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The Effects of Water Deprivation and Conditioned Taste Aversion On a Cognitive Task in Laboratory Rats

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The Effects of Water Deprivation and Conditioned Taste Aversion On a Cognitive Task in Laboratory Rats, *Rattus norvegicus*

by
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Research
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OUTLINE

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C. Learning in Both Animals and Human

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A. Experimental Hypotheses

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2. Water-Deprived Rats Are More Motivated to Drink

3. Conditioned Taste Aversion and Motivation Levels Interact

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Introduction. It is a readily accepted observation that hunger is a powerful motivator. Various experimental studies report that the more hungry the animal, the more motivated that animal will be to acquire food. For instance, a stickleback fish's motivation level of prey foraging increases in relationship to the time period increase since its last feeding. A stickleback fish deprived of food for 24 hours tends to catch prey faster and eat that prey more thoroughly than fish deprived of food for 12- or 1-hour periods (Croy and Hughes 1991). How fast and efficiently an animal eats also depends on its body size and age. R. Scorpin (Pers. Com. 1992) discovered that young, growing rats eat more consistently than full-grown older rats. It has been observed that animals not deprived of food tend to make fewer errors searching for food than their deprived counterparts. In one study, hens deprived of food for three hours spent more time in a tunnel searching for food then non-food-deprived hens (Nicol and Guilford 1991).

Although many studies have focused on the learning behavior of food-deprived animals, very few examined the effects on water-deprived rats. Even the experiments that were found to utilized water-deprived rats did not address motivation levels or the number of errors made during learning tasks by the water-deprived

rats. One such study used water-deprived rats in a conditioned lick suppression experiment to discover what were the effects of potential comparator stimuli on reinforcing conditioned inhibitors, such as a flashing light or noise (Miller et al 1992). Another experiment utilized water-deprived rats in a lick suppression study to observe how a negative response is increased by removing a conditioned inhibitor (Hallam et al 1992).

Still, questions persist as to the relationship between water deprivation and cognitive functioning. For example, are the effects of water deprivation on learning similar to those observed for food-deprived rats? Does water deprivation increase a rat's motivation of acquiring water, and conversely, will rats in a water-deprived state make more errors on a learning task than those not so deprived?

Practical Application and Significance. Past experience has been known to affect present learning behavior and that motivational levels mediate the relationship between prior learning and present learning behaviors. It will be worth investigating to see if there is a relationship between water deprivation and cognitive mapping. Tolman stated that a cognitive map represents the spatial layout of the animal's world and indicates what is where and what leads to what (Pers. Com. 1948). Thus, a general application may be inferred toward learning in both animals and humans. If this relationship holds, then there are interesting implications for education. For humans, the question may be asked how successful college freshmen

can expect to be when they approach learning tasks with different levels of motivation and "aversive conditioning". Since this experiment can be used as an analogy to human experience, it promises to hold both theoretical and practical significance.

Objectives. This experiment addressed three questions: (1) How do aversive treatment influence past and present learning behavior? (2) How does motivation influence learning? (3) How does aversive treatment, coupled with different levels of motivation, affect performance?

Hypotheses. The following experimental hypotheses were addressed in this study:

(1) Rats aversively trained to avoid saccharine water make more errors than those not trained.

(2) Water-deprived rats are more motivated to drink than those not deprived.

(3) There is an interaction between conditioned taste aversion and motivation levels.

(4) Rats receiving aversive training are more motivated to move to another water dish than those not receiving this training.

The following null hypotheses were tested in this study:

(1) There is no difference between the number of errors made by rats aversively trained to avoid saccharine water and those not trained.

(2) Motivation to drink water is the same for both water-deprived and non-deprived rats.

(3) There is no interaction between conditioned taste aversion training and motivation levels.

(4) Rats receiving aversive taste training are equally motivated to move to another water source as those not receiving the training.

Data Analysis. An Analysis of Variance (ANOVA) was used to test any significant difference in mean errors and interaction.

