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Title: SINGLE-TRIAL TASTE AVERSION LEARNING TO WATER: A REASSESSMENT OF FAMILIARITY, NEOPHOBIA, AND MEASUREMENT STRATEGIES

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Stephen F. Davis

Although a relatively new phenomenon, the learned taste aversion paradigm has been extensively researched and applied to a rather impressive number of research areas. For example, Schweitzwer and Green (1982) used learned taste aversions to define better the developmental parameters of learning in preweanling rats. Similarly, Best and his colleagues (Cannon, Best, Batson & Feldman, 1983) have investigated learned taste aversions in cancer patients during chemotherapy. If the mechanism(s) underlying such aversions can be understood, then techniques for interrupting and/or disrupting such associations might be developed.

One interesting variant of basic research in this area has involved attempts to create learned taste aversions to plain tap water in rats. Research has indicated that a

taste aversion to water may be developed if: 1) the animals are exposed to multiple CS-US pairings of water with an illness-inducing agent (Elkins, 1974); 2) if the animals have had NO previous experience with water (Garcia & Koelling, 1967); or 3) if the animals are presented with a second, safe taste prior to taste aversion conditioning to water (Elkins, 1974; Garcia & Koelling, 1967; Nachman, 1970). However, there are potential problems. First, Riley, Jacobs & Mastropaolo (1983) have argued that extensive preexposure (familiarity) of a taste attenuates subsequent aversion learning to that taste. Conversely, Nachman (1970) found that extensive preexposure did not significantly effect the strength of the learned aversion. Secondly, Garcia & Koelling (1967) and Elkins (1974) employed multiple CS-US pairings while Nachman used a single trial of water and illness. Finally, both single-bottle (Nachman, 1970) and two-bottle preference (Elkins, 1974) tests have been used, thus questioning the comparability of the various designs.

The present studies were designed to more clearly delineate these issues. In all five experiments, rats were reared on water, shifted to a coffee solution (Group C) or continued on water (Group W) for 20 days, and then exposed to one pairing of water with Lithium Chloride (LiCl - an illness-inducing agent) in an attempt to establish a learned taste aversion to water. Experiments 1 and 2 employed a single-bottle consumption test to assess aversion learning and differed only with regard to the concentration of the coffee solution that was provided as a second, safe taste. Experiment 3 replicated Experiment 2 using the two-bottle preference test to evaluate aversion learning. Experiments 4 and 5 employed a Familiarity phase to evaluate more clearly the acquired aversion by equating the groups on their preference for coffee prior to testing. However, these experiments differed with regard to the strength of the coffee solution employed. As taste aversion learning was clearly shown under the two-bottle preference test, it is proposed that this type of measurement be emphasized in such studies. Further, the presentation of a second, safe taste prior to conditioning and/or testing appears to enhance subsequent aversion learning to water, although a neophobic response to the second taste is not necessary for this enhancement.

SINGLE-TRIAL TASTE AVERSION LEARNING TO WATER: A REASSESSMENT OF FAMILIARITY, NEOPHOBIA, AND MEASUREMENT STRATEGIES

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CHAPTER 1

INTRODUCTION

During the past 20 years, the area of learned taste aversions has become one of the most popular research topics in animal psychology. Taste aversion learning can best be described as learning that a specific taste may potentially cause illness, and to subsequently avoid that taste. The basic experimental procedure used to create a learned aversion involves offering the animal some specific taste (via fluid or solid food) and then inducing "illness," usually by injecting some illness-inducing drug such as lithium chloride or by exposing the animal to radiation. Subsequent to this procedure, if the animal is given access to the same or a similar taste, it will consume very little, if any, of it. This type of aversion learning has been thoroughly researched and has been shown to be a very robust phenomenon (Barker, Best, & Domjan, 1977).

