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THE EFFECTS OF EMOTIONALLY IMPORTANT STIMULI ON DISSOCIATED
LEARNING IN A DISCRIMINATION PARADIGM

A Thesis Submitted to the Graduate Division in Partial
Fulfillment of the Requirements for the
Degree of Master of Science

By
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July, 1973

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Abstract

Rats were trained to turn in one direction in a modified T-maze while in one drug state and in the opposite direction while in another drug state. Incorrect turns during training were punished with shock and for three of the transfer groups, shock was contiguously conditioned to a 10 KHz buzzer in the drug state and to a 1 KHz buzzer in the non-drug state. During no-shock testing, the dissociation subjects were tested for state-dependency while the transfer subjects were tested for transfer by reversing the buzzer previously associated with the particular drug state in training. The hypothesis, that the transfer subjects would respond in the direction as signalled by the buzzer as often as the dissociation subjects respond in the direction as signalled by the drug state, was not supported since there were no significant differences between transfer and dissociation groups in latencies and the transfer groups did not transfer significantly above chance level. These results were discussed in relation to a prime level of shock for mediating transfer between drug states.

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CHAPTER I

INTRODUCTION

The phenomenon of state-dependent learning, although relatively new as an area of research, has become a center of special interest and experimentation in the past decade, especially in the field of Psychopharmacology and drug-related learning. Overton (1966) described state-dependent learning as a response decrement of an animal tested in a drug state different from the drug state the animal was originally trained in. The response decrement, caused by the change in drug state, occurs whenever the change between training and testing is: (1) from a nondrug state (ND) to a drug state (D), (2) from a D state to a ND state or, (3) from one D state to another D state. To measure a level of responding during testing equivalent to that achieved during training, the corresponding drug state present during both testing and training must also be equivalent. This dependence upon drug states for achieving characteristic response levels of an organism have been demonstrated in a variety of experimental situations.

Historical Survey of State-Dependent Learning. Originally, state-dependent learning was referred to as dissociation of learning between drug and nondrug states. Girden and Culler (1937) found that learned responses of dogs, while subjected to injections of curare, failed to appear after recovery from the drug, and conversely, responses learned in the normal, nondrug state failed to appear in the drug state. Girden and Culler

(1942a, 1942b, 1942c, 1943, 1947) have since demonstrated total dissociation of learning using response measures such as pupillary contraction and blood pressure in such animals as cats, dogs, and monkeys.

From the last experiments of Girden and Culler in the late 1940's until the middle of the 1960's, little research was undertaken in the area of state-dependent learning. An exception was an experiment by Heistad and Torres (1959) who found only partial dissociation between drug and nondrug states. Using 5 mg/kg of thioridazine (an anesthetic), rats were trained in a bar pressing task for a water reward. A conditioned emotional response was thereby acquired with the result that bar pressing for water was almost totally suppressed with the onset of a warning buzzer. After the drug-state had worn off, however, a decrease in the conditioned emotional response was observed. Likewise, animals who had acquired the emotionally conditioned response while in the nondrug state, showed some loss of it when injected with thioridazine.

Recent Research in State-Dependent Learning. The trend in the majority of research in the past 10 years for demonstrating state-dependent learning has been through the administration of different drugs. Using erythroidine, Solomon and Turner (1962) trained dogs in the normal state to avoid shock by pressing a panel whenever a light went out. When this response was learned, the animals were drugged and trained to press a lever after presentation of a tone. When this response was thoroughly learned

in the drug state, the dogs were tested in the nondrugged state with both the light and the tone. The results showed that responses to both the light and tone were of the same magnitude indicating transfer of learning between the drug and nondrug states and therefore lack of dissociation which was in contradistinction to the earlier findings of Girden and Culler (1937) using curare. These conflicting results, however, were interpreted by Sachs, Weingarten and Klein (1966) as being due to the differential effects of erythroidine, which primarily affects the central nervous system, and curare, which blockades muscular responses with very little effect on the central nervous system.

In studying the effects of changing internal stimuli, Belleville (1964) compared groups of rats extinguished under the same drug conditions with groups extinguished under different drug conditions. One acquisition and two extinction sessions were used which consisted of combinations of 3 mg/kg morphine and 2 mg/kg dl-amphetamine for the drug condition and .15 cc saline as the placebo or nondrug condition. The combinations of drug and nondrug conditions included: drug-nondrug, nondrug-drug and drug-drug, with an additional control and nondrug group maintained under constant conditions during the entire experiment. Subjects (Ss) were male albino rats required to press a bar lever in a Skinner box for a food reward. Results showed a greater resistance to extinction for those groups that received a drug different from that received during acquisition thus providing evidence of state-dependent learning with both morphine and

amphetamine drug states.

In a series of experiments, Overton (1964) found that rats demonstrated total dissociation of learning if trained and/or tested in both drug and nondrug states. Using doses of 25 mg/kg sodium pentobarbital, he found that transfer between drug and nondrug states occurred if the dosage level of the drug state was sufficiently low, with the amount of transfer being inversely proportional to the level of the dosage.

Bindra, Nyman and Wise (1965) tested the effects of 30 mg/kg of pentobarbital on the acquisition and extinction of an escape response and a freezing response. Results showed that acquisition of the escape response did not transfer between drug and nondrug states, although the effects of extinction did. Acquisition of the freezing response did transfer between drug and nondrug states but extinction effects did not. In attempting to distinguish the components of learning that were dissociated from those that were transferred, Bindra et. al. (1965) found these components to be the abilities of the animal to initiate movement. They further deduced that drugs, such as pentobarbital, decrease the animal's ability to initiate responses, such as acquisition of an escape response and extinction of a freezing response, by severing the connection between the conditioned stimulus, necessary to elicit the movement initiating response, and the response itself. Therefore the connection between the conditioned stimulus and the movement initiating response is specific to the drug state under which it is formed or state-dependent.

Kornetsky and Bain (1965) examined the effects of .25, .50, 1.0 and 2.0 mg/kg of chlorpromazine and 2.0, 4.0, 8.0 and 12.0 mg/kg of sodium pentobarbital on the bar pressing response by rats for a water reward. They found clear dissociation or state-dependency between the drugs, with chlorpromazine causing an increase in errors of omission or errors caused by lack of response to the correct lights in the apparatus while sodium pentobarbital caused a decrease in errors of omission but an increase in errors of commission or errors caused by response to incorrect lights. Also the reaction time was slightly increased with injections of sodium pentobarbital but decreased by chlorpromazine.

To establish drug controlled responses in a 3-choice maze, Overton (1967) trained rats to escape shock by running into 1 of 3 goal boxes, with each goal box appropriate for only a particular drug state, which consisted of either: (1) 40 mg/kg sodium phenobarbital, (2) 150 mg/kg atrophine sulfate or (3) isotonic saline. After training was completed, it was found that performance in each drug state was statistically significant. Since no discriminative conditions other than the particular drug state were available to the rat, it was concluded, therefore, that complete dissociation or state-dependent learning was achieved.

