

AN ABSTRACT FOR THE THESIS OF

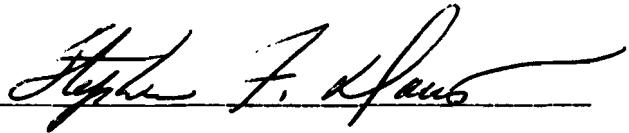
Cynthia A. Erickson for the Master of Science

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Title: THE NATURE OF ASSOCIATIVE CONDITIONING IN

TASTE-MEDIATED ENVIRONMENTAL POTENTIATION

Abstract approved:



Prior to the research done in the area of taste aversion learning, it was believed that the pairing of stimuli in classical or Pavlovian conditioning was arbitrary. However, Garcia and Koelling (1966; 1967) demonstrated that rats will learn to associate a novel taste with illness more readily than they would a sound or a light. More recently, researchers have found that while an odor does not become associated easily with illness, when paired with a taste, the odor acquires the aversive qualities of the taste. In other words, the taste can enhance or potentiate the odor and thus, make it more aversive (Rusiniak, Hankins, Garcia, & Brett, 1979). Other investigators have reported similar findings when a novel taste is presented in compound with environmental cues (Taukulis & St. George, 1982; Best, Brown, & Sowell, 1984). This is referred to as taste-mediated environmental performance. Furthermore, Davis, Best, Richard, & Grover (1987) reported that instrumental performance can be disrupted if preceded by

the presentation of a novel taste in conjunction with illness. While Davis et al. (1987) demonstrated that a novel taste can potentiate an aversion, their data do not indicate the nature of the association learned. The present study examines whether the nature of the associative conditioning is a stimulus-stimulus or response-reinforcer type of conditioning.

Four groups of rats were trained to run a runway for water reward. Two of those groups then received a LiCl injection following completion of the runway trial. The two remaining groups received a LiCl injection in the home cage. One of each of the groups was exposed to a novel flavor prior to the toxicosis treatment, and the other of each locus type tasted water. Runway extinction was measured by goal-approach latencies, stops, retraces, and licks. Each of these measures demonstrated disrupted runway performance for the group receiving the novel taste presented in compound with the instrumental response, followed by toxicosis, but not for the other groups. These data suggest that the association established between the running response and the toxicosis, in the presence of a novel flavor, is most influential in disrupting instrumental performance.

THE NATURE OF ASSOCIATIVE CONDITIONING IN TASTE-MEDIATED  
ENVIRONMENTAL POTENTIATION

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A Thesis

Presented to

the Division of Psychology and Special Education

EMPORIA STATE UNIVERSITY

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In Partial Fulfillment

of the Requirements for the Degree

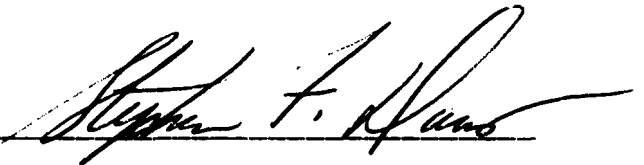
Master of Science

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by

Cynthia A. Erickson

August 1988



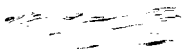
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## CONTENTS

	Page
LIST OF TABLES.....	iv
LIST OF FIGURES.....	v
CHAPTERS	
I. INTRODUCTION.....	1
II. METHOD.....	21
III. RESULTS.....	27
IV. DISCUSSION.....	32
REFERENCES.....	35

LIST OF TABLES

Tables	Page
1. Daily training, conditioning, and extinction schedule. Abbreviations used were: DEP = deprivation, PRE = pretraining, TRAIN = training, COND = conditioning, and EXT = extinction. This particular schedule was used so that all subjects would begin extinction on the same day.....	23
2. Mean number of stops for each of the four groups during the last two days of Acquisition, Conditioning, and Extinction. The abbreviations in this table include: Acq = Acquisition, Con = Conditioning, and Ext = Extinction.....	28
3. Mean number of retraces for each of the four groups during the last two days of Acquisition, Conditioning, and Extinction. The abbreviations in this table include: Acq = Acquisition, Con = Conditioning, and Ext = Extinction.....	29

LIST OF FIGURES

Figures

Page

1. Mean goal approach latencies (seconds) for all four groups. Specific labels utilized include: CAGE-WAT = home cage + water, CAGE-SAC = home cage + saccharin, MAZE-WAT = runway + water, MAZE-SAC = runway + saccharin. The first part of the label describes the locus of conditioning, while the second part indicates which fluid was utilized.....30
  
2. Mean number of licks for each of the four groups on the last two days of Acquisition (ACQ), Conditioning (CON), and Extinction (EXT). Labels include: CAGE-WAT = home cage + water, CAGE-SAC = home cage + saccharin, MAZE-WAT = runway + water, MAZE-SAC = runway + saccharin. The first part of the label describes the locus of conditioning, while the second part indicates which fluid was utilized.....31



## CHAPTER I

### INTRODUCTION

The classical, Pavlovian or stimulus-stimulus (S-S) conditioning paradigm has played an important role, not only in learning, but in psychology as a whole. The basic paradigm involves the pairing of a neutral or conditioned stimulus (CS) with an unconditioned stimulus (US) which reflexively elicits an unconditioned response (UR). After several such pairings the CS, when presented alone, comes to elicit a conditioned response (CR) that is similar to the UR. Moreover, several theorists have suggested that virtually any stimulus may become associated with any other stimulus in this manner (see Domjan & Burkhard, 1982). Within the classical conditioning paradigm it is of interest whether certain, more relevant, stimuli fit together better than arbitrary stimuli. That is, some stimuli seem to be paired easier than others. This position created an anomaly for classical conditioning purists, who theorized that the pairing of classical stimuli was arbitrary. However, relevance appears to be important to the laws governing the associations learned in conditioning (Mackintosh, 1983, chap. 8).