Evidence for the phenomenon of taste aversion learning can be traced to the 1800's, when Alfred R. Wallace hypothesized that caterpillar larvae were distinctively marked as an outward sign of their unpalatability. Twenty years later, E. B. Poulton summarized and extended Wallace's hypothesis in a paper entitled "The Experimental Proof of the Protective Value of Color and Markings in Insects in Reference to their Vertebrate Enemies." Examination of Poulton's 1887 paper reveals a number of similarities between his hypothesis and the modern day notions of taste aversion learning. Thus, as early as 1900, it was evident that taste aversions were learned, that illness acted as the reinforcer, and that food cues served as the necessary or conditioned stimuli (see Garcia & Hankins, 1977).

In the 1950's, Curt P. Richter conducted a great deal of research on the various methods of exterminating wild rats. Within this context, it soon became obvious that if a rat consumes a specific poison, but does not die, the rat will probably not consume that poison again. Further, Richter (1953), clarified the phenomenon of neophobia, noting that wild rats will consume less of an unfamiliar taste than of a familiar taste. This neophobic response often afforded the rat its life, since it would not consume enough poison to die, but would consume enough to become ill and learn not to consume that poison again. This research clearly delineates the concept of taste aversion learning (Richter, 1953).

The beginnings of modern research in this area can be traced to the late 1950's and early 1960's. This research (Garcia, Kimeldorf & Hunt, 1961; McLaurin, Farley, Scarborough & Rawlings, 1961; Smith, Taylor, Morris & Hendricks, 1965) involved examining the effects of ionizing radiation on consummatory behaviors in the rat. It soon became evident that low doses of radiation could produce an aversion to saccharin water even if the illness that was produced occured several minutes after exposure to the taste (Garcia & Kimeldorf, 1960). However, the major focus of this research was on the biological effects of radiation, not on the specific conditioning mechanisms involved. One researcher, Rzoska (1953, 1954), did hint that taste aversion studies showed the possibility of long-delay learning, but this issue was not directly addressed at that time.

Therefore, by the 1960's, the notion of an animal learning to avoid a taste that had been previously associated with illness was not new. However, the next decade produced a number of research projects which clearly suggested that the area of taste aversion learning may be significant, if not unique.

After much research in the area of learned taste aversions, John Garcia and his colleagues began to question the generalizability of two classic principles of conditioning. Garcia felt that unconditioned stimuli (or primary reinforcers) had a selective effect on what was learned or conditioned. This was in opposition to the traditional conditioning contention that a reinforcer associated with one set of stimuli should also be associable with other stimuli and other situations. In 1966, John Garcia and Robert Koelling published the article, "Relation of Cue to Consequence in Avoidance Learning." In a series of four experiments, "bright-noisy," and "tasty" water was conditionally paired with radiation, a toxin, immediate shock, or delayed shock. In other words, as a rat drank, it was presented with three cues: taste, noise and light, which were followd by illness or shock. What Garcia and Koelling found was that conditioning to the "taste" conditioned stimulus (CS) was strongest when illness was the unconditioned stimulus (US), and conditioning to the "bright-noisy" CS was strongest when shock was the US. Through this research it became evident that reinforcers were not equally effective for all classes of discriminable stimuli.

The second principle that Garcia questioned in his study of taste aversion learning concerned the generality of contiguity theory. Ever since Pavlov's dog, it was stated that any delay between the presentation of the CS and US interfered with the course of conditioning (Mackintosh, 1983). Garcia felt that immediate reinforcement was simply not necessary for learning to occur when illness was the US. In a second paper, "Learning With Prolonged Delay of Reinforcement," also published in 1966, Garcia, Ervin and Koelling examined the parameters of the interstimulus interval within the learned taste aversion paradigm. The results of this research did show that with a short (one-minute) interval between presentation of sweet water and an illness-inducing drug rats learned to avoid consuming the sweet water. However, the more interesting finding was that long interstimulus intervals of up to 75 minutes would also support conditioning. Rats exposed to sweet water and made sick 75 minutes after the exposure demonstrated a taste aversion by subsequently not drinking the sweet water. These findings clearly defied the notion that temporal contiguity was a necessary condition for an association to be formed between a taste and illness.