Overton (1968) used 15 mg/kg pentobarbital to investigate whether its response control is mediated by internal stimuli which as cues thus signalling the organism to respond differentially. In the first section of his experiment, Overton demonstrated that Ss did in fact differentiate 15 mg/kg of

pentobarbital from a nondrug state using 1.6 ma shock in each state. He subsequently proceeded to determine, by employing variations in shock intensity, if pentobarbital achieved response control by its analgesic action in reducing the S's sensitivity to shock. Using 3 conditions, consisting of: (1) .8 ma (Drug state) and 2.5 ma (Nondrug state), (2) 1.6 ma (Drug state) and 1.6 ma (Nondrug state) and (3) 2.5 ma (Drug state) and .8 ma (Nondrug state), only minor differences in acquisition rate were found between the three conditions.

In the second section of the experiment, Overton used 4 groups of Ss to determine if pentobarbital achieves response control, and therefore creates state-dependency, by altering visual cues. Group 1 was sighted in both drug states while group 2 was blinded in both drug states after achieving partial response acquisition. Results showed no significant difference between these groups in response acquisition. Group 3 was blinded prior to training but group 4 was not. The resulting data also showed no significant difference between these two groups in terms of response acquisition. Overton concluded that although pentobarbital does achieve response control and state dependency, it does not accomplish this by mediating altered sensitivity to foot shock or visual cues.

More recently, Hill, Jones and Bell (1971) utilized Overton's (1964) design in testing the effectiveness of pentobarbital and morphine in producing state-dependent learning. Although some transfer between drug and nondrug states was measured using

pentobarbital, it was found, however, to produce strong state-dependent learning. No state-dependency was evidenced using morphine. It would appear, therefore, that pentobarbital, in view of the preceding studies, is a drug with a capability of producing strong state-dependent effects and dissociation.

Other drugs, in addition to depressants and anti-convulsants, have demonstrated the ability to produce state-dependent effects in learning situations similar to those mentioned earlier in the paper. Siegel and Jarvick (1971) trained mice to escape footshock in a passive avoidance task in both a drug state of 100 mg/kg of mescaline and in a sterile water nondrug state. The animals showed high performance, in terms of short response latencies, when training and testing sessions were in identical drug states, but significantly poorer performance when training and testing were in opposite drug states.

In testing the acquisition and extinction of avoidance responses of rats injected with librium or sterile water, Kamano and Arp (1963) found that no significant differences occurred between either the group treated with librium or the group treated with sterile water during the acquisition phase. The librium group was then further divided into two subgroups, one continuing on librium and the other deprived of librium for the extinction phase. The sterile water group was also divided into two subgroups for the extinction phase, with one group continuing on sterile water and the other treated with librium. Results showed that the groups treated with librium were less resistant to

extinction than the group treated with sterile water regardless of whether the Ss had been treated with librium or sterile water during acquisition. This differential resistance to extinction between drug and nondrug groups during the extinction phase would tend to suggest state-dependent effects. In view of the fact that the dosage level of 23.56 mg/kg of librium was effective during extinction and yet did not produce ataxia suggests that a higher dosage level may have been required to produce equivalent state-dependent effects during acquisition.

In testing for transfer of training of a conditioned avoidance response, which consisted of jumping over a simple hurdle, Sachs et. al. (1966) found that librium caused significant dissociative effects. When trained after an injection of 15 mg/kg of librium, rats were observed to acquire a conditioned avoidance response significantly faster than rats trained after injections of isotonic saline. However, when tested in the nondrug state, the librium trained animals showed no significant retention of the learned response. Also saline trained animals showed a significant decrement in performance when tested with librium, regardless of whether or not they had received librium subsequent to training.

Further evidence that librium produces state-dependent effects were in a series of two successive experiments by Brown, Feldman and Moore (1968). In experiment I, male rats were trained to jump from a modified Lashley jumping stand in an attempt to determine if their solution of a brightness discrimination problem, utilized by the rats in determining the direction to jump, was

based on the presence or absence of librium. The experimental group was divided into 3 subgroups: (1) group DA (drugged on alternate days--librium on even-numbered days and saline on odd-numbered days), (2) DR (drugged randomly) and (3) DN (never drugged). Results showed that the performance in solving the brightness discrimination problem was not above chance level for the DR and DN groups, but group DA achieved solutions amounting to 97% correct for the saline group and 73% correct for the librium group, with both performance scores being significantly above the performance levels of groups DR and DN.

Because it was shown in experiment I that rats could learn responses based on the absence or presence of librium, experiment II was undertaken to determine if librium acquires response control by acting as a discriminative stimulus or by producing dissociation. Two groups, one of which was trained in the saline state only, and the other group which was trained in the librium state only, were given the same problems as the DA group in experiment I. Results showed that the Ss who were trained in either the drug or nondrug state exclusively, were significantly higher in performance than the DA group who was trained in both states. Brown et. al. (1968) concluded that these results were due to a lack of dissociation between drug and nondrug states, therefore indicating that librium achieves response control by acting as a discriminative stimulus.

Of greater recency in testing for state-dependency using librium was an experiment by Oishi, Iwahara, Yang and Yogi (1972)

using a passive-avoidance task for testing the retention of rats. They found, after testing for retention twice (retention I-48 hours after injection and retention II-72 hours after injection), no significant dissociation with a change in either drug state (D) or nondrug state (S) between acquisition and retention I (ie. SDS vs. SDD). Significant dissociation was found, however, if a change in either drug or nondrug state was made after retention I (ie. SSD vs. SSS and DDS vs. DDD).

Physiological Effects of Librium: Body Weight, Tolerance and Experimental Tasks. It may be seen from the preceding material that a majority of researchers have succeeded in demonstrating state-dependent learning with relatively great success when utilizing librium. However, in spite of its success, the drug, its properties and effects on ss in terms of health, task performance and interaction with other variables in an experiment should be adequately investigated. No uniform conclusion about librium is possible at this time as various researchers have arrived at opposite conclusions. This research, however, has given useful information about the physiological effects of librium.

Marriott and Spencer (1965) referred to librium as a minor tranquilizer, with its most striking feature being an ability to produce increased exploratory activity of rats placed in a Y-box for even a single instance previously in either the saline or librium state. Increased exploratory activity was not caused by higher dosage levels of 100 and 200 mg/kg, but signs of ataxia

were observed. On injections, librium solutions caused some local but brief irritation. Also no increase in defacation was noted.

Geller, Kulak and Seifter (1962) found that rats tolerated a greater number of shocks for a food reward after being injected with doses of 7.5 and 15 mg/kg librium than their nondrug controls. Doses of 30 mg/kg or more completely depressed responding, but this was due to a state of ataxia and not to intolerance of shock. Also rats injected with chlorpromazine accepted less shock than their nondrug controls. In both groups, the level of tolerance to shock was directly related to the dosage level of the particular drug used.

In training rats to solve a previously insoluble problem, which consisted of jumping from a Lashley stand through the correct door of the goal box to prevent falling into a net, Liberson, Kafka, Schwartz and Gaynon (1963) found that 15 mg/kg librium decreased the decision time for attempted solution and that this decrement was a function of the dosage level of the drug.

