The University of Manitoba

# State Dependent Learning: The Effects of Alcohol on Learning and Recall of Information About Alcohol Abuse and Its Consequences Among Light and Heavy Social Drinkers

By

Robert John Goulet

A Dissertation
Submitted to the Faculty of Graduate Studies
In Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

Department of Psychology

Winnipeg, Manitoba

September, 1979

# STATE DEPENDENT LEARNING: THE EFFECTS OF ALCOHOL ON LEARNING AND RECALL OF INFORMATION ABOUT ALCOHOL ABUSE AND ITS CONSEQUENCES AMONG LIGHT AND HEAVY SOCIAL DRINKERS

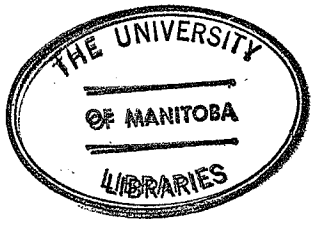
BY

ROBERT JOHN GOULET

A thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

DOCTOR OF PHILOSOPHY





DEDICATION

To my parents who taught me the importance of hard work and compassion for my fellow man.

ACKNOWLEDGMENTS

I would like to express my sincere appreciation to my committee members who allowed me the freedom to develop and conduct this research in my own way and particularly to Ross Hartsough, my advisor, whose confidence, prodding and support played a deciding role in bringing this project to completion. Also, Dan Harper, my internal-external examiner, was responsible for making available the equipment and supplies needed for the breathalyzer measurements. I also wish to thank Lorne Sexton, a fellow student, for his many useful comments and sound advice during the initial planning stages, the two registered nurses, Ora Zablowski and Linda McCray, who played indispensable roles in conducting the drinking experiment, and to my impeccable typist, Vickki Wood, who tolerated my many unreasonable demands. And last, but not least, this project would not have been possible without the financial support and encouragement given me by my parents, Gladys and Medard, whose confidence sustained me through several, rather difficult years in graduate school.

To all of these people, I thank you and hope that I live up to your kind expectations throughout my professional career.

TABLE OF CONTENTS


Page

INTRODUCTION

Historical Background of Research on State Dependent Learning . . . . . 5

Overview of Contemporary Research on State Dependent Learning . . . . . 11

Animal Research . . . . . 12

Human Research . . . . . 20

Investigations of Alcohol State Dependent Learning in Normal Populations . . . . . 24

Comparisons of Alcohol State Dependent Learning in Normal and Alcoholic Populations . . . . . 35

Investigations of the Role of Dissociation in the Production of Alcoholic Blackouts . . . . . 43

The Role of Dissociation in Social Drinking Phenomena, Alcohol Abuse and Treatment . . . . . 47

A. Some observations on the frequency and nature of alcohol-related memory phenomena in natural settings . . . . . 47

B. The role of controlled investigation in determining the causes of memory phenomena . . . . . 49

C. The possible significance of determining causation of memory phenomena for treatment planning and prevention of alcohol abuse . . . . . 51

D. Some aspects of preventive and rehabilitative programs in which dissociation may be a problem . . . . . 51

E. Some practical implications of research findings on alcohol state dependent learning . . . . . 54

F. Some reservations in extrapolating from research findings to therapeutic efforts . . . . . 56

G. The purpose of the present investigation . . . . . 57

TABLE OF CONTENTS (CONTINUED)


| | Page |
|---|---|
| METHOD | 61 |
| Subjects | 61 |
| Apparatus | 62 |
| Materials | 62 |
| Procedure | 70 |
| RESULTS | 76 |
| Intoxication Indicators | 76 |
| Learning and Recall of Factual Information from the Films | 81 |
| A. Immediate Recall (Acquisition) | 82 |
| B. Delayed Recall | 86 |
| Alternate Form Measures of Delayed Recall | 86 |
| Test-Retest Measures of Delayed Recall | 90 |
| Subjective Reactions to the Films and their Subsequent Recall | 93 |
| A. Immediate Judgment Ratings | 95 |
| B. Delayed Recall of Judgment Ratings | 102 |
| Self-report Information About the Drinking Habits and Experiences of the Subjects | 109 |
| A. Self-report Data on the Frequency of Occurence of Dissociation-like Memory Phenomena in Natural Settings | 111 |
| B. Relationships Between Self-Report Measures of Dissociation-like Memory Phenomena and Those of Drinking Habits and Other Experiences | 112 |
| C. Relationships Between Subjects' Reports of Frequency of Occurrence of Dissociation-like Memory Phenomena and their Recall-Performance under State Change Conditions during the Drinking Experiment | 116 |

