RECIPROCAL EFFECTS OF LATENT INHIBITION
BETWEEN TASTE AND VISUAL CUES IN GUINEA PIGS AND QUAIL

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RECIPROCAL EFFECTS OF LATENT INHIBITION BETWEEN TASTE AND VISUAL CUES IN GUINEA PIGS AND QUAIL

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Abstract

This investigation was designed to determine whether or not guinea pigs and quail associated a familiar stimulus from the more salient modality with sickness. The investigation was also designed to determine whether or not increased familiarity with the more salient stimulus influenced the aversion quail and guinea pigs formed to a less salient stimulus. The animals were either familiarized or not familiarized with an experimental cue from the more salient modality; blue water for the quail and saccharin water for the guinea pigs. On the Training Day each animal was permitted access to the experimental cue along with a novel stimulus from the same modality or from a different modality; NaCl water or red water for guinea pigs and red water or HCl water for quail. The animals were then injected with a poison or neutral solution. The animals' aversion to the solutions was determined after their recovery from the injection.

Guinea pigs did not form an aversion to familiar saccharin water, the more salient cue, but did form an aversion to a novel saccharin solution. Furthermore, quail did not form an aversion to familiar blue water, the more salient cue, but did form an aversion to a novel blue solution. The data also indicated that guinea pigs did not associate red water, the less salient cue, with sickness while familiar or novel saccharin water was present. They

did, however, associate red water with sickness if tap water flavor was the only cue available from the more salient modality. Similar data collected from quail indicated that they did not associate HCl water with sickness while familiar or novel blue water was present. However, they did associate HCl water with sickness if the tap water color was the only cue available from the more salient modality.

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Introduction

Animals reduce consumption of a distinctively flavored solution which has been paired with X-irradiation or the injection of a poison. This form of learning has been called poison-based avoidance learning (Rozin & Kalat, 1971). One notable difference between poison-based avoidance learning and traditional learning is the permissible delay between a stimulus and a consequence. Findings from traditional learning studies indicate that there will be no learning if the delay between a stimulus and a consequence is greater than a few seconds (e.g., Kimble, 1961). However, poison-based avoidance learning occurs with delays much greater than an hour between the stimulus and the consequence (Revusky & Garcia, 1970). This apparent discrepancy generated studies which investigated the possibility that aftertastes mediate the delay between ingestion and sickness (reviewed by Revusky & Garcia, 1970; Rozin & Kalat, 1971). For example, it has been shown that rats can associate saccharin or sucrose with sickness which occurred 12 hours (Smith & Roll, 1967) or 7 hours (Revusky, 1968) after ingestion. However, Lavin (1973) found that saccharin flavor cannot be associated with coffee flavor unless the delay between ingestion of the two is 9 seconds or less. If an association is based on aftertastes, it would appear, then, that the delay necessary to obtain a stimulus consequence association could not exceed 9 seconds. Another investigator reported that rats can associate a change in

water temperature with sickness that is delayed by an hour (Nachman, 1970). It is very doubtful that aftertaste mediated the delay between consumption of the water and sickness.

A second difference between poison-based avoidance learning and traditional learning is the nature of the relationship between the discriminative cue and the consequence of responding. A long-standing assumption, in traditional learning theory, which is expressed in most learning texts (e.g., Kimble, 1961), is that any stimulus can be associated with any consequence. However, studies on poison-based avoidance learning show that rats are able to associate sickness with an interoceptive cue, such as taste, but are unable to associate sickness with exteroceptive cues such as lights, noises, or the size of food pellets (Garcia & Koelling, 1966; Garcia, McGowan, Ervin, & Koelling, 1968). In one experiment, it was demonstrated that rats could readily associate sickness with a solution characterized by a flavor but not by a light or an audible click. However, the rats could associate shock with a solution characterized by a flashing light and click but not by a distinctively flavored solution (Garcia & Koelling, 1966). These findings substantiate other investigators' results which showed that rats could form aversions to a flavored solution when made sick by injecting a salt solution directly into the stomach but not when consumption of the flavored solution was followed by shock to the feet or to the mouth

(Braveman & Capretta, 1965; Dietz & Capretta, 1967).

In an attempt to explain the specific relationship between cue and consequence found with rats (i.e., rats' ability selectively to associate gustatory cues with sickness and sounds and lights with shock), Garcia postulated a neurological model for poison-based avoidance learning (Garcia & Ervin, 1968). This model is based on neuroanatomical information which showed that the visceral sensory neuropil in salamanders receives gustatory and visceral afferents (Herrick, 1956). Similar afferents converged in mammals at a similar center, the Nucleus of the Fasiculus Solitarius (Herrick, 1956). Other nervous pathways, the Fasicular Gracilis and a pathway from the Area Postrema, both of which monitor the physiological state of an organism, were found to meet at the same location, the Nucleus of the Fasiculus Solitarius (Garcia & Ervin, 1968). In other words, the neurological pathways involved in eating and sickness appear to converge on a single point in the nervous system. Such data provided Garcia with a neuroanatomical explanation for the finding that rats associate only internal events such as taste with other internal events such as sickness.

The validity of Garcia's model and the relationship between cue and consequence implied by it was challenged by studies that used species other than the rat. For example, guinea pigs (Braveman, 1974a), chickens (Capretta, 1961), monkeys (Ober, 1971), and quail (Wilcoxin, Dragoin, & Kral, 1971) can associate sickness with the visual characteristics

of a solution. A more comprehensive model than Garcia's suggests that different organisms associate sickness with different kinds of eating-related cues (Rozin & Kalat, 1971). Hence, rats use gustatory cues rather than visual or auditory cues to recognize food and consequently associate taste cues with sickness (Barnett, 1963; Garcia & Koelling, 1966). Birds, however, use visual cues to recognize food (Brower, 1969; Shettleworth, 1971) and therefore can associate sickness with visual characteristics of a solution (Wilcoxin et al., 1971).

The evidence presented should not be taken to imply that animals select foods or form aversions on the basis of a single cue. Nor should it imply that poison-based avoidance learning is entirely orthogonal to other, more traditional forms of learning. There are a number of phenomena common to poison-based avoidance learning and more traditional forms. Some examples are latent inhibition, blocking, overshadowing (Revusky, 1971), extinction (Garcia, Ervin & Koelling, 1966), size of reward effect (Dragoin, 1971), sensory preconditioning (Lavin, 1973) and conditioned inhibition (Taukulis & Revusky, 1974). However, research reveals that the basis for the formation of an aversion is quite complex. In addition to gustatory cues, rats, for example, form an aversion to the smell (Taukulis, 1974) or the temperature (Nachman, 1970) of a solution. Quail, although they more readily associate sickness with visual cues, can also associate sickness with taste cues (Wilcoxin

et al., 1971). Similarly, guinea pigs can form both visual and taste aversions, although, unlike quail, aversions to taste cues are stronger and last longer than those to visual cues (Braveman, 1974a). It appears that different species may use the same cues in food selection and in the formation of food aversions, but the relative importance of these cues varies.

An interesting question that arises from the fact that an animal can form aversions to several cues concerns the interrelationship among stimuli in the formation of aversions. What would happen to the salience of visual cues for guinea pigs if the relative importance of flavor were reduced through experimental manipulation? Similarly, what would happen to the salience of taste cues for quail if the relative importance of the visual cue were reduced? It has not been demonstrated thus far that manipulation of a cue from the more salient modality for guinea pigs or quail influences their use of the less salient modality.

It is known, however, that cue salience can be modified within a modality through the process of latent inhibition, which is repeated presentation of a stimulus in the absence of a particular consequence (Lubow, 1973). Latent inhibition has been demonstrated when various tastes are used in the poison-based avoidance learning paradigm (Farley, McLaurin, Scarbourough, & Rawlins, 1964; Garcia & Koelling, 1967; Revusky & Garcia, 1970). For example, rats made familiar with grape juice more readily associated

sickness with milk when milk and grape juice were consumed prior to induced sickness. Conversely, rats familiarized with milk more readily associated sickness with grape juice after both solutions were consumed prior to sickness (Revusky & Bedarf, 1967). Other evidence has shown that a latently inhibited stimulus produces less interference than a novel stimulus (Revusky, 1971). Finally, latent inhibition also appears to occur when animals are familiarized with the consequence through repeatedly inducing sickness in the absence of a flavor (Braveman, 1974b; Brookshire & Brackbill, 1971). Each of these examples demonstrates that an animal does not readily associate a familiar event with another event. The following experiments also are concerned with the effects of latent inhibition on cue salience. However, the major concern is with cross-modality influences.

In this investigation, an attempt is made to answer two related questions: 1) Does latent inhibition of a taste cue, the more salient cue for guinea pigs, influence the association between the less salient visual cue and sickness, and 2) Does latent inhibition of a visual cue, the more salient cue for quail, influence the association between the less salient taste cue and sickness.

Experiment 1

Purpose

This study determined whether a two-bottle training and test procedure was sufficiently sensitive to demonstrate latent inhibition of a saccharin solution with guinea pigs.

Previous work by Braveman (1974c) revealed that familiarizing guinea pigs with saccharin produced latent inhibition of the saccharin solution when a one-bottle training and test procedure was used. Furthermore, data collected from rats indicated that latent inhibition of a solution was obtained when either a one-bottle or a two-bottle training and test procedure was used (Ahlers & Best, 1971; Domjan, 1972; Farley et al., 1964; Garcia & Koelling, 1967; Revusky & Bedarf, 1967). Therefore, it was expected that a two-bottle training and test procedure would adequately demonstrate latent inhibition of saccharin with guinea pigs.

A two-bottle training procedure similar to that of Revusky & Bedarf (1967) was used. Guinea pigs were either familiarized or not familiarized with saccharin for eight days. On the ninth day, the animals were poisoned following consumption of a saccharin and a salt solution. After recovery from sickness, each animal was tested to determine its aversion to the two solutions.

