

THE EFFECTS OF THREE DRIVE CONDITIONS ON  
THE SWIMMING SPEED OF ALBINO  
RATS IN A WATER MAZE  
SITUATION

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## CHAPTER I

### THE PROBLEM

#### Background to the Problem

Since Woodworth (1918) introduced the term drive, a great deal of effort has been spent in determining the utility of this construct for predicting behavior. One generally accepted attribute of drive has been that of energization (Brown, 1953; Dashiell, 1928; Hebb, 1955; Hull, 1943; Lindsley, 1957; Spence, 1956; Tolman, 1951; Young, 1936). According to this view, drives in the role of energizers are assumed to heighten an organism's level of activity. Until recent years, experimental attention had principally been focused upon the effects of single drives on performance. The main intent of these studies was to amass a body of empirical data by systematically relating certain observable antecedent events to consequent behaviors. The most consistent finding of these studies was that with increasing intensities of drive, response strength initially increased, then reached an asymptote and finally decreased.

More recently, psychologists have become interested in the problem of how two drives combine to affect behavior. In a very general way, according to the energization notion of drive, the addition of a drive to an already existing motivational state might be expected to lead to an increase in the strength of response. When one examines the available



evidence, however, this view appears much too oversimplified. Thus, studies reported in the literature suggest that some drives operate in combination to augment behavior while others do not, that the addition of a drive to an already present motivational state at some intensities facilitates responding while at increased intensities produces a decrement, and that drives may affect certain classes of responses but not others. As recognition of the complexities involved in relating drives to performance has increased, it has become apparent that much more attention must be given to the accumulation of systematically detailed data under a variety of conditions. In this regard, more empirically based knowledge needs to be gained about the effects on different kinds of performance of various numbers, kinds, and intensities of drives. With a foundation of this nature, it is believed that we will not only increase the scope and accuracy of our empirical generalizations but also contribute to the eventual development of a general and comprehensive formulation of the role of motivational variables in behavior.

#### Statement of the Problem

In implementing the foregoing objectives, this investigation is concerned with the examination of the effects of three drive variables working singly and in varying combinations, on performance. The approach to the problem was empirical in nature and although it has implications for several motivational formulations, this experiment was not embedded in any particular theory. The three drive conditions selected for study were hunger, oxygen deprivation, and an aversive water temperature condition. In assessing the effects of these drive

conditions on performance, we used both quantitative measures which included four different indices of swimming speed and qualitative measures, consisting of various responses which indicated deviations from a smooth swimming response. In both the variety and number of drives considered, the present study represents a departure from and extension of the types of motivational phenomena with which psychologists have heretofore been concerned.

## CHAPTER II

### A REVIEW OF THE LITERATURE

The intention here is to examine those studies which have related differences in drive level to a variety of response indices. This review can be divided into two general sections: the first dealing with single drive studies which have employed drive conditions similar to those used in this research, and the second with studies using two drives.

#### Single Drive Studies

The strategy used in most single drive studies has been to vary systematically the intensity of a drive either by lengthening the period of deprivation, as for example, hunger, or by increasing the stimulus intensity, as for example, aversive water temperature, and then testing for performance differences among differentially motivated groups with such criteria as running speed, activity rate, etc. In the bulk of studies in this area, the guiding, though not exclusive, assumption made by investigators was that increased drive intensity would lead to increased strength of response.

Hunger Studies: Activity rate as a function of hunger has frequently been studied by the revolving drum method. Hoskins (1925) subjected rats to short periods of food deprivation and found that activity increased by 200%. In several instances, animals persisted in their

increased rate of activity for several days after being satiated. Studies by Richter (1922; 1927), Dashiell (1925), and Anderson & Smith (1926) have reported very similar observations of increased activity with increased lengths of food deprivation. Although there have been difficulties in establishing the reliability of this method, the findings from these and other studies provide evidence that with increased periods of deprivation the rate of activity shows a corresponding increase.

A device balanced to register an animal's movements, the tambour-mounted cage, was used by Richter (1927) to study the activity cycle of animals under food deprivation. His findings indicated that the rate of activity followed a rhythmical pattern showing increases in rate every two hours. Powelson, (1925) noted that contractions of the stomach corresponded to periods of increased activity and that these occurred in two hour intervals, thereby corroborating the work of Richter. At any given time, as for example following 24 hours food deprivation, the effects of hunger on activity rate for a group of animals might reveal some to be performing at the beginning, others in the middle, and still others at the end of an activity cycle.

In contrast to studies which have indicated an increase in activity following periods of food deprivation, Sheffield & Campbell (1954) reported a study in which food deprived animals in a relatively constant environment remained quiescent. Housed in balanced cages which registered the movements of the animals, half the animals were kept in a lighted room, the other half in a dark room. An exhaust fan provided a monotonous masking sound. When the environment was made more stimulating by turning the lights on or off, the animals evidenced increased

activity. This finding suggests that it is not hunger alone, but hunger in conjunction with environmental stimulation which leads to increased activity rate.

The effect of hunger on the evocation of a response has been studied in detail by Skinner (1936) who found that the rate of bar pressing in a Skinner box was inversely proportional to the amount of food eaten before conditioning. Fitts (1940), and Finan and Taylor (1940) have shown that length of food deprivation before conditioning was related to resistance to extinction of the bar press response. Finan and Taylor further demonstrated a decrement in extinction responding following prolonged hunger. Using four groups of animals trained under either 1, 12, 24, and 48 hours of food deprivation, bar pressing was extinguished for all animals 48 and 72 hours later. The group conditioned under the 12 hour food deprivation condition showed the optimal response rate, whereas groups conditioned under 24 and 48 hours food deprivation evidenced a significant decrease in rate of extinction responding.

In sum, the findings relating food deprivation to performance indicate that from relatively short to moderate periods of deprivation a facilitation in response occurs, while for extended periods of time, a decrement in performance usually occurs. Thus, there appears to be a curvilinear relationship between length of food deprivation and rate of activity. The problem that arises with this repeated finding is that the drive energization construct is unable to account for a response decrement as a function of increased energization, which is assumed from longer periods of food deprivation. However, it does appear to be an adequate and sufficient explanation within more moderate



ranges of food deprivation.

Water Temperature: Inferentially, water may be said to have aversive properties for the rat, and several investigators have used escape from water as the motivation for maze learning (Glaser, 1910; Moss, 1924; Dunn, 1935). The utility of swimming speed as a response measure for aversive water conditions has been fairly well substantiated by the few studies reported in this area. Worell & Friedman (1962) forced rats to swim to one arm of a combination Y and T water maze under three temperature conditions of 55°, 70°, and 85° F. Significant differences in rate of swimming were found, such that the colder the water, the faster the animals swam. A similar study was reported by Hack (1933) who used temperatures of 15°, 37.5°, and 45° C. The apparatus used in this study was a straight alley water maze with two blind alleys attached to the sides. If an animal swam close to either side it would come to an obstruction which necessitated turning around and retracing before continuing. The findings indicated that learning was most rapid and swimming fastest for the coldest water condition, and least efficient and slowest for the group under the 37.5° C temperature condition. Animals in the 45° C group fell midway between the other two groups both as to rate of learning and swimming speed. In connection with this finding, it may be noted that Wever (1932) was the first to observe that water temperatures from 10° C up to the body temperature of the rat, about 37.5° C, resulted in slower swimming speeds, but that with increasing temperatures above 37.5° C there was a corresponding increment in rate of swimming. Consequently, in dealing with water temperature as a drive variable, one must take into account both relative units of temperature on a thermal scale and

deviation from body temperature. Since no attempt has been made to determine systematically swimming speeds for temperatures above and below the body temperature of the rat, it cannot be assumed that equal units in degrees centigrade in both directions produce comparable rates of swimming. Relevant to this point, Hack and Wever found that cold and warm water temperatures elicit qualitative differences in response with the greatest variability being associated with the warmer water conditions.

Using a more complex experimental situation, Waller, Waller and Brewster (1960) reported a study in which mice were required to learn a simple discrimination task. The apparatus was similar to a T maze except that the arms curved inward toward the starting alley to prevent exposure of an escape ladder. Employing water temperatures of 20°, 27°, and 34° C, animals in the colder water temperatures were found to swim significantly faster from the first to the last day of the experimental trials. However, a second criterion, number of errors in learning the discrimination was not found to distinguish the three temperature groups. This finding is consistent with dry maze selective learning situations where no attempt is made to control for the frequency of responses to the correct and incorrect discriminanda. (Spence, 1956; 1958; 1959).

Generally, it appears that for simple learning situations where the response criterion has been rate of movement, the experimental evidence indicates that changes in water temperature both above and below the body temperature of the rat produce performance differences, and the more extreme the temperature in either direction, the faster the rate of swimming.

Oxygen Deprivation: There is relatively little data on the effects of oxygen deprivation on swimming performance in an underwater swimming situation. Using a sealed room in which oxygen concentrations were reduced to 12% and 15% (normal amount present in the atmosphere at sea level is 21%), Shock and Scow (1942) found that the most noticeable effect on the maze performance of rats was a marked retardation in movement. While not exactly comparable to total oxygen deprivation, this finding has implications for prolonged oxygen deprivation in an underwater swimming situation.

A pilot study by Broadhurst (1957) appears to have been the only systematic approach to determining the range within which oxygen deprivation, as defined by length of underwater delay, is related to swimming speed. Using underwater delay intervals from 0 to 25 seconds, after which the animals were required to swim a short distance underwater in a straight alley maze, Broadhurst found that delays exceeding 20 seconds resulted in slower swimming speeds. Noteworthy here is that drive intensity as defined by length of oxygen deprivation bears a curvilinear relationship to swimming speed.

Obias & Stone (1953) used an even more stressful underwater delay interval. They report a study in which half the animals were subjected to 30 seconds underwater delay, the remaining half was permitted to surface immediately after immersion. Pretraining was given in a straight alley water maze after which animals were introduced to a U type water maze. In learning first a left and then a right response under the same underwater delays used in the previous situation, the 30 second delay group displayed a greater number of errors and slower learning in addition to more fixated and stereotypical responses, for example,



straddling the alleys, retracing, etc. In this study there was no attempt to control for initial position preferences, nor for the previous experience in the straight alley maze. Moreover, no consideration was given to the possibly reinforcing effects of surfacing and straddling the alleys, both of which could perhaps explain the poorer maze performance for the group under the greater stress.

#### Summary of the Single Drive Studies

This review of the three drive conditions points out that even for the more simple learning situations empirical information is relatively sparse. For food deprivation, activity rate may be subject to individual variation within brief periods of time. For water temperature, consideration should be given to both the intensity and direction of the temperature used in relation to the body temperature of the organism. For the effects of oxygen deprivation on swimming performance data on adaptation are conspicuously absent. The one finding which is more or less consistent for all three drive conditions is that under extreme deprivation or stimulation a response decrement and possibly death occurs. However, there is encouragement that within moderate to mild limits of drive intensity the energization concept of drive has been sustained, at least for simple performance situations.

#### Drive Combination Studies

Studies Using Shock: In the following group of studies, shock has been used in different ways in combination with other drive states, and, consequently has produced different effects on the evocation and strength of response.