The data reported by Garcia et al. (1966a,b) seriously challenged well-accepted learning priniciples. The bold hypotheses that reinforcers had a selective effect on learning and that the optimal interstimulus interval was relative to the specific paradigm had never before been stated or supported by research. These data spurred intensive research in the area of learned taste aversions.

At this point, the research began to diversify. A number of experimentors applied the paradigm of taste aversion learning to clarify other research issues. For example, Schweitzer and Green (1982) used the learned taste aversion paradigm to define better the developmental parameters of learning in preweanling rats. Gustavson and his colleagues (1977) have applied conditioned taste aversions to control predation on range animals and field crops. In an attempt to interfere with or disrupt such conditioning, Cannon, Best, Batson, & Feldman (1983) have extended the study of learned taste aversions to an examination of their formation by cancer patients undergoing chemotherapy.

The second direction of this research has focused directly on the specific conditioning mechanisms involved in taste aversion learning and possible theoretical explanations. For example, Richard Solomon (1977) applied the Opponent-Process Theory to account for taste aversion behavior. It was stated that during original conditioning, an aversive state, illness, is created. Concurrent with this aversive state, a second state also is created, which seeks to return the organism to homeostasis. It is assumed that the second state has a slower onset and a slower offset, and is therefore longer lasting. Hence, when the novel taste (CS) is subsequently presented, the second state is aroused and the animal seeks to regain homeostasis by avoiding the taste stimulus, i.e. taste aversion learning.

Another theoretical perspective was provided by Seligman (1970) who argued that learned taste aversions could be incorporated into "Preparedness Theory." He felt that rats were biologically prepared to make associations between gustatory cues and illness and that this "preparedness" acted to override any delay between the CS and US (taste and illness).

Revusky (1977) hypothesized that all instances of long-delay learning could be accounted for by the Concurrent Interference Theory. According to this perspective, long delays in taste aversion learning are possible because there are no other interfering stimuli. The "taste-illness" pairing is an internal and closed system so interference is minimal and learning maximum, whereas most learning situations are bombarded with potentially interfering stimuli.

In 1974, James Kalat proposed the "learned safety" hypothesis to account for long delays in taste aversion learning. Kalat suggested that when a rat encounters a novel taste which is followed by no unusual consequences, the rat actively learns that the novel taste is "safe." Thus the longer the delay between a taste and illness, the more likely the animal will learn the taste is safe. This hypothesis accounts nicely for the temporal gradient seen in taste aversion learning.

At this point, learned taste aversions were thought to illustrate a unique form of learning. It was felt that the accepted principles of conditioning did not apply to learned taste aversions. However, Best (1975) reviewed Kalat's "learned safety" hypothesis and proposed that learned taste aversions could be explained by traditional conditioning principles. In a series of experiments examining conditioned inhibition and latent inhibition, Best concluded that "latent inhibition" and the idea of "learned safety" may be the same processes. More recent terminology includes "learned irrelevance" as opposed to learned safety, but the issue remains open to further research.

Thus, it can be seen that taste aversion experimentation has followed either an applied aspect, or a basic-research directive. Logue (1979) offers an excellent review of the basic research on the learning mechanisms within the paradigm. One interesting finding of research on the mechanisms of taste aversion learning was that familiarity with the CS (taste) prior to conditioning had subsequent effects on the results of conditioning. More specifically, a number of researchers (Domjan, 1972; Fenwick, Mikulka, & Klein, 1975; Misanin, Guanowsky, & Riccio, 1983; Revusky, 1971; Riley, Jacobs & Mastropaolo, 1983) have argued that familiarity with the CS severely attenuates subsequent conditioning to that CS. In other words, the newness, or novelty of the taste is critical for taste aversion learning. However, other researchers (Elkins, 1974; Garcia & Koelling, 1967; Nachman, 1970) have indicated that although familiarity may slightly attenuate subsequent aversion learning, conditioning will occur. Although these findings indicate a seeming contradiction, closer exmaination of the methods may act to clarify this discrepancy.