TABLE OF CONTENTS (CONTINUED)


| | Page |
|---|---|
| DISCUSSION | 121 |
| Footnotes to the Discussion | 132 |
| REFERENCES | 135 |
| APPENDICES | 145 |
| APPENDIX A | 145 |
| Personal Data Sheet | 145 |
| Drinking Experience Inventory | 146 |
| APPENDIX B | 155 |
| A. Summary Table of Means and Standard Deviations for all Continuous Variables | 155 |
| B. Frequency of Responding for all Categorical Variables | 156 |
| APPENDIX C | 157 |
| Film Rating Sheet | 157 |
| APPENDIX D | 158 |
| Mean Rating Scores on Film Dimensions for the Alcoholism Film, Control Film #1, and Control Film #2 | 158 |
| Comparisons of Mean Rating Scores on Film Dimensions Between the Alcoholism Film and Control Film #1, and Between the Alcoholism Film and Control Film #2 | 158 |
| APPENDIX E | 159 |
| Alcoholism Film Questionnaire, Form A1 | 159 |
| Alcoholism Film Questionnaire, Form A2 | 160 |
| Alcoholism Film Questionnaire, Form C1 | 161 |
| Control Film Questionnaire, Form C2 | 162 |
| APPENDIX F | 163 |
| Judgment Rating Scales | 163 |

LIST OF TABLES


| Table Number | Title | Page |
|---|---|---|
| 1.0 | Investigations of Alcohol State Dependent Learning in Man . . . . . | 25 |
| 2.0 | Means and Standard Deviations of Intoxication Indicators for Subjects who Received Alcoholic Beverages . . . . . | 77 |
| 2.1 | Comparisons of Mean Intoxication Scores Averaged over Pre- and Post Measures for Light and Heavy Social Drinkers . . . . . | 79 |
| 2.2 | Comparisons of Mean Intoxication Scores Averaged over Pre- and Post-Measures from Day 1 to Those of Day 2 for Subjects who Received Alcohol on Both Days . . . . . | 80 |
| 3.0 | Mean Scores and (Standard Deviations) of Immediate Recall of Information from the Alcoholism and Control Films for Intoxicated and Sober Subjects . . | 83 |
| 3.1 | Mean Scores and (Standard Deviations) of Immediate Recall of Information from the Alcoholism and Control Films for Subjects Grouped According to Treatment Assignment on the Second Day . . . . . | 85 |
| 3.2 | Unadjusted Mean Scores and (Standard Deviations) of Alternate Form Delayed Recall of Information from the Alcoholism and Control Films . . . . . | 87 |
| 3.3 | Adjusted Mean Scores of Alternate Form Delayed Recall of Information from the Alcoholism and Control Films . . . . . | 89 |
| 3.4 | Unadjusted Mean Scores and (Standard Deviations) of Test-Retest Delayed Recall of Information from the Alcoholism and Control Films . . . . . | 91 |
| 3.5 | Adjusted Mean Scores of Test-Retest Delayed Recall of Information from the Alcoholism and Control Films . . . . . | 92 |
| 3.6 | Summary of Findings from the Analyses of Variance and Covariance of the Alternate Form and Test-Retest Delayed Recall of Information from the Alcoholism and Control Films . . . . . | 94 |