In several studies, shock has been introduced outside of the experimental situation and precautions had been taken to prevent generalization from stimuli associated in the shock situation with those in the experimental situation. In a study by Siegel & Siegel (1949), the effects of shock in combination with water deprivation were studied. Animals placed on food and water deprivation four hours before the beginning of the experiment were randomly divided into two groups, one of which was removed to an adjacent room, shocked, and then returned to their home cages. Calibrated drinking tubes, left in the cages for a specified period of time, were used to determine the quantity of water ingested by shocked and nonshocked animals. The findings indicated that the shocked animals tended to drink a significantly greater quantity of water than did the nonshocked group. In a similar study, Siegel & Brantley (1951) trained animals under food deprivation to eat during a 30 minute feeding period until the quantity of food eaten reached stability over three such periods. The addition of shock to half the animals outside of the eating situation produced a facilitation in consummatory responding. Amsel & Maltzman (1950) used both a control group and the quantity of water ingested by a shocked group of animals prior to shock in determining the effects of combined shock and thirst. Animals were trained to drink for a specified period of time daily and when the level of water intake remained stable over several such drinking sessions, half the animals were removed to a shock apparatus where they received an electric shock before being placed in the familiar drinking situation. These investigators noted a sharp and significant rise in the average water consumption for the shocked group. On the following day the treatment conditions were reversed for shock

and control groups and no differences in quantity of water ingested were obtained. In these three studies, the addition of shock to an appetitional need resulted in an augmentation of the consummatory response.

In the preceding studies, the precautions taken do not entirely rule out the possibility of generalization from stimuli in the shock situation to those in the drinking situation. The role of generalization was experimentally examined in a study by Amsel & Cole (1953) who shocked animals in three different situations varying in similarity from a drinking situation. Using a procedure similar to that already outlined, the shocked-thirsty animals demonstrated the greatest decrement in drinking behavior when shocked in a situation more similar to the drinking situation. It appears then that generalization of cues from the shock to drinking situations resulted in a decrement in strength of response.

Using a situation less prone to the generalization from stimuli in the shock to learning situation, Levine, Staats & Frommer (1959) reported a study in which shock and an aversive water condition were combined. Animals were first trained to swim in a straight alley water maze, then, half the animals were shocked before being introduced to a U type water maze. The shocked animals, although not significantly different from the control group as to learning efficiency, were found to swim significantly faster.

In all of these studies, shock was delivered outside of the learning situation. The findings indicate that even when stimulus generalization is appreciably reduced, the effect of shock in combination with appetitional needs acts to augment consummatory behavior.

However, when stimuli in the consummatory situation take on "fear" arousing properties, the result is a decrement in consummatory behavior. The possible exception to this is suggested by a study reported by Ellis (1957) in which three levels of shock and three levels of food deprivation were factorially varied. Animals were trained to run a straight alley maze to obtain a food reward. After a rather extensive period of pretraining, half of the animals were shocked in a different room before being introduced into the learning situation, while the remaining half were treated in like manner but not shocked. No significant differences in running speed for groups on combined shock and food deprivation were obtained. However, since Ellis used a single trial following the introduction of shock, and since he also altered the food deprivation conditions for the various treatment groups just prior to running the animals, his findings are difficult to interpret unequivocally.

Apart from the introduction of shock outside of the performance situation, some investigators have used shock inside the performance situation before the organism has made a response. Thus, Amsel (1950b) trained animals in a straight alley maze to escape shock. Using two levels of shock, half of each group of animals was also placed on a food deprivation schedule. Amsel found no significant differences in running speed between shocked and food deprived animals and shocked animals at either level of shock. However, on the following day, animals were shocked on the first trial, as before, but not on the remaining 14 trials. Under these conditions, the previously shocked and food deprived animals were found to run significantly faster than shocked but satiated animals. Amsel (1950) also paired shock with a thirst

drive in a drinking situation. In this experiment, animals were shocked in the situation in which they had learned to drink. The result was a decrement in the quantity of water ingested by the shocked group. Amsel pointed out that animals were at no time shocked as they approached the drinking tube. In these two studies, the administration of shock inside of the performance situation and before the animal had made a response led to a decrement in strength of response.

The effect of combinations of shock and food deprivation on performance has been less consistent when shock has been continuously present in the learning situation. Muenzinger & Fletcher (1936) conducted a study in which shocked and hungry animals were found to learn a maze less efficiently than animals only on food deprivation. However, Bunch & Magdsick (1938) reported a study in which animals learned a maze under either of the following conditions, continuous shock, food deprivation, or a combination of shock and food deprivation. In this experiment, the intensity of the shock was lower than had been employed by Muenzinger & Fletcher. Although animals learned the maze with equal efficiency, the running times were fastest for the combined drive groups. One suggestion offered by this investigation is that while some response criteria may reflect differences in performance as a function of combining drives, others may not.

A study by Ullman (1951) in which shock was presented every minute for a duration of five seconds in a situation in which animals had learned to eat for 20 minutes each day, suggests that the presence of shock during eating although at first inhibiting may eventually lead to an increment in consummatory behavior. For the first two days of this experiment, animals ate less when shock was administered. Later,

however, the quantity of food ingested not only increased, but eating was more frequent during presentation of the shock. During a second portion of this study, with increased intensities of shock, a sharp rise in the incidence of eating was noted.

These studies point out that the use of shock in combination with other drives may lead to considerably different results depending upon whether shock is present inside or outside of the performance situation, and whether it is delivered before or during the response under observation. For studies in which shock was administered outside of the performance situation, it might be that the shock became conditioned to internal cues aroused by a particular level of food or water deprivation. In this context, consummatory behavior would alter these internal cues which had become conditioned to an unpleasant state of affairs or the shock. However, in the study by Levine, et. al., since the stimuli associated with the aversive water condition were not present at the time shock was administered, the evidence suggests that shock may induce a state of "emotionality" for which the mediating factor is not the stimulus situation or stimuli associated with a particular level of drive, but the organism itself. Ullman's study suggests that adaptation, in addition to the level of food deprivation present at the time shock is administered may be an important factor as to whether drives combine to augment or inhibit performance.

Studies Using Temperature: The use of temperature as a motivational variable has been found effective in both water and dry maze learning situations. In a study by Hellmer (1943) animals were raised in three different temperature rooms, 55°, 75°, and 90° F. Each room of animals was then divided into three subgroups which were randomly

assigned to the three temperature conditions under which they learned a 4 unit maze. During maze learning, animals were on a food deprivation schedule and rewarded with food upon successful completion of the maze. Relearning was tested one month later under the same temperature conditions which had obtained during the original learning experience. Using as criteria the number of trials required to learn the maze and running time, animals raised in the colder rooms were found to learn more efficiently and run faster than those raised in the warm room. It was also found that animals tested in the colder rooms learned faster and evidenced faster running times than those in the warm room. Similar findings were obtained for the relearning trials.

This experiment was replicated by Moore (1944) whose groups first learned the maze in the room in which they had been raised and were then subdivided and tested in either the same or one of the other rooms. In this study, as before, for both the temperature condition under which animals had been raised and under which they were later tested, learning was most efficient and running times fastest for the cold and moderate temperature conditions.

Braun, Wedekind & Smudski (1957) trained animals to swim a five choice-point water maze. Two water temperature conditions ( $15^{\circ}$  and  $35^{\circ}$  C.) and two levels of food deprivation (0 and 22 hours) were factorially varied. The results revealed that animals under higher intensities of drive swam significantly faster than did those under lower intensities. A second criterion, number of errors, also indicated significantly superior performance for higher drive groups. There were, however, no significant differences among the four treatment groups as to initially correct choice responses which would appear to

rule out the possibility that the higher drive groups were superior at the outset. In a study by Morey (1924) both speed of swimming and efficiency in learning a water maze were increased by the presence of a nondirectional buzzer sound.

From the preceding studies where temperature has been used in combination with either hunger, shock (Levine, et. al., 1959) or a buzzer sound, the results have consistently demonstrated an augmentation of movement responses and in most cases a facilitation in learning efficiency.

Studies Using Two Appetitional Needs: The evidence for an augmentation of response as a function of the addition of a drive to an already present drive state has been least consistent where two appetitional needs have been combined. Several studies using a selective learning task in a T maze have indicated that animals under combinations of food and water deprivation perform poorer than do animals under either condition alone. Kendler & Law (1950) noted that animals under 22 hours food and water deprivation were less efficient in learning a T maze than were animals under 22 hours food deprivation. In a second portion of this study, animals were trained to respond to one side when hungry, to the other when thirsty to obtain the appropriate reward. In both situations, groups under both food and water deprivation made significantly more errors than groups under a single drive. Levine (1956) obtained very similar findings. Danziger (1953) using a shorter period of water deprivation, 17 hours, in combination with 22 hours hunger deprivation also found that groups under two drive conditions performed less efficiently than groups under a single drive.



Kendler (1945) devised a study to test the effects of combinations of food and water deprivation on the resistance to extinction of the bar press response in a Skinner box. Animals were trained under a combination of 22 hours food deprivation and either 3, 6, 12, or 22 hours water deprivation. Conditions during extinction were the same as those during acquisition. Kendler found an increase in rate of responding up to a combination of 22 hours food and 12 hours water deprivation but noted a sharp decrement in extinction responding for the group under 22 hours food and water deprivation. Kendler's findings suggested a curvilinear relationship between rate of extinction responding and drive intensity. Bolles & Morlock (1960) reported a similar study but systematically varied water deprivation 0, 12, 18, 24, 48 hours for one group of animals under 24 hours food deprivation. Although the situation was a straight alley maze and the criterion running speed, these investigators corroborated the findings reported by Kendler. However, for a second group where food deprivation was systematically varied for animals under 24 hours water deprivation, the result was always a decrement in running speed.

Several explanations have been offered to account for these findings. Strange (1954) for example offers an explanation based on a physiological interaction of hunger and thirst. Amsel (1950) has suggested a competing response interpretation based on the similarity of eating and drinking responses.

#### Summary of Combined Drive Studies

In this second portion of the review of the literature, we have seen that investigators have frequently employed relatively complex

experimental situations and procedures in determining the effects on behavior of two drives in combination. Moreover, the approach to the manner in which drives combine to effect performances has for the most part been unsystematic. At the same time, research in this area has pointed out the importance of the criterion, the nature of the situation, and the particular time at which a given drive condition is introduced into the situation. It can also be seen that the time during which behavior is measured might lead one to quite different conclusions regarding the effects of two drives on performance. In none of these studies, however, has a purposeful attempt been made to determine the effects of three drives on behavior. In the following section we shall outline the method and procedures used to accomplish this purpose.

## CHAPTER III

### METHOD

In this section, we shall describe the manner in which three drive conditions were combined and their effects on the swimming performance of experimental subjects tested.

#### General Design

The experimental procedure involved several different phases. During the first of these, pretraining, all animals were given training in the swimming situation under 11 hours food deprivation, 2 1/2 seconds initial underwater delay, and 75° F water temperature. Each animal was given two successive trials daily for five days. Following pretraining, the experimental period proper began in which the animals were divided into 8 matched groups and run under various combinations of drive treatments. They were all given two successive trials each day for the first five days, and three successive trials per day on four additional days. Then on days 10 and 11, animals who had been subjected to the higher levels of food and oxygen deprivation were subjected to more intense levels of these drive conditions and run for two additional successive trials per day.