It should be noted that the majority of literature on the role of CS preexposure in taste aversion learning has employed plain tap water as the CS. Generally, in uncontrolled situations tap water is a highly familiar "taste" with which rats have a great deal of experience. However, experimental manipulations can present water as being a novel fluid, just as one might present a saccharin solution as a novel taste. Hence, using water as a CS has provided experimentors with an appropriate "neutral" stimulus, having little or no aftertaste and little chance of generalization to other tastes.

One of the first research projects which employed tap water as a CS was conducted by Garcia & Koelling (1967). These researchers reared rats on either a saccharin solution or plain water, and then paired either water or the saccharin solution with illness-inducing X-irradiation. Thus, water was presented as both novel and familiar prior to illness. Garcia & Koelling (1967) concluded "that radiation-induced aversions can be established for (1) gustatory stimuli that are familiar to the rat at the time of irradiation, as well as for novel gustatory stimuli, and for (2) tap water, as well as for flavored solutions." Further, the data indicated that an aversion could be created to any taste, familiar or novel, if that taste was specifically paired with illness, while a second, safe taste was provided for maintenance.

In 1970, Nachman replicated and extended the findings proposed by Garcia and Koelling (1967). Nachman (1970) presented both water and a saccharin solution as familiar tastes to rats. Each group received a six-day series of random saccharin and water presentations. On the third day of this series, all groups received an intraperitoneal injection of lithium chloride (LiCl), an illness-inducing drug, regardless of which solution was present. From this manipulation, Nachman (1970) concluded that rats will learn specifically to avoid the fluid which they had drunk prior to illness. It is interesting to note that although all animals were familiar with both the saccharin solution and water, only one fluid was paired with toxicosis, while the second fluid was never paired with illness. These findings are in agreement with Garcia and Keolling (1967) in that familiarity to a taste does not appear to eliminate subsequent taste aversion learning, especially if a second, safe fluid is provided. These results seem to indicate that rats learn a discrimination between safe and "nonsafe" tastes, and this discrimination learning acts to enhance subsequent taste aversion learning, even to familiar tastes.

Further support for this notion can be seen in a project by Elkins (1974). In this research, rats that had been reared on water were presented with a bitter quinine solution and plain tap water over a series of days. During this period, each time the subjects had access to water, they received injections of cyclophosphamide, an illness-inducing agent. In contrast, the bitter quinine solution was never paired with illness. After nine pairings of water with illness, all subjects were exposed to extended extinction during which both tap water and the quinine solution were constantly available in separate bottles. The results of this manipulation indicated that subjects acquired a strong aversion to plain tap water, and subsequently consumed only the bitter quinine solution during the extinction phase. These data clearly support the previous research projects (Garcia & Koelling, 1967; Nachman, 1970) in that a taste aversion may be learned to a highly familiar taste, such as plain tap water. It should be noted that in all of the above mentioned projects (Elkins, 1974; Garcia & Koelling, 1967; Nachman, 1970) the subjects had experience with a second taste, which was never paired with gastrointestinal distress. Through this experience, the animals may have learned to discriminate between tastes paired with illness, and tastes not paired with illness. Another possible explanation could be that the animals "learn" which tastes have no aversive consequences. This explanation has been termed "learned safety," "learned irrelevance," and/or "latent inhibition," (Best, 1975). For the purposes of the present discussion, the presentation of a second fluid to enhance taste aversion conditioning to another familiar fluid will be considered the presentation of a second, "safe" taste.

