level falls to a safe level. Your blood alcohol concentration at this time is ____%. We remind you not to operate an machinery for the next two hours. Also, you must not drive home (this includes riding a bike). Are you planning on remaining on campus? (If not). How are you planning to return home?

For participants who received the non-alcoholic beverage:

IF SUBJECT INDICATED ON PLACEBO CREDIBILITY QUESTIONNAIRE THAT HE THOUGHT THE DRINKS DID NOT CONTAIN ANY ALCOHOL, ASK:

I see on your questionnaire that you thought that your drinks did not contain any alcohol. At what point in the experiment did you think this? Why? Do you have any suggestions for us so that we might make the drink more believable?

Do you have any questions? Thank you for your co-operation.

We ask that you do not discuss the details of this experiment with anyone at any time. This is extremely important in this study because potential participants who know about our questions must not be included as their data would contaminate the results and ruin the entire project. Therefore we must trust that you do not talk to anyone at anytime about any detail of this experiment. This is very important. Thank you for your co-operation.

We have prepared an information sheet on alcohol that may be of interest to you. It gives some factual information on alcohol and also lists the typical effects alcohol has upon people at different Blood Alcohol Concentrations (BACs). You can take a copy home if you'd like.

APPENDIX H (Cont'd)

Information for participants

This handout, which you may keep, contains useful information about the effects of alcohol on the human body and behaviour that may be of interest to you. Despite the wide variety of alcohol beverages, all are composed of ethyl alcohol and water. Because alcohol is already liquid, it does not have to dissolve in the stomach as does a drug in a tablet form. Thus it is rapidly and completely absorbed by simple diffusion across membranes. The rate of absorption is both determined by the amount of food in the gastro-intestinal tract and the nature of the beverage consumed. In general, the more concentrated the alcohol is the more rapid its absorption, i.e., diluted alcoholic beverages (such as beer) are absorbed more slowly than are concentrated drinks (such as cocktails). Food in the stomach retards the absorption, firstly because it will dilute the concentration of the alcohol and secondly it covers some of the stomach membranes through which alcohol is absorbed. Also, a full stomach will prolong emptying time. Thus blood alcohol levels will rise faster for an individual who has fasted than for a person who has just eaten a large meal. However, the alcohol will still be completely absorbed except that for the person who has eaten, it will be somewhat delayed. Elimination of alcohol (e.g. via lungs, liver, and kidneys) is a gradual process. In humans, elimination proceeds in a linear fashion at the rate of approximately 15 ml. of absolute alcohol per hour (about 1.5 ounces of liquor). Thus the slope of the blood alcohol curve during the absorption phase, commonly referred to as the ascending limb, is steeper than the slope of the elimination phase (descending limb). Considerable evidence is available which suggests that the effects of alcohol are quite different under ascending as opposed to descending BACs. The consumption of caffeine (e.g. in coffee or tea) typically makes people feel more sober but their blood alcohol level will not be affected.

BLOOD ALCOHOL CONCENTRATION (BAC)

The following effects of alcohol occur because of its action upon the brain. Alcohol's effects are fairly predictable from the amount in the bloodstream. Therefore, if you know a person's BAC you can roughly predict what effects alcohol will be having upon him or her. Here are some examples:

At 20 mg% (.02 BAC) light and moderate drinkers begin to feel some effects. This is the approximate BAC reached after one drink.

At 40 mg% (.04 BAC) most people begin to feel relaxed.

At 60 mg% (.06 BAC) judgement is somewhat impaired; people are less able to make rational decisions about their capabilities (e.g., to drive).

At 80 mg% (.08 BAC) there is a definite impairment of muscle coordination and driving skills; legally impaired in Ontario.

At 100 mg% (.10 BAC) there is clear deterioration of reaction time and control; legally impaired in most of the United States.

At 120 mg% (.12 BAC) vomiting occurs unless this level is reached slowly.

At 150 mg% (.15 BAC) balance and movement are impaired. This BAC level means that the equivalent of one-half pint of whisky is circulating in the bloodstream.

At 300 mg% (.30 BAC) many people lose consciousness. At 400 mg% (.40 BAC) most people lose consciousness, some die.

At 450 mg% (.45 BAC) breathing stops, death occurs.

From: Miller, W.R. & Munoz, R.F. (1976) *How to control your drinking*, Prentice-Hall

APPENDIX I

Study One Data on All Subjects: N = 20

In Both A and P groups, subjects 1-5 were in experiment 1 and subjects 6-10 were in experiment 2.

Table 1. Pursuit Rotor (Percentage of Time on Target)

		Tests after Alcohol					
	Baseline	1	2	3	4	5	6
Group A							
1	40	43	37.33	35.33	29.33	25.33	33
2	39.33	46.33	40.67	32.67	30	37.67	34.33
3	66	65	69	57.67	50.67	53.67	62.33
4	54	57.67	57.33	55.67	53.33	54.33	44.67
5	43	44.67	45	39	32.33	32.33	34.67
6	41.67	52.33	43	37.67	36.33	44.67	41
7	31.67	41.67	41.33	35	34.33	37.67	41
8	59.33	59.33	62.33	56.33	56	54.33	55.33
9	64	63.33	66	59.33	59	56.33	57
10	33.67	42	38	33.67	32.33	38.67	38
Group P							
1	34.33	33.67	44.67	40	47.67	45.33	43.33
2	43.67	48.33	45.67	38.67	44.33	44	46.33
3	34.33	35.67	34.67	35.33	41	32.33	38.67
4	55.33	62.33	61.33	65.33	64	61.67	63.67
5	75	76.67	79.67	77	77	75	78.33
6	43.33	49	49	61.33	59.67	58.67	59
7	52	61.33	61.33	56.33	57.67	60.67	65
8	51	56	55	55.33	58	56.33	52.33
9	54.33	61	50	50.33	53.67	51	42.67
10	47	51	60.67	58.33	58.33	60.67	62.33

APPENDIX I (Cont'd)

Table 2. RIP Task (Number of Digits Processed Per Minute)

		Tests after Placebo					
	Baseline	1	2	3	4	5	6
Group A							
1	105.31	91.88	113	106.51	95.6	100.25	91.43
2	110.05	98.7	104.42	111.05	94.16	104.61	104.8
3	103.47	109.86	102.7	92.67	94.74	108.42	105.96
4	129.47	123.81	107.72	114.54	116.29	115.18	113.21
5	115.36	100.84	99.18	103.52	79.74	113.23	101.64
6	127.18	118.75	109.91	105.1	111.31	97.66	92.05
7	120.3	113.64	116.34	111.42	99.14	105.94	106.22
8	98.32	94.72	109.51	106.12	90.28	103.31	94.55
9	129.14	114.45	120.17	118.21	123.34	127.03	95.7
10	93.48	95.57	80.84	81.98	78.55	74.49	82.78
Group P							
1	85.85	78.83	85.84	73.53	76.65	91.58	95.87
2	98.12	91.04	86.33	103.48	71.46	102.35	81.84
3	101.32	114.38	118.29	98.44	97.69	96.28	83.87
4	89.82	96.59	93.76	89.22	98.7	82.29	90.04
5	133.1	133.85	133.83	158.88	131.81	136.32	128.79
6	118.02	126.8	127.12	123.16	116.37	113.96	113.09
7	117.16	131.69	125.92	119.17	128.57	129.34	109
8	130.1	135.03	121.79	132.65	109.71	120.24	125.86
9	133.61	146.22	143.14	143.23	145.27	139.98	136.94
10	87.86	116.35	115.27	108.43	96.38	93.66	107.41

APPENDIX I (Cont'd)

Table 3. Subject Drinking Characteristics:

	Months of Regular Drinking	Weekly Drinking Frequency	Dose	Duration (Hours)	Age
Group A					
1	45	1	1.43	6	19
2	50	2.5	1.48	5	20
3	16	0.25	0.67	5	20
4	38	1.5	1.28	5	19
5	66	2	1.73	6	19
6	32	1	0.39	1.5	21
7	24	0.05	0.25	0.5	20
8	33	2.5	0.37	2.5	21
9	44	2	0.82	2	20
10	162	0.25	1.77	11	21
Group P					
1	21	0.19	1.41	3	19
2	29	0.58	1.26	3.5	20
3	8	2	1.33	2.5	19
4	44	0.81	1.64	4	20
5	30	0.5	1.12	2	21
6	36	0.69	1.27	5	20
7	72	3	1.3	4	21
8	45	3	0.24	2	22
9	12	0.5	1.29	4	19
10	54	2	1.52	5	20

APPENDIX I (Cont'd)

Table 4. SHAS Intoxication Ratings for Subjects in Alcohol and Placebo Groups at Three Time Intervals, Rising (R), Peak (P), and Falling (F) BAC) on Twelve Items

Group	Intoxication Rating - Uncomfortable		
Alcohol	R	P	F
1	8	2	1
2	0	2	1
3	0	7	7
4	0	0	0
5	7	6	0
6	3	10	7
7	18	26	15
8	10	5	5
9	14	11	5
10	20	17	1
Placebo			
1	0	0	0
2	3	0	0
3	0	0	0
4	7	1	1
5	0	0	0
6	0	0	0
7	5	4	1
8	15	16	0
9	0	1	0
10	3	2	1

APPENDIX I (Cont'd)

Table 4 (Cont'd)

Group	Intoxication Rating – High		
Alcohol	R	P	F
1	1	4	1
2	2	2	2
3	15	17	7
4	5	13	5
5	2	0	1
6	17	21	11
7	29	27	18
8	7	9	9
9	17	19	2
10	11	9	0
Placebo			
1	0	0	0
2	1	1	0
3	6	0	0
4	6	1	1
5	0	0	0
6	0	0	0
7	4	3	1
8	7	5	0
9	3	0	0
10	3	2	2

APPENDIX I (Cont'd)

Table 4.(Cont'd)

Group	Intoxication Rating – Clumsy		
Alcohol	R	P	F
1	11	5	1
2	3	2	3
3	7	17	5
4	2	2	0
5	2	6	1
6	23	15	10
7	10	23	11
8	7	9	9
9	9	8	5
10	7	15	1
Placebo			
1	1	2	1
2	0	2	0
3	9	5	0
4	9	2	1
5	0	0	0
6	0	0	0
7	3	3	1
8	15	13	2
9	1	1	0
10	4	2	1

APPENDIX I (Cont'd)

Table 4 (Cont'd)

Group	Intoxication Rating – Confused		
Alcohol	R	P	F
1	0	1	0
2	0	2	3
3	4	9	11
4	0	1	1
5	0	6	1
6	1	5	2
7	5	18	4
8	5	5	6
9	10	8	3
10	7	8	0
Placebo			
1	0	1	0
2	1	3	1
3	5	0	0
4	5	0	0
5	0	0	0
6	0	0	0
7	2	4	1
8	14	19	7
9	1	0	0
10	3	2	1

APPENDIX I (Cont'd)

Table 4.(Cont'd)

Group	Intoxication Rating – Slurred Speech		
Alcohol	R	P	F
1	1	4	0
2	0	1	2
3	4	5	4
4	0	0	0
5	0	3	0
6	5	9	2
7	0	10	2
8	2	2	4
9	20	13	4
10	2	2	0
Placebo			
1	0	0	0
2	1	1	0
3	7	0	0
4	1	0	0
5	0	0	0
6	0	0	0
7	1	2	0
8	2	1	0
9	0	0	0
10	1	0	0

APPENDIX I (Cont'd)

Table 4.(Cont'd)

Group	Intoxication Rating – Effects of Alcohol		
Alcohol	R	P	F
1	2	3	1
2	2	3	6
3	7	15	7
4	7	9	4
5	9	3	1
6	15	24	13
7	27	25	13
8	9	9	8
9	17	17	4
10	19	17	2
Placebo			
1	0	2	1
2	1	6	2
3	4	0	0
4	5	1	2
5	0	0	0
6	0	0	0
7	7	4	2
8	9	4	0
9	1	1	0
10	2	1	0

APPENDIX I (Cont'd)

Table 4.(Cont'd)

Group	Intoxication Rating – Feelings of Floating		
Alcohol	R	P	F
1	0	3	1
2	3	3	7
3	11	28	2
4	9	11	6
5	3	2	0
6	13	28	7
7	19	25	18
8	9	12	10
9	5	17	1
10	2	2	1
Placebo			
1	2	1	0
2	0	5	1
3	6	6	0
4	8	1	2
5	0	0	0
6	0	0	0
7	7	5	1
8	18	7	6
9	0	0	0
10	2	2	2