Since familiarization with the apparatus is basic to an understanding of the procedures and since also the particular water maze

used in this study incorporates several unique and automatic features which have not heretofore been employed for experiments of this nature, we turn first to a description of the apparatus.

### The Water Maze Apparatus

The apparatus was a combination Y and T type water maze consisting of three systems, the water maze proper, a wall-mounted control panel and desk, and a controlled bath reservoir.

The water maze proper, of which only the starting alley and left Y arm were used, was fitted with inserts for underwater swimming. The starting alley measured 13 1/2 inches in length by 7 inches in width, and extended into a wider choice area measuring 10 inches and 13 inches at its widest and longest points, respectively. A second underwater insert, 7 inches in width, extended 12 1/2 inches from the beginning of the left Y arm and terminated 6 inches from the end of the channel. The two inserts were 4 1/2 inches in height throughout, with walls and floor made from galvanized sheet metal painted flat black. The roof of the underwater inserts was made of clear plexiglass sheeting, and was hinged in two places in the event it became necessary to remove an animal from the water. Located at the end of the left Y channel was an escape ladder constructed from carpenter's cloth which permitted the animals to climb out of the water after surfacing. The ladder was suspended above a microswitch by two coil springs such that a slight downward pressure on the ladder closed an electrical circuit.

The animals were immersed in the water by means of a motor-driven elevator which descended at a constant speed. The elevator box made of clear plexiglass, 4 inches in height and width and 6 inches in length, contained a vertically sliding door at the back through which animals were introduced into the apparatus. A circular cut-out in the front of the elevator which measured  $3\frac{3}{4}$  inches in diameter enabled the animals to enter the underwater alley. In order to facilitate the placement of the animals in the elevator box, a plexiglass funnel was constructed for guiding the animals into the elevator.

The elevator and funnel were contained in a sheet metal box which also supported the motor, pulley rig, and connecting linkage. Mounted on the front of the sheet metal box was a guillotine door which prevented the animals from escaping through the circular opening in the elevator. In the raised position, this plexiglass door covered the front of the elevator from its highest to lowest position, but when released, exposed a cut-out area which enabled the animals to enter the underwater alley. The elevator required slightly longer than 2 seconds to completely descend, and, once started, automatically continued downward coming to rest at its lowest point. Coincident with this, contacts to the ON terminals of a Hunter interval timer, model 115, were closed. At the end of the selected interval, the Hunter timer closed a circuit to an electromagnet arrangement which released the guillotine door. Once started again, the elevator automatically came to rest at its highest point although it was necessary to reset the sliding door manually.

The control panel was a coordinating system for the entire

apparatus. In the upper section were a series of relays which, when closed, started several Standard Electric timers. In this experiment, the first timer was started by activation of the sliding door release mechanism. A photocell and light source were located underwater 1 inch from the beginning of the left Y underwater insert. Interruption of this beam of light started the second timer. Both timers were terminated by a slight downward pressure on the escape ladder which was suspended by two coil springs above a hand-made microswitch. A series of colored lights mounted on the control panel in a pattern similar to the shape of the water maze enabled a recorder to follow the progress of an animal during swimming and to check the functioning of the equipment. Once activated, the relays controlling the timers and panel lights interrupted their own source of power and were reset for the next trial by a single switch. Thus, for each phase of operation, the functioning of the relays, and in turn the timers and signal lights, was independent of any subsequent activation, as for example interruption of the underwater light beam a second time due to retracing.

Continuous water circulation was maintained between the water maze proper and a controlled bath reservoir. The water, drawn off at the base of the starting channel, was pumped to the controlled bath where sediment and other solid particles were filtered out. A cooling coil in the controlled bath aided in maintaining the water at lower temperatures. From the controlled bath, the water gravitated through rubber hoses to the base of each of the Y and T arms. Water circulation thus served the dual purpose of keeping the water clean and maintaining uniform temperature throughout the system. In addition to having the water gravitate back into the water maze proper, currents

were further reduced by circulating the water through a network of underwater channels approximately two feet below the swimming level. Temperature stability was enhanced by the quantity of water contained in both the controlled bath reservoir and the outer tank of the water maze. The outer tank, for example, measured 10 inches in width, 30 inches in depth, 29 inches in length for the starting arm, and 24 inches in length for each of the Y and T arms. An illustration of the apparatus may be found in Appendix A.

#### Operation of the Apparatus

Operation of the apparatus required the coordinated efforts of a recorder and experimenter. The recorder, in addition to recording the swimming times, reset the timers, adjusted the photosensitivity control for the underwater photocell, and reset the relays after each trial. The experimenter handled the animals, set the appropriate initial underwater delay interval, controlled the operation of the elevator and escape door, and returned the animals to their home cages. Other matters requiring less constant attention included draining and adding water to obtain the proper temperature and periodically checking the water temperature.

Several evenings were devoted to running animals for practice prior to beginning the experiment. The general procedure which was followed throughout the investigation entailed: (1) setting the water to the proper temperature, (2) adjusting the Hunter interval timer for the appropriate underwater delay, and (3) running an animal through the apparatus.

The animal was obtained from its home cage by the experimenter who identified it for the recorder by an ear punch code. The recorder checked the signal lights, which when off indicated that the apparatus was reset. The experimenter then guided the animal through the funnel and into the elevator and started the elevator downward. When the animal emerged from the elevator, the escape door which had dropped at the end of the preset interval was again raised to prevent the animal from re-entering the elevator. During the course of swimming, the experimenter informed the recorder of any unique or peculiar behaviors observed and the recorder noted these in the record. After recording the times and resetting the timers and relays, the recorder signalled the experimenter to begin the next trial.

### Subjects

Subjects were 48 male albino rats of the Sprague-Dawley strain obtained from the animal colony maintained by the Psychology Department of this institution. Of these, 40 animals with an average age approximating 240 days at the outset of the experiment had been used in a previous study. Although it was believed that this experience would not influence swimming performance in the water maze situation, a matching procedure was used to preclude any differences as a function of the earlier experience. The remaining 8 animals were totally naive and ranged in age from 95 to 100 days at the outset of the investigation.

### Independent Variables

The rationale underlying the selection of particular levels for



each of the three conditions was based upon the requirement that, (1) significant differences in rate of movement or speed obtained between the two levels, and (2) that the more intense level of each drive variable produced something less than maximal response for comparable subjects in similar experimental situations.

The two levels of each drive were, (1) hunger, as defined by 0 and 22 hours food deprivation, (2) oxygen deprivation, as defined by 0 and 5 seconds initial underwater delay, and (3) aversive water temperature, as defined by water temperatures of 90° and 60° F.

### Response Criteria

From the psychological literature on drive studies it is apparent that response acquisition has been less reliable as a measure or index of motivational level than has rate of movement or activity. That is, where the number of errors in learning an instrumental response has been used as the criterion for testing the effects of drive level, the evidence has been equivocal. This served as the rationale for the selection of swimming times as the criterion. Four different swimming time measures were used. First, a total swimming time was obtained from release of the escape door until the animal exerted a slight downward pressure on the escape ladder. Second, a completion time was obtained from the time the animal interrupted the underwater light beam until it touched the escape ladder. Third, a starting time was obtained by subtracting the completion time from the total swimming time. At a later point during the experiment proper, it was observed that animals were spending considerable periods of time in the water after surfacing. In order to obtain a more adequate measure of

actual underwater swimming time an additional timer was installed. This was automatically activated by the release of the guillotine door and was terminated by the experimenter when the animal's nose broke the surface of the water. This underwater total swimming time constituted the fourth swimming criterion.

Several symbols designating nonadaptive or peculiar responses which were noted to occur with a high frequency in earlier work were used to describe such behaviors as turning in the elevator, retracing in the start or finish alley, or any other behaviors which departed from a direct swimming response from elevator to surfacing.

#### Procedure

Pretraining: During pretraining, the 48 animals were randomly assigned three to a cage in which water was available throughout the course of the experiment. Two days before the beginning of pretraining, the animals were switched from a diet of chicken feed to Purina dog food supplemented with extract of yeast. The extract of yeast was intended to insure proper nutrition during the physically exhausting period of pretraining. No special attempts were made to handle the animals or to establish a feeding schedule prior to pretraining.

Food was removed from the cages of all animals 11 hours before the beginning of pretraining trials for the first five days. Removal of food was staggered to insure comparable states of deprivation at the time each animal was run. However, the order of removing food and the order in which each cage of animals was run during pretraining was alternated. All animals were fed 30 minutes after the last

animal had been run.

The water temperature in the maze was adjusted to 75°, and the Hunter interval timer was calibrated for a 2 1/2 second interval according to manufacturer's instructions. Room temperature, recorded daily, varied between 75° and 79° throughout the experiment.

Each animal, after being randomly selected from its home cage and identified for the recorder, was run two successive times. The rest between successive trials was approximately 45 seconds, which was about the time required to record the swimming times and reset the apparatus. On the third day of pretraining, all animals were accidentally run under a slightly lower water temperature of 71° F. Although swimming speeds seemed to have stabilized, two additional days of pretraining were administered to make up for this oversight.

Experimental phase: In the first part of this phase, eight groups of animals, equated according to mean total swimming times obtained during pretraining, were randomly assigned to each of the treatment combinations. During the day intervening between pretraining and this phase animals under the hunger condition were placed on 22 hours food deprivation. The animals were again housed three to a cage, although the order of cages and the order of running animals within each cage remained the same until the end of the experiment. Removal of food from the cages of the food deprived groups was staggered for the two temperature conditions.

About one hour before the beginning of each series of experimental trials, moist Purina dog food was offered to animals not on food deprivation. After a procedure suggested by Koch & Daniels (1945), this was done, at first, by making food available in the cages and then

offering food by hand. However, the hand feeding practice was discontinued after the first day because it appeared that animals engaged in exploratory behavior when the cage was opened and did not eat.

The procedure of adjusting the water temperature and setting the underwater delay interval was the same as that previously outlined. The treatment groups were run in the following order. The cold temperature groups were run first, and within this condition satiated groups were run before hungry groups. For the oxygen deprivation condition, groups under 0 and 5 seconds initial underwater delay were alternated. The same order was followed for groups within the 90° F temperature condition.

It was observed that although the 5 second underwater delay at first produced a "mild panic" and many turning responses inside the elevator, by the third day the animals under this condition evidenced little discomfort. On the sixth day the number of successive trials was increased from two to three.

For the last phase of the experiment proper, animals under the 22 hours food deprived condition were shifted to a 46 hour food deprivation schedule, and groups delayed underwater for 5 seconds were given a 15 second initial underwater delay. Since these added treatments were considered to be very stressful, the number of successive trials was reduced to two and the rest between trials increased to approximately 2 minutes.

## CHAPTER IV

### RESULTS

#### Treatment of the Data

Analysis of the data was based upon the mean swimming times for each day since unequal numbers of trials were administered during different portions of the experimental period proper. Each of the four swimming time measures was analyzed separately by a Lindquist (1953) Type III design, appropriate for repeated measures on the same subjects. For each of these analyses, the New Duncan Multiple Range Test (Edwards, 1960) was used to test the significance of the difference among the treatment group means.