Method

Subjects

Thirty-two experimentally naive guinea pigs of mixed breed and sex, obtained from Canadian Breeding Laboratories,

were assigned randomly to four groups of eight animals each. The animals were housed in groups of four according to sex and were approximately 130 days old (400-600 gm.) on the day of training.

Apparatus

Adaptation, training, and testing in all experiments took place in 36 x 31 x 20 cm. wooden test chambers that were painted white. An external light source insured that the guinea pigs saw the solutions, which were contained in glass-spouted, 120 ml., glass drinking tubes.

Training and test solutions given to the four groups of guinea pigs were 0.5% (w/v) saccharin solution (5.0 gm. per 1000 ml. of water) and 0.8% (w/v) sodium chloride (NaCl) solution (8.0 gm. per 1000 ml. of water). On the Training Day, each animal was given a 1.0% body weight intraperitoneal (i.p.) injection of either a 0.3M lethium chloride (LiCl) solution (12.72 gm. per 1000 ml. of water) or of a physiological saline solution.

Procedure

Adaptation. During the initial 14 days of the experiment, all guinea pigs were adapted to a 23.5 hr. deprivation schedule. On each day the guinea pigs were placed in one of the test chambers for a 15 min. drinking session. This session was divided into three, 5 min. intervals and the animals were allowed access to tap water during the first and third intervals. During the middle 5 min. interval no liquid was available. At the end of

the 15 min. session, animals were allowed an additional 15 min. access to tap water in their home cages.

Pretraining. On Day 15, the 32 animals were randomly assigned to one of two groups. From Day 15 to 22, the 16 animals in Group H (Habituated) were given saccharin water during the test box and home cage sessions while the 16 subjects in Group N (Non-habituated) received tap water. Otherwise the procedure was the same as that used during adaptation.

Training. The 8 animals in Group H-T (Habituated-Toxicosis) and the 8 animals in Group N-T (Non-habituated-Toxicosis) were given saccharin and NaCl water prior to a 1.0% body weight, i.p., injection of .3M LiCl. The 8 animals in Group H-C (Habituated-Control) and the 8 animals in Group N-C (Non-habituated-Control) were given saccharin and NaCl water prior to a 1.0% body weight, i.p., injection of physiological saline. The presentation of the two solutions followed the procedure employed during Adaptation. Within each group the order of solution presentation was counter-balanced so that half the animals received saccharin first and NaCl second while the remaining half received the two solutions in the opposite order. Following the injections, the animals were given tap water, according to the Adaptation procedure, for two days.

Testing. On Day 26 each animal was given the NaCl and saccharin solutions according to the procedure of the Training Day. An animal that received saccharin first and

NaCl second on the Training Day also received saccharin first and NaCl second on the Test Day.

Results

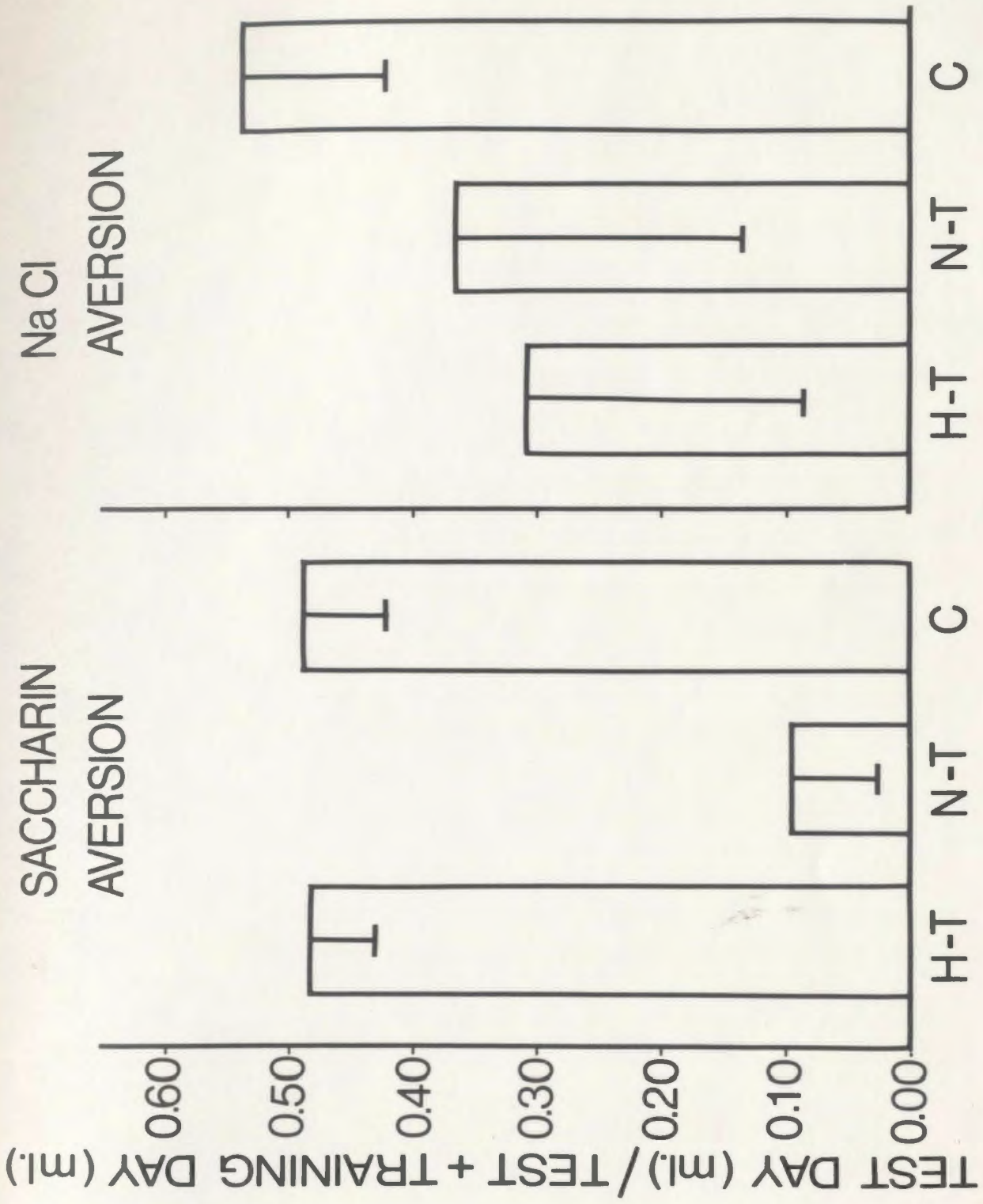
The guinea pigs' water consumption was measured to the nearest ml. These measures were converted to preference ratios by dividing the amount of a flavored solution (saccharin or NaCl) consumed on the Test Day by the amount of the same flavored solution consumed on both the Training and Test Days. Ratios less than 0.50 indicate that the animals consumed more of a solution on the Training Day than on the Test Day. Ratios of 0.50 indicate that an animal consumed the same amount of a solution on the Training Day as on the Test Day and ratios greater than 0.50 indicate that the animal consumed more of a solution on the Test Day than on the Training Day.

Animals in Groups H-C and N-C had saccharin preference ratios that did not differ significantly from each other ($t = 0.37$), $df = 14$, $p > .10$). These two control groups also had NaCl preference ratios that did not differ significantly from each other ($t = 0.34$, $df = 14$, $p > .10$). As a result Group C (Control) was formed by pooling NaCl water preference ratios or by pooling saccharin preference ratios for the separate control groups.

A summary of means and standard deviations of both the saccharin and NaCl ratios for all groups is presented in Figure 1. A single factor analysis of variance (Ferguson,

Figure 1

Mean amounts of saccharin and NaCl consumed on the Test Day relative to the mean amounts consumed on the Training plus Test days. T refers to the groups injected with LiCl on the Training day. C refers to the groups injected with physiological saline. H refers to the group which was familiarized with saccharin and N refers to the group which was not. Perpendicular lines are group standard deviations.


TEST DAY (ml.) / TEST + TRAINING DAY (ml.)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
SACCHARIN AVERSION
H-T
N-T
C
Na Cl AVERSION
H-T
N-T
C

1966) on the saccharin ratios of Groups N-T, H-T, and C, in Table 1, disclose that the three groups differed significantly from each other ($F = 107.14$, $df = 2/29$, $p < .01$). Sheffé multiple comparisons reveal that preference ratios for animals in Group N-T were reliably lower than ratios for animals either in Group H-T ($F = 138.84$, $df = 1/29$, $p < .01$) or in Group C ($F = 192.97$, $df = 1/29$, $p < .01$). The latter two groups did not differ significantly from each other ($F = 0.08$, $df = 1/29$, $p > .10$). These results indicate that novel saccharin water was associated with sickness but familiar saccharin was not.

A second single factor analysis of variance on the NaCl preference ratios of Groups H-T, N-T, and C is presented in Table 2, and shows that the three groups differed significantly from each other ($F = 5.02$, $df = 2/29$, $p < .05$). Subsequent Sheffé multiple comparisons of means reveal that Group C had a reliably stronger NaCl preference than Group N-T ($F = 4.77$, $df = 1/29$, $p < .05$) and Group H-T ($F = 8.37$, $df = 1/29$, $p < .01$). The latter two groups did not differ significantly from each other ($F = 0.38$, $df = 1/29$, $p > .10$). It appears that novel NaCl solution was associated with sickness whether or not animals were familiar with the saccharin solution.