McDonald, Stern and Hahn (1963) have investigated the physiological effects of librium on 60 day old male albino rats. They were injected subcutaneously with either 50 or 150 mg/kg librium. The effects of both a single dose and 5-28 doses per day were investigated. Results for the single daily injection were as follows: (1) Activity was significantly decreased for six days after injection for the 150 mg/kg group but decreased for only 2 days for the 50 mg/kg group, (2) water intake was significantly increased for both groups but only within 24 hours

after injection, (3) body weight increased significantly for 1-4 days in the 150 mg/kg group, (4) food intake did not show any significant change and (5) resting heart rate was significantly higher for the 150 mg/kg group from 1-30 minutes after injection. In general, there was a tendency for both drug-injected groups to manifest a decrease in heart rate to tone stimulation 30 minutes after injection.

For the multiple daily injections, the results were: (1) heart rate was significantly lower for the 150 mg/kg group after two weeks of daily injections, (2) body weight was significantly higher for the 5 injections per day but lower for the 28 injections per day for the 150 mg/kg group, (3) water intake was significantly increased in both groups and (4) food intake was not increased for either group.

However these results have been contradicted, with respect to food intake, in other studies. Bainbridge (1968) used female rats in a Skinner box and found that 8 mg/kg of librium caused a 79% increase in bar pressing for a food reward over a saline control group. In a second test, rats were placed into an experimental box with a food trough containing 6 units of breakfast cereal. After the rat had consumed 2 units of cereal, the food trough was electrified. After a week of training, the feeding latency, or time elapsing before the rat took the first unit of cereal, was measured. It was found that a dose of 8 mg/kg of librium caused a significant decrease in feeding latency as compared with the saline control group. In a third test,

isolated rats on a 22-hour deprivation schedule, were fed 2 hours daily and treated with either 8 mg/kg of librium or isotonic saline 30 minutes before feeding each day. Results showed a 54% increase in food consumption for the group treated with librium.

Liberson et. al. (1963) also found that all of the rats treated with 15 mg/kg of librium ate freely while on the Dashiely jumping stand while 2 of the 8 control animals ate nothing while on the stand. In addition, the remaining 6 control animals also exhibited a significantly longer decision time for eating (18.3 seconds as compared with 10 seconds for the librium treated group).

Randall, Shallek, Heise, Keith and Bagdon (1960) also found librium to be an appetite stimulant. After injections ranging from 12.5 to 50 mg/kg of librium, rats were found to increase their food consumption from 20 to 60% during a 4-hour test.

Richelle, Khenseval, Fontaine and Thone (1962) trained rats to press a lever in a Skinner box for a food reward, either on a fixed interval schedule or on a differential schedule of reinforcement. During the fixed interval schedule, the rats were rewarded every 2 minutes, regardless of the response rate and during the differential schedule, a reward was given only after a minimum time of 34 seconds had elapsed since the last response. Doses of 1, 2, 3, 4, 5, 6, 7 and 8 mg/kg of librium were administered and it was found that as the dosage level was increased, food consumption also increased significantly under both schedules of reinforcement.

In a series of feeding experiments, Randall et. al. (1960) injected doses of 15, 30 and 60 mg/kg of librium into both male and female rats over a period of 14 weeks. A significant increment

in body weight was observed in the males at the 30 and 60 mg/kg dosage level and in the females at the 60 mg/kg dosage level.

Also McDonald et. al. (1963) found a significant increase in body weight after single injections of 50 and 150 mg/kg of librium. The increase was found to persist for 1-2 days for the 50 mg/kg group and from 1-4 days for the 150 mg/kg group. Increasing the injections to 5 per day, a significant increase in body weight was again found for both the 50 and 150 mg/kg librium treated groups. However a significant decrement in body weight was found for both groups if the frequency of injections was increased to 28 per day. McDonald et. al. (1963) have concluded that the reason for the decrement in body weight after two weeks of 28 daily injections as opposed to an increment in body weight after five days of daily injections of 50 and 150 mg/kg of librium, was the manner in which the rats were housed. The rats given the five days of daily injections were individually housed with access to activity wheels while the rats given 28 daily injections were not but rather housed as a group. According to McDonald et. al. (1963) rats housed with access to the activity wheels showed significant increases in body weight while those housed without access to this wheel showed significant decrements in body weight, thus accounting for the discrepancy in body weight between those rats given five days of daily injections and those given 28 injections per day. All results were measured after a 2 week period of daily injections.

Contrary to the findings of Randall et. al. (1960) and McDonald et. al. (1963) are those of Liberson et. al. (1963) who

studied the effects of 15 mg/kg of librium on the fixated behavior of male rats. Liberson found no significant differences in body weight for either control or drug-treated rats during either a soluble or insoluble problem phase over a period of 20 days. However, the period of testing was conceivably not of sufficient length (compared to 14 weeks for Randall et. al. 1960) nor of sufficiently high dosage (30 and 60 mg/kg for Randall et. al. 1960 and 50 and 150 mg/kg for McDonald et. al. 1963) for significant differences in body weight to appear.

Tolerance effects were studied by Hoogland, Miya and Bousquet (1966) by injecting rats with 100 mg/kg of librium and 2 mg/kg saline water for a five day period. On the sixth day the rats were sacrificed and chemically analyzed. They found that tolerance to the skeletal muscle effects of librium had occurred after the above stated dosage of 100 mg/kg per day for 5 days.

The majority of studies undertaken using librium have reported favorable after effects on rats. Only Liberson et. al. (1963) have reported a death while using librium in the course of an experiment and this death was determined to have resulted from a disease completely unrelated to the effects of librium. It would appear, therefore, that librium is pharmacologically safe for use with rats, in relatively high doses, for extended periods of time and with no apparent after effects.

The Relationship of Memory Recall to State-Dependent Learning.

In the area of state-dependent learning, extensive investigative effort has been directed into the dissociation and transfer effects

of different drug states. Connelly (1971) has suggested important implications for research if the area of memory recall were combined with state-dependent learning. This synthesis, according to Connelly, would be quite feasible because these areas are directly related in at least two important ways: (1) both areas assume that learning has taken place and (2) both areas recognize that the effects of interference on memory retrieval mechanism result in decreased recall.

Connelly (1971) also suggests using a device normally found in memory retrieval designs called a "prompter" as a measure of whether any dissociative effects can be transferred to a different drug state. According to Bahrick (1969), a "prompter" is a word or other device which has a predetermined probability of evoking the correct response if no prior training is given. In this study, Bahrick used memory prompters (such as azure or sky to elicit blue) in a paired-associate task with one group of humans but without prompters for the other group. The results showed that during the critical 2 hour period after training, when most forgetting occurs, no loss of retention occurred for the group presented with prompters. Also two weeks after training, the group presented with prompters still maintained 70% of the performance level encountered immediately after training, while the control group showed only 30% of the performance level present after training.