For convenience, the various treatment groups have been designated according to the number and combination of drives they received, where T-60, T-90 represent the two levels of water temperature, 0-0, 0-5 represent the two levels of oxygen deprivation, and H-0, H-22 represent the two levels of food deprivation. For days 10 and 11, the more intense oxygen and food deprivation conditions are designated by 0-15 and H-46 respectively.

#### Underwater Total Swimming Times

The underwater total swimming time criterion measured swimming speed from the time that access to the underwater alley was made

available until the animals surfaced. The results of this analysis of variance, presented in Table I, reveal significant main effects for temperature, oxygen deprivation, food deprivation and days. Examination of the treatment condition means indicates that higher intensities of each drive condition facilitated swimming speed. These effects, however, were not uniform over days. The days main effect shows that all animals swam significantly faster on succeeding days and significantly fastest on day 9.

The interactions for days X temperature, and days X oxygen deprivation were also significant in this analysis. For the days X temperature interaction, the data indicates that while the T-60 condition produced significantly faster swimming throughout the four day period, animals under the T-90 condition showed a significant increase in swimming speed on day 9. For the days X oxygen deprivation interaction, there were significant differences between groups under the 0-0 and 0-5 conditions during days 6 and 7, but not for days 8 and 9, possibly suggesting that animals under both conditions may have been approaching performance stability. This is further suggested by the finding that although groups 0-0 and 0-5 swam significantly faster on day 9, the greater increment in swimming speed occurred for animals under the 0-0 condition.

Analysis of the differences among the 8 treatment group means by the New Duncan Multiple Range Test indicates that all treatment groups were significantly different from one another as to underwater total swimming times. Fig. 1 graphically illustrates the relationship of groups to one another. It can be seen that groups under greater intensities and numbers of drives swam significantly faster than did groups

TABLE I.

Analysis of Variance for Mean Underwater Total Swimming Times  
for Eight Treatment Groups Days 6 Through 9

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Between Subjects	129.37	47	2.75	4.62 **
Within Subjects	85.62	144	.594	
Total	214.99	191		
Temperature	58.50	1	58.50	46.80 **
O <sub>2</sub> Delay	10.47	1	10.47	8.38 **
Food Deprivation	6.02	1	6.02	4.84 *
Temp X O <sub>2</sub>	.24	1	.24	---
Temp X FD	2.37	1	2.37	1.90
O <sub>2</sub> X FD	1.95	1	1.95	1.57
Temp X O <sub>2</sub> X FD	.02	1	.02	---
Error	49.80	40	1.245	
Days	9.94	3	3.31	7.69 **
Days X Temp	3.84	3	1.28	2.98 **
Days X O <sub>2</sub>	5.12	3	1.70	3.95 **
Days X FD	2.14	3	.71	1.65
Days X Temp X O <sub>2</sub>	1.77	3	.59	1.37
Days X Temp X FD	.42	3	.14	---
Days X O <sub>2</sub> X FD	1.35	3	.48	1.11
Days X Temp X O <sub>2</sub> X FD	.32	3	.11	---
Error	60.72	140	.43	

\* Sig. p. < .05

\*\* Sig. p. < .01

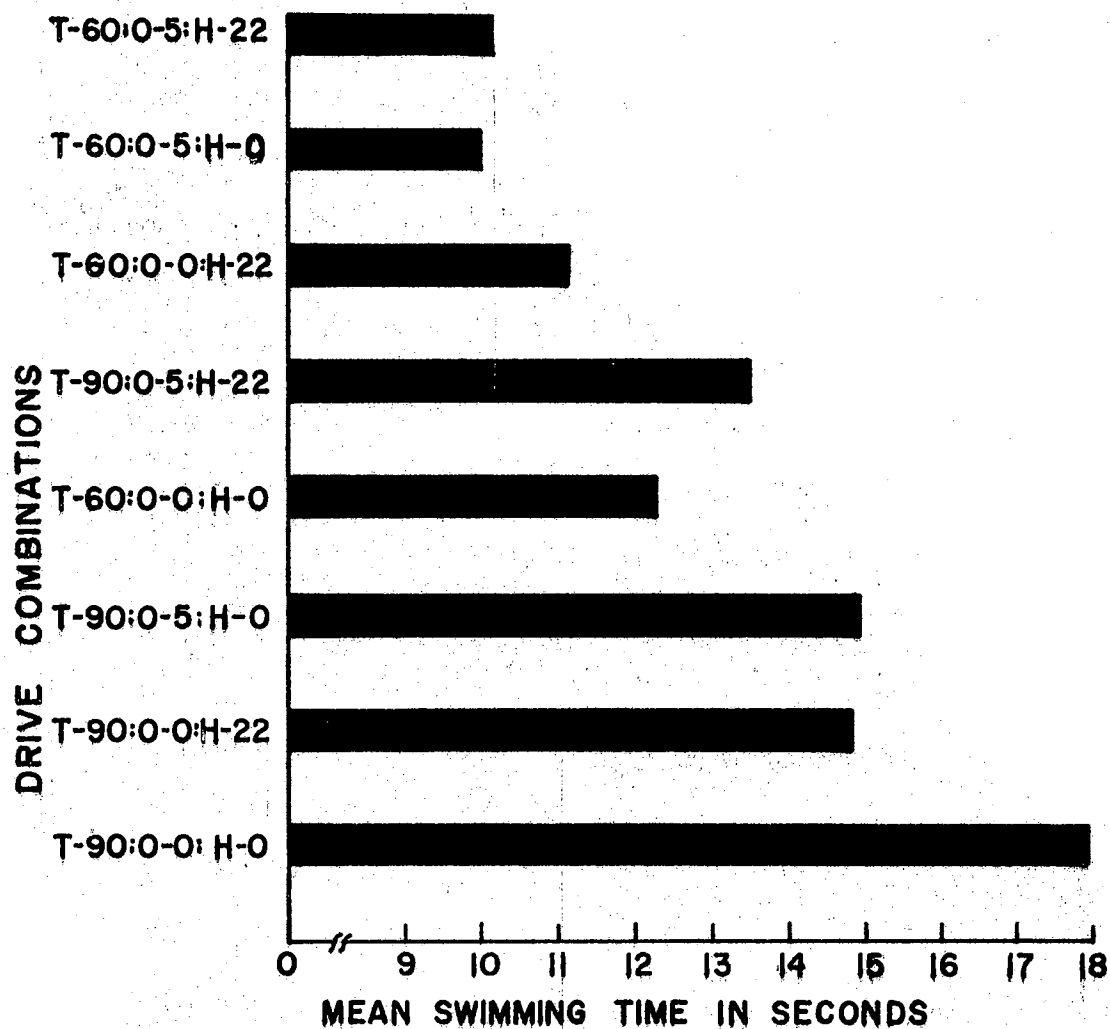


FIG. 1 MEAN UNDERWATER TOTAL SWIMMING TIMES  
FOR EIGHT TREATMENT GROUPS FOR  
DAYS 6 THROUGH 9



TABLE II.

Analysis of Variance for Mean Underwater Total Swimming Times

for Eight Treatment Groups Days 10 Through 11

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Between Subjects	79.17	47	1.684	2.35 **
Within Subjects	34.30	48	.714	
Total	113.47	95		
Temperature	15.56	1	15.56	14.27 **
O <sub>2</sub> Delay	8.77	1	8.77	8.04 **
Food Deprivation	2.81	1	2.81	2.58
Temp X O <sub>2</sub>	2.45	1	2.45	2.25
Temp X FD	.39	1	.39	----
O <sub>2</sub> X FD	5.03	1	5.03	4.63 *
Temp X O <sub>2</sub> X FD	.34	1	.34	----
Error	43.82	40	1.09	
Days	.38	1	.38	2.00
Days X Temp	.33	1	.07	----
Days X O <sub>2</sub>	2.02	1	2.03	10.68 **
Days X FD	2.59	1	2.60	13.68 **
Days X Temp X O <sub>2</sub>	1.24	1	1.49	7.84 **
Days X Temp X FD	1.29	1	1.73	9.11 **
Days X O <sub>2</sub> X FD	0.00	1	0.00	----
Days X Temp X O <sub>2</sub> X FD	.13	1	.13	----
Error	7.98	40	.19	

\*Sig. p. &lt; .05

\*\*Sig. p. &lt; .01

the H-0 condition but not for the H-46 condition.

The significant days X oxygen deprivation interaction reveals that groups under 0-15 swam significantly faster than groups under 0-0 on day 10 but not on day 11. Moreover, groups under 0-0 swam faster than groups under 0-15 on day 11 but the difference was not significant. A similar finding obtained for the days X food deprivation interaction in that groups under H-46 swam significantly faster from groups under H-0 on day 10 but not on day 11. The foregoing simple interactions need to be qualified by the significant days X temperature X oxygen deprivation triple interaction. Here, groups under T-60 swam significantly faster than groups under T-90, and groups under 0-15 swam significantly faster than groups under 0-0 on day 10, but on day 11 difference between 0-15 and 0-0 failed to reach significance although the difference between the two temperature conditions remained the same. Furthermore, the significant days X temperature X food deprivation triple interaction indicates that on day 10 groups under H-46 swam significantly faster than groups under H-0 whereas groups under the two food deprivation conditions did not swim significantly different from one another on day 11.

Analysis of the differences among the 8 treatment group means reveals that the control group again swam significantly slower than all other treatment groups. The difference between the group on the single food deprivation condition and groups under combinations of the average water temperature condition and any other drive were also significant. However, the failure of any differences to appear for any of the other groups under the higher intensities and number of drives, again regardless of source, suggests that the various treatment groups were

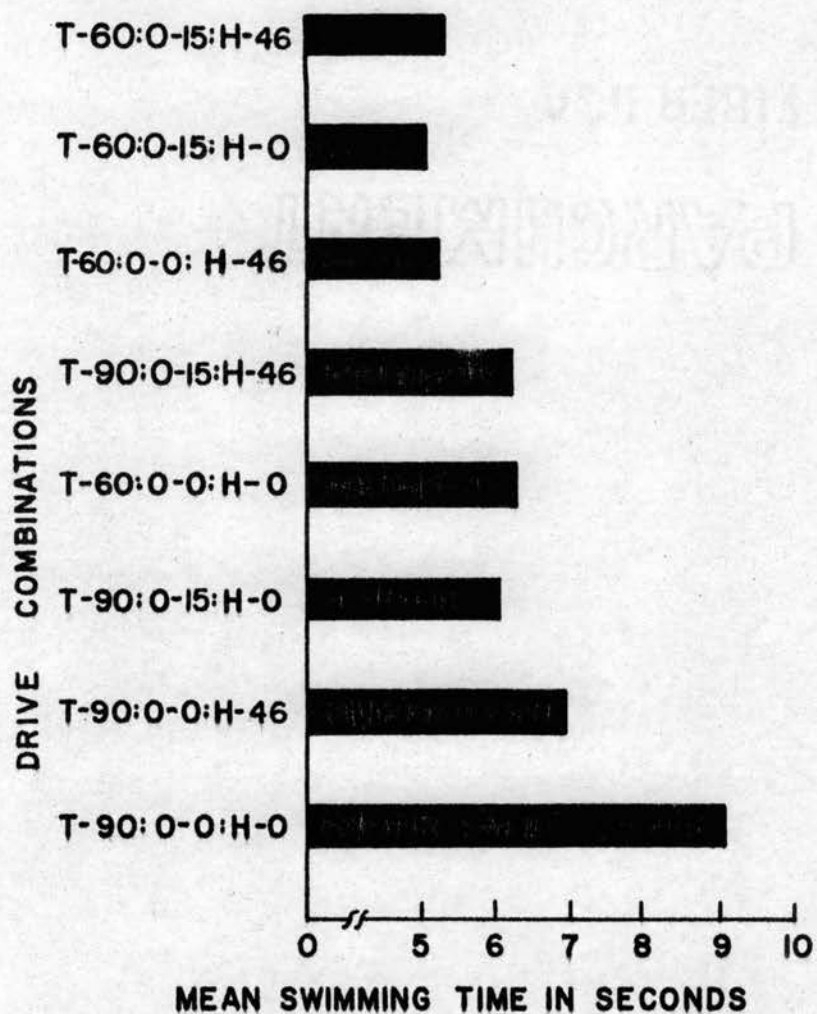
more alike in swimming performance at higher than at lower intensities of drive. This may be seen by comparison of treatment groups for days 6 through 9 (Fig. 1) and days 10 and 11 (Fig. 2).