APPENDIX I (Cont'd)

Table 4.(Cont'd)

Group	Intoxication Rating - Dizzy		
Alcohol	R	P	F
1	4	3	1
2	6	4	6
3	2	10	2
4	8	2	1
5	2	2	1
6	17	22	8
7	12	22	16
8	6	7	4
9	17	15	3
10	2	2	0
Placebo			
1	0	0	0
2	1	1	0
3	1	2	2
4	8	2	1
5	0	0	0
6	0	0	0
7	7	4	1
8	2	7	3
9	3	2	1
10	5	4	2

APPENDIX I (Cont'd)

Table 4 (Cont'd)

Group	Intoxication Rating – Nauseated		
Alcohol	R	P	F
1	2	1	0
2	1	1	2
3	0	0	3
4	0	0	0
5	0	0	0
6	1	5	1
7	6	0	0
8	12	2	1
9	5	4	2
10	0	0	0
Placebo			
1	0	0	0
2	2	0	0
3	1	4	2
4	1	0	0
5	0	0	0
6	0	0	0
7	0	1	0
8	0	3	0
9	0	0	0
10	4	2	2

APPENDIX I (Cont'd)

Table 4.(Cont'd)

Group	Intoxication Rating – Drunk		
Alcohol	R	P	F
1	2	2	1
2	1	3	4
3	11	21	5
4	8	13	4
5	2	4	2
6	14	19	13
7	22	29	12
8	10	10	8
9	17	19	4
10	11	10	1
Placebo			
1	0	0	0
2	1	8	2
3	5	1	0
4	6	1	1
5	0	0	0
6	0	0	0
7	7	4	2
8	10	2	2
9	1	0	0
10	3	1	0

APPENDIX I (Cont'd)

Table 4 (Cont'd)

Group	Intoxication Rating – Terrible		
Alcohol	R	P	F
1	4	3	1
2	0	0	1
3	0	4	3
4	0	0	0
5	2	2	2
6	1	3	0
7	24	25	10
8	14	4	0
9	3	9	4
10	0	0	0
Placebo			
1	0	1	0
2	4	1	0
3	0	0	0
4	3	0	0
5	0	0	0
6	0	0	0
7	7	2	1
8	0	8	0
9	0	0	0
10	5	6	4

APPENDIX I (Cont'd)

Table 4.(Cont'd)

Group	Intoxication Rating – Great		
Alcohol	R	P	F
1	19	18	26
2	2	4	4
3	6	16	1
4	9	15	5
5	7	2	3
6	30	28	30
7	6	0	0
8	0	2	2
9	12	10	4
10	0	0	0
Placebo			
1	0	1	0
2	31	6	32
3	20	16	0
4	5	1	1
5	0	0	0
6	0	0	0
7	7	3	2
8	2	0	0
9	2	0	0
10	0	0	0

APPENDIX I (Cont'd)

Table 5. Expectancy Ratings

Pursuit Rotor Task	
Group	
Alcohol (n = 10)	**Placebo (n = 10)**
0	0
-5	-10
-15	-10
-5	-10
0	-5
-20	-15
-20	-10
-10	-20
-20	-10
-5	-15
RIP Task	
Group	
Alcohol (n = 10)	**Placebo (n = 10)**
15	-5
-10	-5
-25	0
-5	-5
-5	-10
-30	-10
-20	-10
-15	-20
-10	-15
-10	-5

Table 6. Drink Strength Questionnaire Ratings

Group	
Alcohol (n = 10)	**Placebo (n = 10)**
3	2.5
5	3
2.5	3
6	3.5
3.5	0.5
8	1
4	3
3.5	1.5
7	1
9	2

APPENDIX I (Cont'd)

Table 7. BAC Measures at Seven Time Intervals in Group A

	BAC						
Subject	1	2	3	4	5	6	7
1	-	-	-	-	-	-	-
2	55	65	70	65	60	55	50
3	30	55	80	80	80	70	60
4	30	35	60	65	75	75	75
5	35	45	60	60	55	55	50
6	40	50	60	75	70	70	70
7	50	50	65	65	70	60	55
8	25	40	60	70	80	70	70
9	70	75	75	70	60	60	55
10	70	85	85	70	60	50	40

*Measures from subject number one were lost due to equipment failure

APPENDIX J

Study 1 Analyses of Variance of Drinking Habit Measures in Two Groups (n = 10 for each group)

Table 1: Dose:

Source	df	Mean Square	F	p
Between Subjects				
Group	1	0.24	0.98	.33
Residual	18	0.24		

Table 2: Duration of Typical Drinking Occasion (In Hours)

Source	df	Mean Square	F	p
Between Subjects				
Group	1	4.51	0.87	.36
Residual	18	5.21		

Table 3: Number of Months of Regular Drinking

Source	df	Mean Square	F	p
Between Subjects				
Group	1	1264.05	1.21	.29
Residual	18	1048.16		

Table 4: Frequency of Drinking Per Week

Source	df	Mean Square	F	p
Between Subjects				
Group	1	<0.01	<0.01	.96
Residual	18	1.01		

APPENDIX K

One-Way ANOVA on Drug-Free Baseline Scores

Pursuit Rotor

Source	df	Mean Square	F	p
Between Subjects				
Group	1	15.02	0.10	.75
Residual	18	148.06		

RIP Task

Source	df	Mean Square	F	p
Between Subjects				
Group	1	68.90	0.26	.62
Residual	18	269.54		

APPENDIX L

One-Way Analysis of Variance of Seven BAC Measurements

Source	df	Mean Square	F	p
Between Subjects				
Time Interval	6	686.77	4.89	<.01
Residual	48	140.20		

APPENDIX M

Table 1: Covariance Analysis of the Percentage of Time on Target Scores on the Pursuit Rotor Task

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	1	1581.59	15.53	<.01
Experiment (E)	1	429.11	4.21	.06
G x E	1	27.67	0.27	.61
Baseline	1	11662.99	114.5	<.01
Residual	15	101.86		
Within Subjects				
Tests (T)	5	56.56	4.29	<.01
T x G	5	114.16	8.66	<.01
T x E	5	11.81	0.90	.49
T x G x E	5	10.92	0.83	.53
Residual	80	13.18		

Table 2. Adjusted Group Means - Pursuit Rotor Task

Group	Alcohol Trial Adjusted Means for Percentage of Time on Target					
	1	2	3	4	5	6
Alcohol	52.29	50.83	45.01	42.07	44.16	44.81
Placebo	52.74	53.37	53.02	55.43	53.90	54.49

APPENDIX M (Cont'd)

Table 3: Covariance Analysis of the Number of Digits Processed Per Minute on the RIP Task

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	1	4057.84	15.59	<.01
Experiment (E)	1	447.25	1.72	.21
G x E	1	1057.09	4.06	.06
Baseline	1	15971.67	61.37	<.01
Residual	15	260.24		
Within Subjects				
Tests (T)	5	306.99	4.56	<.01
T x G	5	16.41	0.24	.94
T x E	5	81.97	1.22	.31
T x G x E	5	23.87	0.35	.88
Residual	80	63.38		

Table 4. Adjusted Group Means - RIP Task

Group	Alcohol Trial Adjusted Means for Number of Digits Processed Per Minute					
	1	2	3	4	5	6
Alcohol	104.53	104.99	103.22	96.47	103.35	97.59
Placebo	118.77	116.52	117.12	109.10	112.26	108.52

APPENDIX N

Table 19: 2 (Group) by 3 (Time Point) Variance Analyses of Each Adjective in SHAS Intoxication Ratings

Table 1: Uncomfortable

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	1	360.15	5.32	.03
Residual	18	67.74		
Within Subjects				
Time (T)	2	72.80	5.33	<.01
T x G	2	6.20	0.45	.64
Residual	36	13.65		

Table 2: High

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	1	936.15	10.93	<.01
Residual	18	85.68		
Within Subjects				
Time (T)	2	92.62	11.84	<.01
T x G	2	40.95	5.24	.01
Residual	36	7.82		

APPENDIX N (Cont'd)

Table 3: Clumsy

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	1	380.02	7.66	.01
Residual	18	49.60		
Within Subjects				
Time (T)	2	96.02	8.39	<.01
T x G	2	17.62	1.54	.23
Residual	36	11.45		

Table 4: Confused

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	1	52.27	1.37	.26
Residual	18	38.04		
Within Subjects				
Time (T)	2	32.72	4.34	.02
T x G	2	13.82	1.83	.18
Residual	36	7.54		

APPENDIX N (Cont'd)

Table 5: Slurred Speech

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	1	117.60	5.85	.03
Residual	18	20.09		
Within Subjects				
Time (T)	2	17.52	2.95	.07
T x G	2	10.95	1.84	.17
Residual	36	5.94		

Table 6: Effects of Alcohol

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	1	984.15	15.64	<.01
Residual	18	62.93		
Within Subjects				
Time (T)	2	100.12	9.31	<.01
T x G	2	37.05	3.45	.04
Residual	36	10.75		

APPENDIX N (Cont'd)

Table 7: Feelings of Floating

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	1	516.27	6.37	.02
Residual	18	81.06		
Within Subjects				
Time (T)	2	108.62	6.63	<.01
T x G	2	78.32	4.78	.01
Residual	36	16.39		

Table 8: Dizzy

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	1	365.07	6.89	.02
Residual	18	53.02		
Within Subjects				
Time (T)	2	51.22	6.40	<.01
T x G	2	15.32	1.91	.16
Residual	36	8.01		

APPENDIX N (Cont'd)

Table 9: Nauseated

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	1	12.15	2.16	.16
Residual	18	5.64		
Within Subjects				
Time (T)	2	6.07	1.83	.18
T x G	2	3.80	1.14	.33
Residual	36	3.32		

Table 10: Drunk

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	1	843.75	13.30	<.01
Residual	18	64.44		
Within Subjects				
Time (T)	2	104.60	6.40	<.01
T x G	2	58.20	1.91	<.01
Residual	36	9.34		

APPENDIX N (Cont'd)

Table 11: Terrible

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	1	98.82	1.75	.20
Residual	18	56.64		
Within Subjects				
Time (T)	2	28.72	3.45	.04
T x G	2	3.62	0.43	.65
Residual	36	8.33		

Table 12: Great

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	1	244.02	0.91	.35
Residual	18	266.94		
Within Subjects				
Time (T)	2	28.82	2.28	.12
T x G	2	13.62	1.08	.35
Residual	36	12.62		

APPENDIX N (Cont'd)

Table 13. Mean (SD) Ratings on the SHAS

A. Ratings That Showed a Main Effect of Group

	Adjectives							
	Uncom-fortable	High	Slurred Speech	Effects of Alcohol	Clumsy	Drunk	Floating	Dizzy
Group								
A	6.90 (5.91)	9.43 (7.43)	3.37 (3.59)	9.93 (6.27)	7.63 (4.88)	9.40 (6.23)	8.60 (6.64)	6.90 (5.68)
P	2.00 (3.20)	1.53 (1.40)	0.57 (0.74)	1.83 (1.64)	2.60 (3.05)	1.90 (1.85)	2.73 (3.15)	1.97 (1.75)

B. Ratings That Showed a Group by Time Interaction

	Adjectives											
	High			Effects of Alcohol			Drunk			Feelings of Floating		
	Time											
Group	1	2	3	1	2	3	1	2	3	1	2	3
A	10.60 (8.97)	12.10 (8.86)	5.60 (5.74)	11.40 (7.98)	12.50 (8.37)	5.90 (4.43)	9.80 (6.86)	13.00 (8.89)	5.40 (4.27)	7.40 (5.89)	13.10 (10.84)	5.30 (5.62)
P	3.00 (2.71)	1.20 (1.69)	0.40 (0.70)	2.90 (3.21)	1.90 (2.08)	0.70 (0.95)	3.30 (3.53)	1.70 (2.54)	0.70 (0.95)	4.30 (5.74)	2.70 (2.75)	1.20 (1.87)

APPENDIX O

Table 1. Regression of Total Average Change in Number of Digits Processed Per Minute on RIP Task on Expectancy Ratings of A & P Groups

Analysis of Variance				
Source	df	Mean Square	F	p
Regression	2	393.25	6.98	.01
Residual	17	56.33		

N=20 Multiple R: 0.67 Squared Multiple R: 0.45

Adjusted Squared Multiple R: 0.39 Standard Error of Estimate: 7.51

Variable	Coefficient	STD Error	STD Coef	Tolerance	T	P (2 tail)
Constant	-21.52	5.93	0.00	.	-3.63	<.01
Group	12.31	3.40	0.66	0.97	3.62	<.01
RIP Exp	0.06	0.18	0.06	0.97	0.33	.75