Discussion

The results indicate that the guinea pigs, like rats, more readily associate sickness with a novel rather than a

Table 1

Analysis of variance on the aversion to saccharin by the guinea pigs in the Groups N-T, H-T, and C

Source	df	MS	F
Solution Familiarity	2	4603.85	107.14**
Error	29	42.61	

**$p < .01$

Table 2

Analysis of variance on the aversion to NaCl by the guinea pigs in Groups N-T, H-T, and C

Source	df	MS	F
Solution Familiarity	2	1610.89	5.02*
Error	29	320.70	

*$p < .05$

familiar flavor (Ahlers & Best, 1971; Farley et al., 1964; McLaurin et al., 1963; Revusky & Bedarf, 1967). Only the group that had novel saccharin prior to sickness formed a saccharin aversion.

The finding that familiar tasting saccharin water was not associated with sickness differs from two experiments, using rats, that reported an attenuated aversion, rather than a complete elimination of the aversion, to a familiar solution that was followed by sickness (Farley et al., 1964; McLaurin et al., 1963). The discrepancy could be explained by differences in experimental procedures and/or differences in the species used.

Experiments that reported attenuated aversions, rather than complete elimination of the aversion, allowed animals access to only the familiar solution prior to sickness. Investigators who used the two-bottle technique of presenting two solutions prior to sickness found that the aversion to the familiar solution was totally eliminated (Ahlers & Best, 1971).

The species in this study differed from those used in previous studies in that the present experiment used guinea pigs and studies that obtained an attenuation of an aversion, rather than an elimination, used rats (Farley et al., 1964; McLaurin et al., 1963). Data collected on rats (McLaurin et al., 1963) and on guinea pigs (Braveman, 1974c) indicate that different species vary with respect to their response to latent inhibition. Guinea pigs manifested

complete elimination of an aversion when trained and tested under conditions that produced attenuated aversions with rats (Braveman, 1974c; McLaurin et al., 1963). Braveman's findings were extended by the present study in that it demonstrated that guinea pigs are subject to complete elimination of a saccharin aversion when the two-bottle training procedure was used.

In the present study, guinea pigs developed an aversion to both novel tasting saccharin and NaCl solutions. Other studies that used rats indicate that two novel flavors can be associated with sickness (Kalat & Rozin, 1971; Rozin & Kalat, 1971). The aversion formed by the guinea pigs to both novel solutions further suggests that the taste of saccharin and NaCl failed to overshadow one another. In addition, the aversion to NaCl when saccharin was familiar was unchanged. This supports the finding that latent inhibition of one cue does not change the likelihood of another cue being associated with a consequence when neither of the cues can overshadow the other (Carr, 1974; Schnur, 1971).

Experiment 2

Purpose

The results of the first experiment revealed that guinea pigs associate a novel, but not a familiar, saccharin flavor with sickness. In an effort to extend these findings, the second experiment was conducted to determine whether guinea pigs that were familiarized with saccharin formed an aversion to a less salient visual cue.

Previous research with guinea pigs used a one-bottle training and test procedure and showed that novel saccharin overshadowed a novel visual cue, but familiar saccharin or tap water did not (Braveman, 1974a, 1974c). Another study using rats and a two-bottle training procedure demonstrated that novel coffee overshadowed novel saccharin but familiar coffee did not overshadow novel saccharin (Revusky, 1971). In the present experiment, it was expected that a two-bottle training procedure would provide results similar to Braveman's (1974a, 1974c) since the taste of saccharin can be latently inhibited and since novel tasting saccharin can overshadow a novel visual cue. It also was expected that the greater the familiarity of the taste of saccharin, the weaker the saccharin aversion and the stronger the visual aversion.

Method

Subjects

Eighty-eight experimentally naive guinea pigs of mixed breed and sex, obtained from Canadian Breeding Labor-

atories, were used in the experiment. Sixty guinea pigs were randomly assigned to seven experimental groups and the other 28 animals were randomly assigned to seven control groups. One control animal died during Pretraining and was not replaced. The animals were housed in groups of four according to sex and were approximately 130 days old (400-600 gm.) on the day of training.

Apparatus

The materials used were similar to those described in the first experiment but red water (4 drops of red vegetable food dye per 100 ml. of tap water) was used in place of 0.8% NaCl on both the Training and Test days.

Adaptation. The animals were adapted for 14 days according to the adaptation procedure of Experiment 1. Each animal was placed on the Test box for 15 min. and was given access to tap water for the first and third 5 min. intervals. During the middle 5 min. interval no solution was present. The animals were then returned to the home cages where they were permitted another 15 min. access to tap water.

Pretraining. The 28 animals placed in Group 0 (0 Saccharin days) were maintained on tap water according to the adaptation procedure until the Training Day. The remaining 60 animals were divided into 5 equal groups that received saccharin water for 1, 2, 4, 8 or 16 days prior to the Training Day. For example, the 12 animals in Group 1 (1 Saccharin day) were maintained on tap water according to the adaptation procedure for 15 days but were given saccharin

water, rather than tap water, on only Day 16. Similarly, the 12 animals in each of groups 2, 4, 8 and 16 received saccharin water on days 15-16, 13-16, 9-16, or 1-16, respectively.

Training. The guinea pigs were placed in the test box on Day 31 for 15 min. and were allowed access to a solution during the first and third 5 min. intervals. During the middle 5 min. interval no liquid was available.

Twelve animals from Group 0 and the 59 animals from Groups 1, 2, 4, 8 and 16 were permitted access to a red solution for 5 min. and to a saccharin solution for 5 min. prior to an injection. Each of the six groups then was divided into two groups, with eight animals in one group and four animals in the other. The exception was Group 16, with only three animals in the second group. The eight animals from each group were injected, i.p., with 1.0% body weight of .3M LiCl (T) and the remaining four animals from each group, three in Group 16, were injected, i.p., with an equal volume of physiological saline (C). The order of solution presentation was counterbalanced, as in Experiment 1, for both the experimental (T) and the control (C) groups. However, only one animal in Group 16-C was given red water first and saccharin water second. The remaining two animals were given the solutions in the opposite order.

The remaining 16 animals in Group 0 were assigned to Group 0-RC (0 Saccharin days-Red Water Check) to determine whether animals formed red water aversions in the absence

of saccharin water. On the Training Day the 16 animals in Group 0-RC were given tap water in one bottle and red water in the other bottle according to the Adaptation procedure. The group was then divided and 12 animals were injected with 1.0% body weight LiCl (T) and four were injected with 1.0% body weight physiological saline (C). The solution presentation was counterbalanced for one-half of the animals in the experimental (T) and the control groups (C).

Following the injections, all animals were returned to their home cages and for the next two days (Days 32-33) they were maintained on tap water according to the Adaptation procedure.

Testing. The red and saccharin water or the red and tap water given to a guinea pig on the Training Day were also given to that animal on Day 34, the Test Day, according to the Training Day procedure. Thus, animals that consumed saccharin first and red water second on the Training Day received these two solutions in the same order on the Test Day. Similarly, animals that were given tap water first and red water second on the Training Day received these two solutions in the same order on the Test Day.

Results

The guinea pigs' water consumption was measured to the nearest ml. As in Experiment 1, these measures were converted to preference ratios by dividing the amount of a solution (saccharin, red or tap water) consumed on the Test

Day by the amount of the same solution consumed on both the Training and Test Days.

The saccharin preference ratios for the six control groups in Table 3 did not differ significantly from each other ($F = 0.81$, $df = 5/17$, $p > .10$). Similarly, as is reported in Table 4, the red water preferences of the same six control groups and of Group 0-RC-C did not differ significantly from each other ($F = 2.11$, $df = 6/20$, $p > .10$). Group C (Control) was then formed since no significant differences were found. It was divided by pooling red water preference ratios or by pooling saccharin water preference ratios.

A summary of all means and standard deviations of the saccharin preference ratios is presented in Figure 2. A single factor analysis of variance on the saccharin ratios of the seven groups in Table 5 reveals a significant difference between groups ($F = 16.71$, $df = 6/64$, $p < .01$). Sheffé multiple comparisons in Table 6 show that 16 days of saccharin familiarization produced results that did not differ significantly from those of the control group. However, animals that were allowed fewer than 16 days access to saccharin had reliably lower saccharin preference ratios than the control group. These findings suggest that Group 16-T did not develop a saccharin aversion but the other groups did.

Sheffé multiple comparisons in Table 6 also reveal that all of the groups that consumed familiar saccharin prior

Table 3

Analysis of variance on the aversion to saccharin by the guinea pigs in the Groups 16-C, 8-C, 4-C, 2-C, 1-C, and 0-C

Source	df	MS	F
Solution Familiarity	5	76.34	0.81
Error	17	94.36	

Table 4

Analysis of variance on the aversion to red water by the guinea pigs in the Groups 16-C, 8-C, 4-C, 2-C, 1-C, 0-C, and 0-RC-C

Source	df	MS	F
Solution Familiarity	6	258.99	2.11
Error	20	122.88	

Figure 2

Mean amounts of saccharin consumed on the Test Day relative to the mean amounts consumed on the Training plus Test Days. T refers to the groups injected with LiCl on the Training Day and C refers to the groups injected with physiological saline. The numbers prior to T refer to the number of days the animals were familiarized with saccharin. Perpendicular lines are group standard deviations.