### Start Times

Analysis of variance for the start times, days 1 through 9, are presented in Table III, and reveals significant temperature, oxygen deprivation, and days main effects. Consistent with previous findings, animals under higher intensities of oxygen deprivation and the colder water condition swam significantly faster than did those under the less intense conditions.

Since this criterion takes into account the entire 9 days of the experimental period proper, it is not comparable to the underwater total swimming time measure which spans only the last four days. The main effect for days suggests that animals swam progressively faster over time.

The significant interaction for days X temperature reveals that groups under T-60 swam significantly faster than groups under T-90 from days 3 through 9. However, groups under T-90 swam faster, although not significantly so, than groups under T-60 on days 1 and 2. The significant days X oxygen deprivation interaction reveals that groups under 0-5 swam significantly faster than groups under 0-0 on days 4 through 7. In the earlier trials, days 2 and 3, there were nonsignificant reversals for the 0-0 and 0-5 conditions. For the significant days X food deprivation interaction, groups under the H-22 condition swam significantly slower than groups under the H-0 condition on days 1 and 2, and continued to swim slower, although the differences were not



**FIG. 2** MEAN UNDERWATER TOTAL SWIMMING TIMES FOR EIGHT TREATMENT GROUPS FOR DAYS 10 AND 11

TABLE III.

Analysis of Variance for Mean Start Swimming Times for  
Eight Treatment Groups Days 1 Through 9

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Between Subjects	93.29	47	1.98	3.04 **
Within Subjects	249.21	384	.65	
Total	342.50	431		
Temperature	41.98	1	41.98	43.06 **
O <sub>2</sub> Delay	7.08	1	7.08	7.26 *
Food Deprivation	.60	1	.60	---
Temp X O <sub>2</sub>	1.92	1	1.92	---
Temp X FD	.64	1	.64	---
O <sub>2</sub> X FD	.02	1	.02	---
Temp X O <sub>2</sub> X FD	2.03	1	2.03	2.08
Error	39.02	40	.975	
Days	17.83	8	2.23	6.19 **
Days X Temp	19.88	8	2.48	6.89 **
Days X O <sub>2</sub>	11.57	8	1.45	4.03 **
Days X FD	9.94	8	1.24	3.44 **
Days X Temp X O <sub>2</sub>	3.84	8	.48	---
Days X Temp X FD	11.12	8	1.39	3.86 **
Days X O <sub>2</sub> X FD	1.06	8	.13	---
Days X Temp X O <sub>2</sub> X FD	2.95	8	.37	---
Error	116.75	328	.36	

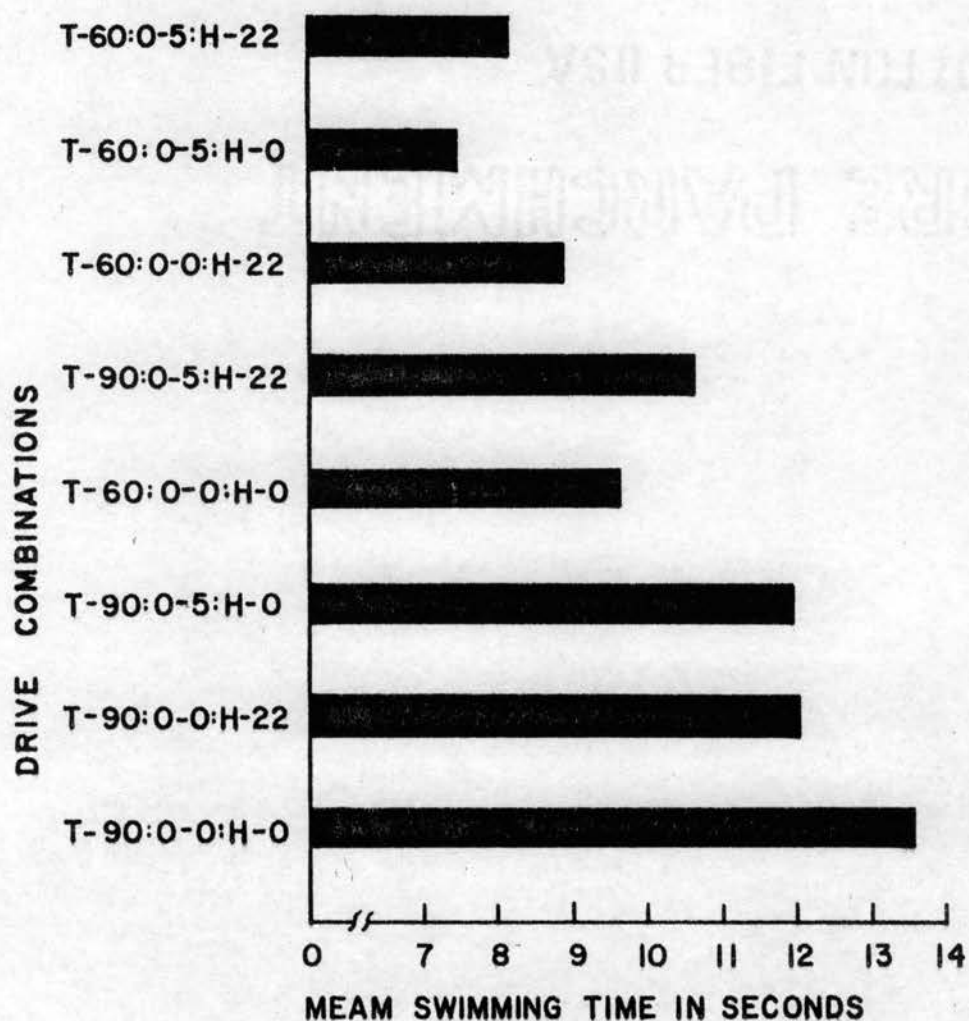
\* Sig. p. < .05

\*\* Sig. p. < .01

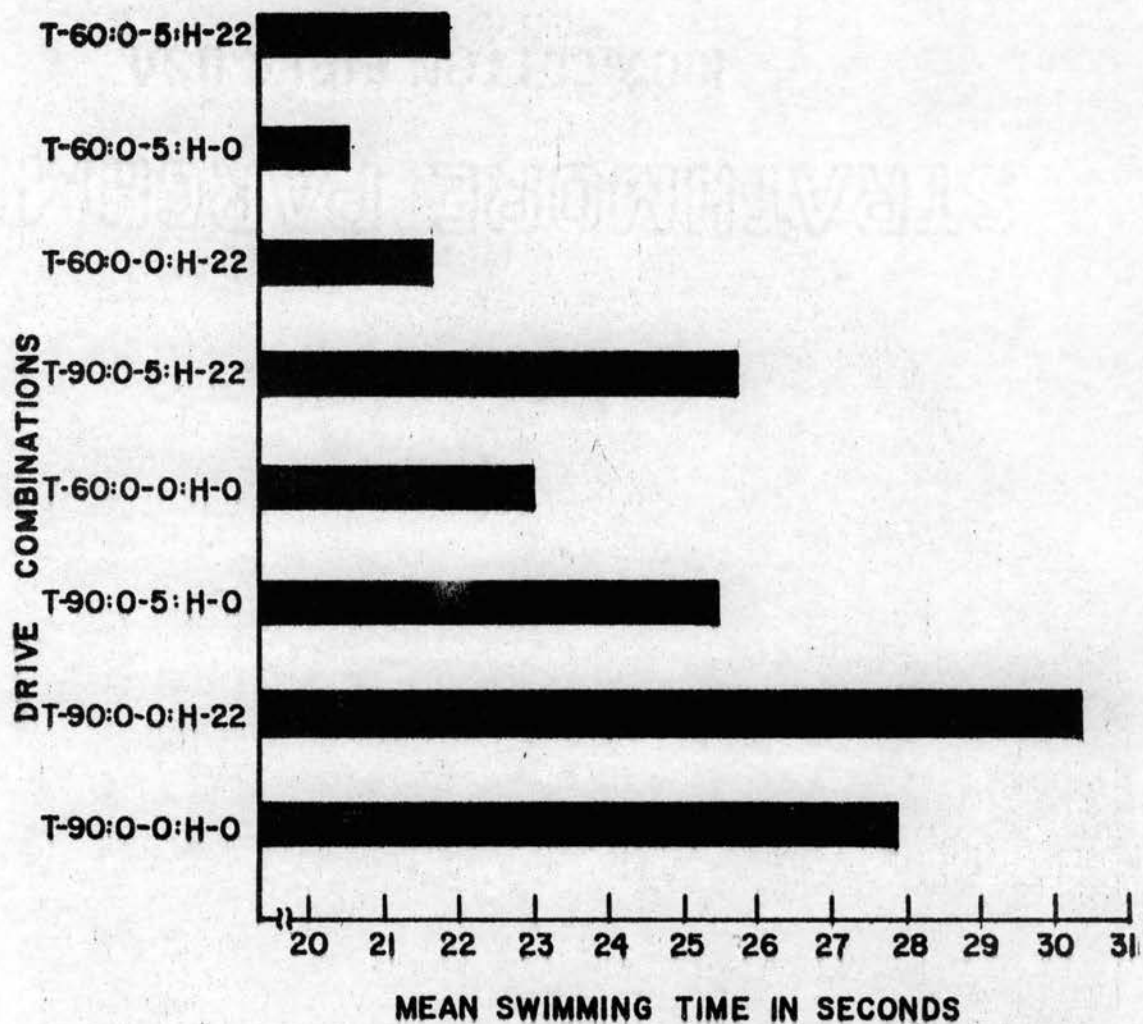


significant, through day 6. For days 7 through 9 the reversals in rate of swimming between the two conditions were not significant. The significant triple interaction for days X temperature X food deprivation reflects these changing relationships of the drive conditions to one another over time.