Table 2. Regression of Average Change on Trials 3 and 4 in Number of Digits Processed Per Minute on RIP Task on Expectancy Ratings of A & P Groups

Analysis of Variance				
Source	df	Mean Square	F	p
Regression	2	440.96	6.04	.01
Residual	17	73.02		

N=20 Multiple R: 0.64 Squared Multiple R: 0.42

Adjusted Squared Multiple R: 0.35 Standard Error of Estimate: 8.55

Variable	Coefficient	STD Error	STD Coef	Tolerance	T	P (2 tail)
Constant	-23.90	6.75	0.00	.	-3.54	<.01
Group	13.07	3.87	0.63	0.97	3.38	<.01
RIP Exp	0.06	0.21	0.05	0.97	0.28	.79

APPENDIX O (Cont'd)

Table 3. Regression of Total Average Change in Percentage of Time on Target on PR Task on Expectancy Ratings of A & P Groups

Analysis of Variance				
Source	df	Mean Square	F	p
Regression	2	135.70	6.27	.01
Residual	17	21.63		

N=20 Multiple R: 0.65 Squared Multiple R: 0.43

Adjusted Squared Multiple R: 0.36 Standard Error of Estimate: 4.65

Variable	Coefficient	STD Error	STD Coef	Tolerance	T	P (2 tail)
Constant	-10.12	3.61	0.00	.	-2.80	.01
Group	6.95	2.08	0.62	1.00	3.34	<.01
PR Exp	-0.17	0.16	-0.19	1.00	-1.05	.31

Table 4. Regression of Average Change on Trials 3 and 4 in % of Time on Target on PR Task on Expectancy Ratings of A & P Groups

Analysis of Variance				
Source	df	Mean Square	F	p
Regression	2	282.76	9.67	<.01
Residual	17	29.24		

N=20 Multiple R: 0.73 Squared Multiple R: 0.53

Adjusted Squared Multiple R: 0.48 Standard Error of Estimate: 5.41

Variable	Coefficient	STD Error	STD Coef	Tolerance	T	P (2 tail)
Constant	-16.42	4.20	0.00	.	-3.91	<.01
Group	10.36	2.42	0.71	1.00	4.28	<.01
PR Exp	-0.16	0.18	-0.14	1.00	-0.85	.41

APPENDIX P

Session 2 Instructions

Before we begin, I need to ask you some questions. When did you last eat? What did you eat? (BETWEEN 3 AND FOUR HOUR FAST IS OK - FOODS EATEN ARE MORE IMPORTANT)

Now I would like you to practice giving a breath sample to the breathalyser so that you can become familiar with the procedure and to get an idea of how hard you have to blow into the machine. Try to blow a steady stream of air that you can maintain for at least 10 seconds. (TAKE INITIAL BAC.)

After you drink, I will be asking you to provide some more breath samples. However, I will not tell you what your blood alcohol readings were until the end of the experiment.

Timing is very important in this experiment. You will be asked to perform each of the tasks at specified times, drink your drinks within a certain time period and give breath samples at certain time periods. Thanks for co-operating with this time schedule.

Now I would like you to rate how you feel at this time using this scale. Note that there are 12 sensations for you to rate. If you do not feel like the adjective applies to how you feel right now, circle "Normal". If you do feel like the adjective applies to how you feel right now, circle the rating that you feel best suits this feeling.

CHECK BAC READING TO MAKE SURE IT IS ZERO. SET SUBJECT UP IN FRONT OF COMPUTER.

GROUP#1 - BOTH RIP AND PR REINFORCED

Let me explain to you what will happen in this session. Today you will have an opportunity to earn bonus money on each task. You will do the task with the numbers first. I have taken your scores from the practice session on this task and averaged them. This line here [POINT TO LINE ON GRAPH] corresponds to that average on this task. I have also done this with the other task and this sheet applies to that task [POINT]. For each test on both tasks, you will earn 25 cents if your score is better than or equal to your practice score. I will say good whenever you have earned the extra money on each test, and you can put a check mark above the line for each test that you earn the extra money. That is all I can say about your performance until the end of the session. Timing during the task is very important so please put the check on the sheet right away and then you will move to the next task.

At the end of the experiment, we can add up all the check marks and pay you all the extra money you have earned. You cannot lose any of your $20 for participating in the experiment, but you have a chance to make more money.

Do you have any questions? Today we are going to do one test on each of the tasks before you receive your drinks. We will start off on this task. We will perform one drug-free test and then some tests after your drinks. The chance to earn bonus money applies to all tests you will do today. Remember that you press the #1 key when you see 3 even digits in a row or 3 odd digits in a row. It

is important that you respond as quickly and accurately as possible and that you attempt to achieve the highest digit presentation rate possible. As soon as I close the door, press the space bar to begin the first test. I will see you immediately after this task is finished.

COME BACK INTO ROOM.

CHECK SCORE, TELL SUBJECT TO PUT A CHECK MARK ON SHEET RIGHT AWAY IF EQUAL OR BETTER

IF SUBJECT DOES NOT DO EQUAL OR BETTER, STAY SILENT.

Now I will set you up on the other task. This line represents your average on the three trials that make up the tests in the practice session. [POINT] Each test consists of 3 trials. If you equal or better your practice score on the average of the 3 trials, you will earn 25 cents. Do you have any questions?

Remember that this involves tracking the moving target with the sight, using the mouse. As before, you will do three short tests on this task, with breaks in between. Its important that you try to keep the sight on top of the target as much as you possibly can. As soon as I close the door, click done to begin and I will see you immediately after you are done on this task

COME BACK INTO ROOM.

CHECK SCORE, GET SUBJECT TO PUT A CHECK MARK ON SHEET IF EQUAL OR BETTER

Group #2 - RIP REINFORCED

Let me explain to you what will happen in this session. Today you will have an opportunity to earn bonus money on one of the tasks. This task is determined randomly for every subject and yours is the task with the numbers. For this task, I have taken the scores from the practice session and averaged them. On this sheet, this line [POINT TO LINE ON GRAPH] corresponds to that average on the task. For each test on the task, you will earn 25 cents if your score is better than or equal to your practice score. Your chance to earn the bonus money applies to all the tests that you perform on the task with the numbers today. I will say good whenever you have earned the extra money on each test, and you can put a check mark above the line for each test that you earn the extra money. That is all I can say about your performance until the end of the session. Timing during the task is very important so please put the check on the sheet right away.

At the end of the experiment, we can add up all the check marks and pay you all the extra money you have earned. You cannot lose any of your $20 for participating in the experiment, but you have a chance to make more money.

Do you have any questions? As I mentioned, today you will only have a chance to receive bonus money for the task with the numbers, but you will perform both. It is important that you try to

perform as well as you can on both tasks. You will do one test on each task before receiving your drinks and then several more tests on both tasks, after you receive your alcohol.

We will start off on the task you have an opportunity to earn bonus money. This will be the task with the numbers. Remember that you press the #1 key when you see 3 even digits in a row or 3 odd digits in a row. It is important that you respond as quickly and accurately as possible and that you attempt to achieve the highest digit presentation rate possible. As soon as I close the door, press the space bar to begin the first test. I will see you immediately after this task is finished.

COME BACK INTO ROOM.

CHECK SCORE, TELL SUBJECT TO PUT A CHECK MARK ON SHEET IF EQUAL OR BETTER

Now we will do the tracking task. Remember that this task involves tracking the moving target with the sight, using the mouse. As before, you will do three short tests on this task, with breaks in between. Its important that you try to keep the sight on top of the target as much as you possibly can. Do you have any questions? As soon as I close the door, click done to begin the first test. I will see you immediately after this task is finished.

OR

Let me explain to you what will happen in this session. Today you will have an opportunity to earn bonus money on one of the tasks. This task is determined randomly for every subject and yours is the task with the numbers. For this task, I have taken the scores from the practice session and averaged them. On this sheet, this line [POINT TO LINE ON GRAPH] corresponds to that average on the task. For each test on the task, you will earn 25 cents if your score is better than or equal to your practice score. Your chance to earn the bonus money applies to all the tests that you perform on the task with the numbers today. I will say good whenever you have earned the extra money on each test, and you can put a check mark above the line for each test that you earn the extra money. That is all I can say about your performance until the end of the session. Timing during the task is very important so please put the check on the sheet right away.

At the end of the experiment, we can add up all the check marks and pay you all the extra money you have earned. You cannot lose any of your $20 for participating in the experiment, but you have a chance to make more money. Do you have any questions? As I mentioned, today you will only have a chance to receive bonus money for the task with the numbers, but you will perform both tasks. Its important that you try to perform as well as you can on both tasks. You will do one test on each task before receiving your drinks and then several more tests on both tasks, after you receive your alcohol.

The task, which you have a chance to earn the bonus money, is the task with the numbers. But we will do the tracking task first. Remember that this task involves tracking the moving target with the sight, using the mouse. As before, you will do three short tests on this task, with breaks in between. Its important that you try to keep the sight on top of the target as much as you possibly can. Do you

have any questions? As soon as I close the door, click done to begin the first test. I will see you immediately after this task is finished.

COME BACK IN, SET SUBJECT UP IN FRONT OF RIP TASK.

Now I will set you up on the other task. This line represents your average on the three trials that make up the tests in the practice session. [POINT] Each test consists of 3 trials. If you equal or better your practice score on the average of the 3 trials, you will earn 25 cents. Do you have any questions?

Remember that you press the #1 key when you see 3 even digits in a row or 3 odd digits in a row. It is important that you respond as quickly and accurately as possible and that you attempt to achieve the highest digit presentation rate possible. As soon as I close the door, press the space bar to begin the first test. I will see you immediately after this task is finished.

COME BACK INTO ROOM.

CHECK SCORE, TELL SUBJECT TO PUT A CHECK MARK ON SHEET IF EQUAL OR BETTER

Group #3 - PR REINFORCED

Let me explain to you what will happen in this session. Today you will have an opportunity to earn bonus money on one of the tasks. This task is determined randomly for every subject and yours is the tracking task. For this task, I have taken the scores from the practice session and averaged them. On this sheet, this line [POINT TO LINE ON GRAPH] corresponds to that average on the task. For each test on the task, you will earn 25 cents if your score is better than or equal to your practice score. Your chance to earn the bonus money applies to all the tests that you perform on the tracking task today. I will say good whenever you have earned the extra money on each test, and you can put a check mark above the line for each test that you earn the extra money. That is all I can say about your performance until the end of the session. Timing during the task is very important so please put the check on the sheet right away.

At the end of the experiment, we can add up all the check marks and pay you all the extra money you have earned. You cannot lose any of your $20 for participating in the experiment, but you have a chance to make more money.

Do you have any questions? As I mentioned, today you will only have a chance to receive bonus money for the tracking task, but you will perform both. Its important that you try to perform as well as you can on both tasks. You will do one test on each task before receiving your drinks and then several more tests on both tasks, after you receive your alcohol.

We will start off on the task you have an opportunity to earn bonus money. This will be the tracking task. Remember that this task involves tracking the moving target with the sight, using the mouse. As before, you will do three short tests on this task, with breaks in between. It is important

that you try to keep the sight on top of the target as much as you possibly can. As soon as I close the door, click done to begin the first test. I will see you immediately after this task is finished.

COME BACK INTO ROOM.

CHECK SCORE, TELL SUBJECT TO PUT A CHECK MARK ON SHEET IF EQUAL OR BETTER

Now we will do the task with the numbers. Remember that you press the #1 key when you see 3 even digits in a row or 3 odd digits in a row. It is important that you respond as quickly and accurately as possible and that you attempt to achieve the highest digit presentation rate possible. As soon as I close the door, click the space bar to begin the first test. I will see you immediately after this task is finished.

OR

Let me explain to you what will happen in this session. Today you will have an opportunity to earn bonus money on one of the tasks. This task is determined randomly for every subject and yours is the tracking task. For this task, I have taken the scores from the practice session and averaged them. On this sheet, this line [POINT TO LINE ON GRAPH] corresponds to that average on the task. For each test on the task, you will earn 25 cents if your score is better than or equal to your practice score. Your chance to earn the bonus money applies to all the tests that you perform on the tracking task today. I will say good whenever you have earned the extra money on each test, and you can put a check mark above the line for each test that you earn the extra money. That is all I can say about your performance until the end of the session. Timing during the task is very important so please put the check on the sheet right away.