Also of theoretical interest is the nature of the

associations formed within the classical conditioning paradigm. In addition to Pavlovian conditioning, which refers to the learning of a relationship between two stimuli, there is response-reinforcer or R-R learning, whereby a relationship between a specific behavior or response and a particular reinforcer is learned (Bolles, Holtz, Dunn & Hill, 1980). Of particular interest to learning theorists is which of these two types of learning occurs in any given situation.

#### Taste Aversion Learning

The general procedure used in taste aversion research involves an animal first being presented with a novel gustatory stimulus (either a fluid or a solid) and then made ill. The illness is usually induced by injecting a toxin such as lithium chloride (LiCl), exposing the animal to x-rays, or rotating them on a turntable to induce nausea (Green & Rachlin, 1976).

Wild rats learn to avoid tainted food after ingesting it, becoming ill, and then surviving; making further attempts to poison them futile. This illness does not seem to classically condition to the place of illness, i. e., the pairing of the illness and surrounding stimuli appears to be based on the possible relevance of those stimuli to each other (Barnett, 1963). Furthermore, evidence obtained in several

laboratories indicates that classical conditioning does not always occur as earlier, Western learning theorists would have suggested. Associations which belong together, or are more relevant, seem to be learned more readily. Taste aversion learning, the pairing of a novel taste with illness resulting in an avoidance of that taste, occurs more readily than the pairing of auditory or visual stimuli with illness (Garcia & Koelling, 1966, 1967).

John Garcia's evolutionistic, theoretical orientation suggests that animal survival entails two prerequisites (Garcia, Hankins & Rusiniak, 1974). First, animals must utilize information from the outside world. Second, animals must attend to internal messages as well as external information. Taste aversion learning directly addresses the second prerequisite, and is thus an adaptive learning mechanism.

Garcia and Koelling (1966) reported the seminal data which supported the conceptualization of taste aversion as an adaptive behavior. Laboratory rats quickly learned to avoid a taste (saccharin) when it was paired with illness (caused by either x-rays or a LiCl injection). However, a second group of animals did not learn an association between this flavor and an electric shock. In addition, when an audiovisual stimulus was

substituted for the taste, animals learned to avoid the audiovisual stimulus when it was paired with an electric shock, but not when paired with illness. Clearly, the pairing of stimuli in classical conditioning need not be arbitrary.

Garcia and Koelling (1967) noted that conditioned pairings of x-rays with olfactory, gustatory and olfactory, or environmental cues were not of the same associative strength. The combined gustatory and olfactory cues proved to be the most effective cue for producing a learned taste aversion to water when paired with radiation-induced illness. The gustatory stimulus alone was more effective in producing an aversion than a distinctive environment; however, it was not as effective as the combined gustatory and olfactory cues. They also reported that while aversions are more successfully produced with novel tastes, radiation-induced avoidance was readily established with flavors to which the animals had been exposed from birth. Animals who consumed LiCl or were injected with apomorphine hydrochloride developed an avoidance to the taste, but not to a novel or distinctive environment. This research indicated that toxin- and radiation-induced aversions can be established for both novel and familiar tastes.

Underscoring the adaptiveness of taste-aversion learning, Garcia et al. (1974) suggested that "the animal must be able to accept or reject food in the mouth before ingestion . . . . The simplest way to accomplish this is to acquire a taste for nutrients and an aversion for toxins" (p. 824). Not surprisingly learned taste aversions have been demonstrated to a variety of tastes using a wide range of species including rats, mice, cats, monkeys, ferrets, coyotes, birds, fish, and reptiles (Lett, 1982). Even humans report incidents of taste aversion (Bernstein, 1978; I. L. Bernstein, Webster & I. D. Bernstein, 1982).

#### Potentiation of Odor by Taste

One area of considerable research interest has involved pairing a compound stimulus, comprised of a taste and an odor, with illness. Pavlovian theory predicts the occurrence of overshadowing in this situation (Pavlov, 1927/1940; 1928). In other words, the stronger taste would be more salient or potent than the less salient odor stimulus. Thus, stronger conditioning should be shown to the taste than to the odor.

Rusiniak, Hankins, Garcia, and Brett (1979) questioned the generality of overshadowing by demonstrating that the aversion to the weaker odor

presented in compound with the stronger flavor during toxicosis conditioning could be potentiated or enhanced, rather than overshadowed. These experimenters initially suggested that second-order conditioning was the underlying mechanism responsible for this effect. Second-order conditioning occurs when a neutral stimulus is paired with a conditioned CS, such that the third stimulus is subsequently rendered capable of eliciting the CR. For example, if a bell is paired with an electric shock, then the bell will elicit an aversion. According to the theory, if the bell is subsequently paired with a light, the light eventually will come to elicit the conditioned fear response (CR).