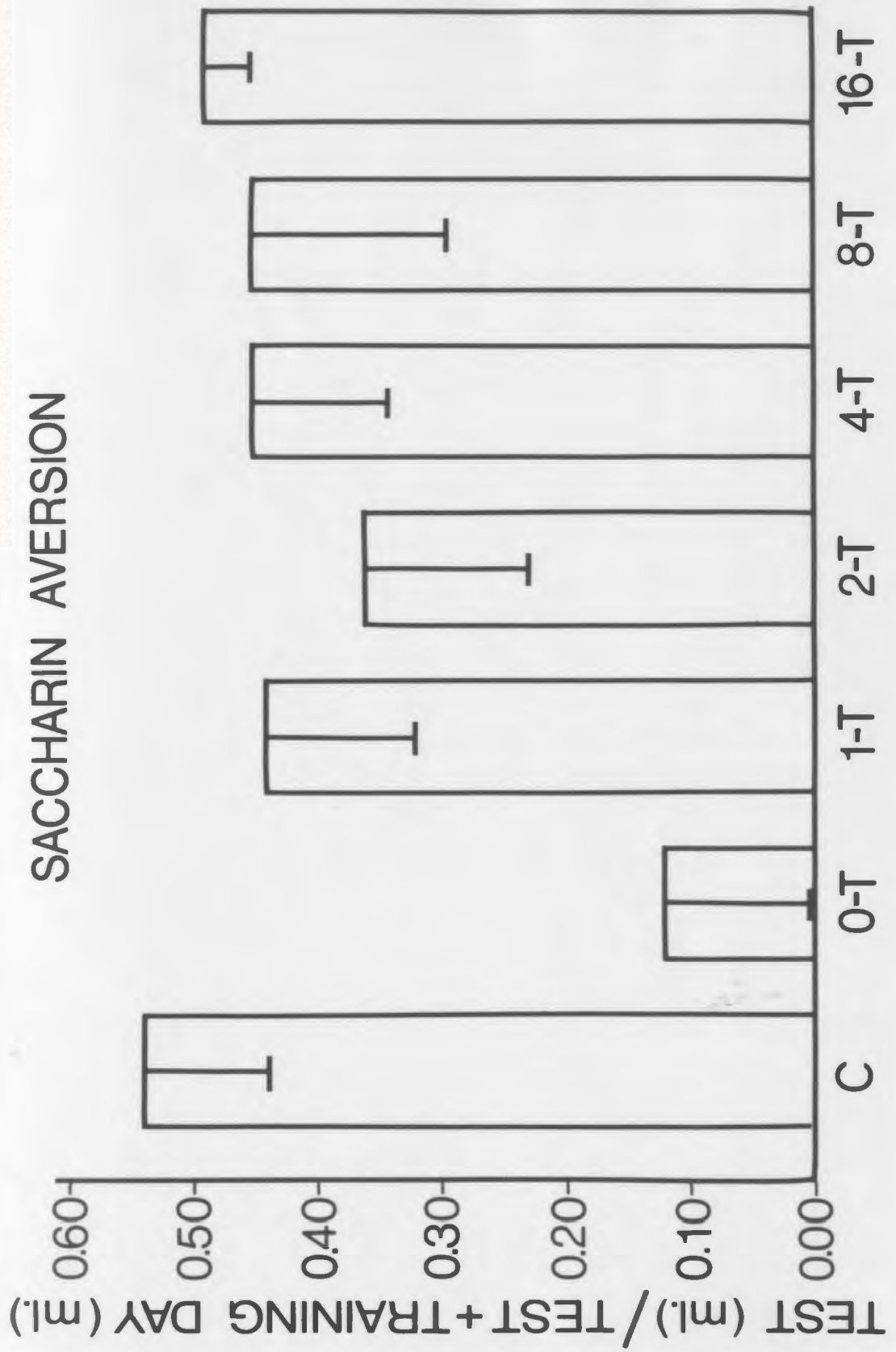

SACCHARIN AVERSION
TEST (ml.)/TEST+TRAINING DAY (ml.)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
C
0-T
1-T
2-T
4-T
8-T
16-T

Table 5

Analysis of variance on the aversion to saccharin by the guinea pigs in Groups 16-T, 8-T, 4-T, 2-T, 1-T, 0-T, and C

Source	df	MS	F
Solution Familiarity	6	1868.36	16.17**
Error	64	115.54	

*$p < .01$

Table 6

Sheffé multiple F tests for the saccharin aversions formed by guinea pigs, degrees of freedom 1/64

Groups		16-T	8-T	4-T	2-T	1-T	0-T
Groups	C	1.85	4.16*	4.16*	14.84**	5.14*	90.60**
	0-T	44.86**	37.69**	37.69**	21.63**	35.44**	-
	1-T	0.31	0.03	0.03	1.70	-	-
	2-T	4.19*	2.21	2.21	-	-	-
	4-T	0.31	0.00	-	-	-	-
	8-T	0.31	-	-	-	-	-

*$p < .05$

**$p < .01$

to sickness had higher saccharin preference ratios than the groups that consumed novel saccharin prior to sickness. The reliably higher preference ratios of the groups that were familiar with saccharin indicate that even one day of saccharin familiarity attenuated the saccharin aversion.

A summary of means and standard deviations of the red water ratios is presented in Figure 3. A single factor analysis of variance on the red water preference ratios of the eight groups given in Table 7 reveals that the groups differed significantly from each other ($F = 3.73$, $df = 7/78$, $p < .01$). Sheffé multiple comparisons in Table 8 show that the group that consumed red and tap water prior to sickness had red water preference ratios that were reliably lower than the control groups red water preference ratios. These findings indicate that a red water aversion was formed by the group that consumed red water and tap water prior to sickness. All other groups consumed saccharin and red water prior to sickness and did not reveal red water preference ratios that differed significantly from the red water preference ratio of the control group. This suggests that no other group formed a red water aversion.

The group that showed a red water aversion consumed tap water and red water on the Training and Test Days. This group's tap water preference ratios did not differ significantly from the tap water preference ratios of its control group ($t = 0.30$, $df = 14$, $p > .10$). This indicates that the group that consumed red and tap water prior to sickness did not

Figure 3

Mean amounts of red water consumed on the Test Day relative to the mean amounts consumed on the Training plus Test Days. T refers to the groups injected with LiCl on the Training Day and C refers to the group injected with physiological saline. The numbers prior to T refer to the number of days the animals were familiarized with saccharin. 0-RC-T refers to the group that was given red water and tap water prior to sickness. Perpendicular lines are group standard deviations.

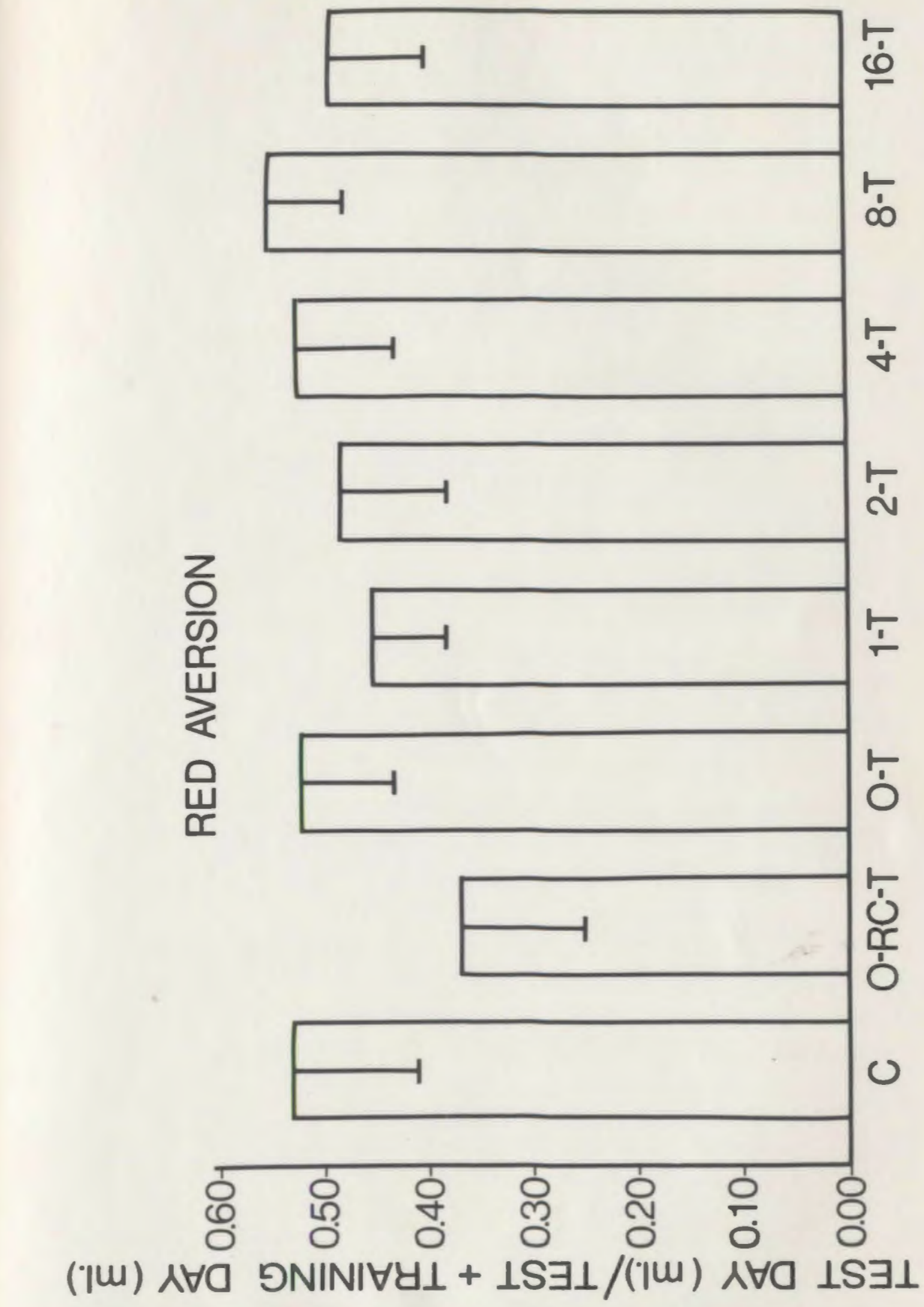

RED AVERSION
TEST DAY (ml.)/TEST + TRAINING DAY (ml.)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
C
O-RC-T
O-T
1-T
2-T
4-T
8-T
16-T

Table 7

Analysis of variance on the aversion to red water by the guinea pigs in Groups 16-T, 8-T, 4-T, 2-T, 1-T, 0-T, 0-RC-T, and C

Source	df	MS	F
Solution Familiarity	7	400.72	3.73**
Error	78	107.41	

**$p < .01$

Table 8

Sheffé multiple F tests for the red water aversions formed by guinea pigs, degrees of freedom 1/78

Groups	16-T	8-T	4-T	2-T	1-T	0-T	0-RC-T
C	0.89	0.22	0.06	1.40	3.57	0.06	19.23**
0-RC-T	10.42**	23.44**	16.28**	8.76**	4.63*	16.28**	-
0-T	0.33	0.33	0.00	0.58	1.77	-	-
1-T	0.58	3.62	1.77	0.33	-	-	-
2-T	0.04	1.77	0.58	-	-	-	-
4-T	0.33	0.77	-	-	-	-	-
8-T	1.30	-	-	-	-	-	-

*$p < .05$

**$p < .01$

reduce tap water consumption but reduced red water consumption on the Test Day.