Materials. The aversive training apparatus (see Figure 1) was built inside a 10-gallon glass aquarium. A small section (10 x 6 in. x height 10 in.) was isolated by a piece of cardboard from the rest of the aquarium. Two glass water dishes (diameter 4 in; height 3 in.) were placed side by side in the enclosed area. One of the dishes contained saccharine flavored water while the other contained tap water. A cardboard floor, level with and surrounding the dishes, was placed inside the area.

The radial-arm maze (see Figure 2) consisted of a central platform (diameter 9 in.) from which eight rectangular sidearms (12 x 3 in. x height 6 in.)extended like spokes in a wheel. A glass dish (diameter 1.5 in.; height 1.5 in.) containing saccharine-flavored water was placed at the end of each arm. A wire roof was placed over this maze. Both the aversive training apparatus and the radial-arm maze were placed on a lab desk in the experimental lab. The lab was evenly lit and maintained at room temperature.

General Methods. The experiment was carried out on 30 young laboratory rats, *Rattus norvegicus,* (15 males and 15 females)

with initial body weights of 40 to 80 g. Each rat was individually marked to distinguish between them. The rats were randomly assigned to six groups of five rats each for housing purposes. The rats were housed in six ten-gallon glass aquariums, containing wood shavings, food, and water dishes. The housing lab received normal sunlight and darkness and was maintained at room temperature. The rats were fed dried rat food and given fresh water daily. Their cages were cleaned twice a week.

Fifteen of the rats comprised the control (non-conditioned or NC) group. The other 15 rats, the experimental (conditioned taste aversion or CTA) group, were trained to avoid saccharine-flavored water. Prior to giving them their daily supply of tap water, each CTA rat was individually taken to the experimental lab and placed in the aversive training apparatus for 5 minutes, once a day, for seven days. Each time a CTA rat tasted the saccharine water, an electronic alarm sounded. By doing this, the experimenter intended to train the CTA rats to equate saccharine water to this sound, thus conditioning them to avoid saccharine water. Saccharine-flavored water was used as the conditioned taste aversion substance.

During the training week, each group of 15 rats was divided into two groups of rats. The first five rats of both the CTA and NC groups were not deprived of tap water. These two groups were labeled as the conditioned taste aversion/non-water deprived group (CTA/ND) and non-conditioned/non-water deprived group

(NC/ND), respectively. The remaining 10 rats in both the CTA and NC groups were deprived of tap water for time periods ranging from 23 to 26 hours. These two groups were labeled as the conditioned taste aversion/water-deprived group (CTA/WD) and non-conditioned/water-deprived group (NC/WD), respectively. Thirst, as measured by degree of water deprivation, was used as a motivator.

Pre-Experiment. For the six days following the aversive training week, the experimenter gradually deprived the CTA/WD and NC/WD rats of water. These rats were given access to water for 12 hours the first day. The time period was decrease by two hours each day for the next five days. On Day 7, the deprived groups were given access to water for 24 hours. Then the water dishes were removed from the CTA/WD and NC/WD rats' housing aquariums for the next 24 hours. On Day 9 all the rats were tested in the maze.

Experiment. Before any of the rats received a fresh supply of tape water in their aquariums, each rat was individually moved to the experimental lab and placed in the center of a maze. Records were taken how much water each rat drank and how many errors it made. An error was defined as returning to a previously encountered water dish. The electronic alarm sounded whenever a CTA rats tasted the water since these rats had been conditioned to equate the sound with the saccharine-flavored water and thus avoid the water.

Results. It was hypothesized that the conditioned taste

aversion rats would make more errors than the non-conditioned rats. Experimental data appeared to support this claim (see Graph 1). The CTA group made 185% more errors than the NC group. However, the difference was not statistically significant ($p > 0.05$).

It was expected that water-deprived rats would be more motivated to drink than non-deprived rats. While 95% of the deprived rats drank the water in the maze, only 33% of the non-deprived rats drank the water (see Graph 2). It was also observed that none of the non-deprived rats drank all the water from any dish. On the other hand, 30% of the deprived rats emptied a water dish. A striking significant difference was noted here ($p < 0.005$).