The first experiment presented by Rusiniak et al. (1979) verified that saccharin was a highly effective cue for pairing with LiCl intubation (a process where LiCl is administered directly to the stomach via a tube placed in the mouth and down the esophagus). However, the results of a second experiment reported by Rusiniak et al. (1979) failed to support second-order conditioning as a feasible explanation. Instead, they found that second-order conditioning produced no effects on suppression of either consumption or approach to the second-order stimulus, whether that stimulus was an odor or a taste. When either a taste or an odor was paired

with illness, the taste acquired stronger aversive qualities than did the odor, and the aversion did not generalize to either the second-order taste or the second-order odor.

Finally, Rusiniak et al. (1979) reported that stronger concentrations of saccharin actually increased the aversiveness of the weaker odor cue. Second-order conditioning may occur under other circumstances, but, in the words of Rusiniak et al. (1979), "Two-phase flavor-illness learning appears to be just too weak to account for rapid adjustments in approach responses toward aversive foods in one or two trials, at least in the laboratory rat" (p. 14). Thus, an odor's potential aversiveness is directly proportional to the concentration or intensity of the taste stimulus. This was termed "synergistic potentiation" (cf. Palmerino, Rusiniak & Garcia, 1980).

Durlach and Rescorla (1980) also reported that a taste paired with an odor potentiated the associative strength of the odor. They attempted to assimilate potentiation into the Pavlovian conditioning paradigm by utilizing the summation principle in which the sum of the associations possessed by the two stimuli created an enhanced effect. In support of this principle, they demonstrated (Experiment 4) that extinction of the taste

aversion also diminished the effects of the potentiated odor.

Holder, Leon, Yirmiya, and Garcia (1987) reexamined the effects of preexposure of stimuli in taste and odor aversions. In two experiments they reported the attenuation of aversion conditioning by preexposing the to-be-conditioned stimuli. They also noted in a third experiment that preexposure, in addition to weakening subsequent taste aversions, tended to facilitate aversion to tastes not paired with illness.

Utilizing a similar procedure, Rosellini and Lashley (1986) failed to find potentiation using banana- or almond-scented saccharin water. They concluded that potentiation was a fragile phenomenon.

Rusiniak, Palmerino, Rice, Forthman, and Garcia (1982) reported that while a taste-potentiated aversion to odor occurred when visceral feedback was involved, it did not occur when shock was employed as the reinforcer. Experiment 1 was designed to determine if the physical locus of odor was a critical variable in the potentiation of odor by taste. Potentiation occurred whether the odor was in the water or near the spout. Experiment 2 demonstrated that while almond odor was a strong cue when conditioned to shock, saccharin was a weak cue in that situation. They also reported that



while taste potentiated the aversion to odor, the reverse was not true. However, it was shown that when the strength of the resultant taste aversion and odor potentiation were dependent (i.e., positively related) to the amount of reinforcer administered. Clearly, this result is in agreement with the summation principle espoused by Durlach and Rescorla (1980). In addition to verifying the validity of potentiation, these results confirmed the notion that visceral feedback was necessary for potentiation of an odor by a taste.

In 1984, Coburn, Garcia, Kiefer, and Rusiniak reported that an asymmetrical temporal relationship existed between the two components involved in odor-taste potentiation. Specifically, potentiation was enhanced when the two stimuli were presented in close temporal proximity (either simultaneously or when a 2-minute interval occurred between the odor and the taste). Five-minute intervals disrupted the potentiation effect. The decrease in potentiation occurred faster when the odor was presented following the taste.

Holder and Garcia (1987) also have examined the role of the temporal ordering of odor and taste. The timing of the odor presentation did not seem to affect the learning of the taste aversion. However, temporal

contiguity was critical to the development of an aversion to the odor. A third experiment investigated the importance of odor intensity. The results of that study indicated that as odor intensity was increased the conditioned aversion to odor also increased. Obviously, that result is analagous to the dose-dependent relationship reported by Durlach and Rescorla (1980).

In summary, several general statements can be made about potentiation of odor by taste when paired with illness in rodents. First, it is a reasonably robust phenomenon that has been well supported by studies from several labs (Lett, 1982; Rusiniak, Hankins, Garcia & Brett, 1979). Second, preexposure attenuates this phenomenon (Holder et al., 1987). Third, young adult rats lend themselves more readily to potentiation than aged or weanling rats (Peterson, Valliere, Misanin & Hinderliter, 1985). Fourth, temporal contiguity is necessary for the development of an odor aversion, but is not necessary for taste-aversion learning (Holder & Garcia, 1987). Finally, potentiation only occurs in those conditions where taste is paired with visceral cues, such as upper gastrointestinal disturbances (Rusiniak et al., 1979).

### Taste/Taste Potentiation

Taste-mediated potentiation also has been found to occur when two tastes are presented in compound. Kucharski and Spear (1985) presented coffee and saccharin either in compound or sequentially. They reported that potentiation can occur even when there is a delay between the presentation of the taste and illness. Potentiation occurred in both preweanling and adult rats. However, it occurred more readily in preweanlings. Similarly, Bouton, Dunlap, and Swartzentruber (1987) reported that saccharin potentiated conditioning to a dilute saline solution.