At the end of the experiment, we can add up all the check marks and pay you all the extra money you have earned. You cannot lose any of your $20 for participating in the experiment, but you have a chance to make more money. Do you have any questions? As I mentioned, today you will only have a chance to receive bonus money for the tracking task, but you will perform both tasks. Its important that you try to perform as well as you can on both tasks. You will do one test on each task before receiving your drinks and then several more tests on both tasks, after you receive your alcohol.

The task, which you have a chance to earn the bonus money, is the tracking task. But we will do the task with the numbers first. Remember that you press the #1 key when you see 3 even digits in a row or 3 odd digits in a row. It is important that you respond as quickly and accurately as possible and that you attempt to achieve the highest digit presentation rate possible. As soon as I close the door, press the space bar to begin the first test. I will see you immediately after this task is finished.

COME BACK IN, SET SUBJECT UP IN FRONT OF PR TASK.

Now I will set you up on the other task. This line represents your average on the three trials that make up the tests in the practice session. [POINT] Each test consists of 3 trials. If you equal or

better your practice score on the average of the 3 trials, you will earn 25 cents. Do you have any questions?

Remember that this task involves tracking the moving target with the sight, using the mouse. As before, you will do three short tests on this task, with breaks in between. Its important that you try to keep the sight on top of the target as much as you possibly can. Do you have any questions? As soon as I close the door, click continue to begin the first test. I will see you immediately after this task is finished.

COME BACK INTO ROOM.

CHECK SCORE, TELL SUBJECT TO PUT A CHECK MARK ON SHEET IF EQUAL OR BETTER

Group #4 - NEITHER TASK IS REINFORCED

Let me explain to you what will happen in this session. Before you drink, you will complete one test on each of the two computer tasks that you practiced last time. This time, I will be coming into the room at the end of each trial to set up the computer for the next trial. You will do the task with the numbers first. Remember that you press the #1 key when you see 3 even digits in a row or 3 odd digits in a row. It is important that you respond as quickly and accurately as possible and that you attempt to achieve the highest digit presentation rate possible. As soon as I close the door, press the space bar to begin the first test. I will see you immediately after this task is finished.

Now I will set you up on the other task. Remember that the other task involves tracking the moving target with the sight, using the mouse. You will also do three short tests on this task, with breaks in between. Its important that you try to keep the sight on top of the target as much as you possibly can. As soon as I close the door, click done to begin and I will see you immediately after you are done on this task

OR

Let me explain to you what will happen in this session. Before you drink, you will complete one test on each of the computer tasks that you practiced last time. This time, I will be coming into the room at the end of each trial to set up the computer for the next trial. You will do the tracking task first. Remember that you track the moving target with the sight, using the mouse. You will also do three short tests on this task, with breaks in between. Its important that you try to keep the sight on top of the target as much as you possibly can. As soon as I close the door, click CONTINUE to begin and I will see you immediately after you are done on this task.

Now I will set you up on the other task with the numbers. Remember that you press the #1 key when you see 3 even digits in a row or 3 odd digits in a row. It is important that you respond as quickly and accurately as possible and that you attempt to achieve the highest digit presentation rate possible. As soon as I close the door, press the space bar to begin the first test. I will see you immediately after this task is finished.

THEN: Come back and sit in this chair. You will drink each of your two drinks here, one at a time. Here is your first drink. You have 1 minute in which to drink it. I'll tell you when your time is up. You can start drinking now (start stopwatch and time for 1 minute).

AFTER SUBJECT HAS FINISHED DRINK:

To get accurate readings from the breathalyser, it is important that you rinse the alcohol residue from your mouth. Sip some water from this container, swish it around in your mouth, and then spit it out in this container. Do this a couple of times, but please do not drink any water. Now I will go and get the second drink.

SECOND DRINK: You also have one minute to drink this. I will tell you when your time is up. Please rinse your mouth again, but do not swallow.

SIT SUBJECT IN FRONT OF RESPECTIVE TASK: As you did a few minutes ago, you will perform this computer task and then the other computer task.

> REMEMBER YOU CAN STILL EARN MONEY ON EACH TASK. [POINT TO SHEET]. I WILL BE BACK TO SET YOU UP ON THE NEXT TASK.
>
> REMEMBER, YOU CAN STILL EARN MONEY ON THIS TASK. [POINT TO SHEET]. IT IS IMPORTANT TO TRY YOUR BEST ON BOTH TASKS. I WILL BE BACK TO SET YOU UP ON THE NEXT TASK.

I will come into the room after you finish on this one and set you up on the other task. Begin the task when I close the door.

GO IN AFTER TEST ON ONE TASK, GIVE FEEDBACK IF NECESSARY. SET SUBJECT UP ON SECOND TASK. WHEN SECOND TASK IS DONE, INSTRUCT SUBJECT TO GIVE BREATH SAMPLE.

Now you will perform another block of tests on the two tasks, exactly like before. When both tasks are complete, you will give another breath sample.

You will continue alternating between performing the two computer tasks and providing a breath sample. There will also be some short rest breaks. I will continue to tell you whenever you earn any money

> FOR THIS TASK
> OR
> FOR BOTH TASKS

I will always be there to tell you what to do if this sounds confusing! At the end, I can tell you a little more about the experiment and give you your payment. **Any Questions??**

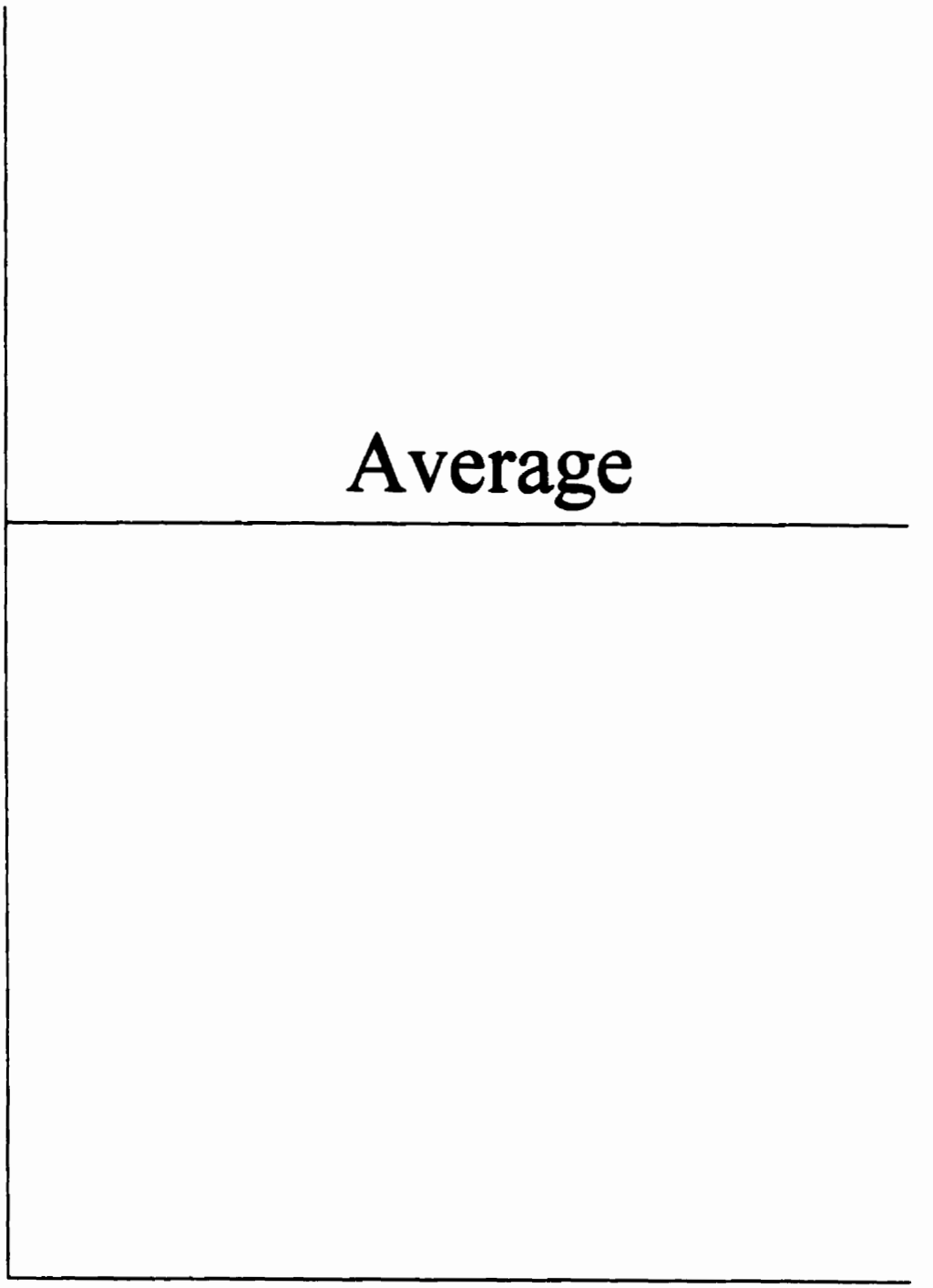
APPENDIX P (Cont'd)

Now I would like you to rate how you feel at this time using this scale. Note that there are 12 sensations for you to rate. For each of these, you would mark NORMAL if you feel like you did before you had any alcohol and you should mark a higher ratings as you experience a greater change from your pre-alcohol state.

IF SUBJECT ASKS ABOUT PERFORMANCE ON ANY GIVEN TRIAL, SAY: I CAN ONLY TELL YOU WHEN YOUR SCORE IS AS GOOD OR EQUAL ON THIS TEST

APPENDIX P (Cont'd)

Tally Sheet Used In Study Two Reinforcement Groups



APPENDIX Q

Study Two Data on All Subjects: N = 56

Table 1: Pursuit Rotor: Percentage of Time on Target

	Tests after Alcohol					
Group	Baseline	1	2	3	4	5
$P_R R_R$						
1	58.67	60.00	59.67	59.33	60.00	61.67
2	35.67	34.33	24.67	31.33	34.33	32.33
3	60.67	63.00	55.33	49.00	49.33	54.67
4	53.33	57.67	55.33	55.33	50.67	55.33
5	29.67	28.33	25.00	30.33	37.33	37.00
6	30.00	26.67	23.67	30.33	28.67	28.67
7	39.33	45.67	50.67	48.67	49.33	50.67
8	43.67	41.00	37.33	42.33	42.33	44.33
9	34.33	46.33	43.00	41.33	43.33	42.00
10	48.67	55.33	57.67	56.33	44.33	57.67
11	28.33	29.00	22.33	22.00	21.33	23.33
12	50.67	51.33	49.00	52.33	54.67	50.67
13	40.00	43.00	38.00	42.67	37.33	42.33
14	60.67	53.00	60.67	57.00	55.00	59.67
$P_N R_R$						
1	56.00	54.00	50.67	47.67	48.67	53.67
2	29.67	32.33	30.33	33.67	33.67	31.67
3	44.67	44.00	36.67	43.67	40.00	50.33
4	33.33	33.33	29.00	29.67	22.33	21.67
5	50.00	45.33	50.00	52.00	44.33	54.33
6	43.00	47.00	47.67	49.67	48.67	44.67
7	39.00	43.33	38.67	41.67	45.00	42.00
8	52.67	55.33	56.67	52.33	47.00	53.67
9	47.67	46.33	44.33	46.00	49.33	53.33
10	55.33	53.33	50.67	42.33	52.67	48.33
11	38.33	36.00	35.00	31.00	36.00	37.33
12	57.00	59.33	47.67	47.00	54.67	52.33
13	48.67	52.33	43.00	52.33	49.00	42.33
14	44.33	40.33	34.67	36.67	35.67	40.67
$P_R R_N$						
1	58.00	58.33	58.00	56.67	56.00	58.33
2	45.00	43.33	48.67	47.67	49.67	54.33
3	57.33	59.00	57.00	54.67	56.00	53.33
4	57.33	54.67	53.00	46.00	44.33	55.33
5	48.67	48.67	44.67	42.33	38.67	42.67

APPENDIX Q (Cont'd)

Table 1: Pursuit Rotor: Percentage of Time on Target (Cont'd)