It was also hypothesized that the CTA/WD group would make the most errors, and the experimental data showed that they made 64.5% of the total errors made by all the rats (see Graph 3). Thus, experimental data showed there was an interaction between aversive taste training and motivation level. Nevertheless, statistical data revealed no interaction between the two factors ($p > 0.05$).

It was expected that the conditioned taste aversion rats would be more likely to visit different water dishes than the non-conditioned rats. The conditioned taste aversion rats did in fact visit more different dishes than the non-conditioned rats. On average the conditioned taste aversion rats visited 78% more bowls than the non-conditioned rats (see Graph 4). A significant

difference resulted between the experimental and control rats ($p < 0.05$).

(Note: Since one of the NC/ND rats clung to the wire roof which was place over the maze and refused to move, the experimenter was unable to include that rat in the final experiment or in the calculated data.)

Discussion and Conclusion. It appears that thirst is a powerful motivator. Experimental and statistical data reveal a significant difference between water-deprived rats and non-deprived rats. Water-deprived rats appear to be more motivated to acquire water than their non-deprived counterparts.

Experimental data appear to support the belief that there is a relationship between water-deprivation and conditioned taste aversion. CTA/WD rats made more errors than the other three groups combined. Statistical and experimental data support that CTA rats appear to be more motivated to visit different water dishes than the NC rats.

If these conclusions hold for humans as well as rats, then one can predict that a person deprived of a life's necessity may be more motivated to acquire that need than one not so deprived. Since no statistical difference is noted between the number of errors made on a cognitive task by water-deprived and non-deprived rats, one can also be concluded that deprived students could have an equal chance to succeed in college as a non-deprived students. Deprived students may even be more motivated to succeed in college because they have been deprived. By acquiring an college education, these deprived student may reason that they will be more able to supply their needs.

Future Work. Further studies can be performed to determine how three or four different levels of water deprivation affect the cognitive functioning of laboratory rats.

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Literature Cited

Croy, Marion I. and Roger N. Hughes. 1991. The influence of hunger on feeding behaviour and on the acquisition of learned foraging skills by the fifteen-spined stickleback, *Spinachia spinachia L.* Animal Behavior. 41:161-170.

Hallam, Steve C., Nicholas J. Grahame, Kathleen Harris, and Ralph R. Miller. 1992. Associative structures underlying enhanced negative summation following operational extinction of a Pavlovian inhibitor. Learning and Motivation. 23:43-62.

Miller, Ralph R. James J. Esposito, and Nicholas J. Grahame. 1992. Overshadowing-like effects between potential comparator stimuli: covariation in comparator roles of context and punctate excitor used in inhibitory training as a function of excited salience. Learning and Motivation. 23:1-26.

Nicol, Christine J. and Tim Guilford. 1991. Exploratory activity as a measure of motivation in deprived hens. Animal Behavior. 41:333-341.