Also Cheek (1959) found that human Ss could recall events that were experienced originally under a drug state of sodium pentothal, in a nondrug state under hypnosis. Perhaps hypnosis

produced an external discriminative stimulus which acted as a memory prompter (Connelly 1971).

In any event, if transfer effects are to overcome the dissociative effects of drug-produced states, and these in turn studied at the level of the rat, then memory prompters, other than words, will have to be utilized. Also an emotionally important stimulus, equivalent to some emotionally important words as used by humans, must be devised and presented to the rat. Connelly (1971) used shock paired with a buzzer in training and thus allowed the buzzer to serve as a conditioned stimulus taking on the aversive properties of the shock (which is already an emotionally important stimulus), and therefore became an emotionally important stimulus itself. Subsequently, during testing, half of the SS received the buzzer and half did not. The foot shock was not presented during testing and therefore the buzzer now acted as a memory prompter. No state-dependency was observed, but rather extinction occurred. Connelly interpreted these results as due to the lack of reminder trials during testing, which led to the buzzer gradually ceasing to be an emotionally important stimulus.

However Connelly, Connelly and Epps (1972) demonstrated both state-dependent learning and its disruption in an escape learning task also using male rats. Two experimental groups were used: a dissociation group, which was trained to turn in one direction in a modified T-maze under the effects of 15 mg/kg librium and in the opposite direction while in the nondrug state, and a transfer group, which was also trained to turn in one direction while in a

15 mg/kg librium state and in the opposite direction while in the nondrug state. However wrong turns were followed by .65 ma of shock and paired with a 10KHz buzzer in the drug state and with a 1KHz buzzer in the nondrug state. During testing, the buzzer was presented without the foot shock in the opposite drug state. The results showed that the Ss in the transfer group turned in the direction signalled by the buzzer (and now acting as a memory prompter) as often as the Ss in the dissociation group turned in the direction signalled by the drug state. It was concluded that the buzzer took on the aversive properties of the foot shock and overcame the effects of drug-state dependency by mediating transfer between the drug and nondrug states.

This writer proposed also to use shock as an emotionally important stimulus and to thoroughly test its aversive characteristics, several levels of shock intensity should be utilized. In the Connelly, Connelly and Epps (1972) study, only a single level of shock intensity was used and it was assumed that the aversive nature of this level of shock, when paired with the buzzer in training, enabled the buzzer to assume the same aversive characteristics and therefore overcome the effects of drug state-dependency in testing. However since varying levels of foot shock were not used, reciprocal effects on drug state-dependency, in terms of varying amounts of transfer between drug and nondrug states was not observed. The aversive characteristics of foot shock, and in turn, of the memory prompters, in terms of maximum and minimum levels of effectiveness in mediating transfer between drug states

during testing was not investigated by Connelly et. al. (1971). The effectiveness of foot shock in mediating transfer between drug states, through the use of memory prompters contiguously associated with the foot shock, could be measured if the shock level of .65 ma as utilized by Connelly et. al. (1971) is used as a baseline and greater or lesser values than this are used. If the amount of transfer is observed to vary between drug states as a function of the level of foot shock used, and in turn of the buzzer used, then the level of foot shock and of the buzzer as an emotionally important stimulus in mediating transfer between drug and nondrug states, could be measured.

Problem. To determine whether the effects of 15 mg/kg of librium or of a non-drug state could be overcome or transferred by the utilization of memory prompters in the form of buzzers.

Hypothesis. That the groups receiving the buzzers or memory prompters inappropriate to the drug state demonstrate more transfer in the direction of the memory prompter or respond in the direction signalled by the memory prompter as often as the dissociation groups respond in the direction as signalled by the drug state. Also that the amount of transfer varies as a function of the emotional strength of the buzzer which in turn varies as a function of the intensity of the foot shock. These predictions were evaluated in terms of latencies and correct turns.

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CHAPTER II

METHOD

Subjects. Ss were 64 male-hooded rats of Long-Evans strain, purchased from Maxfield Farms, New Jersey, and were approximately 90 days old at the beginning of testing. The Ss were maintained in separate cages in a room that was relatively controlled in terms of temperature, humidity, light and background noise. Four squads of animals were used with 16 animals per squad. Ss were assigned randomly to each squad.

Apparatus. The testing apparatus was a gray wooden T-maze measuring 75 cm. long and 18 cm. wide with the start box located between each goal box. The start box measured 19 cm. long, 18 cm. wide and 26.8 cm. high. The goal boxes were 28 cm. long, 18 cm. wide and 13.4 cm. in height. Two wooden guillotine doors also separated each goal box from the start box and a Lafayette .01 second timer, connected to a photoelectric cell located in each goal box, recorded response latencies. Two manually operated buzzers, with 1 and 10 KHz tones delivered through a 13.13 cm. radio speaker, were placed at the choice point. Additional apparatus included one nondisposable tuberculin long 1 cc syringe, two 6.3 mm. needles, 10 cc vials of Librium (CDP) and one vial of sterile water.

Drugs. Drugs were injected intramuscularly in the hip muscle of each animal 16 minutes before trial running. The CDP dosage was 15 mg/kg for both experimental and control groups and

1 cc/kg sterile water for both experimental and control groups. Ss were injected at the same time each day for both drug states and in the same order to allow for tolerance effects of the drug.

General Procedure. A 3 (D-D-D vs. ND-ND-ND vs. D-ND-D) x 2 (buzzer vs. no buzzer) factorial design was used. 2 transfer groups (.6 ma and 1.5 ma foot shock) were added yielding the 8 groups as summarized in Table 1. 8 Ss were used in each group.

The basic design was a discrimination learning paradigm with training and testing given in both the drug and nondrug states as shown in columns 1 and 2, Table 1.

There were four experimental groups: 3 transfer groups (groups 1, 2 and 3) and 1 dissociation group (group 4). Dissociation was measured by comparing this group's performance with the performance of two control groups (groups 5 and 7) receiving all D or ND training.

During training, the transfer Ss were always presented with a 10 KHz buzzer paired with foot shock in the D state and a 1 KHz buzzer paired with foot shock in the ND state if entry into the incorrect goal box occurred. However, during non shock testing, the buzzer-drug state association was reversed so that the ability of the buzzer to mediate transfer between D and ND states could be measured. Transfer was measured by recording the number of times the transfer Ss turned in the direction as signalled by the buzzer as compared with the number of times the dissociation Ss turned in the direction as signalled by the drug state. Since the buzzer, as a conditioned stimulus, represented the emotionally

important stimulus of foot shock, and because a conflict resulted due to the command to turn in one direction as signalled by the buzzer and the command to turn in the opposite direction as signalled by the drug state, a direct test of the hypothesis, that an emotionally important stimulus can overcome the effects of drug-state control, was made possible.

Each transfer group was presented with a different level of shock intensity to measure its effect on dissociation and drug-state control. The shock intensities were: (1) .6 ma, (2) 1.0 ma and (3) 1.5 ma.