LIST OF TABLES (CONTINUED)


| Table Number | Title | Page |
|---|---|---|
| 4.0 | Mean Rating Scores and (Standard Deviations) of the Attention Holding Judgments Grouped According to Acquisition State, Recall State, Drinking Experience and Film Type | 96 |
| 4.1 | Mean Rating Scores and (Standard Deviations) of the Interest Value Judgments Grouped According to Acquisition State, Recall State, Drinking Experience and Film Type | 97 |
| 4.2 | Mean Rating Scores and (Standard Deviations) of the Comprehension Difficulty Judgments Grouped According to Acquisition State, Recall State, Drinking Experience and Film Type | 98 |
| 4.3 | Mean Rating Scores and (Standard Deviations) of the Emotional Impact Judgments Grouped According to Acquisition State, Recall State, Drinking Experience and Film Type | 99 |
| 4.4 | Mean Rating Scores of the Interest Value Judgments Grouped According to Acquisition State and Film Type for Heavy and Light Drinkers | 101 |
| 4.5 | Mean Rating Scores of the Emotional Impact Judgments Grouped According to Drinking Experience and Acquisition State for the Alcoholism and Control Films | 103 |
| 4.6 | Mean Recall Scores and (Standard Deviations) of Previous Day Judgment Ratings Grouped According to Acquisition State, Recall State, Drinking Experience and Film Type | 104 |
| 4.7 | Analysis of Variance Summary Table of Delayed Recall Scores for Previous Day Film Judgments | 105 |
| 4.8 | Mean Recall Scores of Previous Day Judgments Grouped According to Recall State and Drinking Experience | 107 |
| 4.9 | Mean Recall Scores of Previous Day Judgments Grouped According to Acquisition State and Recall State | 108 |

LIST OF TABLES (CONTINUED)


| Table Number | Title | Page |
|---|---|---|
| 4.10 | Mean Recall Scores of Previous Day Judgments Grouped According to Drinking Experience and Combined Acquisition and Recall State Treatment Conditions . . . . . | 110 |
| 5.0 | Correlations Between Types of Reported State-Dependent-Like Memory Phenomena and Other Experiential and Phenomenological Measures for all Subjects . . . . . | 114 |
| 5.1 | Correlations Among Experiential and Phenomenological Measures Other than Reported State-Dependent-Like Memory Phenomena . . . . . | 115 |
| 5.2 | Correlations Between Alternate Form Delayed Recall Scores from the Control Film and Reports of State-Dependent-Like Memory Phenomena for the Same State and Changed State Groups . . . . . | 118 |
| 5.3 | Correlations Between Delayed Recall of Judgment Ratings for the Alcoholism and Control Films Combined and Reports of State-Dependent-Like Memory Phenomena for the Same State and Changed State Groups . . . . . | 120 |

## Abstract

Several researchers have pointed out the possible ecological and thereapeutic significance of state dependent learning for problems of alcohol abuse and its treatment. These speculations have been based on findings from both animal and human experiments in which relatively simple kinds of learning tasks, which lend themselves to easy and accurate quantification and experimental control, have been employed. However, since there is abundant evidence from this research that the presence or absence of state dependent effects often depends on the specific kind of learning task used, the external validity of these findings for practical concerns about failures of therapeutic gains acquired while sober to transfer effectively to later occasions involving alcohol consumption can be seriously questioned. It seemed reasonable that, in order to more validly determine the practical significance of state dependent learning for therapeutic efforts, a first step would be to examine kinds of learning experiences which more closely approximate those characteristics of existing forms of treatment.

The present study was conducted to determine if state dependent learning could be demonstrated for information acquired through exposure to realistic, filmed material of the variety used by programs designed to prevent alcohol abuse and its consequences. Nonalcoholic, social drinkers were shown two educational films, an alcoholism film and a control film unrelated to alcohol abuse while intoxicated or sober and were tested for recall of sampled information from the films both immediately after and again twenty-four hours later under either similar

or alternate state conditions. Immediate and delayed recall of factual information from the films was assessed by questionnaires using a fill-in-the-blank format with delayed recall being measured by both an alternate form and a test-retest method. Later recall of judgment ratings made by the Ss immediately after the films about their subjective reactions to the material presented was also evaluated. Self-report data on the drinking habits and various alcohol-related experiences of the Ss were also collected and an attempt was made to determine possible relationships between these measures and recall performance under alternate state conditions.