Thus, research indicates that a taste aversion to water may be acquired 1) if animals are exposed to multiple pairings of water with an illness-inducing agent (Elkins, 1974); 2) if animals have had no previous experience with water, i.e. water is presented as novel (Garcia & Koelling, 1967); or 3) if they are provided with a second, safe taste prior to conditioning, regardless of previous experience with water (Elkins, 1974; Garcia & Koelling, 1967; Nachman, 1970).

Clearly these data are supportive of the use of plain tap water as a conditioned stimulus within the learned taste aversion paradigm. However, there are potential interpretation problems. Recent data reported by Riley, Jacobs, & Mastropaolo (1983), contend that taste aversion conditioning to water will be severely attenuated if the animal has had previous experience with water. This appears to be in opposition to the results obtained by Nachman (1970), who argued that preexposure to a fluid does not appear to greatly affect subsequent aversion learning to that fluid, if a substitute fluid is provided. Further, Nachman (1970) contended that aversion learning would be evident after only one CS-US pairing, as opposed to Elkins (1974) who employed nine CS-US pairings, and Riley, Jacobs and Mastropaolo (1983) who employed eight CS-US pairings in order to obtain an aversion to familiar water. Clearly there is a discrepancy of the role of preexposure on taste aversion learning and the need for multiple CS-US pairings. Further, it would appear necessary to examine the role of providing a safe, substitute fluid prior to conditioning of water with illness. It may be that providing a substitute fluid acts to enhance taste aversion learning. More specifically, it might be argued that experience with a safe, substitute fluid prior to conditioning will enhance conditioning, regardless of previous experience with the "to-be-conditioned" taste. Clearly, Nachman's (1970) data would be supportive of such a contention. His animals had exposure to the saccharin solution prior to conditioning to water, and subsequently demonstrated a learned aversion to water. The lack of aversion learning on the part of the animals that had no previous experience with saccharin prior to conditioning to water, as reported by Riley, Jacobs & Mastropaolo, (1983), would also support this view.

One further discrepancy in this literature involves the type of measurement strategy employed. Elkins (1974) employed a two-bottle preference test when measuring the acquired aversion, whereas Nachman (1970) and Riley, Jacobs & Mastropaolo (1983) employed a single bottle test. Such differing measurement strategies could bias the results and hence call the comparability of such data into question.

The present studies were designed specifically to address several of these issues. First, it would appear to be of some intrinsic value to reexamine and more clearly delineate the parameters involved in creating a learned aversion to water. Second, it would appear worthwhile to compare the effectiveness of one CS-US pairing of water with an illness-inducing agent as opposed to multiple pairings, in producing a taste aversion to water. Third, an assessment of the role of the substitute taste would appear relevant in evaluating the acquired aversion to water. A consideration of the effect of the type of measurement strategy employed, single-bottle versus two-bottle preference test, provides a final, important focus.

CHAPTER 2

EXPERIMENT 1

Clearly from the previous discussion (see Chapter 1) it can be seen that there are a number of discrepant views concerning whether or not a taste aversion can be learned to water. However, these discrepancies may be a result of the different methodologies employed in the various experiments. Hence, the purpose of Experiment 1 was to examine the parameters involved in creating a taste aversion to water. One variable of potential importance is the presentation of more than one fluid. In other words, creating a learned taste aversion to water may be dependent upon the availability of a second, "safe," taste (Elkins, 1974; Garcia & Koelling, 1967; Nachman, 1970). A second variable affecting the strength of conditioning is the number of "taste-illness" pairings, or, more specifically, the number of CS-US pairings. It is evident that there is a positive relationship between the number of CS-US pairings and the strength of the subsequent learned aversion (Elkins, 1974, Riley, Jacobs, & Mastropaolo, 1983). However, it would be potentially interesting to examine taste aversion learning to water with only one CS-US pairing of water with illness. Hence, Experiment 1 was designed to examine taste aversion learning to familiar water. A second taste, coffee, was presented prior to one pairing of water with illness.

Method.