A Pilot Study was undertaken prior to the experiment to determine if the values of shock intensity initially proposed were capable of mediating significantly different amounts of transfer between drug and nondrug states. The study consisted of 3 groups of Ss (2 Ss per group) for a total of 6 Ss, with each group receiving a different level of shock intensity (group 1 - .6 ma, group 2 - 1.0 ma and group 3 - 1.5 ma) for entry into the incorrect goal box. Training consisted of 10 trials per day, with 5 trials in the morning in one drug state and 5 trials, at least 6 hours later, in the afternoon in the opposite drug state. After a criterion of 9 out of 10 correct trials was reached, 5 days of non shock testing occurred, in which the buzzer-drug state association was reversed for the transfer Ss and the amount of transfer between drug states was measured. After testing was completed, the Pilot Study was terminated.

To provide a baseline for measuring the performance of the

state-dependent groups, 4 control groups (groups 5, 6, 7 and 8), consisting of 2 D and 2 ND groups were used as shown in column 1, Table 1. To evaluate any possible effects of either buzzer's pitch, 3 groups, 1 experimental group (group 4) and 2 control groups (groups 5 and 7) were not given the buzzer during training or testing. To evaluate any possible effects due to drug toxicity, 2 control groups (groups 6 and 8) were given the buzzer in the same drug states as experimental groups 1, 2 and 3 but only in a single drug state as opposed to both drug states per day for experimental groups 1, 2 and 3.

Training consisted of 10 trials per day for experimental groups 1, 2, 3 and 4 which amounted to 5 trials in the morning and 5 trials, at least 6 hours later, in the afternoon. The drug states were randomized for morning and afternoon sessions. For the remaining 4 control groups (groups 5, 6, 7 and 8), a total of 5 trials were run each day, all of which were run in a single drug state.

Testing consisted of 10 trials per day for 5 days with 5 trials in the morning in one drug state and 5 trials in the afternoon, also at least 6 hours later, in the opposite drug state, for experimental groups 1, 2, 3 and 4. Drug and nondrug states were balanced for testing in regard to time of testing (morning or afternoon) and day of testing, with the first testing day in the opposite drug state (with respect to afternoon or morning) as the last day of training.

A reminder trial was given after each 5 test trials, in the

same drug state as in training, and served to eliminate any possible extinction effects due to presentation of the conditioned stimulus (buzzer) without the unconditioned stimulus (foot shock). The control groups were given 5 trials per day for 5 days in the same drug state as in the training sessions. Ss were assigned to their respective groups in a random manner on January 29, 1973.

CHAPTER III

RESULTS

A 2 (Buzzer vs. No Buzzer) x 3 (D-D-D vs. ND-ND-ND vs. D-ND-D) x 5 (Trials) analysis of variance (ANOVA), (Winer, 1962, Pg. 342) with repeated measures on the last factor was computed separately for training and testing sessions in terms of number of correct turns and choice latencies (See Tables 2, 3, 4 and 5). A 4 (Dissociation vs. three Buzzer groups) x 2 (D vs. ND) x 5 (Trials) analysis of variance (ANOVA), (Winer, 1962, Pg. 324) with repeated measures on the last two factors was computed separately for training and testing sessions in terms of number of correct turns (See Tables 6 and 7). Also a 2 (Buzzer vs. No Buzzer) x 2 (D control vs. D experimental) analysis of variance was computed separately for training sessions in terms of trials to criterion (Winer, 1962, Pg. 233) (See Table 8) and a 2 (Buzzer vs. No Buzzer) x 3 (D-D-D vs. ND-ND-ND vs. D-ND-D) x 2 (Trials) analysis of variance (Winer, 1962, Pg. 342) with repeated measures on the last factor was computed for choice latencies in terms of the last training and first testing session (See Table 9). The results for the correct turns will be discussed first.

Correct Turns. During training, a highly significant difference was found between the first and last four training

days for both experimental and control groups ($F=35.04$; $df=4/168$; $p<.001$). During testing, a highly significant difference was found between the drug and nondrug control groups and the experimental groups with a greater number of correct turns attained by the control groups ($F=75.35$; $df=2/42$; $p<.001$). Also significant differences were found for the interactions of drug state and test days ($F=2.43$; $df=8/168$; $p<.05$) and between buzzer groups, drug states and test sessions ($F=2.88$; $df=8/168$; $p<.001$). An additional ANOVA for both training and testing sessions was performed, which added to the dissociation and median level transfer group (1.0 ma), two additional transfer groups (.6 ma and 1.5 ma) but excluded the buzzer and drug control groups (See Tables 6 and 7). This analysis permitted a direct comparison of all experimental groups for any significant differences in terms of correct turns. A highly significant difference was found between the first and last four sessions of training for all four groups ($F=33.54$; $df=4/112$; $p<.001$). During testing, a significant difference was found between buzzer or transfer and non-buzzer or dissociation groups with a greater number of correct turns achieved by the non-buzzer group. A significant difference was also found for the interaction between buzzer groups and test days ($F=2.621$; $df=12/112$; $p<.01$) and for the interaction of buzzer groups, drug states and test days ($F=2.77$; $df=12/112$; $p<.01$).

Latencies. No significant differences were found over the last training session and five testing sessions, (See

Table 5), however a highly significant difference was found, (See Table 4), over the first and last four training sessions ($F= 6.56$; $df= 4/168$; $p<.001$). Also a significant difference was found between the drug and nondrug control and experimental groups over the last training and first testing session (See Table 9), ($F=3.48$; $df= 2/42$; $p<.05$).

Trials to Criterion. A highly significant difference was found between the drug and nondrug control and experimental groups (See Table 8), with fewer trials necessary to reach criterion for the control group ($F=22.31$; $df= 1/28$; $p<.001$).

CHAPTER IV

DISCUSSION

For the hypothesis of this thesis to be verified, the transfer Ss must perform during testing as signalled by the buzzer, as often as the dissociation Ss perform as signalled by the drug state. Their performance may be ascertained according to the response measures of latency and correct turns.

In terms of latency, the hypothesis would appear to be supported in view of the fact that no significant difference was found between dissociation and transfer Ss during the last training and subsequent testing sessions. The only significant difference was between the first and last four days of training for both experimental groups. This would tend to be expected because as the S progresses through the course of training, the rate of learning increases, thereby causing an increase in running speed and a decrease in latency.

In the case of correct turns, the results were neither supportive nor non-supportive, but rather unusable. By use of the sign test (Dixon and Massey, 1951, Table 1) it was found that the performance of all of the Ss, in both dissociation and transfer groups, was not above random responding during testing (See Fig. 1). Several reasons for this may be given.

First, it was found, by using a digital frequency counter, that the audio generator (used to produce differential frequency tones), was malfunctioning and producing frequencies of 300 and

3200 Hz while positioned to produce 1,000 and 10,000 Hz. It is obvious that the frequency differential for discriminating auditory cues, consisting of 2,900 Hz, is greatly reduced from the initially proposed 9,000 Hz, therefore making discrimination much more difficult. If the discrimination of auditory cues or memory prompters is greatly reduced, then their ability to mediate transfer between drug states is correspondingly reduced, resulting in random responding.