Discussion

The present study supported the findings of previous investigations in that guinea pigs developed weaker aversions to saccharin water when familiarity to the taste of saccharin was increased (Domjan & Siegel, 1971; Lubow, 1965). Animals with 16 days of saccharin experience revealed no saccharin aversion and animals with 1-8 days of saccharin experience developed saccharin aversions that were reliably weaker than aversions formed by animals that consumed novel saccharin prior to sickness.

Group 16-T did not form a red water aversion, even though both completely latently inhibited saccharin and novel red water were followed by sickness. The result was unexpected since guinea pigs under similar experimental conditions in Braveman's (1974c) study formed a red water aversion. It also was contrary to the finding that rats associate shock with the less salient cue when the more salient one is latently inhibited (Carr, 1974).

The failure of Group 16-T to form a red water aversion cannot be accounted for simply by the use of a two-bottle training procedure, since Group 0-RC-T, using the same method of solution presentation, showed a red water aversion. The presence of familiar saccharin would not account for the failure, either, since Braveman (1974c) showed that guinea

pigs developed a red water aversion while familiar saccharin was present.

It appears that Group 16-T did not associate the visual cue with sickness because the red coloring was dissolved in tap water rather than in the familiar saccharin solution. In other respects the procedure of the present study was similar to the procedure used in the experiment in which guinea pigs developed a red water aversion while familiar saccharin was present (Braveman, 1974c). Braveman's animals consumed saccharin water that was colored red prior to sickness and could have associated sickness with either the familiar saccharin flavor or the novel visual cue. The red color was associated with sickness, however, probably because the visual cue was the only new feature of the red saccharin solution that was presented prior to sickness on the Training Day.

In the present experiment, the guinea pigs from Group 0-RC-T were familiarized with tap water and received tap water in one bottle and red tap water in another bottle prior to sickness. These animals also formed a red water aversion because the visual cue was the only new feature of the red tap water that was presented on the Training Day. In contrast, the animals in Group 16-T did not associate the red color with sickness perhaps because they did not characterize the red tap water by its color. Apparently 16 days of saccharin experience prior to the Training Day made it possible for animals to identify the red tap water either by the flavor of tap water, or the red color. Since guinea pigs tend to

use taste cues more readily than visual cues in the identification of food (Braveman, 1974a), they identified the red tap water by its taste rather than by its appearance. At the same time, however, these animals did not associate the flavor of tap water with sickness, because tap water had been made familiar during the animals' rearing prior to the experiment. This analysis, therefore, implies that latent inhibition procedures influence the associative processes independently from the attentional processes and, as such, they appear to be correlated with Mackintosh's (1973) notions about latent inhibition. More will be said about this at a later time.

Experiment 3

Purpose

A recent study demonstrated that Japanese quail, like Bob-white quail, associated a novel visual cue with sickness and that a novel visual cue completely overshadowed a novel taste cue (Wilcoxin, 1972; Wilcoxin et al., 1971). It is not known whether quail are subject to other learning phenomena such as latent inhibition. Therefore, the present experiment determined whether a two-bottle training and test procedure was sensitive enough to demonstrate latent inhibition of a visual cue with Japanese quail.

A two-bottle training and test procedure similar to the procedure in Experiment 1 was employed. Quail were either familiarized or not familiarized with blue water for eight days. On the ninth day, the animals were poisoned following consumption of a blue and a red solution. Following recovery from sickness, each animal's aversion to both solutions was determined.

Method

Subjects

Thirty-four experimentally naive quail (Japonica coturnix) of mixed sex, obtained from the Animal Behaviour Laboratory, Memorial University, were assigned randomly to four groups. The animals were housed individually during the experiment and were approximately 70-100 days old (80-120 gm.) on the day of training.

Apparatus

The animals were housed, adapted, trained, and tested in wire cages 50 x 30 x 26 cm. An external light source insured that the quail saw the solutions, that were contained in 125 ml. glass tubes that had outside diameters of 3.5 cm. and lengths of 18.0 cm. Each tube had a drinking spout with an outside diameter of 2.0 cm. and a depth of 3.0 cm. The tubes were attached to the quail's home cage by means of clips that were connected to the front of each cage.

Training and test solutions given to the four groups of quail were blue water (4 drops of blue vegetable food dye per 100 ml. of tap water) and red water (4 drops of red vegetable food dye per 100 ml. of tap water). On the Training Day, some animals were injected, i.p., with 132 mg./kg. of cyclophosphamide, the same dosage used by Wilcoxin et al., (1971). The cyclophosphamide was dissolved in 25% ethanol (Peck & Ader, 1974). The remaining animals were injected with an equivalent volume of physiological saline.

Procedure

Adaptation. During the initial 5 days of the experiment, all quail were maintained on a deprivation schedule which allowed them to drink tap water during two drinking sessions per day since one session did not sustain the animals. The first 10 min. drinking session was at 0800 hrs. and the second 6 hrs. later. Each session was divided into three intervals with first and third intervals of 2.5 min. in duration and a middle interval of 5 min.

The quail were given access to tap water during the first and third intervals. During the middle interval, no liquid was available.

Pretraining. On Day 6 the 34 animals were randomly assigned to one of two groups. From Days 6-13 the 18 animals in Group H (Habituated) were familiarized with blue water during the two drinking sessions and the 16 subjects in Group N (Non-habituated) received tap water. Otherwise the procedure was the same as that used during adaptation.

Training. On Day 14 all animals were given access to both a blue and a red solution during the drinking session at 0800 hrs. The nine animals in Group H-T (Habituated-Toxicosis) and the nine animals in Group N-T (Non-habituated-Toxicosis) were given blue and red water prior to an injection of cyclophosphamide. The eight animals in Group H-C (Habituated-Control) and the eight animals in Group N-C (Non-habituated-Control) were given blue and red water prior to an injection of physiological saline. Within each group the order of solution presentation was counterbalanced. Four animals in each group received red water first and blue water second, and the remaining animals in each group received the two solutions in the opposite order. All animals were maintained on tap water according to the Adaptation procedure during Days 15-16.

Testing. On Day 17, each animal was given red water and blue water in the same order as on the Training Day. An animal that received red water first and blue water second on the Training Day also received these solutions in the same order on the Test Day.

Results

Water consumption was measured to the nearest ml. These measures were converted to preference ratios by dividing the amount of a colored solution (red or blue water) consumed on the Test Day by the amount of the same colored solution consumed on both the Training and Test Days.

Animals in Group H-C and N-C had *blue* water preference ratios that did not differ significantly from each other ($t = 0.24$, $df = 13$, $p > .10$). These two control groups also had *red* water preference ratios that did not differ significantly from each other ($t = 0.41$, $df = 13$, $p > .10$). Thus, Group C (Control) was formed, since no significant differences were found by pooling *red* water preference ratios or by pooling the *blue* water preference ratios for the separate control groups.

A summary of means and standard deviations of both the *red* and *blue* water preference ratios for all groups is presented in Figure 4. A single factor analysis of variance on the *blue* water ratios of Groups H-T, N-T, and C in Table 9 reveals that the three groups differed significantly from each other ($F = 19.58$, $df = 2/31$, $p < .01$). Sheffé multiple comparisons demonstrate that preference ratios for animals in Group N-T were reliably lower than ratios for animals either in Group H-T ($F = 23.95$, $df = 1/31$, $p < .01$) or in Group C ($F = 36.02$, $df = 1/31$, $p < .01$). The latter two groups did not differ significantly from each other ($F = 0.47$,

Figure 4

Mean amounts of blue and red water consumed on the Test Day relative to the mean amounts consumed on the Training plus Test Days. T refers to the groups injected with cyclophosphamide on the Training Day and C refers to the groups injected with physiological saline. H refers to the group which was familiarized with blue water and N refers to the group which was not. Perpendicular lines are group standard deviations.