General Methodology. Since the methods employed in all five experiments are similiar, a discussion of these general procedures will ensue. Specific details or differences among the experiments will be outlined with each individual experiment. All experiments employed two groups of rats which were maintained on plain tap water until the time of experimental manipulation. At this time one group was switched to a coffee solution for 20 days. Immediately following this 20-day-preexposure phase, these subjects were given a single CS-US pairing of water with Lithium Chloride (LiCl), an illness- inducing agent, in an attempt to create a learned taste aversion to water. In addition, a control group, which received continued access to water and no experience with a second taste prior to conditioning, was employed in each experiment.

Subjects. Twelve, naive, male albino rats obtained from the Holtzman Co., Madison, Wisconsin, served as subjects. All subjects were approximately 100 days old at the beginning of the experiment and weighed between 500 and 600 grams. Subjects were housed in stainless steel, wire-mesh cages with food freely available throughout the duration of the experiment.

Apparatus. All procedures were carried out in the home cage.

Procedure. The animals were randomly assigned to one of two equal-sized groups (n=6) and placed on water deprivation. Twenty-four hours later marked the beginning of the experiment. All subjects were maintained on a 23

1/2 hour water-deprivation regimen throughout the duration of the experiment. In other words, subjects had access to fluids for 30 minutes per day. The amount of fluid consumed in grams was recorded daily. The first five days of the experiment comprised Baseline, during which daily water consumption was recorded for each subject. Subsequent to the Baseline phase, Preexposure was begun. During this phase, Group C was switched from water to a coffee solution consisting of 7.59 grams Brim Decaffeinated coffee per liter of water as their daily maintenance fluid. Group W continued to receive water as their daily maintenance fluid. Subjects were maintained on this preexposure schedule for 20 days. The Conditioning day immediately followed the last day of preexposure. On this day, all subjects received 30 minutes access to water, which was immediately followed by a 2% of body weight, .15M LiCl intraperitoneal injection. Testing procedures were conducted subsequent to the Conditioning day and consisted of 30 minutes access to water for all subjects, for three consecutive days.

Results and Discussion.

General Statistical Procedures. As similar analytical procedures were employed in all experiments, they will be discussed briefly at this point. In those cases where two or more days were analyzed, a split-plot factorial analysis of variance (see Kirk, 1982) incorporating one between-subjects factor (Groups: C versus W) and one within-subjects factor (Days) was performed. Simple main effects analyses and appropriate Newman-Keuls tests were used to probe significant interaction effects, while only Newman-Keuls tests were used to evaluate significant main effects. For analyses comparing the two groups on only one selected day, _t_ tests for independent samples were employed. In all cases an alpha level of .05 was adopted for the determination of statistical significance.

Experiment 1. Group mean consumption scores (grams) for the Baseline, Preexposure, Conditioning and Test phases are shown in Figure 1, Part A. As can be seen, consumption scores for Groups C and W appear to be equivalent throughout the experiment, although consumption across days appears to vary. Analysis of the last three days of Baseline yielded a significant Days effect, $F(2,20) = 12.31$, $p < .001$, supporting this contention. Newman-Keuls tests indicated that consumption scores on Day 4 were significantly ($p < .01$) lower than those of Days 3 and 5, which did not differ reliably. As signigicant effects were not produced by the analysis of the first three days of Preexposure, it can be concluded that the groups were equivalent at the start of the experiment. In this regard, it is interesting to note that Group C did not appear to decrease its consumption when presented with the novel coffee solution (the first day of Preexposure), thus not exhibiting neophobia. The Days effect was significant in the analysis of the last