The mean start times for days 6 through 9 are presented in Fig. 3. It can be seen that the 8 treatment group means closely parallel those obtained for the underwater total swimming criterion. The findings are somewhat different for the entire 9 day experimental period using the start time criterion. Analysis of the difference among the 8 treatment group means for days 1 through 9, indicates that the group under the aversive water and oxygen deprivation conditions swam significantly faster than the group under three drives, and that both groups swam significantly faster than all other groups. This finding was consistent with those obtained using the underwater total swimming times. However, in this analysis, the group under the single food deprivation condition swam significantly slower than the control group. Furthermore, groups under oxygen and food deprivation, and oxygen deprivation alone did not differ as to swimming speed. Fig. 4 presents the mean start swimming times for days 1 through 9. With the exception already mentioned, all other differences among these treatment groups were significant. It seems that food deprivation, during the earlier trials, resulted in a decrement in rate of swimming, and this appears to account for the failure of the food deprivation condition in this analysis to reach significance.



**FIG. 3** MEAN START SWIMMING TIMES FOR EIGHT TREATMENT GROUPS FOR DAYS 6 THROUGH 9



**FIG. 4** MEAN START SWIMMING TIMES FOR EIGHT TREATMENT GROUPS FOR DAYS 1 THROUGH 9



## FREQUENCY OF QUALITATIVE RESPONSE VARIATIONS

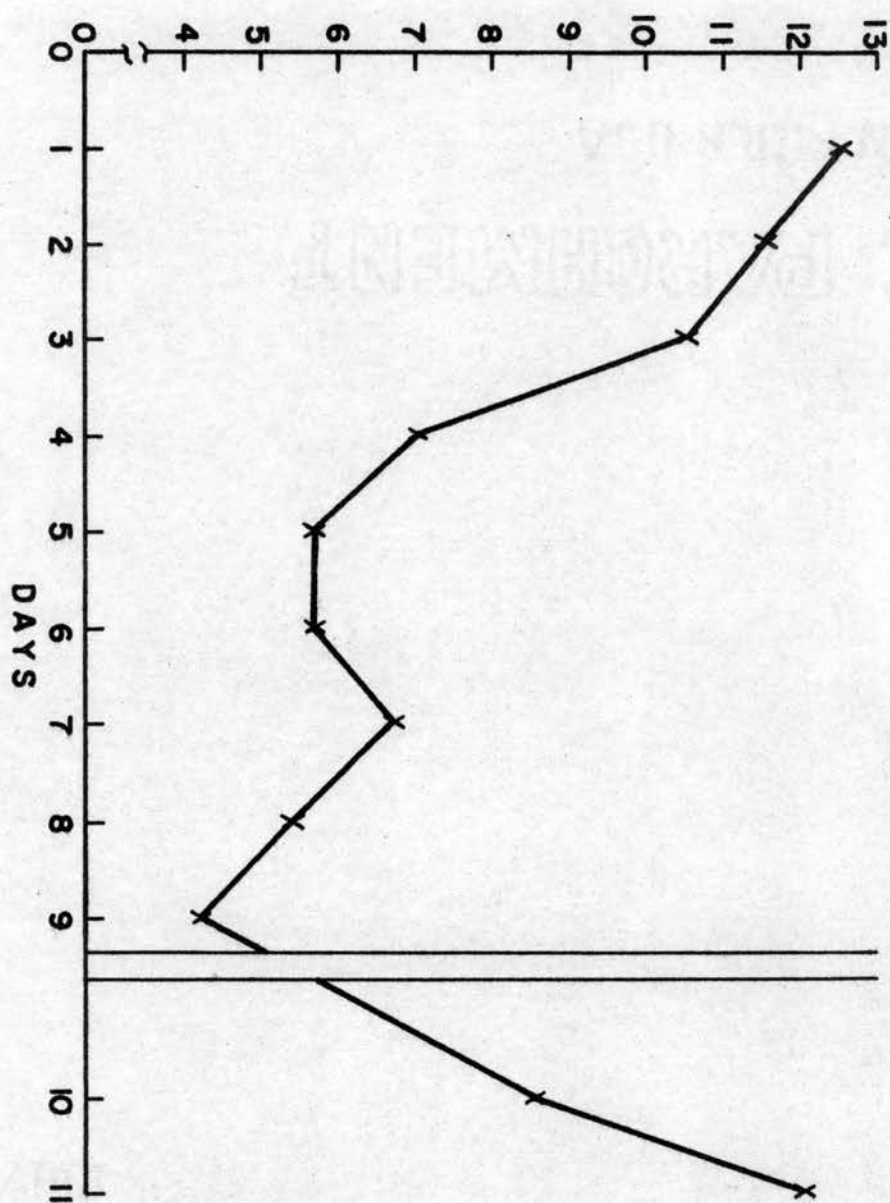


FIG. 5 MEAN FREQUENCY OF QUALITATIVE RESPONSE VARIATIONS PER DAY

### Completion Times

As can be seen from Table IV, analysis of variance for the completion times indicates a significant temperature main effect and a significant days X temperature interaction. The main effect for temperature reveals that animals in the T-60 condition swam significantly faster than did those in the T-90 condition. The days X temperature interaction indicates that with the exception of day 3, groups under the T-60 condition swam significantly faster than groups under the T-90 condition. However, animals under the T-90 condition swam significantly slower on days 5, 6, 7, and 8, whereas the only significant change for groups under the T-60 condition was on day 5 at which time swimming speed decreased. These findings are not consistent with previous findings, but what they apparently reflect is the after-surface delays which became more pronounced with increasing numbers of trials. In this analysis, then, there is a confounding of swimming speed with after-surface delays, such that it is not possible to determine whether animals in the T-90 condition swam slower or delayed longer. The New Duncan Multiple Range Test revealed no significant differences among the 8 treatment group means.

### Total Times

Analysis of variance for the total times swimming criterion presents essentially the same problem in interpretation as occurs for the completion time criterion. This analysis, presented in Table V, reveals a significant main effect for temperature and for days. The main day effect indicates a significantly slower rate of swimming for

TABLE IV.

Analysis of Variance for Mean Completion Swimming Times for  
Eight Treatment Groups Days 1 Through 9

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Between Subjects	1265.27	47	26.92	6.97 **
Within Subjects	1482.46	384	3.86	
Total	2747.73	431		
Temperature	250.98	1	250.98	10.91 **
O <sub>2</sub> Delay	13.16	1	13.16	---
Food Deprivation	4.00	1	4.00	
Temp X O <sub>2</sub>	13.03	1	13.03	---
Temp X FD	.90	1	.90	---
O <sub>2</sub> X FD	17.42	1	17.42	---
Temp X O <sub>2</sub> X FD	12.87	1	12.87	---
Error	952.91	40	23.82	
Days	36.58	8	4.57	1.70
Days X Temp	91.29	8	11.41	4.26 **
Days X O <sub>2</sub>	29.20	8	3.65	1.36
Days X FD	38.86	8	4.85	1.80
Days X Temp X O <sub>2</sub>	34.07	8	4.26	1.59
Days X Temp X FD	18.51	8	2.31	---
Days X O <sub>2</sub> X FD	17.79	8	2.22	---
Days X Temp X O <sub>2</sub> X FD	23.97	8	2.99	1.12
Error	879.83	328	2.68	

\* Sig. p. < .05

\*\* Sig. p. < .01

TABLE V.  
 Analysis of Variance for Mean Total Swimming Times for  
 Eight Treatment Groups Days 1 Through 9

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Between Subjects	2674.63	47	56.89	11.44 **
Within Subjects	1909.84	384	4.97	
Total	4584.47	431		
Temperature	775.19	1	775.19	17.07 **
O <sub>2</sub> Delay	.03	1	.03	---
Food Deprivation	2.26	1	2.26	---
Temp X O <sub>2</sub>	2.62	1	2.62	---
Temp X FD	1.74	1	1.74	---
O <sub>2</sub> X FD	37.21	1	27.21	---
Temp X O <sub>2</sub> X FD	38.76	1	38.76	---
Error	1816.82	40	45.41	
Days	311.86	8	38.98	27.25 **
Days X Temp	87.90	8	10.99	7.68 **
Days X O <sub>2</sub>	28.74	8	3.59	2.51 *
Days X FD	36.72	8	4.59	3.21 **
Days X Temp X O <sub>2</sub>	25.97	8	3.25	2.27 *
Days X Temp X FD	30.44	8	3.80	2.66 **
Days X O <sub>2</sub> X FD	36.94	8	4.62	3.23 **
Days X Temp X O <sub>2</sub> X FD	21.21	8	2.65	1.85
Error	472.25	328	1.43	

\* Sig. p. < .05

\*\* Sig. p. < .01



all animals on days 4, 6, and 7 which occurred about the time the after-surface delays became most noticeable. It can also be seen that the major variables interacted with days and with each other over days, and it is believed that this effect was due to factors already mentioned. The New Duncan Multiple Range Test revealed no significant differences among the 8 treatment group means.

Mean day swimming times for the 8 treatment groups for the 4 swimming speed measures, Tables VI through IX, are presented in Appendix B.

#### Qualitative Response Variations

We have combined under the heading of qualitative response variations all responses which deviated from a smooth swimming response. In order of frequency of occurrence, these behaviors include (1) turning or facing backwards in the elevator at the time the escape door was released, (2) scratching or pawing at the crevice between the elevator and the beginning of the underwater alley, (3) retracing in either the start or completion alleys, and, (4) retarding the movement of the escape door by pressing against it with either the nose or body.

As might be expected, the greatest frequency of response variations occurred during pretraining. As soon as the elevator was started downward, most of the animals turned and scratched at the door through they had been introduced into the apparatus. It appeared that most of the animals had just turned or were completing a turn when, after the 2 1/2 second initial underwater delay, the escape door was released. The contiguous occurrence of turning behaviors and release of the

escape door apparently led to the development of "superstitious" behavior.

Fig. 5 presents the mean number of response variations per day for all groups combined during the experimental period. It can be seen that there was a gradual decrease in the frequency of these responses from earlier to later trials. However, with the increase in intensity of the food and oxygen deprivation conditions, a sharp rise in the incidence of irrelevant responses was noted. For the entire experimental period, the greatest frequency of occurrence of response variations was associated with groups with the higher intensities of food and oxygen deprivation, and with the warm water condition. For the 8 treatment groups, a greater frequency of response variations occurred for those animals under greater numbers of drives.

In the following chapter, we shall discuss the significance of these findings in terms of the objectives for which this study was designed.

## CHAPTER V

### DISCUSSION

The findings from this investigation offer some encouragement for anticipating that predictions based on the effects on performance of single drive states and two drives in combination may be extended to include three and possibly more simultaneously aroused motivational states.

#### Combined Drive Effects

It was found that increased intensities of drive as defined by the number or combination of drives employed produced an increase in swimming speed. Moreover, it appeared that increases in rate of swimming were not related directly to particular drive conditions but rather that the three drive conditions were functionally equivalent in facilitating swimming performance. For example, it was also found that treatment groups under fewer drives swam significantly slower than did those under greater numbers of drives. Thus, support was obtained for the energization notion of drive. The implication of this finding is that particular drive sources might not be important in predicting the effects of drive on strength of response. Although it was generally found that increased intensities in drive led to increased strength of response, the data also indicated that differences in performance as a

function of increasing the drive intensity were dependent upon the level of drive at which the animals were functioning. That is, the shift in status from the no drive group to groups for which there was a single drive operative, and then from a shift in status from single drive groups to groups in which two drives were operative, etc., resulted in faster swimming. Thus there was the indication of a progressively diminishing effect of drive on performance for organisms under increasing intensities of drive.