The results pertaining to learning and recall of factual information from the films indicated that (1) mild to moderate degrees of alcohol intoxication had no significant effect on the amount of sampled information acquired through exposure to either of the films, (2) evidence of state dependent learning was found on the test-retest method of delayed recall assessment but not on the alternate form method for the alcoholism film, and on the alternate form measure but not on the test-retest measure for the control film, and (3) no significant differences were found between the light and heavy drinkers on measures of original learning or later recall under alternate state conditions. Evidence of state dependent learning was also found for later recall of judgments made about subjective reactions to the films. However, in this case, state dependent effects were found to be similar for both films and also a function of previous drinking experience whereby the light drinkers were significantly more impaired in their recall attempts than the heavy drinkers by changes in state. And lastly, self-report data about the frequency of experienced state dependent-like memory phenomena associated with previous occasions of

alcohol intoxication were not found to be good predictors of recall performance under alternate state conditions in the drinking experiment.

The implications of these findings for therapeutic concerns about problems of effective transfer arising from state specificity were discussed and it was concluded that future research employing learning experiences more akin to those for which predictions are being attempted is needed to provide definitive answers to some of these practical questions about the ecological significance of human state dependent learning.

The terms 'state dependent' and 'dissociated' learning have been used to describe an intriguing phenomenon reported in numerous animal and human studies investigating the effects of various pharmacological agents on learning and memory. In addition to expected deficits arising from specific drug effects on the performance of a learned response, a change in 'state' has often been reported to have produced a substantial performance decrement as well. Behaviors acquired under drugged conditions seem to be best elicited at later times while similarly drugged, and often either partially or totally fail to transfer to the nondrugged state. Conversely, behaviors acquired under nondrugged conditions often fail to transfer to the drugged state. In short, these observations suggest that the performance of a learned response is dependent, at least in part, on the presence of a similar state, defined either in behavioral, pharmacological or biochemical terms, to that which was present during the acquisition of that response.

During its forty year history of experimental investigation, the phenomenon of state dependent learning has attracted an ever-increasing number of investigators from many diverse fields for many different reasons. For instance, psychopharmacologists, who initially considered dissociated learning to be a nuisance variable which needed to be controlled for in investigating behavioral effects of drugs, currently employ the phenomenon as a criterion for drug classification. Physiological psychologists have viewed state dependent learning as a possible means of uncovering neurochemical mechanisms of memory. Classical and operant conditioning researchers have been attracted to the possibility of its use to investigate conditioning based on internal stimuli. Cognitive theorists have attempted to use the phenomenon to investigate human memory

processes and develop information processing models of memory. And applied psychologists have been concerned by the practical implications of dissociation for drug abuse and therapies. As a consequence, there is at present not one but several rather distinct lines of research interest which have evolved in this rapidly growing field of investigation.

The scope of the present review will necessarily be restricted with a primary focus on published investigations of alcohol state dependent learning in man. However, because of the similarity and repetitive nature of many of the current issues and themes prevalent in this body of research to those present in the field as a whole, this review will be preceded by (1) a survey of the historical highlights of current interest in dissociated learning, and (2) an overview of some of the major trends, issues and findings apparent in comtemporary research.

## Historical Background of Research on State Dependent Learning

The formal beginning of research on drug-induced, state dependent learning is usually ascribed to Girden and Culler's (1937) investigations of the effects of curare on conditioned leg flexion in dogs. Basically, they found that (1) curare did not impede the rate of development of the conditioned response to the sound of a bell, (2) the conditioned response established under curare vanished on return to the normal state and reappeared only after re-curarization, (3) a conditioned response established in the normal state disappeared while under curare and reappeared only after return to normal, and (4) two, distinct conditioned responses could be established to the same stimulus, one under curare and the other in the normal state, in the same animal, and that their subsequent elicitation depended upon reinstating the drug conditions present at time of their acquisition. They coined the term 'dissociation

of learning' to describe this absence of transfer of training between the curare and normal states. These initial findings were subsequently replicated and extended by other studies in which dissociation was observed with curare and other drugs, which also produce muscular paralysis, using other animal species and other classically conditioned responses (e.g., Girden, 1942a; Girden, 1942b; Girden, 1942c).