Second, even if the reduced frequency differential were discriminable, its presentation was in a range of high threshold sensitivity. Although Blackwell and Schlosberg (1943) demonstrated that rats could discriminate tones of 8,000 and 10,000 Hz, these tones were presented in a range of the rat's greatest sensitivity, which according to Cowles and Pennington (1943) is centered at 11,584 Hz. Below this range, the rat's threshold increases gradually to 1,000 Hz and below this frequency, a steep 20 db/octave rolloff occurs with a difference limen situated at 320 Hz, as stated in the findings of Gourevitch and Cole (1963). Thus the effective lower limit of audibility of the rat would appear to be 1,000 Hz, also in agreement with Munn (1950), leading to the conclusion that detection, and hence discrimination of the lower auditory cue of 300 Hz used in the present study, was extremely difficult, if not impossible.

If the inability to discriminate tones, acting as cues or memory prompters, is shown to be a primary reason for lack of significant amounts of transfer for the transfer groups, the same

rationale cannot be used for explaining lack of significant amounts of dissociation for the dissociation groups because this group was not presented with auditory cues. Since the dissociation Ss, in order to achieve significant state-dependency, must utilize cues for differential responding obtained from the drug state itself, as demonstrated by Connelly et. al. (1971), failure to achieve state dependency must be due in part to the level of shock utilized. It was shown in the Connelly et. al. (1971) study that memory prompters mediate transfer between drug states because of their association with the aversive motivational characteristics of foot shock in training. It is apparent, therefore, that the level of shock, as well as the ability of the S to discriminate memory prompters, is responsible for transfer in the case of the transfer Ss. This logic could be applied to the dissociation Ss, for example, if it is hypothesized that a prime level of shock exists for maximum dissociation of drug states and if this level is surpassed, transfer between drug states occurs and therefore only partial dissociation. Although none of the transfer groups in the present study demonstrated significant transfer, the amount of transfer did increase with an increase in shock up to the median shock level used and subsequently decreased with an increase to the highest shock level used, suggesting again the existence of a prime level of shock for maximum transfer and dissociation.

Another variable that may have prevented the dissociation Ss from achieving total state-dependency in the present study might have been the dosage level of librium utilized. If the dosage

level used was too low for total dissociation to occur, then transfer between drug states would have occurred, causing interference and therefore increased difficulty of learning. However this explanation is not particularly convincing in view of the fact that Connelly et. al. (1971) utilized an equivalent dosage level and whose dissociation Ss thereby achieved total state-dependency. Also if an inadequate dosage level were responsible for partial dissociation in testing in the present study, then total state-dependency would have been unattainable in training also. This was not the case, as all dissociation Ss achieved at least 90%, and in some instances, 100% state-dependency during the final two days of training.

However dosage level may be a relevant variable if viewed as necessarily interacting with shock to produce state-dependency. If shock is considered not only as an aversive and therefore motivating stimulus, but also as producing or enabling the S to discriminate additional cues for learning a particular task, then if a prime level of shock exists for maximum dissociation, as discussed previously, utilizing a level greater than this would cause transfer of cues and therefore partial dissociation. This explanation would explain the discrepancy in results between the dissociation Ss in the present study and those used by Connelly et. al. (1971). If a prime level of shock is equal to .65 ma, as used by Connelly et. al. (1971), and a higher value such as 1.0 ma is used, as in the present study, then transfer and only partial dissociation would result, which was equivalent to the

findings in the present study. If total dissociation is to be achieved using this shock level, then perhaps a higher dosage level would have to be utilized possibly to reduce distracting cues from other drug states caused by the increased shock level, thereby allowing the S to concentrate more fully on cues produced by the dominant drug state. It therefore appears that for maximum dissociation and transfer to occur, an interaction between a prime dosage level, as well as a prime shock level must exist.

Recommendations are for a repeat of the above study, using tones of 1,000 and 10,000 Hz as auditory cues or memory prompters for the transfer groups. Also a shock level of .65 ma and/or .8 ma might be utilized in training for the dissociation Ss in order to achieve a greater and possibly significant amount of state-dependency and therefore more precisely define a prime shock level for maximum dissociation, and in turn, for mediating transfer. The study might also be expanded to determine the effects of different dosage levels of librium, as well as other similar, state-dependent drugs, in combination with different shock levels in producing dissociation and transfer. The effects of dosage level, shock level and frequency of auditory cues on dissociated learning could then be parametrically analyzed.

CHAPTER V

SUMMARY

The effects of aversive stimuli and their disruption of dissociated learning in a discrimination paradigm were investigated in this study. Eight groups of eight rats each were used with one group trained as a dissociation group and three other groups trained as dissociation groups but utilized as transfer groups during testing. All of these groups were trained to turn in one direction in a modified T-maze, while in a particular drug state and in the opposite direction while in another drug state. Incorrect turns were punished with foot shock, and in the case of the transfer groups, a different buzzer was sounded for each drug state, contiguous with the foot shock. Thus the aversive properties of the foot shock became conditioned to the buzzer. During testing, foot shock was terminated. The dissociation group was tested for state-dependency and the transfer groups were tested for transfer by reversing the buzzer-drug state association.

Results were analyzed in terms of correct turns, latencies and trials to criterion. No significant differences in latencies during testing were found between dissociation and transfer groups. However a significant difference was found in the number of correct turns in testing between dissociation and transfer groups, with the dissociation group achieving a greater number of correct turns. None of the groups, however, performed above a random level of response.

The results were discussed in relation to a prime shock level for producing maximum dissociation and transfer.

Appendixes

Appendix A--Tables

TABLE 1.

Group Division - Training and Testing

Ex Groups		Training	Testing				
1 (.6 ma)	A.M.	D**	ND**	D*	ND**	D*	ND**
	P.M.	ND*	D*	ND**	D*	ND**	D*
2 (1.0 ma)	A.M.	D**	ND**	D*	ND**	D*	ND**
	P.M.	ND*	D*	ND**	D*	ND**	D*
3 (1.5 ma)	A.M.	D**	ND**	D*	ND**	D*	ND**
	P.M.	ND*	D*	ND**	D*	ND**	D*
4 (1.0 ma)	A.M.	D	ND	D	ND	D	ND
	P.M.	ND	D	ND	D	ND	D

Cn Groups		Training	Testing				
5 (1.0 ma)		D	D	D	D	D	D
6 (1.0 ma)		D**	D**	D**	D**	D**	D**
7 (1.0 ma)		ND	ND	ND	ND	ND	ND
8 (1.0 ma)		ND*	ND*	ND*	ND*	ND*	ND*

Note * = Low (1 KHz) Buzzer
 ** = High (10 KHz) Buzzer

Note Half of each Cn Group was run in the A.M. and half in the P.M.