6	28.33	29.00	28.00	32.33	33.00	38.33
7	45.33	46.67	42.67	40.67	42.00	42.67
8	42.33	42.00	47.00	41.00	42.33	49.00
9	48.33	51.33	58.33	56.67	64.67	62.00
10	43.33	51.00	48.00	46.67	44.67	48.33
11	36.67	34.67	40.33	46.33	42.00	49.33
12	41.67	39.67	38.00	36.67	34.33	39.33
13	42.67	40.67	42.00	44.00	43.33	58.00
14	64.00	52.67	39.33	46.33	50.33	49.67
$P_N R_N$						
1	57.33	57.33	48.00	38.67	38.00	45.33
2	60.00	55.00	50.00	44.67	46.33	55.00
3	54.00	57.67	51.00	57.00	56.33	55.33
4	34.00	25.33	22.00	24.00	19.67	31.67
5	53.00	42.33	31.33	30.67	25.00	39.00
6	57.33	49.67	43.33	50.00	51.00	49.67
7	43.00	39.33	40.67	33.33	39.33	44.67
8	69.67	71.33	63.00	55.67	46.33	51.67
9	50.33	49.33	43.67	43.67	49.67	50.67
10	46.33	46.33	40.67	30.67	26.00	24.33
11	52.00	57.33	55.00	52.33	49.33	56.00
12	53.00	55.33	54.33	49.67	49.00	48.67
13	30.67	33.67	32.67	27.33	26.00	28.67
14	52.00	52.00	51.00	47.33	54.33	53.67

APPENDIX Q (Cont'd)

Table 2. Rapid Information Processing Task: Number of Digits Processed Per Minute

	Tests after Alcohol					
Group	Baseline	1	2	3	4	5
$P_R R_R$						
1	109.00	94.55	96.84	97.64	88.08	104.12
2	111.86	100.48	96.98	102.37	100.94	86.99
3	108.21	106.27	109.63	96.34	107.12	109.05
4	116.24	98.83	109.57	115.70	123.35	105.19
5	118.91	105.34	91.52	109.27	111.78	125.17
6	114.60	78.14	92.03	97.62	93.12	91.53
7	87.17	97.77	92.24	104.08	85.43	97.66
8	120.46	113.90	122.65	125.21	126.67	114.00
9	129.04	135.62	128.72	138.07	138.68	143.18
10	93.75	86.21	90.21	83.38	79.22	82.65
11	101.68	89.52	88.29	89.10	81.73	91.11
12	119.83	132.18	111.06	124.89	134.26	127.29
13	102.17	91.87	89.00	91.19	95.24	95.99
14	98.08	94.00	90.70	89.02	87.95	71.49
$P_N R_R$						
1	112.02	111.79	114.24	100.89	127.55	126.45
2	112.66	96.01	95.66	106.92	106.73	108.54
3	97.85	94.93	100.87	104.69	93.06	109.43
4	99.45	98.91	88.35	78.05	87.78	99.28
5	91.86	83.23	99.68	99.45	99.07	103.58
6	98.15	99.99	96.46	101.48	90.10	111.62
7	94.37	87.83	95.22	107.73	93.59	100.11
8	86.96	97.72	95.01	88.20	86.59	85.10
9	128.59	125.36	114.24	126.52	123.06	125.07
10	107.96	108.99	100.01	109.45	112.30	116.48
11	89.96	103.20	96.15	72.48	106.84	93.44
12	150.48	131.38	132.17	127.64	127.80	150.33
13	120.56	100.37	103.53	115.87	100.76	96.15
14	108.64	92.22	71.01	74.47	110.39	87.71
$P_R R_N$						
1	122.06	121.05	117.41	109.77	124.69	116.98
2	115.55	115.74	102.33	114.28	114.04	104.90
3	94.14	101.40	98.04	71.72	93.96	69.13
4	121.45	119.96	120.12	121.28	127.31	127.84
5	116.62	97.20	75.63	70.74	83.44	69.71
6	93.87	86.89	81.76	91.66	78.11	85.98
7	119.21	96.07	93.27	95.44	96.35	93.26

APPENDIX Q (Cont'd)

Table 2. Rapid Information Processing Task: Number of Digits Processed Per Minute (Cont'd)

8	137.76	124.38	106.22	121.48	127.19	134.51
9	147.46	144.76	127.39	127.47	127.96	121.60
10	133.70	114.04	117.76	118.11	121.48	121.89
11	85.70	87.98	69.92	86.34	89.80	77.64
12	93.15	83.82	76.15	77.68	85.52	76.61
13	98.07	90.45	90.70	84.38	104.67	101.86
14	107.61	96.39	103.54	102.37	92.09	96.21
$P_N R_N$						
1	115.35	110.58	115.66	111.45	97.33	111.05
2	120.87	111.67	113.90	122.18	121.58	119.48
3	126.42	112.23	114.86	121.73	127.82	132.50
4	89.96	93.51	90.21	84.35	90.60	68.51
5	95.83	113.94	79.88	86.25	88.93	85.64
6	103.71	119.36	102.16	115.30	116.62	116.44
7	136.36	129.23	116.25	118.69	105.76	121.22
8	115.73	114.34	89.56	102.24	90.40	62.47
9	100.47	118.00	112.19	108.43	109.70	117.71
10	108.43	96.43	81.18	74.32	88.03	75.82
11	146.35	136.72	144.38	141.91	145.22	140.01
12	104.55	111.82	111.07	96.92	117.80	116.88
13	107.59	92.65	87.19	99.79	96.19	97.32
14	119.83	123.96	126.84	127.16	128.57	127.35

APPENDIX Q (Cont'd)

Table 3. Subject Drinking Characteristics:

Group	Months of Regular Drinking	Weekly Drinking Frequency	Dose	Duration (Hours)	Age
$P_R R_R$					
1	66.00	.46	1.16	4.00	19.00
2	60.00	2.50	1.25	.	20.00
3	54.00	.58	.40	3.00	23.00
4	60.00	1.50	1.54	6.00	19.00
5	80.00	1.00	.88	6.00	22.00
6	42.00	1.04	.42	2.00	19.00
7	21.00	1.50	.92	3.00	19.00
8	66.00	2.00	2.02	5.00	19.00
9	42.00	3.00	1.32	3.00	21.00
10	58.00	1.50	.96	5.00	20.00
11	42.00	2.00	1.87	4.00	19.00
12	64.00	.02	.26	.50	19.00
13	43.00	2.00	1.43	5.00	20.00
14	1.00	.04	.42	1.00	20.00
$P_N R_R$					
1	96.00	1.00	1.56	.	24.00
2	41.00	1.50	2.08	4.50	19.00
3	73.00	2.00	1.27	3.00	22.00
4	28.00	2.00	1.14	4.00	21.00
5	54.00	3.50	1.14	8.50	19.00
6	46.00	2.00	1.96	7.00	20.00
7	51.00	.23	.47	2.00	19.00
8	54.00	.23	.67	2.00	19.00
9	21.00	2.00	1.66	5.00	19.00
10	11.00	1.00	1.61	7.00	19.00
11	63.00	4.50	2.18	5.00	19.00
12	34.00	3.00	1.56	5.00	19.00
13	50.00	.46	2.00	5.00	19.00
14	51.00	2.00	1.13	7.00	19.00
$P_R R_N$					
1	12.00	.23	.59	4.00	19.00
2	55.00	2.00	.84	2.00	19.00
3	30.00	.81	1.78	5.00	19.00
4	96.00	1.50	.30	2.00	22.00
5	20.00	.08	1.95	4.00	19.00
6	28.00	2.50	1.52	5.00	20.00

APPENDIX Q (Cont'd)

Table 3. Subject Drinking Characteristics (Cont'd)

7	63.00	.23	.60	4.00	21.00
8	58.00	2.00	1.65	4.00	21.00
9	45.00	2.00	.67	3.00	19.00
10	84.00	2.50	.77	4.50	23.00
11	20.00	.69	1.74	3.00	20.00
12	16.00	.23	.73	1.50	19.00
13	31.00	.46	1.13	3.00	19.00
14	58.00	3.00	1.68	4.00	19.00
$P_N R_N$					
1	68.00	3.00	1.40	5.00	19.00
2	42.00	.46	.71	3.00	21.00
3	74.00	2.50	2.50	8.00	20.00
4	48.00	.02	.21	.33	21.00
5	87.00	4.00	.89	4.50	19.00
6	43.00	1.00	2.05	5.00	19.00
7	66.00	1.00	.49	2.00	23.00
8	14.00	.23	1.49	4.00	19.00
9	44.00	.46	1.04	3.50	19.00
10	39.00	.69	1.15	5.00	19.00
11	50.00	2.00	1.36	3.00	20.00
12	30.00	.46	1.13	4.00	20.00
13	75.00	.69	.25	1.00	21.00
14	48.00	1.15	1.68	5.00	20.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings for Subjects in all Groups at Four Time Intervals (Drug-Free Baseline (B), Rising (R), Peak (P), and Falling (F) BAC) on Twelve Items

Group	Intoxication Rating - Uncomfortable			
$P_R R_R$	B	R	P	F
1	.00	.00	3.00	10.00
2	6.00	.00	.00	.00
3	5.00	2.00	2.00	2.00
4	.00	.00	.00	.00
5	.00	4.00	3.00	3.00
6	.00	.00	.00	.00
7	1.00	1.00	1.00	1.00
8	.00	.00	.00	.00
9	.00	.00	.00	.00
10	5.00	1.00	.00	.00
11	.00	12.00	2.00	2.00
12	.00	.00	4.00	.00
13	.00	.00	.00	.00
14	.00	.00	.00	.00
$P_N R_R$				
1	5.00	2.00	.00	.00
2	3.00	2.00	1.00	1.00
3	.00	.00	.00	.00
4	.00	.00	.00	.00
5	.00	.00	.00	.00
6	.00	.00	.00	.00
7	.00	.00	.00	.00
8	.00	.00	.00	.00
9	.00	.00	.00	.00
10	.00	.00	.00	.00
11	9.00	5.00	4.00	5.00
12	.00	.00	.00	.00
13	.00	.00	.00	.00
14	1.00	1.00	1.00	1.00
$P_R R_N$				
1	.00	.00	1.00	.00
2	.00	.00	3.00	.00
3	.00	.00	.00	.00
4	.00	2.00	2.00	4.00
5	.00	.00	.00	.00
6	.00	.00	.00	.00
7	.00	2.00	6.00	2.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

8	2.00	.00	.00	.00
9	.00	.00	.00	.00
10	.00	.00	.00	.00
11	4.00	1.00	1.00	2.00
12	.00	.00	.00	.00
13	.00	1.00	.00	.00
14	.00	.00	.00	16.00
$P_N R_N$				
1	1.00	.00	.00	.00
2	3.00	11.00	.00	.00
3	3.00	5.00	2.00	2.00
4	.00	.00	.00	.00
5	.00	.00	.00	2.00
6	5.00	.00	.00	.00
7	.00	.00	.00	.00
8	.00	.00	.00	2.00
9	.00	.00	.00	.00
10	.00	.00	.00	.00
11	.00	7.00	.00	.00
12	.00	.00	.00	.00
13	.00	5.00	6.00	7.00
14	.00	.00	.00	.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

Group	Intoxication Rating - High			
$P_R R_R$	B	R	P	F
1	2.00	8.00	5.00	2.00
2	.00	8.00	12.00	11.00
3	1.00	2.00	3.00	4.00
4	.00	11.00	10.00	2.00
5	.00	2.00	4.00	2.00
6	.00	5.00	7.00	2.00
7	1.00	1.00	6.00	6.00
8	.00	10.00	5.00	.00
9	.00	.00	.00	.00
10	.00	.00	.00	.00
11	.00	15.00	6.00	14.00
12	.00	2.00	9.00	7.00
13	.00	5.00	1.00	1.00
14	.00	.00	.00	.00
$P_N R_R$				
1	.00	3.00	1.00	1.00
2	.00	.00	.00	.00
3	.00	5.00	1.00	.00
4	.00	4.00	1.00	.00
5	.00	.00	3.00	1.00
6	.00	.00	.00	.00
7	.00	9.00	7.00	.00
8	.00	.00	.00	.00
9	.00	7.00	4.00	2.00
10	.00	.00	.00	.00
11	.00	.00	.00	.00
12	.00	16.00	23.00	21.00
13	.00	3.00	1.00	.00
14	1.00	1.00	1.00	1.00
$P_R R_N$				
1	.00	.00	1.00	.00
2	.00	4.00	3.00	1.00
3	.00	7.00	2.00	.00
4	4.00	9.00	14.00	3.00
5	.00	.00	.00	.00
6	.00	2.00	.00	.00
7	.00	1.00	4.00	3.00
8	.00	4.00	.00	.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