The next independent report of state dependent learning was published by Conger (1951). In an attempt to further investigate the observations of Masserman and Yum (1946) on the effects of alcohol on neurotic behavior in cats, he successfully demonstrated the 'disinhibiting' properties of alcohol on an approach-avoidance conflict in rats. In a second experiment, Conger found that alcohol selectively reduced the avoidance tendency, but not the approach tendency of rats in which a simple approach-avoidance conflict had been established under sober conditions. Once having established that the disinhibiting effects of alcohol on conflict behavior resulted from the production of a decrease in the avoidance response motivated by fear, he attempted to determine the basis of this effect. He reasoned that in addition to the obvious interpretation that alcohol was having a specific effect on some underlying fear mechanism, his results might simply have been produced by a change in the animal's stimulus situation resulting from inebriation by introducing a variety of novel sensations (tingling, staggering, etc.). His colleagues, Miller and Kraeling (1952) had demonstrated that an approach-avoidance conflict, established in a narrow, black alley, could be effectively eliminated by a shift in locale to a wide, white alley (stimulus generalization decrement). And a second study by Murray and Miller (1952) had shown that this stimulus change

effect was much greater in reducing avoidance responses motivated by fear than approach responses motivated by hunger. To investigate this possibility, Conger ran a final experiment to determine if animals could establish a reliable discrimination based solely on the presence or absence of intoxication. One group of animals was trained to run down an alley to a goal box for food after an injection of alcohol, but to avoid electric shock in the same goal box after an injection of water. A second group was trained in the reverse order to avoid after alcohol and approach after water. He found that both groups were able to learn the discrimination task, and that the first group acquired it more rapidly than the second group. Conger interpreted these findings as support for both hypotheses. He concluded that since both groups learned the discrimination, alcohol must have changed the stimulus situation for the rat, but that in addition the group which was favored by any fear-reducing effects of alcohol did in fact learn the discrimination more rapidly.

Neal Miller, in a series of review articles on psychopharmacological studies of the motivational effects of drugs (Miller, 1957; Miller and Barry, 1960; Miller, 1961) emphasized the need to control for drug-induced stimulus change in future investigations as highlighted by Conger's findings. As a method of control, he recommended the use of a 2 x 2 factorial design as diagrammed below.

| | | Testing State: Drug | Testing State: No Drug |
|---|---|---|---|
| Training State | Drug | D-D | D-N |
| | No Drug | N-D | N-N |

Procedurally, half the subjects receive initial training when drugged and the other half when not drugged. Then each of these two groups is split into two halves, one of which is tested for the learned response when drugged and the other when not drugged. In this design, four treatment groups are required. Computationally, comparison of the row sums (D-D + D-N to N-D + N-N) indicates the effects on test performance of having had the drug during previous training, comparison of the column sums (D-D + N-D to D-N + N-N) indicates the effects on test performance of having the drug during testing, and comparison of the diagonal sums (D-D + N-N to D-N + N-D) indicates the effects on test performance of having changed the drug state from training to testing (i.e., the training state by testing state interaction).

Most of the studies investigating drug effects on learned behavior, at that time, typically had employed a design where animals were first trained under no drug conditions and drug effects were then evaluated by comparing subsequent performance of half the animals under drug conditons to the remainder under no drug conditions (i.e., comparison on test performance of groups N-D to N-N). Miller pointed out that any existing differences in test performance might be the result of either the action of specific drug effects on performance, or the more indirect effects of drug-induced, stimulus change, or both. Miller argued that by including the remaining two groups (D-D and D-N) to balance the design, these two possible sources of performance differences could be independently evaluated.