Recently, Davis, Best, and Grover (1988) reported that denatonium saccharide (an extremely bitter substance), when presented in compound with saccharin, resulted in potentiation of the saccharin aversion. Similar to odor/taste potentiation, taste/taste potentiation was not due to preexposure effects, and that effect did not occur when those two substances were presented sequentially. Those studies indicated that potentiation can occur when one taste is presented in compound with another taste, and then paired with illness.

### Auditory Potentiation

Auditory aversions also have been shown to be potentiated by the presence of a taste (Ellins, Cramer & Whitmore, 1985). Subjects showed a preference for food not accompanied by noise over food paired with a tone, when noise had been presented in compound with the food and illness. Avoidance did not occur when only the tone was paired with illness (Ellins & von Kluge, 1987).

### Taste Potentiation to Visual Cues

In addition to the finding that taste can potentiate olfactory, gustatory, or auditory stimuli, Galef and Osborne (1978) reported the potentiation of an aversion to visual cues. They reported that while rats did not readily learn an aversion to visual cues, they developed an aversion to such cues when they were paired with a novel flavor. Neither higher order conditioning nor sensory preconditioning were supported as possible explanations for this phenomenon.

Lett (1980) reported that color-aversions were potentiated by taste in pigeons and quail. Using hawks as subjects, Brett, Hankins, and Garcia (1976) reported similar findings. Clarke, Westbrook, and Irwin (1979) reported that pigeons conditioned to a compound stimulus consisting of blue-colored, salty water drank less than those conditioned to and tested on just colored water.

Their data suggested that taste aversions were stronger than color aversions, but that the aversion to color was potentiated by the presence of taste.

### Environmental Potentiation

While earlier research (Garcia & Koelling, 1967) indicated that visual or environmental information did not easily become associated with illness, evidence indicating that the presence of a taste can potentiate aversion conditioning to other environmental stimuli also has been reported. For example, Galef and Dalrymple (1981) demonstrated that visual stimuli were potentiated only if those stimuli were related to feeding.

Taukulis and St. George (1982) paired LiCl injections with either a dark, drinking compartment and an odor (oil of eucalyptus), a dark box only, or a dark box and a taste (sodium chloride). As expected, the group which received the taste/box compound showed the greatest aversion to water when tested in the box. However, the presence of the odor resulted in overshadowing, rather than potentiation, of the environmental cues.

Best, Brown, and Sowell (1984) evaluated the production of overshadowing and potentiation of environmental stimuli in the toxicosis conditioning

situation. In Experiment 1, three groups received a novel taste (saccharin), water, or no fluid in an operant conditioning chamber paired with a LiCl injection. Since subjects exposed to the novel taste drank less water in the experimental chamber than did either of the other two groups, it was argued that the novel taste potentiated the environmental aversion. Because all subjects received water on the days between the four conditioning trials and testing, subjects were exposed to unequal amounts of the test fluids. The second experiment sought to control for the unequal exposure to the test stimuli by allowing the animals to drink a saline solution, rather than water, in the home cage. Results similar to those of Experiment 1 were obtained. Experiment 3 demonstrated that when a novel taste was paired with a distinct environment, those environmental cues subsequently blocked a lithium-induced aversion to another taste. Thus, these data demonstrated that diffuse environmental stimuli were potentiated when conditioned in compound with taste.

In a series of related experiments, Best, Batson, Meachum, Brown, and Ringer (1985) further examined the potentiation of environmental stimuli. The first experiment determined the contribution of stimulus

generalization between taste and environment. The researchers found that when saccharin was presented in compound with a distinct environment the environment subsequently became more aversive than if the taste and the environment had been paired with a LiCl injection separately. The second experiment found that animals learned an aversion to a familiar environment when that environment was paired with a novel taste, but not when it was paired with a taste to which they had been previously exposed. The presence of a novel flavor, not a novel environment was the key factor in the resulting aversion. The third experiment reported by Best et al. (1985) examined the possibility that environmental potentiation could be explained by second-order conditioning. Saccharin was paired both with the experimental chamber and with LiCl injections in the home cage on separate occasions. The effects of order of pairing were controlled by the utilization of two groups in which the pairings were presented in different orders. The experimental groups developed an aversion to saccharin, yet this did not generalize to the experimental chamber. Groups did not differ in mean consumption of water in the experimental chamber. Finally, extinguishing the aversion of taste also diminished the effects of the aversion to the

environment.

More recently, Best, Meachum, Davis, and Nash (1987) sought to examine the abilities of environmental cues to "alter the performance of an instrumental response" (p. 44). In the first experiment a T-maze was utilized to determine if a novel taste paired with an instrumental response could alter that response. Animals were trained in the T-maze to receive a novel flavor (saline or saccharin). During conditioning one group was given a second taste in the runway followed by a LiCl injection. The other two groups served as controls. When tested in the T-maze with the taste paired with illness in one arm, the experimental animals displayed slower running speeds, drank significantly less, and spent less time in the goal box than did the controls. These results suggested that the animals learned to avoid the environment in which they were made ill.

The second experiment conducted by Best, Meachum, Davis, and Nash (1987) sought to determine whether the animals had learned an aversion to the environment or simply avoided the taste which had been paired with illness. This time a straight runway was employed as the test apparatus. The experimental group of interest received taste-aversion conditioning after receiving



access to a novel flavor in the runway. Subsequently, an extinction phase was administered. Goal-approach latencies were recorded. The group which received a novel taste followed by toxicosis ran significantly slower than a control group that had received water followed by toxicosis.