Table 2

Summary Table and ANOVA of Correct Turns for Training

		c ₁	c ₂	c ₃	c ₄	c ₅	Total
a ₁	b ₁	23	28	30	37	39	157
	b ₂	31	30	33	36	39	169
	b ₃	26	29	33	36	37.5	161.5
a ₂	b ₁	31	26	29	38	39	163
	b ₂	29	33	32	36	39	169
	b ₃	24	29.5	30.5	36.5	38.5	159
		164	175.5	187.5	219.5	232	978.5

Source of Variation	SS	df	MS	F	p
Between subjects	26.72	47			
A (Buzzer vs. No Buzzer)	.05	1	.05	.089	N.S.
B (D vs. ND vs. D-ND-D)	2.62	2	1.31	2.34	N.S.
AB	.48	2	.24	.43	N.S.
Subj w. groups (error bet.)	23.57	42	.56		
Within subjects	164.60	192			
C (Trials)	70.09	4	17.52	35.04	.001
AC	.82	4	.21	.42	N.S.
BC	4.78	8	.60	1.20	N.S.
ABC	4.64	8	.58	1.16	N.S.
C x subj w. groups (error (within))	84.27	168	.50		

Note - (a₁ = Buzzer vs. No Buzzer, b₁ = D vs. ND vs. D-ND-D, c₁ = Trials).

Table 3

Summary Table and ANOVA of Correct Turns for Testing

		c ₁	c ₂	c ₃	c ₄	c ₅	Total
a ₁	b ₁	39	38	38	37	39	191
	b ₂	37	40	39	39	39	194
	b ₃	19	29	19	28.5	23	118.5
a ₂	b ₁	35	31	36	40	39	181
	b ₂	36	40	40	39	40	195
	b ₃	21.5	22.5	22.5	19	19.5	105
		187.5	200.5	194.5	202.5	199.5	984.5

Source of Variation	SS	df	MS	F	p
Between Subjects	268.499	47			
A (Buzzer vs. No Buzzer)	2.11	1	2.11	1.53	N.S.
B (D vs. ND vs. D-ND-D)	207.22	2	103.61	75.35	.001
AB	1.43	2	.715	.52	N.S.
Subj w. groups (error (between))	57.744	42	1.375		
Within Subjects	86.25	192			
C (Test Days)	3.025	4	.756	1.99	N.S.
AC	2.96	4	.74	1.95	N.S.
BC	7.40	8	.925	2.43	.05
ABC	8.77	8	1.096	2.88	.001
C x subj w. groups (error (within))	64.10	168	.38		

Note - (a₁ = Buzzer vs. No Buzzer, b₁ = D vs. ND vs. D-ND-D, c₁ = Test Days).

Table 4

Summary Table and ANOVA of Latencies for Training

		c ₁	c ₂	c ₃	c ₄	c ₅	Total
a ₁	b ₁	82.08	9.28	7.47	2.77	2.15	103.75
	b ₂	29.64	23.41	22.90	17.41	4.67	98.03
	b ₃	25.304	2.4	1.30	1.285	1.295	31.585
a ₂	b ₁	13.99	10.40	7.10	3.69	2.12	37.30
	b ₂	33.65	33.66	25.055	13.45	6.68	115.495
	b ₃	29.975	9.01	9.68	2.34	1.845	52.85
		214.64	91.16	73.505	40.945	18.76	439.01

Source of Variation	SS	df	MS	F	p
Between Subjects	1666.86	47			
A (Buzzer vs. No Buzzer)	3.202	1	3.202	.09	N.S.
B (D vs. ND vs. D-ND-D)	104.676	2	52.338	1.47	N.S.
AB	61.459	2	30.73	.86	N.S.
Subj w. groups (error between)	1497.523	42	35.655		
Within Subjects	3955.43	192			
C (Trials)	484.708	4	121.177	6.56	.001
AC	81.87	4	20.467	1.11	N.S.
BC	120.96	8	15.11	.82	N.S.
ABC	165.449	8	20.68	1.12	N.S.
C x subj w. groups (error within)	3102.487	168	18.47		

Note - (a₁ = Buzzer vs. No Buzzer, b₁ = D vs. ND vs. D-ND-D, c₁ = Trials).

Table 5

Summary Table and ANOVA of Latencies for Testing

		c ₁	c ₂	c ₃	c ₄	c ₅	c ₆	Total
a ₁	b ₁	2.15	1.70	1.86	3.85	1.59	1.51	12.66
	b ₂	4.67	5.76	5.23	4.20	6.49	15.20	41.55
	b ₃	1.295	1.74	1.52	2.115	1.975	2.39	11.035
a ₂	b ₁	2.12	5.00	4.06	4.59	3.92	3.49	23.18
	b ₂	6.68	8.73	5.60	4.66	1.96	2.22	29.85
	b ₃	1.845	3.735	2.57	6.155	3.53	4.945	22.78
		18.76	26.665	20.85	25.57	19.465	29.755	141.055

Source of Variation	SS	df	MS	F	p
Between Subjects	129.795	47			
A (Buzzer vs. No Buzzer)	.388	1	.388	.14	N.S.
B (D vs. ND vs. D-ND-D)	9.31	2	4.655	1.68	N.S.
AB	3.628	2	1.814	.654	N.S.
Subj w. groups (error (between))	116.469	42	2.773		
Within Subjects	125.446	240			
C (Trials)	2.068	5	.414	.807	N.S.
AC	3.508	5	.702	1.37	N.S.
BC	3.491	10	.349	.68	N.S.
ABC	8.631	10	.863	1.68	N.S.
C x subj w. groups (error (within))	107.748	210	.513		

Note - (a₁ = Buzzer vs. No Buzzer, b₁ = D vs. ND vs. D-ND-D, c₁ = Trials).

Table 6

Summary Table and ANOVA of Correct Turns for Training

	b_1					b_2					Total
	c_1	c_2	c_3	c_4	c_5	c_1	c_2	c_3	c_4	c_5	
a_1	30	28	31	33	38	22	28	33	38	36	317
a_2	28	30	30	34	39	25	33	31	35	39	324
a_3	25	29	30	36	37	23	30	31	37	40	318
a_4	30	30	35	35	39	26	31	26	36	38	326
	113	117	126	138	153	96	122	121	146	153	1285

Source of Variation	SS	df	MS	F	p
Between Subjects	18.022	31			
A (Buzzer vs. NO Buzzer)	.734	3	.245	.397	N.S.
Subj w. groups (error (a))	17.288	28	.617		
Within Subjects	308.9	288			
B (D vs. ND)	.253	1	.253	.211	N.S.
AB	1.91	3	.637	.531	N.S.
B x subj w. groups (error (b))	33.537	28	1.198		
C (Trials)	91.531	4	22.88	33.54	.001
AC	4.469	12	.372	.545	N.S.
C x subj w. groups (error (c))	76.40	112	.682		
BC	6.044	4	1.51	1.91	N.S.
ABC	6.356	12	.529	.670	N.S.
BC x subj w. groups (error (bc))	88.40	112	.789		

Note - (a_1 = Buzzer vs. No Buzzer, b_1 = D vs. ND, c_1 = Trials).