Aversive Training Apparatus

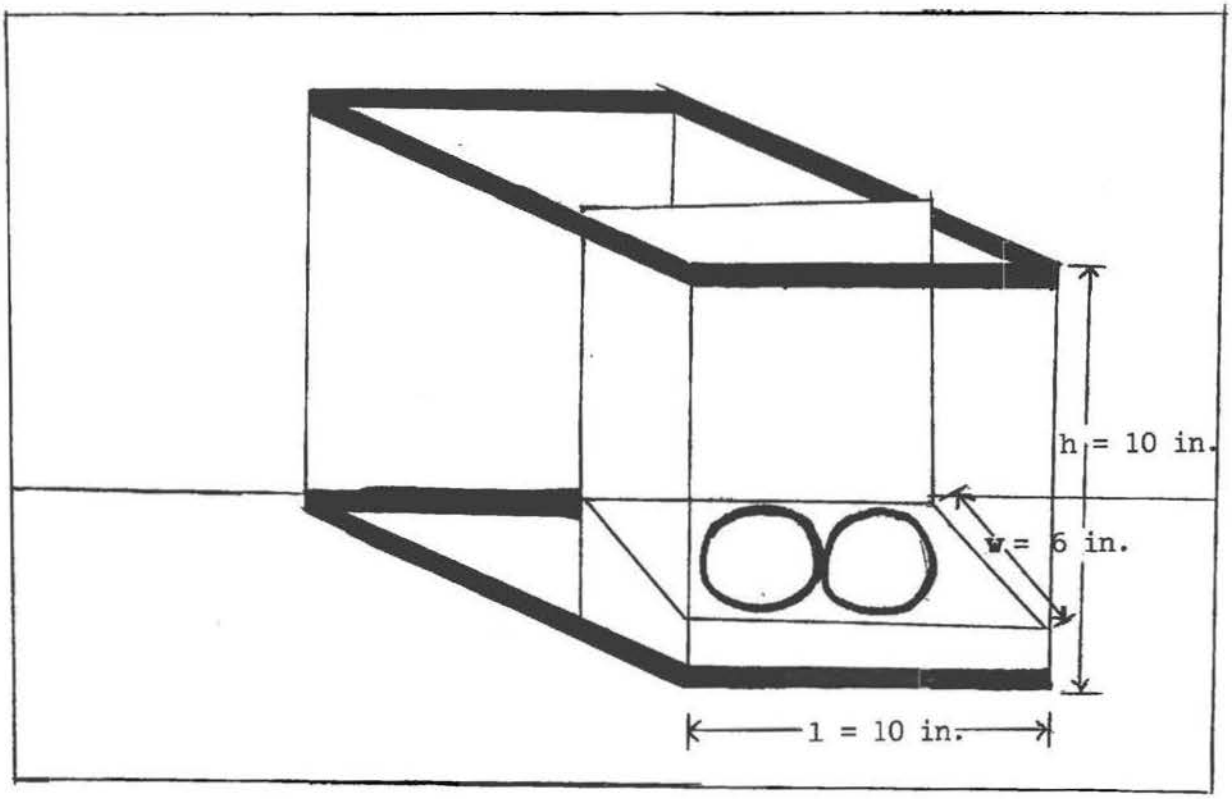


Figure 1