Davis, Best, Richard, and Grover (1987) also examined instrumental responding (runway performance) following the pairing of a novel taste or water with a LiCl injection. They reported that goal-approach latencies were longer for those animals that traversed the runway to receive a novel taste (saccharin) prior to toxicosis, than those that received water. Their data suggested that when a novel taste was paired with toxicosis in the presence of environmental stimuli, those stimuli were conditioned more strongly than when a familiar taste was present. As those data have a direct bearing upon the present experiment, they are considered in some detail below.

In the first of the three experiments, rats were placed on water deprivation, and trained to traverse a runway to receive water reinforcement. During the conditioning phase of the experiment, either water or saccharin was paired with a LiCl injection which was administered immediately following the completion of the

runway trial. Significantly longer mean extinction latencies were reported for the saccharin group.

The second experiment examined the extinction performance of groups conditioned either in the runway or in the home cage. After conditioning, the runway group was more reluctant to approach the goal. However, it was suggested that the use of several toxicosis conditioning trials possibly had resulted in the conditioning of fear via punishment, not enhanced associations with the environment. Hence, Experiment 3 employed only one conditioning trial. Supporting taste-mediated potentiation of environmental stimuli, findings similar to those of Experiment 2 were observed. Similarly, Best, Davis, and Grover (1987, August) found that straight runway extinction was most strongly disrupted when the runway had been previously paired with a novel taste and illness.

While the previous studies (Best, Davis, & Grover, 1987, August; Davis, Best, Richard, & Grover, 1987) indicated that aversions will potentiate the aversion established to runway cues, they do not reveal the nature of the associations formed in such situations. The present study was designed to examine whether the effective association consists of a stimulus-stimulus (S-S) or response-reinforcer (R-R) relationship. A

Pavlovian or S-S association is one in which two stimuli are paired and eventually become associated with each other. A response-reinforcer association involves the pairing of a designated response with a reinforcer.

In the present study, four groups of rats were trained to run a straight runway for water. On the first day of conditioning two groups of subjects received toxicosis induction in the goalbox of the runway, one group following presentation of a novel flavor (saccharin), and the other following water exposure. The remaining two groups also received either saccharin or water in the runway on that day. However, runway fluid exposure for those groups were not followed by illness. On the two following days the designated flavor (either water or saccharin) was then paired with toxicosis in the home cage for those subjects. During extinction if the subjects in both groups presented with the novel taste demonstrate decreased goal-approach latencies, then the environmental potentiation demonstrated in the previous studies would be attributed to the pairing of the stimuli (compound CS and illness), or an S-S association. However, if only the group which were presented with the illness and novel flavor in the goalbox demonstrated decreased run times, then the nature of the effective association would involve the

pairing of the running response and the toxicosis reinforcer in the presence of the novel saccharin flavor.

## CHAPTER II

## METHOD

Subjects

Twenty-eight male Holtzman rats served as subjects. All subjects were individually housed in stainless steel cages in an animal vivarium adjacent to the testing room. The animals remained on a 24-hour light cycle, with food available throughout the entire experiment. Subjects were maintained on a water deprivation schedule, which included 10 minutes access to water each day.

Apparatus

The apparatus used in this experiment was a straight runway divided into three sections (start, run, and goal) by two guillotine type doors, and covered by a wire-mesh top. The startbox was 38.10 cm long and was painted gray. The run-section and goalbox were painted black and were 91.44 cm and 30.10 cm long, respectively. Breaking a photoelectric beam located 91.42 cm beyond the start door activated an electronic timer (Lafayette Model 54030), while breaking a second beam 24.40 cm beyond the first stopped the timer, thus yielding a goal-approach latency. Breaking the final beam also resulted in lowering the goaldoor and activation of a 30-second

confinement timer.

In addition to recording the runway latencies, the number of stops (defined as a complete cessation of forward movement) and retraces (movements to return to the startbox, in which the subject faced away from the goalbox) were recorded for each subject on each trial. At the end of the goalbox, a 50 ml centrifuge tube was mounted on the outside of the runway. The spill-resistant spout protruded into the end of the goalbox such that the animal was required to break the last beam in order to drink. A drinkometer (Layfayette Model 58008) was attached to the spout and the number of licks was recorded for each subject for each trial. The lighting in the runway room was dim.

### Procedures

The subjects were randomly divided into four equal groups ( $n = 7$ ). Groups CAGE-WAT and CAGE-SAC (injections in the home cage) were placed on deprivation three days prior to the start of pretraining, while the two remaining groups (MAZE-WAT & MAZE-SAC; injections after completing the maze) placed on deprivation five days prior to pretraining. All experimental procedures were conducted at 0800 hrs. The experimental design is delineated in Table 1. This staggered deprivation schedule was implemented in order to insure that all

subjects entered extinction at the same time. As can be seen, other than conditioning procedures, the groups were treated identically.

TABLE 1.

Daily training, conditioning, and extinction schedule.

The staggered schedule allowed all groups to experience extinction on the same day.