9	.00	5.00	6.00	14.00
10	8.00	10.00	15.00	4.00
11	.00	6.00	5.00	2.00
12	.00	.00	.00	.00
13	.00	.00	.00	.00
14	.00	5.00	3.00	13.00
$P_N R_N$				
1	20.00	21.00	18.00	19.00
2	.00	24.00	13.00	7.00
3	.00	.00	1.00	1.00
4	.00	.00	.00	.00
5	.00	6.00	18.00	.00
6	.00	5.00	5.00	.00
7	.00	5.00	5.00	.00
8	.00	.00	3.00	2.00
9	.00	.00	4.00	6.00
10	.00	.00	4.00	3.00
11	.00	.00	.00	.00
12	.00	.00	.00	.00
13	.00	.00	.00	.00
14	.00	6.00	14.00	15.00

APPENDIX O (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

Group	Intoxication Rating - Clumsy			
$P_R R_R$	B	R	P	F
1	.00	4.00	13.00	5.00
2	.00	8.00	7.00	8.00
3	2.00	4.00	6.00	7.00
4	.00	4.00	3.00	.00
5	1.00	6.00	2.00	1.00
6	.00	22.00	7.00	3.00
7	1.00	1.00	3.00	1.00
8	2.00	10.00	8.00	1.00
9	.00	3.00	6.00	6.00
10	.00	5.00	1.00	1.00
11	.00	31.00	22.00	17.00
12	.00	.00	10.00	11.00
13	.00	.00	.00	.00
14	.00	24.00	2.00	21.00
$P_N R_R$				
1	7.00	3.00	3.00	4.00
2	.00	11.00	3.00	1.00
3	.00	4.00	.00	.00
4	.00	7.00	4.00	1.00
5	.00	2.00	2.00	1.00
6	.00	2.00	1.00	.00
7	.00	14.00	4.00	.00
8	.00	23.00	3.00	1.00
9	1.00	6.00	3.00	2.00
10	.00	4.00	2.00	.00
11	.00	.00	.00	.00
12	.00	17.00	26.00	18.00
13	2.00	3.00	2.00	1.00
14	1.00	9.00	5.00	1.00
$P_R R_N$				
1	.00	2.00	5.00	2.00
2	.00	4.00	3.00	2.00
3	.00	.00	.00	.00
4	1.00	.00	9.00	.00
5	.00	2.00	6.00	3.00
6	.00	7.00	2.00	1.00
7	.00	8.00	12.00	9.00
8	.00	.00	.00	.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

9	.00	2.00	5.00	12.00
10	.00	.00	1.00	1.00
11	2.00	9.00	11.00	2.00
12	.00	7.00	17.00	7.00
13	.00	18.00	14.00	9.00
14	.00	9.00	17.00	19.00
P_N R_N				
1	1.00	.00	1.00	.00
2	2.00	27.00	10.00	6.00
3	.00	2.00	1.00	1.00
4	16.00	18.00	17.00	16.00
5	.00	4.00	18.00	.00
6	.00	9.00	5.00	2.00
7	.00	9.00	9.00	3.00
8	.00	3.00	9.00	6.00
9	.00	7.00	9.00	8.00
10	.00	5.00	13.00	1.00
11	.00	7.00	8.00	2.00
12	.00	.00	.00	.00
13	.00	6.00	18.00	23.00
14	.00	.00	8.00	17.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

Group	Intoxication Rating - Confused			
$P_R R_R$	B	R	P	F
1	.00	.00	2.00	4.00
2	.00	.00	.00	8.00
3	6.00	5.00	2.00	3.00
4	.00	.00	.00	.00
5	.00	2.00	2.00	1.00
6	.00	2.00	.00	.00
7	1.00	1.00	1.00	4.00
8	.00	3.00	2.00	.00
9	.00	.00	.00	.00
10	.00	.00	1.00	.00
11	1.00	31.00	27.00	17.00
12	.00	.00	.00	.00
13	.00	.00	.00	.00
14	.00	.00	.00	.00
$P_N R_R$				
1	1.00	4.00	3.00	1.00
2	.00	4.00	3.00	2.00
3	.00	2.00	.00	.00
4	.00	3.00	3.00	1.00
5	2.00	.00	1.00	1.00
6	.00	.00	.00	.00
7	.00	2.00	.00	.00
8	.00	4.00	3.00	1.00
9	.00	.00	.00	.00
10	.00	.00	.00	.00
11	.00	.00	.00	.00
12	.00	15.00	26.00	14.00
13	2.00	7.00	2.00	3.00
14	1.00	1.00	1.00	1.00
$P_R R_N$				
1	.00	1.00	4.00	2.00
2	.00	.00	3.00	1.00
3	.00	.00	.00	.00
4	3.00	.00	4.00	1.00
5	.00	.00	.00	.00
6	.00	.00	.00	.00
7	.00	5.00	13.00	8.00
8	.00	.00	.00	.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

9	1.00	4.00	5.00	11.00
10	.00	.00	.00	.00
11	2.00	5.00	7.00	2.00
12	.00	10.00	13.00	7.00
13	.00	.00	2.00	1.00
14	.00	.00	9.00	9.00
$P_N R_N$				
1	.00	.00	.00	.00
2	.00	13.00	5.00	.00
3	.00	3.00	1.00	2.00
4	.00	.00	.00	.00
5	.00	.00	.00	2.00
6	.00	1.00	2.00	2.00
7	.00	.00	.00	.00
8	.00	.00	3.00	2.00
9	4.00	6.00	10.00	10.00
10	.00	.00	.00	.00
11	.00	.00	.00	.00
12	.00	.00	.00	.00
13	.00	5.00	7.00	13.50
14	.00	5.00	.00	9.00

APPENDIX O (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

Group	Intoxication Rating – Slurred Speech			
$P_R R_R$	B	R	P	F
1	3.00	12.00	9.00	7.00
2	.00	3.00	5.00	5.00
3	1.00	2.00	3.00	7.00
4	.00	.00	.00	.00
5	.00	1.00	4.00	.00
6	.00	2.00	3.00	.00
7	1.00	8.00	5.00	6.00
8	.00	3.00	.00	1.00
9	.00	.00	.00	.00
10	.00	.00	.00	.00
11	.00	23.00	20.00	11.00
12	.00	.00	1.00	3.00
13	.00	.00	.00	.00
14	.00	.00	.00	.00
$P_N R_R$				
1	.00	3.00	2.00	4.00
2	.00	4.00	1.00	.00
3	.00	7.00	.00	.00
4	.00	2.00	2.00	.00
5	2.00	2.00	2.00	1.00
6	.00	.00	.00	.00
7	.00	.00	1.00	.00
8	.00	.00	.00	.00
9	.00	.00	.00	.00
10	.00	12.00	6.00	.00
11	.00	2.00	3.00	4.00
12	.00	8.00	20.00	15.00
13	.00	1.00	.00	.00
14	1.00	1.00	1.00	1.00
$P_R R_N$				
1	.00	.00	.00	.00
2	.00	4.00	2.00	1.00
3	.00	.00	.00	.00
4	.00	3.00	5.00	3.00
5	.00	.00	.00	.00
6	.00	6.00	2.00	1.00
7	.00	1.00	6.00	2.00
8	.00	.00	.00	.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

9	.00	1.00	5.00	10.00
10	.00	.00	.00	.00
11	.00	3.00	6.00	.00
12	.00	2.00	6.00	12.00
13	.00	.00	6.00	.00
14	.00	2.00	7.00	7.00
$P_N R_N$				
1	.00	.00	.00	.00
2	.00	10.00	3.00	3.00
3	.00	1.00	1.00	1.00
4	.00	.00	.00	.00
5	.00	.00	.00	.00
6	.00	.00	.00	.00
7	.00	.00	.00	.00
8	.00	.00	.00	.00
9	.00	.00	4.00	3.00
10	.00	.00	.00	.00
11	.00	4.00	.00	.00
12	.00	.00	.00	.00
13	.00	.00	7.00	4.00
14	.00	.00	.00	3.00

Table 4. SHAS Intoxication Ratings (Cont'd)

Group	Intoxication Rating – Effects of Alcohol			
$P_R R_R$	B	R	P	F
1	.00	8.00	13.00	10.00
2	.00	9.00	12.00	9.00
3	1.00	7.00	12.00	10.00
4	.00	13.00	15.00	8.00
5	.00	10.00	5.00	3.00
6	.00	2.00	3.00	3.00
7	1.00	8.00	10.00	1.00
8	.00	8.00	4.00	2.00
9	.00	5.00	8.00	9.00
10	.00	9.00	12.00	4.00
11	.00	34.00	31.00	16.00
12	.00	6.00	12.00	7.00
13	.00	.00	2.00	1.00
14	.00	16.00	6.00	10.00
$P_N R_R$				
1	.00	12.00	6.00	4.00
2	.00	9.00	3.00	2.00
3	.00	5.00	.00	.00
4	.00	8.00	8.00	2.00
5	.00	1.00	3.00	1.00
6	.00	4.00	4.00	.00
7	.00	26.00	14.00	3.00
8	.00	12.00	6.00	2.00
9	.00	8.00	4.00	1.00
10	.00	12.00	6.00	.00
11	.00	10.00	4.00	5.00
12	.00	29.00	35.00	19.00
13	.00	7.00	1.00	.00
14	1.00	13.00	8.00	3.00
$P_R R_N$				
1	.00	1.00	1.00	1.00
2	.00	4.00	4.00	2.00
3	.00	7.00	2.00	.00
4	.00	4.00	11.00	4.00
5	.00	12.00	19.00	7.00
6	.00	6.00	4.00	2.00
7	.00	6.00	11.00	7.00
8	.00	4.00	2.00	.00

Table 4. SHAS Intoxication Ratings (Cont'd)

9	.00	3.00	6.00	12.00
10	.00	.00	3.00	1.00
11	.00	4.00	9.00	3.00
12	.00	10.00	8.00	6.00
13	.00	18.00	21.00	6.00
14	.00	10.00	20.00	23.00
$P_N R_N$				
1	.00	6.00	10.00	3.00
2	.00	20.00	10.00	6.00
3	.00	5.00	2.00	3.00
4	.00	17.00	25.00	17.00
5	.00	3.00	15.00	10.00
6	.00	3.00	5.00	2.00
7	.00	14.00	9.00	3.00
8	.00	6.00	19.00	21.00
9	.00	8.00	6.00	9.00
10	.00	2.00	4.00	3.00
11	.00	4.00	8.00	2.00
12	.00	3.00	8.00	9.00
13	.00	6.00	18.00	.00
14	.00	.00	11.00	17.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

Group	Intoxication Rating - Floating			
$P_R R_R$	B	R	P	F
1	.00	8.00	12.00	9.00
2	.00	9.00	9.00	13.00
3	1.00	2.00	3.00	1.00
4	.00	.00	2.00	.00
5	.00	4.00	4.00	3.00
6	.00	2.00	3.00	2.00
7	1.00	3.00	1.00	1.00
8	2.00	8.00	4.00	2.00
9	.00	.00	2.00	4.00
10	.00	3.00	3.00	3.00
11	.00	32.00	31.00	13.00
12	.00	12.00	19.00	15.00
13	.00	3.00	1.00	.00
14	.00	9.00	.00	.00
$P_N R_R$				
1	1.00	2.00	1.00	1.00
2	.00	6.00	3.00	1.00
3	.00	9.00	.00	.00
4	.00	4.00	5.00	.00
5	.00	.00	3.00	1.00
6	.00	.00	.00	.00
7	.00	14.00	5.00	.00
8	.00	22.00	5.00	.00
9	.00	3.00	2.00	.00
10	.00	6.00	2.00	.00
11	.00	.00	.00	.00
12	.00	15.00	30.00	13.00
13	.00	7.00	1.00	.00
14	1.00	1.00	1.00	1.00
$P_R R_N$				
1	.00	2.00	6.00	3.00
2	.00	.00	.00	.00
3	.00	.00	.00	.00
4	.00	2.00	7.00	6.00
5	.00	3.00	3.00	1.00
6	.00	3.00	1.00	1.00
7	.00	7.00	6.00	5.00
8	.00	1.00	.00	.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