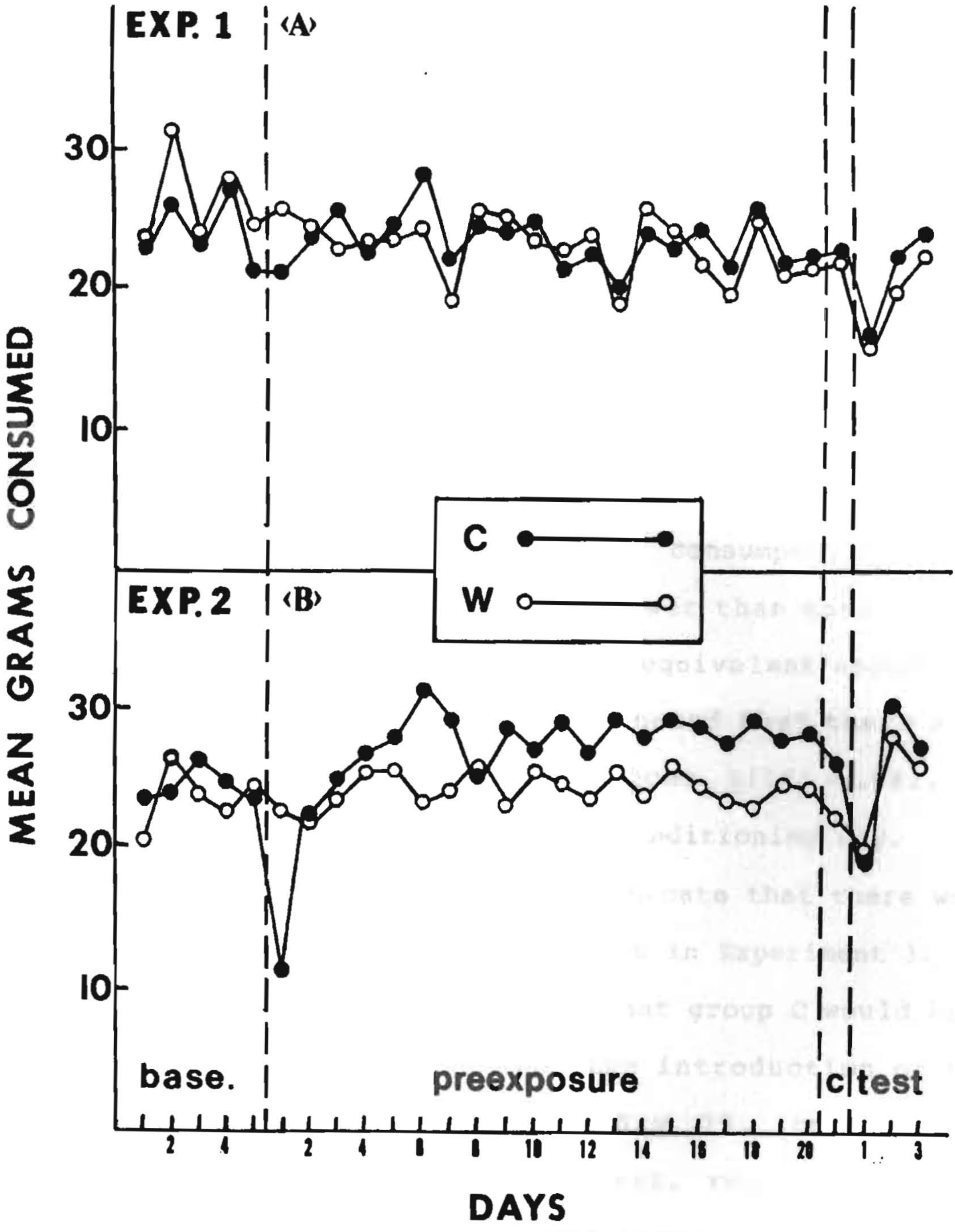

FIGURE 1: Part 1 - Group mean fluid consumption (grams) for Groups C and W during the Baseline, Preexposure, Conditioning and Testing phases of Experiment 1.