A third finding was that under some conditions, an increase in drive intensity led to significantly slower swimming speeds. For example, during the early trials of the experimental period proper, animals under the food deprivation condition swam significantly slower than did satiated animals. Furthermore, the three drive treatment group was found to swim significantly slower than the group under the combined aversive temperature and oxygen deprivation conditions. Taken together, the present findings suggest a curvilinear relationship of drive intensity to swimming performance. In this connection, the findings were consistent with the bulk of studies reported in the literature where it has been found that drive conditions sometimes facilitate performance, under some conditions inhibit the strength of response, and at other times produce no significant change in the response.

It was also noted that the three drives were not of equal intensity, and that the temperature conditions had the most pronounced effect upon rate of swimming, oxygen deprivation the next, and food deprivation the least. However, under increased intensities of food and



oxygen deprivation during the third phase of the experiment, treatment groups under the single temperature, oxygen deprivation or food deprivation conditions were not found to differ from one another as to swimming speed. This finding again suggests that it is not the drive per se, but its intensity which affects the strength of response.

#### Qualitative Response Variations

An important finding in this investigation was that the frequency of deviant responses progressively decreased from earlier to later trials. The corresponding increase in rate of swimming for all groups from earlier to later trials suggests that the swimming speed criteria and qualitative response variations were inversely related to one another. That is, the greater the incidence of deviant responses the slower the speed of swimming. Related to this was the finding that with increased intensities of oxygen and food deprivation, a corresponding increase in the number of response variations was also noted. Thus, there was the suggestion of a possible correlation between the incidence of response variations and drive intensity.

It was further found that competing responses were more prevalent for the more intense levels of oxygen and food deprivation but not for the more aversive water temperature condition. In fact, it will be recalled that the less intense water temperature was more markedly associated with these response deviations. The implication of this finding is that while strength of response may be independent of drive source, the tendency toward more variable behaviors seems to be related to the nature of the particular drive. Thus, particular drives might have markedly different effects on performance in a free responding

situation, and the source of drive might be more important than drive intensity in determining the direction of behavior.

#### Suggestions for Future Research

There were some disquieting findings regarding the equivalence of the various swimming criteria. The underwater total swimming time, although encompassing only the last four days of the experimental period, was perhaps the most adequate of the response measures. The start time, while subject to initially occurring variations in response was found to be quite comparable to the underwater total swimming time for days 6 through 9. The completion and total time swimming measures, for which there was a confounding of after-surface delays with underwater swimming speed, provided a rather distorted measure of actual underwater swimming. This investigation suggests that a single measure of underwater swimming, as for example the underwater total swimming criterion, may be sufficient as a response measure for determining the effects of combined drives on swimming performance. It might also be useful, however, to employ a start-latency measure to determine the manner in which varying numbers and combinations of drives affect the initiation of the swimming response.

One objective of the present investigation was to make the experimental situation as simple as possible in order that the effects of the drive conditions on a single response measure would be unequivocal. However, the frequency of response variations suggested that the experimental situation might be even further simplified. Among the ways in which this could be accomplished would be in making the elevator and underwater alleys narrower, thereby restricting the number of

alternative behaviors available to subjects.

Finally, there were some suggestions in the data that increased intensities of the drive conditions during different segments of the experimental period may have different effects on swimming performance. It might therefore be of interest to continue the pre-training trials for longer periods of time than were employed here before introducing the various drives. Further, the continuation of trials under the various drive combinations might be helpful in illuminating the effects on swimming performance of such factors as practice and adaptation.

## CHAPTER VI

### SUMMARY AND CONCLUSIONS

#### Summary

This investigation represented an attempt to determine the effects of three drives in varying combinations on the swimming performance of albino rats in a water maze situation. More specifically, on the assumption that the relative drive strength of an organism is increased by the addition of varying sources of drive, the intent was to determine the effects on swimming speed of increased drive intensities. In implementing the foregoing, 48 male albino rats were given training in a combination Y and T water maze, where the animals were required to swim underwater to the left Y arm. During this phase of the experiment, all animals were subjected to 2 1/2 seconds initial underwater delay, 11 hours food deprivation, and an aversive water temperature of 75° F. For the second phase of the experiment, the animals were divided into 8 matched groups and randomly assigned to the various treatment combinations which included, (1) 0 and 5 seconds oxygen deprivation, (2) 0 and 22 hours food deprivation, and (3) aversive water temperatures of 90° and 60° F. For the final phase of the experiment, the 5 second initial oxygen deprivation condition and 22 hours food deprivation condition were increased in intensity to 15 seconds and 46 hours, respectively. Strength of response was

measured by four indices of swimming speed: a total time, a start time, a completion time, and an underwater swimming time. In addition to the four speed of swimming measures, all deviant responses occurring during the experimental period were tabulated.

### Conclusions

Animals under increased intensities of drive were found to swim faster than those under lesser intensities. Furthermore, increments in rate of swimming were found to be related to the total drive intensity rather than to any particular drive condition. It was also found that the addition of drives to groups already under relatively intense drive levels produced less of a difference in swimming performance than did the addition of drives to groups initially under lower drive intensities.

The effects of the three drives over time presented a somewhat different picture. During the earlier trials, satiated animals swam significantly faster than did those under the 22 hour food deprivation condition, and significant differences for groups under the two levels of temperature and oxygen deprivation did not occur during the first few days.

The frequencies of variations from a smooth swimming response were found to progressively decrease from the earlier to later trials. However, when the intensity of the food and oxygen deprivation conditions was increased, the frequency of deviant responses increased sharply, suggesting a possible correlation between drive intensity and competing responses for some drives.

### Implications of the Study

This investigation offered some encouragement for anticipating that predictions based on single drive states and two drives in combination may be extended to include three and possibly more simultaneously aroused motivational states. One implication of the findings was that psychologists may be able to predict certain characteristics of a response without recourse to any particular drive or motivational source. However, the greater association of qualitative variations in response for some drive conditions suggested that a particular drive may contribute to the kinds of responses which are elicited, and may be the more important determiner of behavior in a free responding situation.

### Suggestions for Future Research

Several methodological improvements were suggested for future research. The occurrence of variations in response suggested that the experimental situation might be further simplified by restricting an animal's movements in both the elevator and underwater alleys. This could be accomplished by making the elevator and underwater alleys narrower. In addition, the substitution of a starting latency measure for the starting time measure might be helpful in illuminating specific drive effects on the initiation of a response. Finally, the continuation of trials over a longer period of time might provide information of the effects on swimming performance of adaptation and practice.

## APPENDIX A

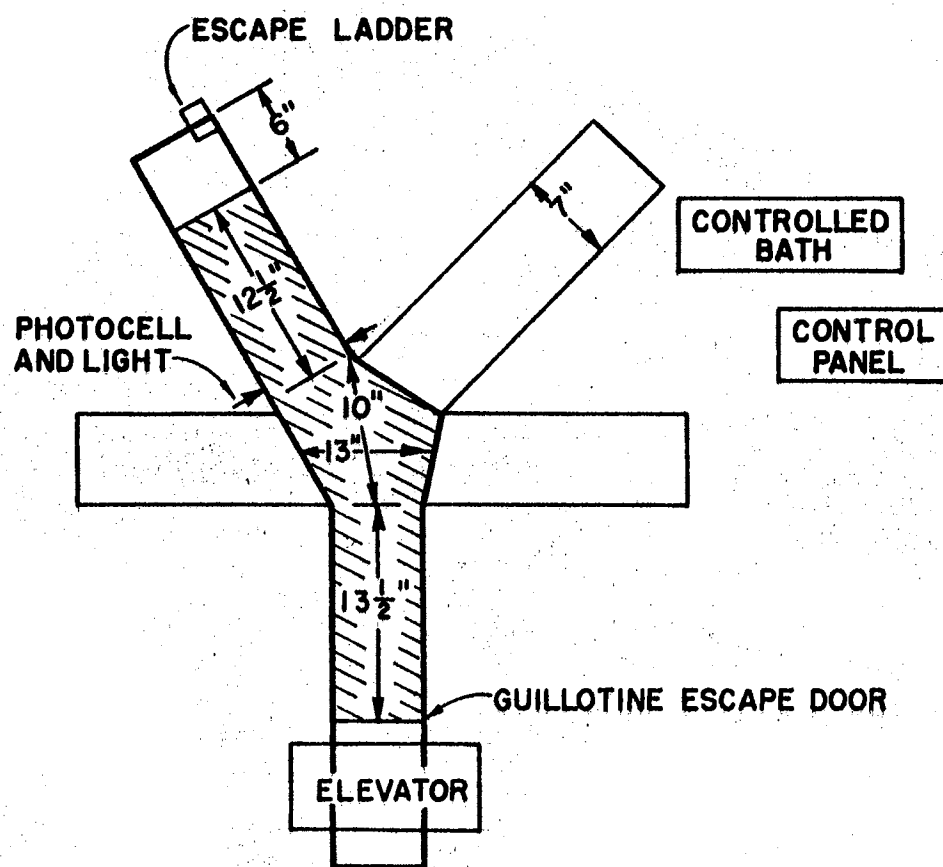


FIG. 6 COMBINATION Y & T TYPE WATER MAZE



## APPENDIX B

TABLE VI.

Mean Underwater Total Swimming Times for Eight Treatment Groups Days 6 Through 11

Treatment Groups	DAYS								Total
	6	7	8	9	6-9	10	11	10-11	
T-60:0-5:H-22	2.58	2.64	2.51	2.50	10.23	2.42	2.88	5.30	16.53
T-60:0-5:H-0	2.37	2.64	2.55	2.44	10.00	2.45	2.60	5.05	15.05
T-60:0-0:H-22	2.98	2.83	2.70	2.53	11.04	2.49	2.70	5.19	16.23
T-90:0-5:H-22	3.23	3.57	3.75	2.97	13.52	2.62	3.63	6.25	19.77
T-60:0-0:H-0	2.99	3.60	2.94	2.80	12.33	3.08	3.22	6.30	18.63
T-90:0-5:H-0	3.33	3.75	4.40	3.48	14.96	2.99	3.05	6.04	21.00
T-90:0-0:H-22	4.39	3.78	3.59	3.04	14.80	3.40	3.54	6.94	21.74
T-90:0-0:H-0	4.68	5.13	4.75	3.42	17.98	5.10	3.94	9.04	27.02
Total	26.55	27.94	27.19	23.18	104.86	24.55	25.56	50.11	155.97

TABLE VII.