9	.00	.00	5.00	11.00
10	.00	.00	.00	.00
11	.00	6.00	2.00	2.00
12	.00	3.00	16.00	4.00
13	.00	12.00	16.00	4.00
14	.00	3.00	7.00	17.00
$P_N R_N$				
1	1.00	.00	2.00	.00
2	.00	29.00	13.00	9.00
3	.00	2.00	3.00	3.00
4	.00	.00	.00	.00
5	.00	3.00	15.00	7.00
6	.00	2.00	5.00	.00
7	.00	4.00	.00	.00
8	.00	3.00	9.00	17.00
9	.00	3.00	2.00	1.00
10	.00	.00	.00	.00
11	.00	.00	.00	.00
12	.00	3.00	12.00	7.00
13	.00	2.00	12.00	7.00
14	.00	.00	.00	13.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

Group	Intoxication Rating - Dizzy			
$P_R R_R$	B	R	P	F
1	1.00	4.00	9.00	7.00
2	.00	3.00	2.00	4.00
3	1.00	2.00	3.00	1.00
4	.00	3.00	.00	.00
5	.00	2.00	3.00	1.00
6	.00	2.00	3.00	3.00
7	1.00	3.00	1.00	1.00
8	2.00	.00	1.00	1.00
9	.00	2.00	2.00	4.00
10	.00	5.00	.00	1.00
11	.00	32.00	31.00	13.00
12	.00	3.00	15.00	11.00
13	.00	.00	.00	1.00
14	.00	3.00	2.00	3.00
$P_N R_R$				
1	.00	1.00	1.00	.00
2	.00	6.00	3.00	1.00
3	.00	.00	.00	.00
4	.00	.00	.00	.00
5	.00	.00	.00	.00
6	.00	.00	.00	.00
7	.00	2.00	2.00	1.00
8	.00	18.00	8.00	.00
9	.00	.00	.00	.00
10	.00	.00	.00	.00
11	.00	.00	.00	.00
12	1.00	16.00	32.00	7.00
13	.00	.00	.00	.00
14	1.00	1.00	1.00	1.00
$P_R R_N$				
1	.00	4.00	6.00	4.00
2	.00	2.00	1.00	1.00
3	.00	.00	.00	.00
4	4.00	2.00	8.00	4.00
5	.00	9.00	10.00	1.00
6	.00	11.00	5.00	3.00
7	.00	7.00	13.00	6.00
8	.00	.00	.00	.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

9	.00	2.00	6.00	12.00
10	.00	.00	.00	.00
11	.00	2.00	6.00	.00
12	.00	8.00	20.00	4.00
13	.00	.00	.00	.00
14	.00	10.00	5.00	23.00
$P_N R_N$				
1	.00	.00	.00	.00
2	.00	29.00	13.00	5.00
3	.00	.00	.00	1.00
4	.00	10.00	14.00	5.00
5	.00	3.00	31.00	17.00
6	.00	.00	.00	1.00
7	.00	8.00	9.00	3.00
8	.00	2.00	19.00	17.00
9	.00	3.00	5.00	5.00
10	.00	.00	4.00	.00
11	.00	.00	5.00	.00
12	.00	.00	.00	4.00
13	.00	9.00	18.00	19.00
14	.00	9.00	12.00	17.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

Group	Intoxication Rating - Nauseated			
$P_R R_R$	B	R	P	F
1	1.00	2.00	4.00	7.00
2	.00	.00	.00	.00
3	2.00	2.00	1.00	1.00
4	.00	.00	.00	.00
5	.00	.00	.00	.00
6	.00	2.00	3.00	6.00
7	1.00	1.00	1.00	1.00
8	1.00	.00	.00	.00
9	.00	.00	.00	.00
10	.00	.00	.00	.00
11	.00	12.00	3.00	1.00
12	.00	.00	.00	.00
13	.00	1.00	.00	.00
14	.00	3.00	.00	.00
$P_N R_R$				
1	4.00	.00	.00	.00
2	.00	.00	3.00	.00
3	.00	.00	.00	.00
4	.00	.00	.00	.00
5	.00	.00	.00	.00
6	.00	.00	.00	.00
7	.00	.00	.00	.00
8	.00	2.00	.00	.00
9	.00	.00	.00	.00
10	.00	4.00	6.00	21.00
11	.00	1.00	.00	.00
12	.00	.00	.00	.00
13	.00	.00	.00	.00
14	1.00	1.00	1.00	1.00
$P_R R_N$				
1	.00	.00	.00	.00
2	.00	.00	1.00	1.00
3	.00	.00	.00	.00
4	.00	4.00	.00	.00
5	.00	.00	.00	.00
6	.00	.00	.00	.00
7	.00	1.00	5.00	.00
8	.00	.00	.00	.00

Table 4. SHAS Intoxication Ratings (Cont'd)

9	.00	.00	.00	.00
10	.00	.00	.00	.00
11	.00	1.00	3.00	.00
12	.00	.00	.00	.00
13	.00	.00	.00	.00
14	.00	.00	.00	.00
$P_N R_N$				
1	.00	.00	.00	.00
2	.00	2.00	.00	.00
3	.00	.00	.00	.00
4	.00	.00	.00	.00
5	.00	1.00	8.00	36.00
6	.00	.00	.00	.00
7	.00	.00	.00	.00
8	.00	.00	.00	.00
9	.00	.00	.00	.00
10	.00	.00	.00	.00
11	.00	.00	.00	.00
12	.00	.00	.00	.00
13	.00	.00	.00	.00
14	.00	.00	.00	.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

Group	Intoxication Rating - Drunk			
$P_R R_R$	B	R	P	F
1	.00	8.00	12.00	8.00
2	.00	9.00	13.00	12.00
3	1.00	7.00	16.00	8.00
4	.00	11.00	15.00	5.00
5	.00	13.00	5.00	4.00
6	.00	12.00	7.00	2.00
7	1.00	8.00	11.00	8.00
8	.00	8.00	4.00	2.00
9	.00	3.00	5.00	9.00
10	.00	15.00	7.00	2.00
11	.00	35.00	3.00	15.00
12	.00	6.00	8.00	6.00
13	.00	3.00	1.00	1.00
14	.00	24.00	7.00	3.00
$P_N R_R$				
1	.00	9.00	6.00	7.00
2	.00	5.00	2.00	1.00
3	.00	4.00	.00	.00
4	.00	9.00	14.00	2.00
5	.00	.00	.00	.00
6	.00	4.00	4.00	.00
7	.00	33.00	26.00	1.00
8	.00	10.00	11.00	1.00
9	.00	8.00	4.00	1.00
10	.00	.00	3.00	.00
11	.00	4.00	5.00	5.00
12	.00	33.00	36.00	15.00
13	.00	7.00	1.00	.00
14	1.00	11.00	1.00	6.00
$P_R R_N$				
1	.00	1.00	2.00	1.00
2	.00	17.00	6.00	3.00
3	.00	2.00	1.00	.00
4	.00	5.00	11.00	7.00
5	.00	11.00	10.00	1.00
6	.00	5.00	2.00	2.00
7	.00	5.00	12.00	3.00
8	.00	2.00	1.00	.00

Table 4. SHAS Intoxication Ratings (Cont'd)

9	.00	2.00	6.00	10.00
10	.00	.00	5.00	.00
11	.00	6.00	9.00	2.00
12	.00	17.00	23.00	4.00
13	.00	12.00	24.00	5.00
14	.00	15.00	24.00	23.00
$P_N R_N$				
1	.00	1.00	9.00	1.00
2	.00	25.00	12.00	6.00
3	.00	1.00	1.00	2.00
4	.00	13.00	20.00	3.00
5	.00	1.00	21.00	3.00
6	.00	8.00	6.00	1.00
7	.00	13.00	13.00	3.00
8	.00	3.00	19.00	17.00
9	.00	.00	6.00	8.00
10	.00	3.00	6.00	1.00
11	.00	8.00	8.00	1.00
12	.00	.00	7.00	7.00
13	.00	6.00	6.00	15.00
14	.00	8.00	15.00	14.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

Group	Intoxication Rating - Terrible			
$P_R R_R$	B	R	P	F
1	2.00	.00	8.00	5.00
2	.00	.00	.00	.00
3	1.00	1.00	3.00	1.00
4	.00	.00	.00	.00
5	.00	3.00	.00	1.00
6	.00	7.00	4.00	6.00
7	1.00	1.00	1.00	1.00
8	.00	.00	.00	.00
9	.00	.00	.00	.00
10	.00	.00	4.00	2.00
11	.00	22.00	2.00	8.00
12	.00	.00	.00	.00
13	.00	.00	.00	.00
14	.00	.00	.00	4.00
$P_N R_R$				
1	12.00	.00	.00	.00
2	.00	.00	.00	.00
3	.00	.00	.00	.00
4	.00	.00	.00	.00
5	.00	.00	.00	.00
6	.00	.00	.00	.00
7	.00	.00	.00	.00
8	.00	.00	.00	.00
9	.00	.00	.00	.00
10	.00	.00	.00	.00
11	.00	5.00	5.00	.00
12	3.00	.00	.00	.00
13	.00	.00	.00	.00
14	1.00	1.00	1.00	1.00
$P_R R_N$				
1	.00	1.00	1.00	.00
2	.00	4.00	4.00	1.00
3	.00	.00	1.00	.00
4	.00	3.00	12.00	.00
5	.00	.00	.00	.00
6	7.00	5.00	3.00	3.00
7	.00	1.00	4.00	.00
8	.00	.00	.00	.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

9	.00	1.00	5.00	2.00
10	.00	.00	.00	.00
11	.00	1.00	5.00	.00
12	1.00	4.00	6.00	2.00
13	.00	.00	.00	.00
14	.00	4.00	7.00	21.00
$P_N R_N$				
1	.00	.00	.00	.00
2	2.00	.00	.00	.00
3	.00	.00	.00	.00
4	.00	.00	.00	.00
5	.00	.00	.00	3.00
6	.00	.00	.00	.00
7	.00	.00	.00	.00
8	3.00	3.00	3.00	7.00
9	.00	.00	.00	.00
10	.00	.00	.00	.00
11	.00	.00	.00	.00
12	.00	2.00	8.00	4.00
13	.00	2.00	7.00	13.00
14	.00	.00	.00	.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

Group	Intoxication Rating - Great			
$P_R R_R$	B	R	P	F
1	1.00	.00	11.00	5.00
2	28.00	31.00	36.00	28.00
3	1.00	5.00	3.00	1.00
4	.00	.00	.00	.00
5	36.00	36.00	30.00	31.00
6	28.00	.00	.00	.00
7	36.00	36.00	36.00	36.00
8	36.00	36.00	36.00	36.00
9	31.00	31.00	30.00	29.00
10	.00	9.00	22.00	15.00
11	17.00	14.00	8.00	3.00
12	29.00	24.00	27.00	23.00
13	27.00	9.00	27.00	29.00
14	19.00	18.00	2.00	.00
$P_N R_R$				
1	.00	9.00	5.00	2.00
2	.00	.00	.00	.00
3	.00	4.00	2.00	.00
4	.00	9.00	5.00	.00
5	8.00	2.00	6.00	3.00
6	31.00	29.00	29.00	29.00
7	11.00	33.00	25.00	.00
8	.00	19.00	13.00	2.00
9	32.00	36.00	34.00	33.00
10	.00	16.00	3.00	12.00
11	.00	2.00	5.00	2.00
12	.00	22.00	36.00	24.00
13	.00	9.00	3.00	.00
14	1.00	16.00	15.00	17.00
$P_R R_N$				
1	.00	.00	.00	1.00
2	36.00	36.00	34.00	34.00
3	30.00	32.00	26.00	22.00
4	.00	9.00	15.00	7.00
5	.00	.00	.00	.00
6	7.00	3.00	3.00	3.00
7	5.00	2.00	5.00	1.00
8	36.00	36.00	36.00	36.00

APPENDIX Q (Cont'd)

Table 4. SHAS Intoxication Ratings (Cont'd)

9	9.00	1.00	2.00	15.00
10	8.00	12.00	15.00	7.00
11	36.00	35.00	33.00	.00
12	33.00	22.00	22.00	33.00
13	36.00	36.00	36.00	36.00
14	.00	9.00	7.00	11.00
$P_N R_N$				
1	22.00	25.00	18.00	19.00
2	.00	13.00	3.00	1.00
3	.00	1.00	1.00	1.00
4	36.00	36.00	36.00	36.00
5	.00	3.00	24.00	.00
6	.00	16.00	9.00	.00
7	.00	17.00	4.00	.00
8	33.00	33.00	33.00	29.00
9	2.00	4.00	10.00	3.00
10	.00	.00	.00	.00
11	.00	14.00	6.00	5.00
12	.00	.00	.00	.00
13	.00	.00	.00	.00
14	.00	7.00	13.00	7.00