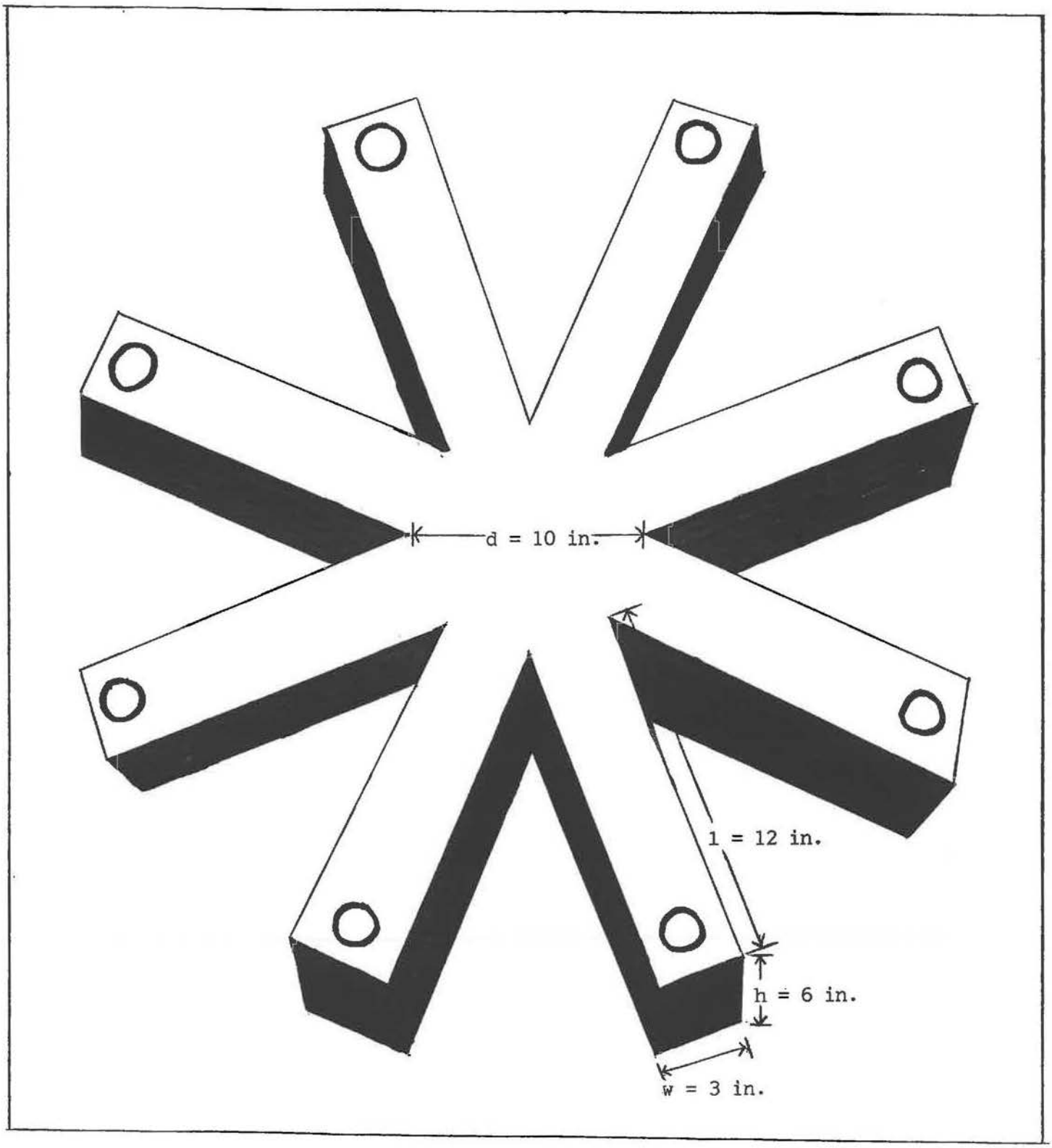
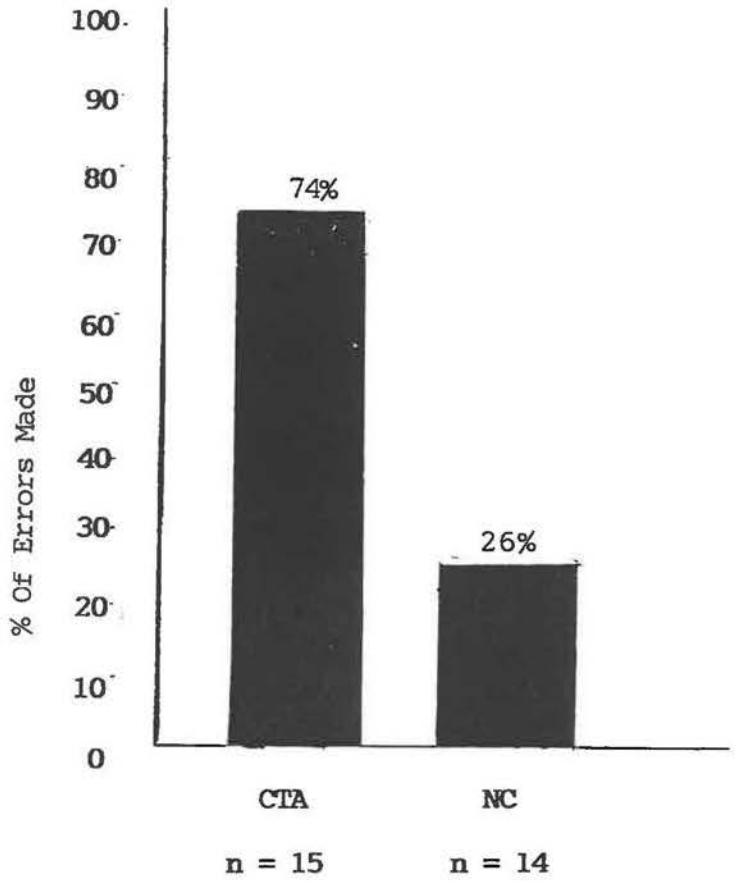