Grossman and Miller (1961) reported the first study to use this completely balanced design in evaluating the fear-reducing effects of alcohol and chlorpromazine on an approach-avoidance conflict in rats. All

the animals received preliminary approach training under no drug conditions. Then half of them received avoidance training under drug conditions, while the other half received similar training under no drug conditions. These two groups were then halved again, with each half receiving test trials under either drug or no drug conditions. Their analysis of the test performance data, which was a measure of approach tendency, indicated (1) no effect of having had the drugs during avoidance training (D-D + D-N = N-D + N-N), (2) a significant effect of having had the drugs during testing (D-D + N-D > D-N + N-N), and (3) no effect of having changed the drug state from training to testing (D-D + N-N = D-N + N-D). They concluded that the fear-reducing effects of alcohol and chlorpromazine on conflict behavior were the result of the specific drug actions on the avoidance response rather than the effects of stimulus change, as inferred from their finding that the changes in drug conditions from training to testing did not affect test performance.

In contrast to Grossman and Miller's (1961) findings, however, two subsequent studies were reported in which convincing demonstrations of state dependent learning were obtained. Otis (1964) in a study investigating the effects of chlorpromazine on the performance of an active avoidance, pole jumping response in rats reported that in addition to a retarding effect of the drug on response acquisition, a significant state change effect was observed. Rats which were trained under the influence of chlorpromazine and tested under saline and those which were trained under saline and tested under chlorpromazine showed less recovery of the avoidance response than animals which received only saline, or only chlorpromazine during training and testing. In other words, the state change groups (N-D and D-N) showed less recovery of original learning than did the same state groups

(D-D and N-N) which is indicative of state dependent learning (state change effects) as defined by Miller's design.

The second convincing demonstration of state dependent learning was reported by Overton (1964) in a series of experiments designed to extend some of Girden and Culler's (1937) observations. Overton sought to determine (1) if a centrally acting drug (pentobarbital) in contrast to those previously investigated which had strong peripheral actions (curare, etc.) might also produce dissociated learning, and (2) if operant responses were also subject to state dependent effects as classically conditioned ones had been shown to be. In the first experiment, he found that rats trained to escape to one side of a T-maze while in one state, as induced by pentabarbital or saline injections, responded randomly when tested in the alternative state. Other animals given discrimination training based on drug state (pentobarbital, turn left; saline, turn right) when tested alternatively in either state gave responses appropriate to their existing state. In a second study, rats were trained to one side while in one state, then retrained to the same side while in the alternate state. Retraining took as long as original training which indicated that no transfer of training had occurred between the two states. A third experiment showed that opposite response tendencies could be established in the same animal concurrently by alternating training trials in the two states. Rate of acquisition for learning opposite responses in alternate states was identical to that of animals learning a single response in either state indicating that there was no interference generated by learning antagonistic responses simultaneously in different states. A fourth experiment demonstrated that the amount of dissociation observed was a function of dosage size. And a fifth experiment compared the effectiveness of the

presence and absence of drug state in controlling differential responses to that of various exteroceptive stimuli (multiple stimuli-visual, auditory and tactile; single stimulus-visual), interoceptive stimuli (peripherally acting drugs--gallamine and tetiaethylammonium), and drive states (food and water deprivation). Pentobarbital was found to establish respond control significantly faster than any other condition which implied that dissociation could not be accounted for by peripherally induced, stimulus change, and seemed to be more likely the result of drug-induced alterations of the central nervous system itself.

In sum, Overton's experiments clearly demonstrated that (1) centrally acting drugs can produce dissociated learning of operant responses, (2) centrally acting drugs can acquire discriminative control over operant responses, (3) drug-induced performance decrements can result from state change rather than specific drug actions on performance variables, and (4) dissociation may not be the product of peripheral stimulus change as suggested by others (Conger, 1951; Miller, 1960; Otis, 1964) but may reflect some unknown action of the drug in temporarily altering the function of the central nervous system. By and large, Overton's convincing demonstrations of state dependent learning, along with that of Otis (1964), have been responsible for renewed interest in dissociation and have resulted in its general acceptance as a bone fide phenomenon of unknown origin.

Overview of Contemporary Research on State Dependent Learning

During the last fifteen years, a host of studies investigating drug-induced state dependent learning both in a variety of animal species and in man have been reported. An exhaustive review of the literature will not be attempted. The last attempt was made by Overton (1968). More recent