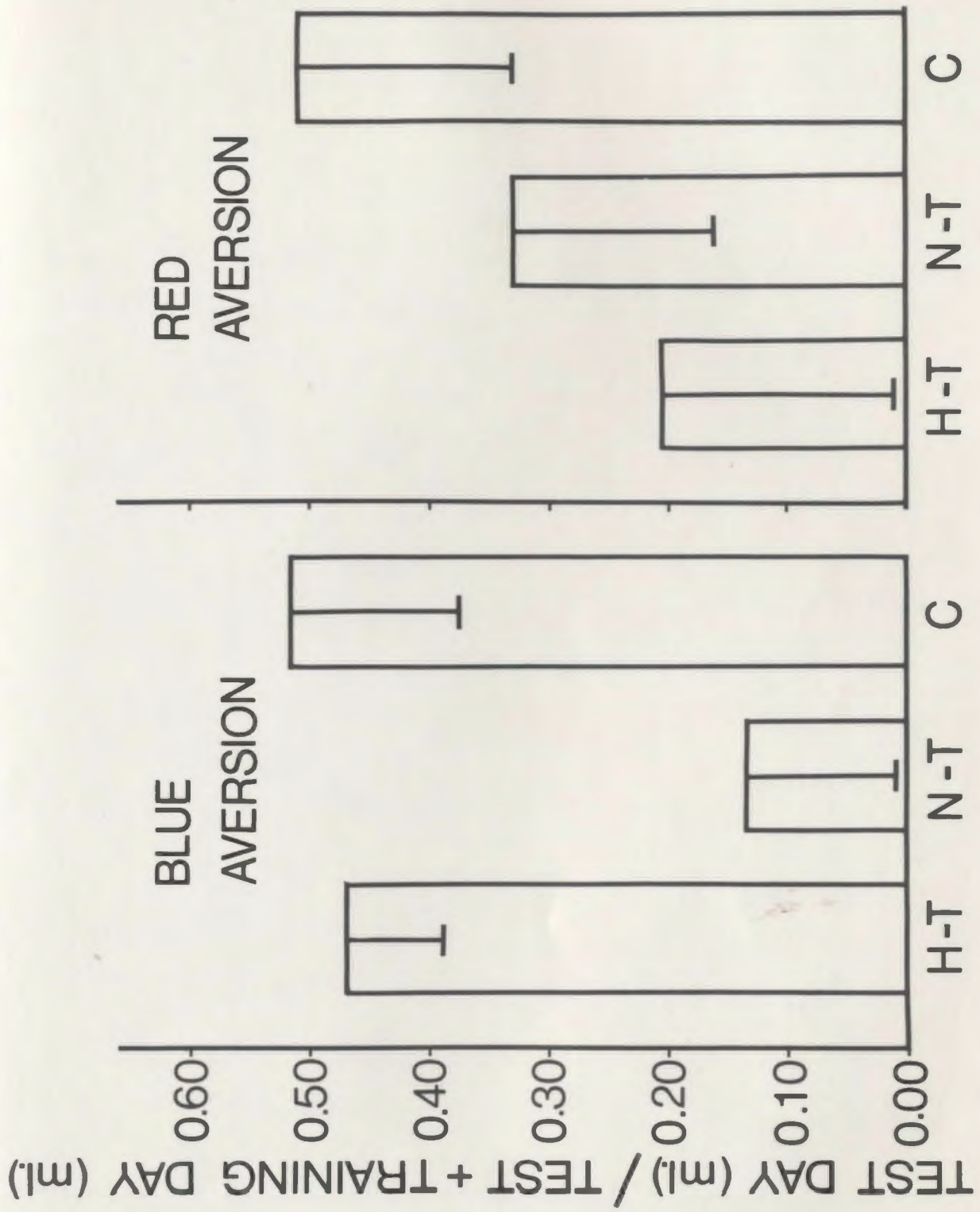

TEST DAY (ml) / TEST + TRAINING DAY (ml)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
BLUE AVERSION
H-T
N-T
C
RED AVERSION
H-T
N-T
C

Table 9

Analysis of variance on the aversion to blue water by the quail in Groups H-T, N-T, and C

Source	df	MS	F
Solution Familiarity	2	4348.57	19.58**
Error	31	222.09	

**$p < .01$

df = 1/31, p > .10). These results suggest that novel blue water was associated with sickness but familiar blue water was not.

A second single factor analysis of variance on the red water preference ratios of Groups H-T, N-T, and C is presented in Table 10 and shows that the three groups differed significantly from each other ($F = 8.95$, df = 2/31, $p < .01$). Subsequent Sheffé multiple comparisons of these means reveal that Group C had a reliably higher red water preference ratio than either Group N-T ($F = 5.70$, df = 1/31, $p < .05$) or Group H-T ($F = 17.17$, df = 1/31, $p < .01$). The latter two groups did not differ significantly from each other ($F = 2.20$, df = 1/31, $p > .10$). These results indicate that the novel red solution was associated with sickness whether or not animals were familiar with the blue solution.

Discussion

Quail exhibited the same response pattern to visual cues that guinea pigs did to taste cues in Experiment 1. Only a novel visual cue was associated with sickness and no aversion was shown to a familiar blue solution. These results and similar findings with guinea pigs in Experiment 1 and with rats (Ahlers & Best, 1971) are further support for the conclusion that animals do not form aversions to a familiar cue when a two-bottle training procedure is used.

As in Experiment 1, animals that consumed two novel solutions on the Training Day showed an aversion to both

Table 10

Analysis of variance on the aversion to red water by the quail in Groups H-T, N-T, and C

Source	df	MS	F
Solution Familiarity	2	2999.11	8.95**
Error	31	334.98	

**$p < .01$

solutions on the Test Day. The aversion to both novel solutions is in agreement with findings from Experiment 1 and with findings from rats (Kalat & Rozin, 1971). It also appears that the red and the blue solutions did not overshadow one another, since the quail formed aversions to both on the Training Day. Further, the red water aversion did not vary as blue water familiarity varied. The reliability of the response to red water further supports the suggestion that latent inhibition of a stimulus does not facilitate the association of another stimulus with a consequence if neither of the stimuli can overshadow the other (Carr, 1974).

Experiment 4

Purpose

Previous experiments in this paper and by other investigators (Braveman, 1974a, 1974b; Wilcoxin, 1972) indicated that quail and guinea pigs exhibit certain similarities in the way in which they form food aversions. One similarity is that a familiar stimulus is less salient for both species. That is to say, quail did not associate a familiar visual cue with sickness, and guinea pigs did not associate a familiar taste cue with sickness. Another similarity is that taste and visual cues appear to play a role in governing food intake, although to a different degree in the two species. For example, with quail a novel visual cue overshadows a novel taste (Wilcoxin, 1972), whereas with guinea pigs a novel taste cue overshadows a novel visual cue (Braveman, 1974a). Related to this is the finding that quail associate a taste cue with sickness when no novel visual cue is present (Wilcoxin, 1972) and that guinea pigs associate a visual cue with sickness when no novel taste cue is present (Braveman, 1974a).

These similarities suggested that conclusions based on results from Experiment 2 with guinea pigs could be generalized to quail. In Experiment 2, it was found that the more familiar the saccharin the weaker the aversion that was formed to the saccharin. Group 16-T, the one that consumed familiar saccharin water and novel red water prior to sickness did not show aversion to either of the two

solutions. Group 0-RC-T, the one that consumed tap water and red water prior to sickness, formed a red water aversion. It was expected, therefore, in the present experiment that the greater the familiarity with a blue solution, the weaker the aversion formed to a blue solution. It was also expected that quail would not form a HCl water aversion if blue and HCl water were presented prior to sickness. However, quail would form a blue water aversion if HCl water and tap water were presented prior to sickness. That is to say, based on the outcome of Experiment 2 and on the similarities in the way in which guinea pigs and quail form aversions, it was predicted that, as in Experiment 2, there would not be a cross-modality effect of latent inhibition when quail were used as subjects.

Method

Subjects

Sixty experimentally naive quail (Japonica coturnix) of mixed sex, obtained from the breeding colony of the Animal Behaviour Laboratory, were used in the present study. Forty quail were randomly assigned to five experimental groups and the other 20 were randomly assigned to five control groups. The animals were housed individually during the experiment and were approximately 70-100 days old (80-120 gms.) on the day of training.

Apparatus

The materials used in Experiment 3 also were used in this experiment. However, a 0.019% hydrochloric acid (HCl)

solution (0.5 ml. of 38.0% HCl per 1000 ml. of tap water) replaced red water on the Training and Test Days.

Adaptation. The quail were adapted to tap water for 5 days according to the Adaptation procedure of Experiment 3. The first 10 min. drinking session was 0800 hrs. and the second drinking session was 6 hrs. later. Each session was divided into three intervals with the first and third intervals lasting 2.5 min. each and the middle interval, 5 min. The quail were given access to tap water during the first and third intervals. During the middle interval no liquid was presented.

Pretraining. The 24 animals in Group 0 (0 Blue water days) were maintained on tap water according to the Adaptation procedure until the Training Day. The remaining 36 animals were assigned in one of three equal groups that received blue water for either 4, 8, or 16 days prior to the Training Day. For example, the 12 animals in Group 4 (4 Blue water days) were maintained on tap water according to the Adaptation procedure for 12 days but were given blue water rather than tap water during the four days immediately prior to the Training Day.

Training. On Day 22, the quail were given access to two solutions at the 0800 hrs. drinking session. The order of solution presentation was counterbalanced as in previous experiments.

Animals in Groups 4, 8, and 16 and the 12 animals from Group 0 were permitted access to an HCl solution and a

blue solution prior to an injection. The animals from these four groups were then divided so that 8 animals from each group were injected with 132 mg./kg. of cyclophosphamide (T) and the remaining 4 animals were injected with an equal volume of physiological saline (C).

The remaining 12 animals in Group 0 were assigned to Group 0-HC (0 Blue water days-HCl Water Check) to assess whether animals formed HCl aversions in the absence of the blue water. They were given tap water in one bottle and HCl water in the other bottle according to the Adaptation procedure. The group was divided so that 8 animals were injected with 132 mg./kg. of cyclophosphamide (T) and the other 4 were injected with an equal volume of physiological saline (C).

Following the injections, all animals were maintained on tap water according to the Adaptation procedure for the next two days (Days 23-24).

Testing. The blue water and HCl water or the blue water and tap water given a quail on the Training Day were also given to that animal on Day 25, according to the procedure of the Training Day. For example, animals that consumed HCl first and blue water second on the Training Day also consumed these solutions in the same order on the Test Day. Similarly, animals that were given tap water first and blue water second on the Training Day also received tap water first and blue water second on the Test Day.

Results

Water consumption was measured to the nearest ml. and converted to preference ratios by dividing the amount of a solution (Blue, HCl, or tap water) consumed on the Test Day by the amount of the same solution consumed on both the Training and Test Days.