Figure 2

Percentage of Errors Made by Rats

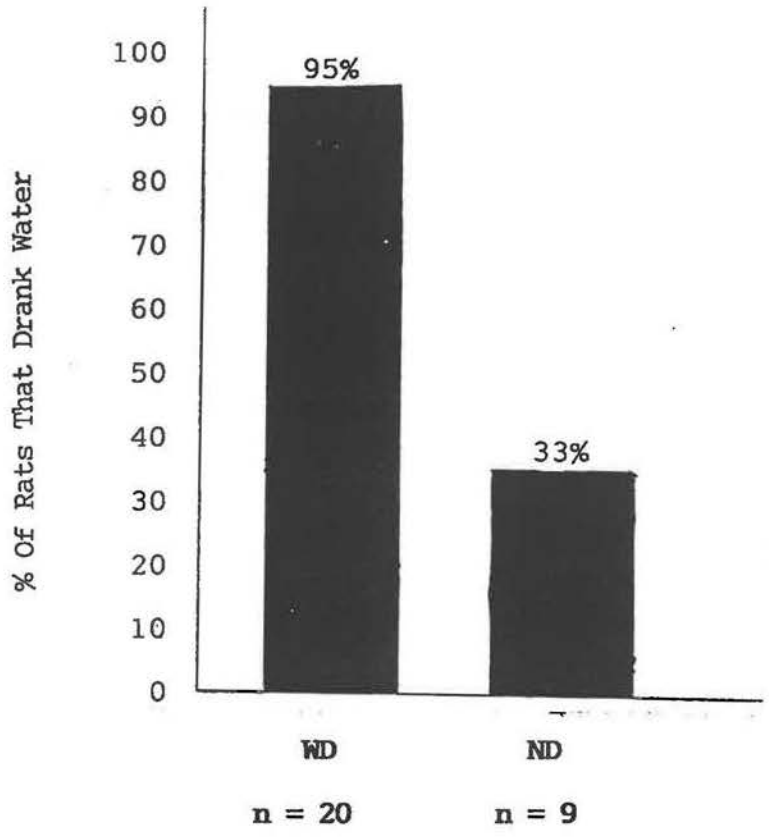


GRAPH 1. CTA = Conditioned Taste Aversion Group. NC = Non-Conditioned Group. n = Number of Rats Per Group.