Table 7

Summary Table and ANOVA of Correct Turns for Testing

	b_1					b_2					Total
	c_1	c_2	c_3	c_4	c_5	c_1	c_2	c_3	c_4	c_5	
a_1	25	22	27	22	37	13	36	11	35	9	237
a_2	17	20	14	14	16	15	8	27	9	21	161
a_3	20	29	18	25	19	23	16	27	13	20	210
a_4	13	34	9	34	8	32	8	28	10	24	200
	75	105	68	95	80	83	68	93	67	74	808

Source of Variation	SS	df	MS	F	p
Between Subjects	127.8	31	4.123		
A (Buzzer vs. No Buzzer)	37.175	3	12.392	3.828	.05
Subj w. groups (error (a))	90.625	28	3.237		
Within Subjects	1356.0	288	4.708		
B (D vs. ND)	4.513	1	4.513	1.375	N.S.
AB	8.013	3	2.671	.814	N.S.
B x subj w. groups (error (b))	91.875	28	3.281		
C (Test Days)	3.143	4	.786	.567	N.S.
AC	43.607	12	3.634	2.621	.01
C x subj w. groups (error (c))	155.25	112	1.386		
BC	40.458	4	10.115	1.457	N.S.
ABC	231.393	12	19.283	2.777	.01
BC x subj w. groups (error (bc))	777.75	112	6.944		

Note - (a_1 = Buzzer vs. No Buzzer, b_1 = D vs. ND, c_1 = Test Days).

Table 8

Summary Table and ANOVA for Trials to Criterion

	b_1	b_2	Total
a_1	180	410	590
a_2	200	370	570
	380	780	1160

Source of Variation	SS	df	MS	F	p
A (Buzzer vs. No Buzzer)	12.50	1	12.50	.056	N.S.
B (D vs. ND)	5000.0	1	5000.0	22.31	.001
AB	112.50	1	112.50	.50	N.S.
Within cell	6275.00	28	224.11		
Total	11400.00				

Note - (a_1 = Buzzer vs. No Buzzer, b_1 = D vs. ND).

Table 9

Summary Table and ANOVA of Latencies for Training and Testing

		c ₁	c ₂	Total
a ₁	b ₁	2.15	1.70	3.85
	b ₂	4.67	5.76	10.43
	b ₃	1.295	1.74	3.035
a ₂	b ₁	2.12	5.00	7.12
	b ₂	6.68	8.73	15.41
	b ₃	1.845	3.735	5.58
		18.76	26.665	45.425

Source of Variation	SS	df	MS	F	p
Between Subjects	39.714	47			
A (Buzzer vs. No Buzzer)	1.218	1	1.218	1.55	N.S.
B (D vs. ND vs. D-ND-D)	5.456	2	2.728	3.48	.05
AB	.093	2	.046	.06	N.S.
Subj s. groups (error (between))	32.947	42	.784		
Within Subjects	20.024	48			
C (Trials)	.655	1	.655	1.46	N.S.
AC	.388	1	.388	.86	N.S.
BC	.008	2	.004	.008	N.S.
ABC	.103	2	.0515	.114	N.S.
C x subj w. groups (error (within))	18.92	42	.45		

Note - (a₁ = Buzzer vs. No Buzzer, b₁ = D vs. ND vs. D-ND-D, c₁ = Trials).

Appendix B--Figures

PERCENT DRUG STATE TURNS

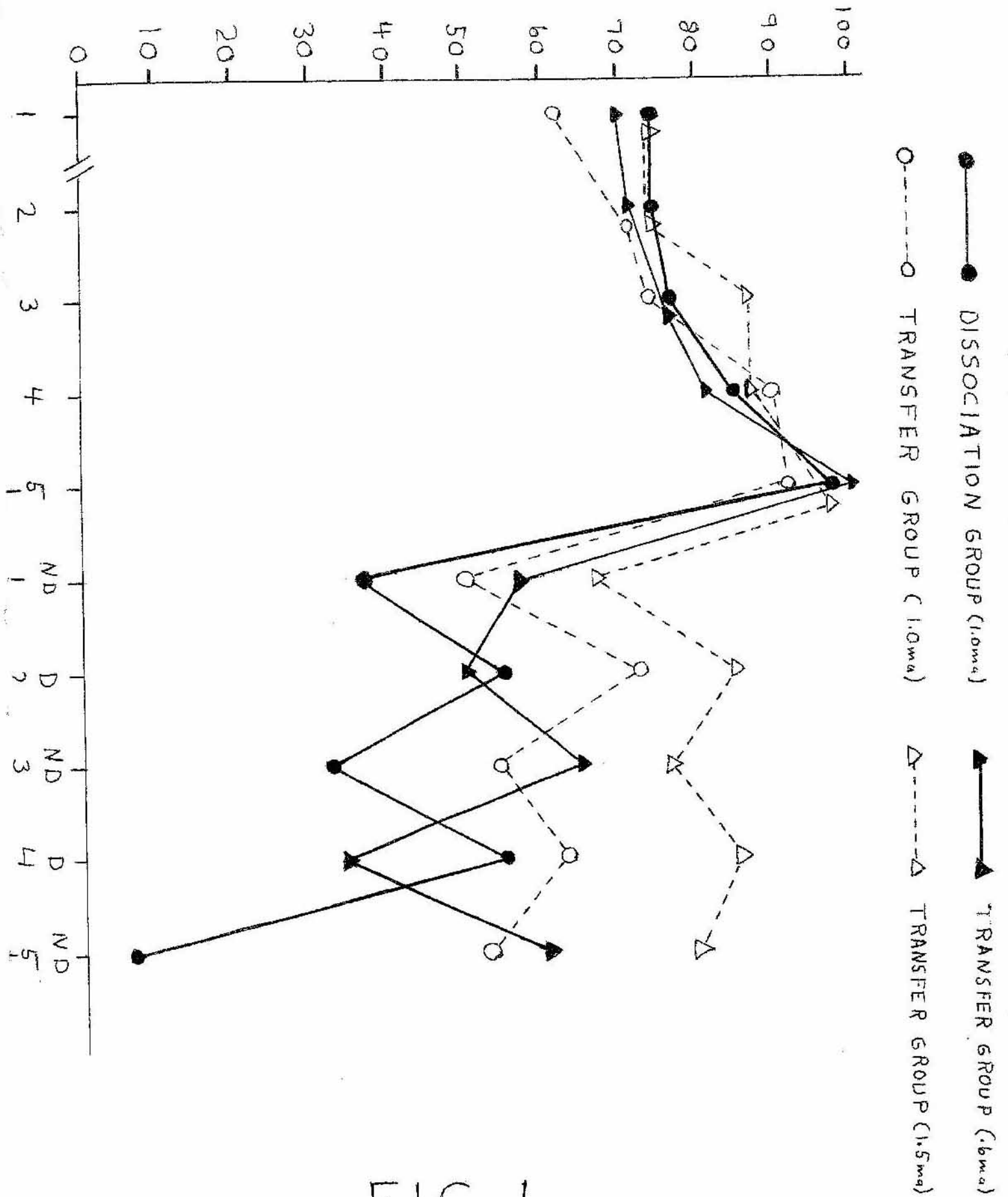


FIG. 1

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