---

	Days																				
GROUPS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
CAGE-SAC	DEP			PRE				TRAIN						COND							EXT
CAGE-WAT	DEP			PRE				TRAIN						COND							EXT
MAZE-SAC	DEP					PRE				TRAIN					COND						EXT
MAZE-WAT	DEP					PRE				TRAIN					COND						EXT

---

Deprivation. As noted in Table 1, all animals were placed on water deprivation prior to training. In addition, all subjects were handled by the experimenter on a daily basis. Subjects received free access to water for 10 minutes each day at 1400 hrs. throughout the experiment.

Pretraining. Each subject was individually handled for two minutes during the first two days of pretraining. After all animals had been handled, each animal was confined to the goalbox for 30 seconds with water available. Days 3 and 4 of Pretraining consisted of a five-minute-exploration period during which each subject was placed in the startbox for three seconds. The startbox door was then raised and the subject allowed to move freely throughout the runway. Water was available in the goalbox on all exploration trials.

Acquisition. Two runway trials were administered each day on Days 1-10 of Acquisition. The daily running order within each group was determined randomly, while the group sequence was rotated daily (i.e., 1-2-3-4, 2-3-4-1, etc.) in order to control for order effects. A trial consisted of placing the designated subject in the startbox with both the goalbox and startbox doors down. After three seconds both doors were raised. When the subject broke the first photobeam, the startbox door was



lowered. The goalbox door was lowered when the last photobeam had been broken. Once the animal started to drink it was confined to the goalbox for 30 seconds. On the last two days of Acquisition (i.e., Days 11-12), only one trial was administered each day, in order for those days to be more similar to the conditioning and extinction days.

Conditioning. Conditioning lasted one day for Groups MAZE-SAC and MAZE-WAT, and three days for Groups CAGE-SAC and CAGE-WAT. During Conditioning Groups MAZE-SAC and MAZE-WAT received either saccharin or water, respectively, in the goalbox for 30 seconds following the completion of a single runway trial. This confinement was followed immediately by an intraperitoneal injection of LiCl (.12% body weight, .30 M). Groups CAGE-SAC and CAGE-WAT received either saccharin or water, respectively, for 30 seconds following the completion of the runway trial. No injection followed at this time. On each of the following two days Group CAGE-SAC received 30 second exposure to saccharin in the home cage, followed by a LiCl injection. An identical procedure was followed for Group CAGE-WAT except that the subjects drank water instead of saccharin.

Extinction. A one-day Extinction phase followed conditioning. Extinction consisted of a runway trial identical to those administered during Acquisition, with the exception that an empty centrifuge tube was present in the goalbox.

## CHAPTER III

## RESULTS

It will be recalled that goal-approach latencies, stops, retraces, and licks were recorded for each runway trial for each subject. A separate analysis was performed on each of those dependent measures for the last two days of Acquisition, Conditioning, and Extinction.

Analysis of the Acquisition data indicated that the groups did not differ reliably on the goal-approach,  $F(3, 24) = 1.05$ ,  $p = .386$ ; stops  $F(3, 24) = 1.53$ ,  $p = .230$ ; retraces,  $F(3, 24) = .73$ ,  $p > .50$ ; and licks,  $F(3, 24)$ ,  $p > .05$ , measures. These patterns of results clearly indicated that the groups were performing in an equivalent manner at the end of Acquisition.

Analysis of the Conditioning data also failed to yield significant effects for the goal-approach,  $F(3, 24) = .59$ ,  $p > .50$ ; stops,  $F(3, 24) = .45$ ,  $p > .50$ ; and retraces,  $F(3, 24) = 1.51$ ,  $p = .22$ , measures. However, there was a significant effect for licks,  $F(3, 24) = 14.397$ ,  $p < .001$ . The Newman-Keuls procedure was employed to probe the significant licks effect. The results of that analysis indicated that Groups MAZE-SAC and CAGE-SAC made significantly fewer ( $p < .01$ ) licks on the Conditioning day than did Groups MAZE-WAT and

## CAGE-WAT.

Figures 1 and 2 on the following pages depict the goal-approach latency and lick data, respectively, for the four groups on the last two days of Acquisition, Conditioning, and Extinction. The stop and retrace data for the corresponding experimental phases are shown in Table 2 and Table 3, respectively, which appear below.

Table 2.

Mean number of stops on the last two days of Acquisition (Acq), Conditioning (Con), and Extinction (Ext).

Group	Phase			
	Acq	Acq	Con	Ext
CAGE-WAT	.23	.26	.43	.43
COGE-SAC	.14	.29	.29	.14
MAZE-WAT	.29	.17	.14	.14
MAZE-SAC	.21	.21	.14	4.57

Table 3.

Mean number of retraces shown on the last two days of Acquisition (Acq), Conditioning (Con), and Extinction (Ext).

Group	Phase			
	Acq	Acq	Con	Ext
CAGE-WAT	.14	.00	.29	.57
CAGE-SAC	.00	.00	.00	.00
MAZE-WAT	.00	.00	.00	.14
MAZE-SAC	.14	.14	.00	1.43

During Extinction all four dependent measures yielded significance; goal-approach latency,  $F(3, 24) = 69.129$ ,  $p < .001$ ; licks,  $F(3, 24) = 7.788$ ,  $p < .01$ ; retraces,  $F(3, 24) = 8.386$ ,  $p < .001$ ; and stops,  $F(3, 24) = 8.386$ ,  $p < .001$ . Newman-Keuls tests indicated Group MAZE-SAC differed significantly ( $p < .01$ ) from the other three groups in all four dependent measures.