In Table 11 an analysis of blue water preference ratios for the four control groups reveals that they did not differ significantly from each other ($F = 0.14$, $df = 3/12$, $p > .10$). The HCl water preference ratios of the same four control groups and Group 0-HC-C, in Table 12, also show no significant differences between groups ($F = 1.24$, $df = 4/15$, $p > .10$). Thus, Group C (Control) was formed, since no significant differences were found, by pooling blue water preference ratios or by pooling HCl water preference ratios from the separate control groups.

A summary of means and standard deviations of the blue water preference ratios for all groups is presented in Figure 5. A single factor analysis of variance on the blue water preference ratios in Table 13 shows that they differed significantly from each other ($F = 30.89$, $df = 4/43$, $p < .01$). Sheffé multiple comparisons, reported in Table 14, show that the control groups' blue water preference ratios did not differ significantly from either Group 16-T or Group 8-T. Apparently, the animals in Group 16-T and Group 8-T did not form blue water aversions. As few as eight days of blue water experience completely latently inhibited the blue solution.

Table 11

Analysis of variance on the aversion to the blue water by the quail in Groups 16-C, 8-C, 4-C, and 0-C

Source	df	MS	F
Solution Familiarity	3	66.23	0.14
Error	12	118.50	

Table 12

Analysis of variance on the aversion to the HCl water by the quail in Groups 16-C, 8-C, 4-C, 0-HC-C and 0-C

Source	df	MS	F
Solution Familiarity	4	102.45	1.24
Error	15	85.85	

Figure 5

Mean amounts of blue water consumed on the Test Day relative to the mean amounts consumed on the Training plus Test Days. T refers to the groups injected with cyclophosphamide on the Training Day and C refers to the groups injected with physiological saline. The numbers prior to T refer to the number of days the animals were familiarized with blue water. Perpendicular lines are group standard deviations.

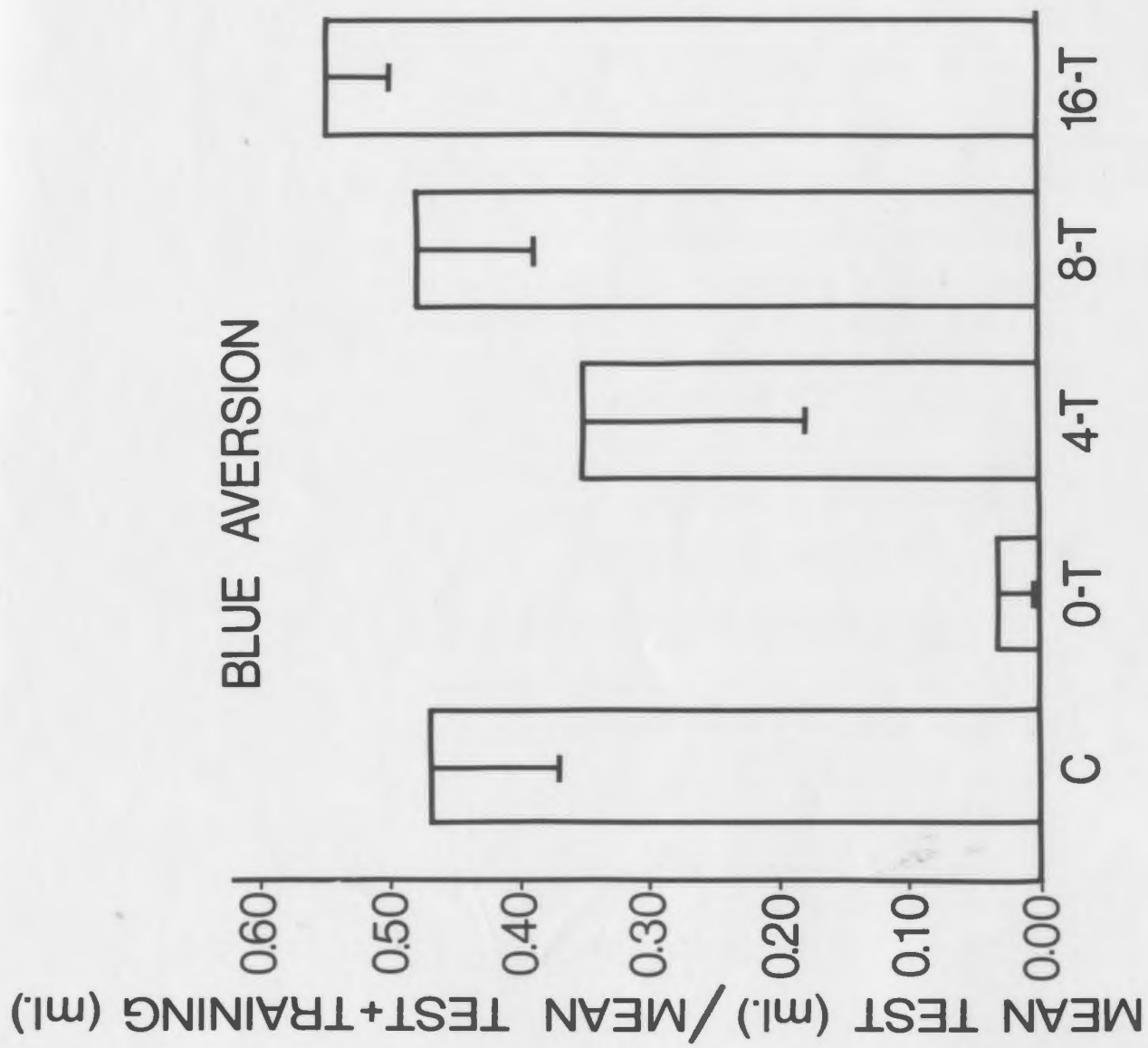

BLUE AVERSION
MEAN TEST (ml.) /MEAN TEST+TRAINING (ml.)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
C
0-T
4-T
8-T
16-T

Table 13

Analysis of variance on the aversion to blue water by the quail in Groups 16-T, 8-T, 4-T, 0-T, and C

Source	df	MS	F
Solution Familiarity	4	3564.45	30.89**
Error	43	115.39	

**$p < .01$

Table 14

Sheffé multiple F tests for the blue aversions formed by quail, degrees of freedom 1/43

Groups	C	0-T	4-T	8-T
16-T	2.96	93.77**	13.87**	1.70
8-T	0.05	70.20**	5.86*	-
4-T	6.65*	35.50**	-	-
0-T	89.46**	-	-	-

Groups

*p < .05

**p < .01

It also can be seen in Table 14 that both Group 4-T and Group 0-T had reliable blue water aversions, i.e., their preference ratios were reliably lower than those of animals in Group C. Further Sheffé multiple comparisons revealed that the animals in Group 0-T had reliably lower preference ratios than the animals in Group 16-T, 8-T, and 4-T, indicating that as few as four days of blue water experience attenuates a blue water aversion. Moreover, the blue water preference ratios of Group 4-T were reliably lower than the blue water preference ratios of Groups 16-T and 8-T. In other words, less familiarized Group 4-T had a reliably stronger aversion to blue water than the more familiarized groups. All other multiple comparisons did not reach significance.

A summary of means and standard deviations of the HCl water preferences ratios is presented in Figure 6. A single factor analysis of variance on the HCl water preference ratios in Table 15 demonstrates that all groups differed significantly from each other ($F = 2.41$, $df = 5/54$, $p < .05$). Sheffé multiple comparisons are reported in Table 16 and reveal that the group that consumed HCl water and tap water prior to sickness had HCl water preference ratios that were reliably lower than the HCl water preference ratios of the control group. This indicates that an HCl aversion was formed by the group that consumed HCl water and tap water prior to sickness. All other groups consumed blue water and HCl water prior to sickness and did not have HCl water preference ratios that differed significantly from the

Figure 6

Mean amounts of HCl water consumed on the Test Day relative to the mean amounts consumed on the Training plus Test Days. T refers to the groups injected with cyclophosphamide on the Training Day and C refers to the groups injected with physiological saline. The numbers prior to T refer to the number of days the animals were familiarized with blue water. 0-HC-T refers to the group that was given tap water and HCl water prior to sickness. Perpendicular lines are group standard deviations.