APPENDIX Q (Cont'd)

Table 5: BAC Measures at Six Time Intervals in all Groups (N = 56)

Group	Minutes After Drinking					
$P_R R_R$	19	35	55	71	90	126
1	40.00	68.00	77.00	78.00	69.00	63.00
2	50.00	54.00	83.00	76.00	76.00	59.00
3	32.00	41.00	63.00	76.00	94.00	70.00
4	32.00	50.00	67.00	81.00	74.00	59.00
5	48.00	62.00	70.00	69.00	60.00	55.00
6	60.00	80.00	70.00	67.00	67.00	62.00
7	33.00	48.00	53.00	58.00	58.00	51.00
8	40.00	48.00	69.00	73.00	80.00	63.00
9	40.00	69.00	93.00	88.00	80.00	67.00
10	58.00	58.00	70.00	70.00	83.00	72.00
11	85.00	93.00	83.00	80.00	70.00	55.00
12	36.00	59.00	75.00	90.00	90.00	69.00
13	48.00	60.00	70.00	84.00	88.00	86.00
14	32.00	58.00	58.00	58.00	70.00	60.00
$P_N R_R$						
1	52.00	70.00	91.00	87.00	81.00	71.00
2	39.00	51.00	63.00	74.00	80.00	73.00
3	63.00	87.00	86.00	74.00	62.00	50.00
4	41.00	60.00	79.00	76.00	66.00	52.00
5	30.00	55.00	55.00	55.00	70.00	60.00
6	75.00	85.00	85.00	78.00	72.00	60.00
7	78.00	101.00	101.00	88.00	75.00	65.00
8	50.00	50.00	52.00	52.00	70.00	52.00
9	71.00	93.00	108.00	88.00	80.00	55.00
10	57.00	85.00	108.00	98.00	82.00	70.00
11	49.00	91.00	109.00	97.00	80.00	68.00
12	70.00	106.00	110.00	110.00	91.00	75.00
13	65.00	68.00	60.00	60.00	58.00	54.00
14	53.00	98.00	93.00	69.00	65.00	28.00
$P_R R_N$						
1	52.00	63.00	78.00	78.00	75.00	69.00
2	83.00	124.00	107.00	102.00	91.00	82.00
3	37.00	52.00	65.00	70.00	74.00	56.00
4	26.00	39.00	91.00	85.00	78.00	65.00
5	35.00	58.00	70.00	82.00	89.00	62.00
6	72.00	98.00	87.00	80.00	65.00	65.00
7	50.00	62.00	88.00	95.00	85.00	78.00
8	57.00	75.00	88.00	72.00	72.00	66.00

APPENDIX Q (Cont'd)

Table 5: BAC Measures at Six Time Intervals in all Groups (Cont'd)

9	20.00	20.00	28.00	42.00	60.00	50.00
10	72.00	72.00	95.00	95.00	81.00	68.00
11	80.00	101.00	92.00	77.00	65.00	45.00
12	43.00	79.00	83.00	87.00	79.00	64.00
13	57.00	62.00	62.00	60.00	60.00	60.00
14	29.00	53.00	83.00	83.00	66.00	40.00
$P_N R_N$						
1	42.00	62.00	94.00	97.00	105.00	72.00
2	69.00	110.00	94.00	85.00	77.00	65.00
3	41.00	75.00	91.00	98.00	72.00	54.00
4	60.00	80.00	88.00	80.00	75.00	56.00
5	45.00	50.00	78.00	80.00	73.00	61.00
6	67.00	100.00	100.00	75.00	75.00	61.00
7	70.00	80.00	92.00	88.00	72.00	62.00
8	50.00	50.00	74.00	74.00	70.00	56.00
9	48.00	74.00	98.00	81.00	77.00	60.00
10	57.00	72.00	82.00	96.00	92.00	78.00
11	26.00	48.00	52.00	57.00	70.00	65.00
12	37.00	52.00	80.00	83.00	82.00	65.00
13	21.00	38.00	52.00	63.00	70.00	67.00
14	57.00	62.00	75.00	68.00	65.00	53.00

APPENDIX R

Study 2: Analyses of Variance of Drinking Habit Measures in Four Groups (n = 14 for each group)

Table 1: Dose:

Source	df	Mean Square	F	p
Between Subjects				
Group	3	0.43	1.30	.29
Residual	52	0.33		

Table 2. Frequency of Drinking Per Week

Source	df	Mean Square	F	p
Between Subjects				
Group	3	0.92	0.77	.51
Residual	52	1.19		

Table 3. Duration of Typical Drinking Occasion (In Hours)

Source	df	Mean Square	F	p
Between Subjects				
Group	3	6.18	2.07	.12
Residual	50	2.99		

Table 4. Number of Months of Regular Drinking

Source	df	Mean Square	F	p
Between Subjects				
Group	3	162.05	0.33	.80
Residual	52	484.50		

APPENDIX S

One-Way ANOVA on Drug-Free Baseline Scores

Pursuit Rotor

Source	df	Mean Square	F	p
Between Subjects				
Group	3	125.64	1.26	.30
Residual	52	99.75		

RIP Task

Source	df	Mean Square	F	p
Between Subjects				
Group	3	141.25	0.55	.65
Residual	52	257.01		

APPENDIX T

Table 1 ANOVA of BACs Tested at Six Time Intervals in Four Groups

Source	df	Mean Square	F	p
Between Subjects				
Group (G)	3	698.52	0.94	.43
Residual	52	744.40		
Within Subjects				
Time Interval (T)	5	7072.54	56.20	<.01
T x G	15	207.45	1.65	.06
Residual	260	125.86		

Table 2. Mean (SD) BAC values at each of the six time intervals

BAC Measurement	Minutes After Drinking Commenced	Mean (SD) BAC (mg/100 ml)
1	19	50.54 (16.44)
2	35	68.91 (20.94)
3	55	79.79 (17.30)
4	71	78.34 (13.63)
5	90	75.11 (9.95)
6	126	61.95 (10.02)

APPENDIX T (Cont'd)

Table 3. Estimated Mean BACs during each test on the two tasks

Test	Time	Midpoint BAC (mg/100 ml)
1	20-30	57.43
2	40-50	74.35
3	60-70	78.88
4	95-105	71.45
5	115-125	64.14

APPENDIX U

Table 1. Covariance Analysis of Change in Percentage of Time on Target as a Function of 2 reinforcement conditions and 2 contexts across 5 tests

Source	df	Mean Square	F	p
Between Subjects				
Baseline (B)	1	17101.95	124.01	<.01
Reinforcement (R)	1	920.05	6.67	.01
Context (C)	1	247.10	1.79	.19
R x C	1	218.09	1.58	.21
Residual	51	137.91		
Within Subjects				
Tests (T)	4	143.67	9.48	<.01
T x R	4	48.55	3.20	.01
T x C	4	25.63	1.69	.15
T x R x C	4	26.81	1.77	.14
Residual	208	15.16		

Table 2. Adjusted Group Means - Pursuit Rotor Task

Group	Adjusted Mean Percentage Time on Target				
	1	2	3	4	5
$P_R R_R$	45.33	43.02	44.17	43.43	45.74
$P_N R_R$	45.88	42.50	43.26	43.36	44.74
$P_R R_N$	46.55	46.07	45.57	45.81	50.05
$P_N R_N$	49.43	44.76	41.79	41.17	45.31

Table 3. Covariance Analysis of Mean Change in Number of Digits Processed Per Minute as a Function of 2 reinforcement conditions and 2 contexts across 5 tests

Source	df	Mean Square	F	P
Between Subjects				
Baseline (B)	1	43695.73	89.97	<.01
Reinforcement (R)	1	321.88	0.66	.42
Context (C)	1	1356.62	2.79	.10
R x C	1	323.83	0.67	.42
Residual	51	485.66		
Within Subjects				
Tests (T)	4	181.81	2.81	.03
T x R	4	177.09	2.73	.03
T x C	4	26.37	0.41	.80
T x R x C	4	56.30	0.87	.48
Residual	208	64.83		

Table 4. Adjusted Group Means – Rapid Information Processing Task

Group	Adjusted Mean Number of Digits Processed Per Minute				
	1	2	3	4	5
$P_R R_R$	101.76	100.67	104.56	103.83	103.24
$P_N R_R$	102.28	100.19	100.99	104.69	108.09
$P_R R_N$	105.72	98.59	99.48	104.76	99.87
$P_N R_N$	113.17	106.10	107.91	108.90	106.60

APPENDIX V

2 (activity) by 2 (reinforcement) by 2 (context) by 5 (test) ANOVA for each Task to Examine the Effect of Motor Stimulation

Table 1. Pursuit Rotor:

Source	df	Mean Square	F	p
Between Subjects				
Reinforcement (R)	1	758.04	5.15	.03
Context (C)	1	408.03	2.77	.10
Activity (A)	1	563.00	3.83	.06
R x C	1	175.45	1.19	.28
R x A	1	154.87	1.05	.31
C x A	1	1.31	<0.01	.93
R x C x A	1	87.58	0.60	.44
Residual	48	147.20		
Within Subjects				
Tests (T)	4	151.78	9.65	<.01
T x R	4	31.69	2.02	.09
T x C	4	19.41	1.23	.30
T x A	4	19.21	1.22	.30
T x R x C	4	27.16	1.73	.15
T x R x A	4	8.22	0.52	.72
T x C x A	4	2.73	0.17	.95
T x R x C x A	4	2.54	0.16	.96
Residual	192	15.73		

APPENDIX V (Cont'd)

Table 2. Rapid Information Processing Task

Source	df	Mean Square	F	p
Between Subjects				
Reinforcement (R)	1	161.21	0.31	.58
Context (C)	1	897.08	1.72	.20
Activity (A)	1	46.62	0.09	.77
R x C	1	85.04	0.16	.69
R x A	1	1264.23	2.43	.13
C x A	1	437.61	0.84	.36
R x C x A	1	268.21	0.52	.48
Residual	48	520.27		
Within Subjects				
Tests (T)	4	117.85	1.84	.12
T x R	4	77.60	1.21	.31
T x C	4	60.28	0.94	.44
T x A	4	69.79	1.09	.36
T x R x C	4	67.79	1.06	.38
T x R x A	4	68.66	1.07	.37
T x C x A	4	101.40	1.58	.18
T x R x C x A	4	69.22	1.08	.37
Residual	192	64.10		

APPENDIX V (Cont'd)

Table 3. Pursuit Rotor Difference Score Means (SD) as a Function of Additional Activity Across Tests

Activity	1	2	3	4	5
No (n = 17)	-0.73 (3.76)	-5.18 (6.81)	-5.37 (7.40)	-5.75 (7.14)	-2.39 (6.31)
Yes (n=39)	0.20 (4.59)	-1.74 (6.61)	-2.22 (7.29)	-2.43 (8.62)	0.44 (8.01)

Table 4. Rapid Information Processing Task Difference Score Means (SD) as a Function of Additional Activity Across Tests

Activity	1	2	3	4	5
No (n = 17)	-6.85 (7.48)	-7.67 (10.22)	-8.68 (10.10)	-3.27 (9.61)	-4.97 (11.55)
Yes (n=39)	-4.38 (12.35)	-10.26 (12.80)	-7.17 (13.12)	-6.22 (13.35)	-7.04 (16.77)

APPENDIX W

Table 1. One way ANOVA of Summed SHAS Baseline Ratings Across Groups

Source	df	Mean Square	F	p
Between Subjects				
Group	3	9.40	0.40	.76
Residual	52	23.81		

Table 2. 2 (PR reinforced or not) by 2 (RIP task reinforced or not) by 3 (time) ANOVA of the change in SHAS ratings

Source	df	Mean Square	F	p
Between Subjects				
PR Reinforced or Not ($P_{R\ vs\ N}$)	1	660.05	0.23	.64
RIP Reinforced or Not ($R_{R\ vs\ N}$)	1	70.72	0.02	.88
$P_{R\ vs\ N}$ x $R_{R\ vs\ N}$	1	3429.05	1.18	.28
Residual	52	2908.44		
Within Subjects				
Time (T)	2	3745.01	7.10	<.01
T x $R_{R\ vs\ N}$	2	2434.29	4.61	.01
T x $P_{R\ vs\ N}$	2	159.88	0.30	.74
T x $R_{R\ vs\ N}$ x $P_{R\ vs\ N}$	2	209.38	0.40	.67
Residual	104	527.63		