Percentage of Rats in Water-Deprived

And Non-Water Deprived Groups

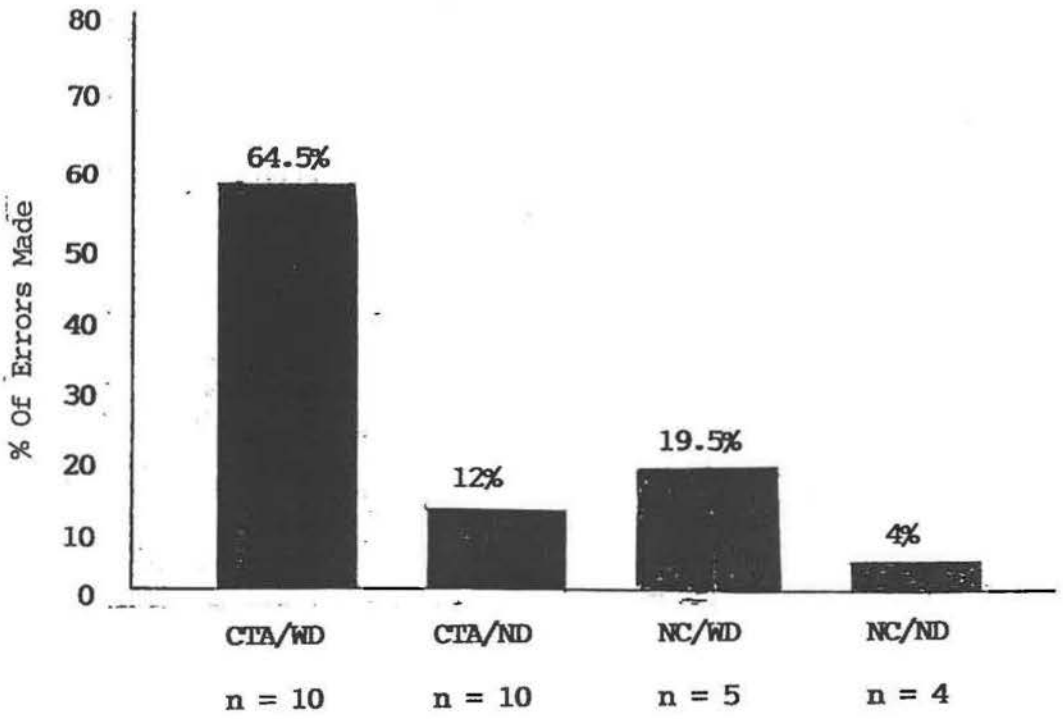
That Drank Water



GRAPH 2. WD = Water-Deprived Group. ND = Non-Water Deprived Group. n = Number of Rats Per Group.

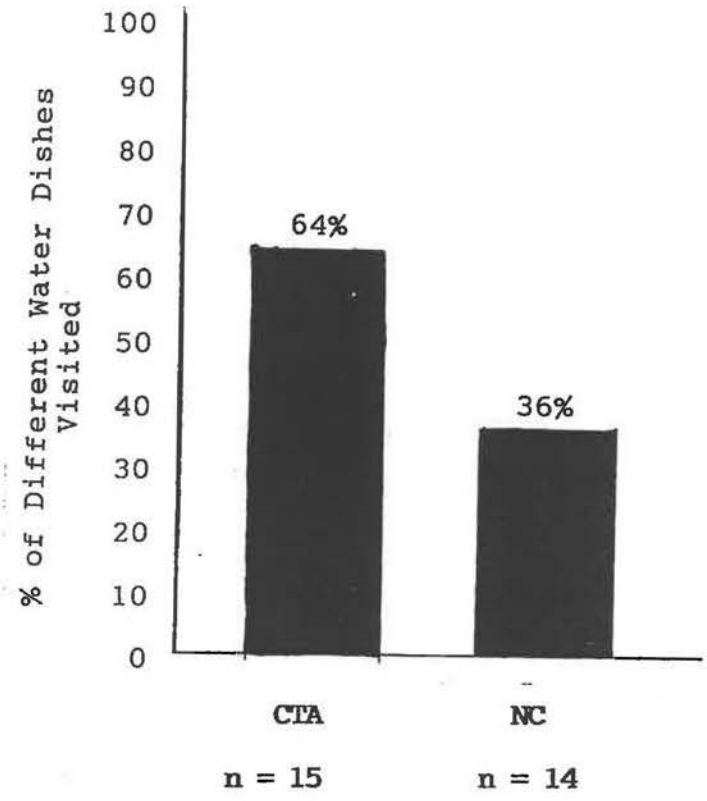
Percentage of Errors Made by Rats

(Relationship Between Conditioned Taste Aversion and Water Deprivation)



GRAPH 3. CTA/WD = Conditioned Taste Aversion/Water-Deprived Group. CTA/ND = Conditioned Taste Aversion/Non-Water Deprived Group. NC/WD = Non-Conditioned/Water-Deprived Group. NC/ND = Non-Conditioned/ Non-Water Deprived Group. n = Number of Rats Per Group.

Percentage of Water Dishes Visited



GRAPH 4. CTA = Conditioned Taste Aversion. NC = Non-Conditioned. n = Number of Rats Per Group.