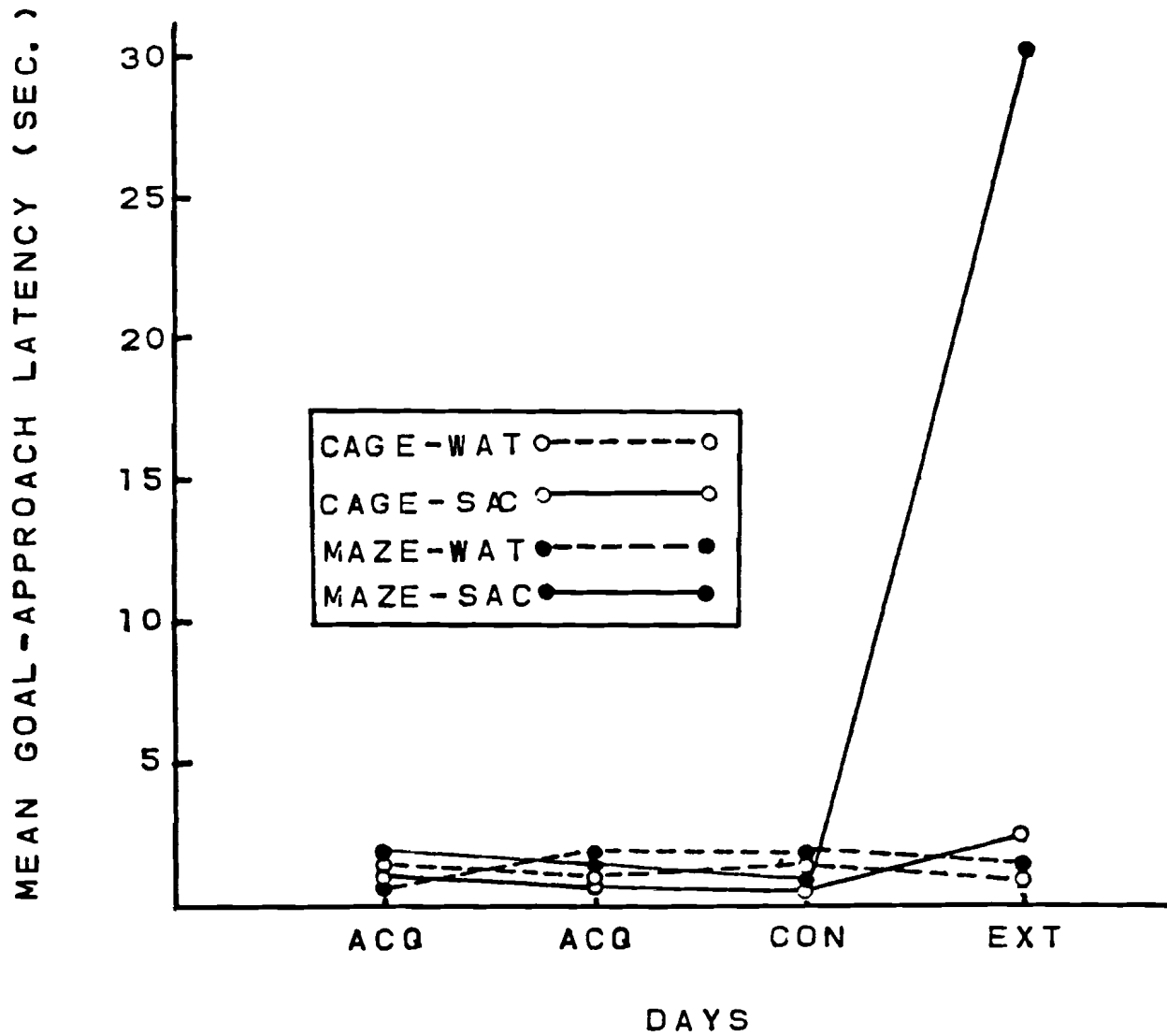
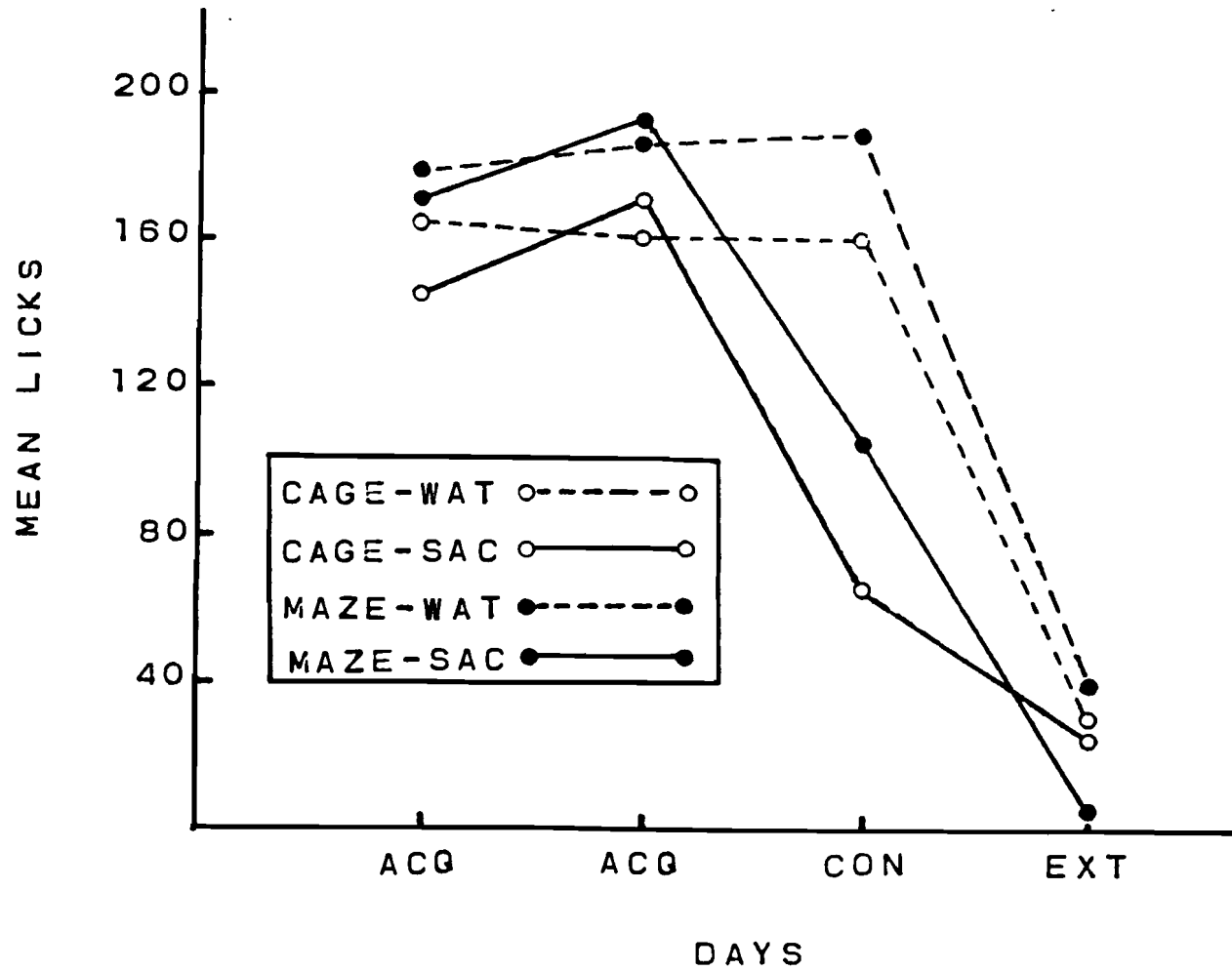