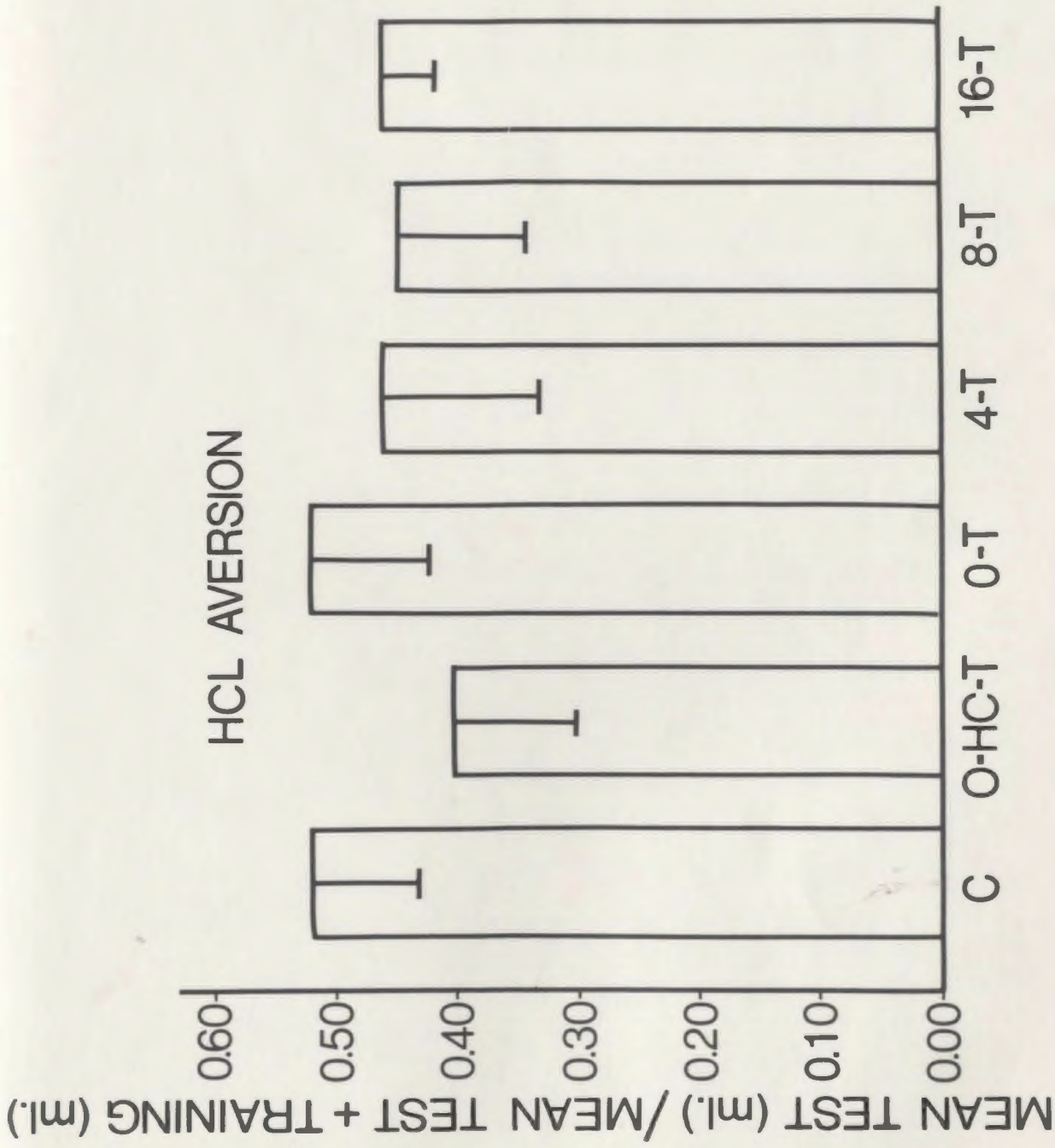

HCL AVERSION
MEAN TEST (ml.) /MEAN TEST + TRAINING (ml.)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
C
O-HC-T
0-T
4-T
8-T
16-T

Table 15

Analysis of variance on the aversion to HCl water by the quail in Groups 16-T, 8-T, 4-T, 0-T, 0-HC-T, and C

Source	df	MS	F
Solution Familiarity	5	231.30	2.41*
Error	15	96.09	

*$p < .05$

Table 16

Sheffé multiple F tests for the HCl aversions formed by quail, degrees of freedom 1/54

Groups		C	0-HC-T	0-T	4-T	8-T
	16-T	1.49	2.04	1.04	0.04	0.17
	8-T	2.91	1.04	2.04	0.04	-
Groups	4-T	2.14	1.50	1.50	-	-
	0-T	0.00	5.99*	-	-	-
	0-HC-T	8.56*	-	-	-	-

*$p < .05$

control group's ratios. These results indicate that these groups did not form an HCl aversion.

The group that formed an HCl water aversion consumed tap water and HCl water on the Training and Test Days. The group's tap water preference ratios did not differ significantly from the tap water preference ratios of its control group (t = 0.30, df = 10, p > .10). This indicates that the group that consumed HCl and tap water prior to sickness did not reduce tap water consumption but reduced HCl water consumption on the Test Day.

Discussion

The results are consistent with those of Experiment 2 in that quail showed reliably weaker blue water aversions when they were made familiar with blue water. The groups with 8 and 16 days of blue water familiarity showed no blue water aversion, and the group with 4 days of blue water familiarity evidenced a blue water aversion that was significantly weaker than the aversion of the group that had no blue water experience. Other data indicate that quail did not form HCl aversions when they consumed the latently inhibited blue solution and the novel HCl solution prior to sickness. The response of the quail, then, to the less salient taste cue was the same as the response of guinea pigs to the less salient visual cue.

The results of the present experiment are similar to the results of Experiment 2. That is to say, latent

inhibition of a stimulus from the more salient modality for a species did not appear to insure that a stimulus from the less salient modality will be associated with sickness. The comparison between the two species cannot be completed, however, since no attempt has been made to show that quail associate the less salient cue with sickness if the less salient taste cue and the latently inhibited visual cue are presented in the same bottle prior to sickness.

General Discussion

The results from Experiments 1 and 3 confirmed the findings of previous investigators in that guinea pigs and quail did not associate familiar cues with sickness but did associate novel cues with sickness. Such findings supported explanations of latent inhibition that were based on attention (Sutherland & Mackintosh, 1971), stimulus salience (Rescorla & Wagner, 1972), learned safety (Kalat & Rozin, 1973), or learned irrelevance (Mackintosh, 1973). They were in agreement with these models in that each model predicted that animals would associate a novel cue with sickness more readily than a familiar cue. The learned safety model and the attention model can be rejected, however, in view of findings from other investigators.

According to an attention explanation an animal does not attend to a familiar stimulus and consequently does not associate it with a consequence. Animals, however, develop increased preferences for solutions which are repeatedly

presented (Domjan, 1971; Revusky & Bedarf, 1967). As pointed out by Revusky (1971), it is difficult to conceive of how preference for a flavor can be increased without the animal attending to it. A reduced attention explanation, therefore, does not appear to adequately explain latent inhibition.

The learned safety explanation suggests that an animal gradually learns during the passage of time between consumption and sickness that a particular flavor is safe and therefore it does not associate the flavor, when it is presented again, with sickness. Some investigators have refuted this explanation of latent inhibition. They contend it is the number of stimulus exposures that is important, not simply the passage of time (Domjan, 1974; Domjan & Bowman, 1974). It appears that Kalat & Rozin (1973) selected the wrong parameter when they developed their learned safety explanation.

The reduced salience explanation of latent inhibition has not been challenged because it has been supported by most recent studies (Braveman, 1974c; Carr, 1974; Revusky, 1971). This model predicts that animals associate a novel cue with a consequence because the novel cue is more salient than a familiar cue. For example, in Braveman's (1974c) study, when red-saccharin water was followed by sickness, the guinea pigs formed an aversion to the appearance when the flavor was familiar. They did not form an aversion to the appearance when the flavor was novel. A reduced salience explanation would claim that, because the salience of the

more salient saccharin was reduced, the animals associated the less salient visual cue, whose salience had not been changed, with sickness. Such an explanation of latent inhibition does not appear to account for the findings obtained from guinea pigs in the present study. The guinea pigs did not form a visual aversion although the salience of the saccharin solution was reduced, as was demonstrated by the failure of the guinea pigs to associate saccharin with sickness. It was expected that the guinea pigs would form a visual cue aversion as they had in Braveman's (1974c) study, since the salience of the visual cue had not changed. The guinea pigs did not form a visual aversion in the present study, however, and this indicates that a reduced salience explanation of latent inhibition may be limited in its ability to explain the present findings.

The learned irrelevance explanation of latent inhibition suggests that latent inhibition occurs when an animal learns that a stimulus is not a reliable predictor of environmental events (Mackintosh, 1973). The results from Braveman's (1974c) study and from Experiment 2 appear to support Mackintosh's model. A learned irrelevance explanation of latent inhibition could claim that the guinea pigs in Braveman's (1974c) study did not associate the familiar saccharin with sickness because they had learned, during familiarization, that it did not predict new consequences. Consequently, the animals associated the red cue with sickness since it was the only new cue available. A similar analysis

could be applied to the finding, in Experiment 2, that guinea pigs formed a red aversion when the only flavor present was familiar tap water. The group that consumed familiar tap water and novel red water prior to sickness did not associate familiar tap water with sickness because they had learned, during rearing, that tap water did not predict new consequences. Therefore, the animals associated the red cue with sickness since it was the only new cue available.

The group that was familiarized with saccharin for 16 days and received red tap water and saccharin water prior to sickness and did not form aversions either to the saccharin or to the red tap water. Apparently these animals could not associate familiar saccharin water with sickness, because they had learned, during familiarization, that saccharin did not predict new consequences. They also learned during rearing prior to the experiment that tap water did not predict new consequences. At the same time, it appears that the animals did identify the red tap water by the tap water flavor probably because it had a novel taste after the 16 saccharin water days. Therefore, for these animals, the tap water flavor overshadowed the red color because taste is a more salient cue for guinea pigs. No tap water aversion (i.e., red water aversion) was formed, however, since the animals had learned prior to the experiment that tap water predicted no new consequences. If the tap water overshadowed the visual cue, the reduced salience explanation

would predict a tap water aversion (i.e., reduction in red water consumption) because tap water would be more salient than a cue that could be associated with sickness. However, since this did not occur, it must be concluded that the reduced salience explanation is inappropriate since no reduction in red water consumption occurred.

The learned irrelevance model also appears to apply to the findings from Experiment 4 with quail. It will be recalled that the results obtained from this experiment were similar to those found in Experiment 2 with guinea pigs. Caution must be exercised, however, when this model is applied to quail data since it has not been demonstrated that quail form HCl aversions when a latently inhibited visual cue and HCl solution are presented in the same bottle prior to sickness.

The results, however, indicate that quail and guinea pigs respond to more salient and less salient cues in a similar manner. The similarities between quail and guinea pigs support the hypothesis of recent writers that animals are subject to general laws of learning (Revusky, 1971; Taukulus & Revusky, 1974). The present investigator took into account the propensity of quail to use visual cues and the propensity of guinea pigs to use taste cues and subsequently showed that both species responded similarly to the effects of latent inhibition.

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