Mean Start Swimming Times for Eight Treatment Groups Days 1 Through 9

Treatment Groups	DAYS									Total
	1	2	3	4	5	6	7	8	9	
T-60:0-5:H-22	3.19	3.73	2.34	2.29	2.16	2.06	2.23	1.93	1.91	21.84
T-60:0-5:H-0	2.64	2.69	2.67	2.66	2.48	1.77	2.05	1.76	1.83	20.55
T-60:0-0:H-22	2.87	3.06	2.20	2.40	2.26	2.35	2.15	2.29	2.02	21.60
T-90:0-5:H-22	2.93	2.91	3.32	2.90	3.00	2.70	2.67	2.86	2.40	25.69
T-60:0-0:H-0	2.47	2.69	2.41	2.67	3.12	2.39	2.84	2.23	2.17	22.99
T-90:0-5:H-0	2.44	2.88	2.71	2.80	2.69	2.52	3.20	3.61	2.63	25.48
T-90:0-0:H-22	3.28	3.12	3.47	4.18	4.24	3.59	3.29	2.82	2.35	30.34
T-90:0-0:H-0	2.74	2.44	2.59	3.35	3.16	3.80	3.64	3.68	2.46	27.86
Total	22.56	23.52	21.71	23.25	23.11	21.18	22.07	21.18	17.77	196.35

TABLE VIII.

Mean Completion Swimming Times for Eight Treatment Groups Days 1 Through 9

Treatment Groups	DAYS									Total
	1	2	3	4	5	6	7	8	9	
T-60:0-5:H-22	2.53	2.61	1.51	1.62	2.03	1.43	1.55	1.24	1.67	16.19
T-60:0-5:H-0	1.50	2.32	1.49	1.50	1.86	1.49	1.41	1.30	1.25	14.12
T-60:0-0:H-22	1.54	2.19	2.55	2.10	2.29	1.86	1.73	1.27	1.13	16.66
T-90:0-5:H-22	3.67	3.11	3.09	2.87	2.08	2.85	4.26	4.78	2.38	29.09
T-60:0-0:H-0	1.24	1.36	1.48	1.38	1.86	1.74	1.55	1.44	1.57	13.62
T-90:0-5:H-0	1.60	1.48	2.63	4.66	2.77	4.76	5.07	7.11	4.81	34.89
T-90:0-0:H-22	2.85	3.12	2.49	2.75	3.89	4.64	3.37	3.51	2.96	29.58
T-90:0-0:H-0	1.25	1.62	2.02	2.90	2.69	2.51	4.30	2.16	2.47	21.92
Total	16.18	17.81	17.26	19.78	19.47	21.28	23.24	22.81	18.24	176.07

TABLE IX.

Mean Total Swimming Times for Eight Treatment Groups Days 1 Through 9

Treatment Groups	DAYS									Total
	1	2	3	4	5	6	7	8	9	
T-60:0-5:H-22	4.04	4.87	3.86	3.99	5.49	3.49	3.61	3.20	3.58	36.13
T-60:0-5:H-0	4.01	3.98	4.28	4.17	5.75	3.26	3.42	3.12	3.09	35.08
T-60:0-0:H-22	4.04	4.94	4.91	4.67	6.60	4.23	3.71	3.36	3.14	39.60
T-90:0-5:H-22	6.60	5.20	6.34	5.78	7.32	5.55	6.93	7.18	4.69	55.59
T-60:0-0:H-0	3.71	6.06	3.90	4.03	6.26	4.09	4.34	3.67	3.53	39.59
T-90:0-5:H-0	6.01	6.44	5.28	7.82	11.20	7.29	8.26	9.63	7.49	69.42
T-90:0-0:H-22	5.72	6.55	5.97	6.94	11.11	8.21	6.65	6.34	6.31	63.80
T-90:0-0:H-0	4.20	5.36	4.69	6.08	8.12	6.32	7.94	6.01	7.43	56.15
Total	38.33	43.40	39.23	43.48	61.85	42.44	44.86	42.51	39.26	395.36

## BIBLIOGRAPHY

- Amsel, A. The combination of a primary appetitional need with primary and secondary emotionally-derived needs. J. exp. Psychol., 1950, 40, 1-14.
- Amsel, A. The effect upon level of consummatory response of the addition of anxiety to a motivational complex. J. exp. Psychol., 1950, 40, 709-715.
- Amsel, A., and Cole, K. F. Generalization of fear-motivated interference with water intake. J. exp. Psychol., 1953, 46, 243-247.
- Amsel, A. and Maltzman, I. The effect upon generalized drive strength of emotionality as inferred from the level of consummatory response. J. exp. Psychol., 1950, 40, 563-569.
- Anderson, J. E., and Smith, A. H. The effect of quantitative and qualitative stunting upon maze learning in the white rat. J. comp. Psychol., 1926, 13, 337-359.
- Bolles, R. C., and Morlock, H. Some asymmetrical drive summation phenomena. Psychol. Rep., 1960, 7, 373-378.
- Braun, H. W., Wedekind, C. E., and Smudski, J. F. The effect of an irrelevant drive on maze learning in the rat. J. exp. Psychol., 1957, 54, 345-352.
- Broadhurst, P. L. Emotionality and the Yerkes-Dodson law. J. exp. Psychol., 1957, 54, 345-352.
- Brown, J. S. Problems presented by the concept of acquired drives. In Brown, J. S., et. al., Current theory and research in motivation: a symposium. Lincoln: University of Nebraska Press., 1953.
- Bunch, M. E., and Magdsick, W. K. The retention in rats of an incompletely learned maze solution for short intervals of time. J. comp. Psychol., 1938, 25, 496-506.
- Danziger, K. The interaction of hunger and thirst in the rat. Quart. J. exp. Psychol. 1953, 5, 10-21.
- Dashiell, J. F. A quantitative demonstration of animal drive. J. comp. Psychol., 1925, 5, 205-208.

- Dashiell, J. Fundamentals of objective psychology. Boston: Houghton-Mifflin, 1928.
- Dunn, B. M. A comparison of food reward and escape from water in motivating learning in the white rat. J. comp. Psychol., 1935, 19, 107-112.
- Edwards, A. L. Experimental Design in Psychological Research. New York: Rinehart and Company, Inc, 1960.
- Ellis, N. R. The immediate effects of emotionality upon behavior strength. J. exp. Psychol., 1957, 54, 339-344.
- Finan, J. L., and Taylor, L. F. Quantitative studies in motivation I. Strength of conditioning in rats under varying degrees of hunger. J. comp. Psychol., 1940, 29, 119-131.
- Fitts P. M. Perseveration of non-rewarded behavior in relation to food-deprivation and work-requirement. J. genet. Psychol., 1940, 57, 165-191.
- Glaser, O. C. The formation of habits at high speed. J. comp. Neur. and Psychol., 1910, 20, 165-184.
- Hack, E. R. Learning as a function of water temperature. J. exp. Psychol., 1933, 16, 442-445.
- Hebb, D. O. Drives and the C. N. S. (Conceptual nervous system). Psychol. Rev., 1955, 62, 243-254.
- Hellmer, L. A. The effect of temperature on the behavior of the white rat. Amer. J. Psychol., 1943, 56, 408-421.
- Hoskins, R. G. Studies on Vigor. II. The effect of castration on voluntary activity. Amer. J. Physiol., 1925, 72, 324-330.
- Hull, C. L. Principles of Behavior. New York: Appleton-Century-Crofts, Inc. 1943.
- Kendler, H. H. Drive interaction. I. Learning as a function of the simultaneous presence of the hunger and thirst drives. J. exp. Psychol., 1945, 35, 96-109.
- Koch, S. and Daniel, W. H. The effect of satiation on the behavior mediated by a habit of maximum strength. J. exp. Psychol., 1945, 35, 167-187.
- Levine, S. The effects of a strong irrelevant drive on learning. Psychol. Rep. 1956, 2, 29-33.
- Levine, S., Staats, S. R., and Frommer, G. Drive summation in a water maze. Psychol. Rep. 1959, 5, 301-304.

- Lindsley, D. B. Psychophysiology and motivation. In Jones, M. R., Current theory and research in motivation. Lincoln: University of Nebraska Press, 1957.
- Lindquist, E. F. Design and analysis of experiments in psychology and education. Boston: Houghton Mifflin, 1953.
- Moore, K. The effect of controlled temperature changes on the behavior of the white rat. J. exp. Psychol., 1944, 34, 70-79.
- Morey, R. H. Swimming speed of rats as a function of the presence or absence of sound. J. comp. Psychol., 1934, 17, 329-354.
- Moss, F. A Study of animal drives. J. exp. Psychol., 1924, 7, 165-185.
- Muenzinger, K. F., and Fletcher, M. Motivation in learning. VI. Escape from electric shock compared with hunger-food tension in the visual discrimination habit. J. comp. Psychol., 1936, 23, 383-392.
- Obias, M. D., and Stone, C. P. Effects of pretrial immersion on maze performance of rats. I. A one choice maze. J. comp. psychol. Psychol., 1953, 46, 479-483.
- Powelson, M. H. Gastric transplantation. Science, 1925, 62, 247-248.
- Richter, C. P. A behavioristic study of the activity of the rat. comp. Psychol. Monog. 1, 2, 1922.
- Richter, C. P. Animal behavior and internal drives. Quart. Rev. Biol., 1927, 2, 307-343.
- Sheffield, F. D., and Campbell, B. A. The role of experience in the "spontaneous" activity of hungry rats. J. comp. physiol. Psychol., 1954, 47, 97-100.
- Shock, N. W., and Scow, R. O. The effect on learning of repeated exposures to lowered oxygen tension of the inspired air. J. comp. Psychol., 1942, 34, 55-63.
- Siegel, P. S. Alien drives, habit strength and resistance to extinction. J. comp. Psychol., 1946, 39, 307-317.
- Siegel, P. S., and Brantley, J. J. The relationship of emotionality to the consummatory response of eating. J. exp. Psychol., 1951, 42, 304-306.
- Siegel, P. S., and Siegel, H. S. The effect of emotionality on the water intake of the rat. J. comp. and physiol. Psychol., 1949, 42, 374-382.



- Skinner, B. F. Conditioning and extinction and their relation to drive. J. gen. Psychol., 1936, 14, 296-317.
- Spence, K. A. Behavior Theory and Conditioning. New Haven: Yale University Press, 1956.
- Spence, K. W. Behavior theory and selective learning. In Jones, M. R., et. al., Current theory and research in motivation. Lincoln: University of Nebraska Press, 1958.
- Spence, K. W., Goodrich, K. P., and Ross, L. E. Performance in differential conditioning and discrimination learning as a function of hunger and relative response frequency. J. exp. Psychol., 1959, 58, 8-16.
- Strange, J. R. The effect of an irrelevant drive on the reaction tendency specific to another drive. J. gen. Psychol., 1954, 51, 31-40.
- Tolman, E. C. Purposive Behavior in Animals and Men. Berkeley: University of California Press, 1951.
- Ullman, A. D. The experimental production and analysis of a "compulsive eating symptom" in rats. J. comp. physiol. Psychol., 1951, 44, 575-581.
- Waller, M. B., Waller, P. F., and Brewster, L. A. A water maze for use in studies of drive and learning. Psychol. rep., 1960, 7, 99-102.
- Wever, E. G. Water temperature as an incentive to swimming activity in the rat. J. comp. Psychol., 1932, 14, 219-224.
- Woodworth, R. S. Dynamic psychology. New York: Columbia University Press, 1918.
- Worell, L. and Friedman, C. J. The effects of stimulus change vs. drive intensity on the swimming performance of rats in a water maze. (unpublished manuscript).
- Young, P. T. Motivation of behavior. New York: Wiley, 1936.

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