Figure 1.  
 Mean goal-approach latencies (sec) for Groups CAGE-WAT, CAGE-SAC, MAZE-WAT, and MAZE-SAC on the last two days of Acquisition, Conditioning, and Extinction.



**Figure 2.**  
 Mean licks for Groups CAGE-WAT, CAGE-SAC, MAZE-WAT, and MAZE-SAC on the last two days of Acquisition, Conditioning, and Extinction.

## CHAPTER IV

## DISCUSSION

The results of this study support the data reported by Best, Davis, and Grover (1987) which demonstrated that consumption of a novel taste in a straight runway can potentiate a toxicosis-induced aversion to the physical aspects of the runway. The subjects displayed longer goal-approach latencies and made significantly more stops during extinction. While their data did provide evidence for the robustness and generalizability of environmental potentiation, they did not give much indication as to the mechanism underlying this phenomenon.

The present data serve to answer some of the unanswered questions raised by this earlier work. It was found that extinction performance was disrupted only if the subjects were made ill following the instrumental running response. Because MAZE-SAC was the ONLY group which demonstrated an aversion, it seems that the crucial relationship between the instrumental response and toxicosis must be consummated in the presence of a novel flavor.

The nature of the association established in cases of taste-mediated environmental potentiation of disruption in instrumental performance was the central



question this project was designed to address. If either Group CAGE-SAC or CAGE-WAT had demonstrated a disruption in performance, then it could be assumed that the relationship was a stimulus-stimulus type of association. This was not the case. Based on the performance of Group MAZE-SAC, the association of interest involves a response-reinforcer type of learning. As noted above, it also is important for the novel taste to be presented in compound with the environment. This is evidenced by the absence of disruption of performance by the MAZE-WAT group. If a novel taste were not a necessary component, then instrumental performance would have been disrupted in Group MAZE-WAT.

Another finding of interest is that whereas it only required one conditioning trial for the disruption of instrumental performance in the case of Group MAZE-SAC, Groups CAGE-SAC and CAGE-WAT received two conditioning trials and exhibited no disruption of instrumental performance. The failure of Group CAGE-SAC, which received the novel saccharin in both the runway and the home cage, to show disrupted performance is most informative. This failure also highlights the aversive conditioning of the environmental stimuli in the maze that resulted from the contingency between the

instrumental response, the novel flavor, and LiCl-mediated toxicosis.

The use of instrumental responding provides an alternative method of measuring taste-mediated environmental potentiation. Earlier studies (Best, Brown, & Sowell, 1984; Best et al, 1985) utilized consumption as a dependent variable. The disruption of instrumental conditioning provides additional support for environmental potentiation.

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