Part 2 - Group mean fluid consumption (grams) for Groups C and W during the Baseline, Preexposure, Conditioning and Testing phases of Experiment 2.

three days of the Preexposure phase, $F(2,20) = 16.74$, $p <$ 001. Newman-Keuls analyses demonstrated that consumption on Day 18 was significantly ($p < .01$) less than consumption on Days 19 and 20, which did not differ significantly. It is also of particular interest that both Groups C and W decreased consumption on the first Test day. The analysis of the three Test days yielded a significant Days effect, $F(2,18) = 14.602$, $p < .001$. Newman-Keuls analysis revealed that consumption on Test Day 1 was significantly ($p < .01$) lower than consumption on Test Days 2 and 3, which yielded equivalent amounts of consumption. Finally, it should be noted that there were no significant consumption differences, $t(10) = .681$, $p >$ .20, between Groups C and W on the Conditioning day.

Taken together, these results indicate that there were no reliable between-group differences in Experiment 1. In that it would have been predicted that group C would have shown a neophobic response upon the introduction of the coffee solution (Preexposure Day 1), this is an interesting, and potentially relevant, result. Further, as the consumption scores of both groups on Day 1 of the Test phase were significantly lower than those shown on Days 2 and 3, it might be argued that both groups displayed a learned taste aversion to water. However, a more plausible explanation would be to attribute this decreased consumption to a general sensitization effect. In this case, it could be argued that the severe gastrointestinal distress experienced on the Conditioning day generalized to all fluids. In other words, the animals became sensitized to the presentation of any fluid, for fear of becoming ill, and avoided drinking all fluids. A third possibility would be to attribute the significant decrease in consumption on Test day 1 to chance fluctuations in consumption (see also the differences between Days 18-20 of Preexposure). Experiment 2 was designed to address some of the issues and/or problems raised by Experiment 1.

CHAPTER 3

EXPERIMENT 2

As was shown in Experiment 1, it could be suggested that Group C did not exhibit a learned taste aversion to water. One explanation for this possible lack of aversion learning may be related to the absence of a neophobic response when the coffee solution was introduced on Day 1 of Preexposure (see Figure 1, Part A). Although it has been shown that reduced neophobia to novel solutions does not appear to affect subsequent aversion learning (Braveman & Jarvis, 1978), it is questionable whether a neophobic response to the substitute fluid affects subsequent conditioning. Since the coffee solution was intended to be distinctly different from water, thus providing the animals with a safe, substitute fluid, it might be argued that the lack of a neophobic response indicated that there was no discriminable difference between the coffee solution and plain tap water. If the coffee solution was not perceived as distinctly different from water by Group C, then Group C would not be predicted to differ from Group W. Thus, the purpose of Experiment 2 was to attempt to insure that Group C did perceive the coffee solution as being distinctly different from water. This was accomplished by tripling the concentration of the coffee solution relative to that employed in Experiment 1. If Group C responds to the initial presentation of the coffee solution with neophobia, then it may be argued that the coffee solution was perceived as distinctly different from water, and therefore enhance taste aversion learning to the water.

Method.

Subjects. Twelve, naive, male albino rats obtained from the Holtman Co., Madison, Wisconsin, served as subjects. Subjects were approximately 100 days old at the beginning of the experiment and weighed between 450 and 550 grams. Housing and feeding procedures were identical to those of Experiment 1.

Apparatus. All procedures were carried out in the home cage.

Procedures. All procedures were identical to those described for Experiment 1, with the exception of the strength of the coffee solution presented during Preexposure. For Experiment 2, 22.77 grams of Brim Decaffeinated coffee per liter of water comprised the coffee solution.

Results and Discussion.

Group mean consumption scores (grams) for the Baseline, Preexposure, Conditioning and Test phases are shown in Figure 1, Part B. As can be seen from the figure, consumption scores appear to be equivalent for Groups C and W throughout the experiment, with the exception of the first day of Preexposure. Analysis of the last three days of Baseline yielded no significant differences between Groups C and W. However, analysis of the first three days of Preexposure yielded a significant

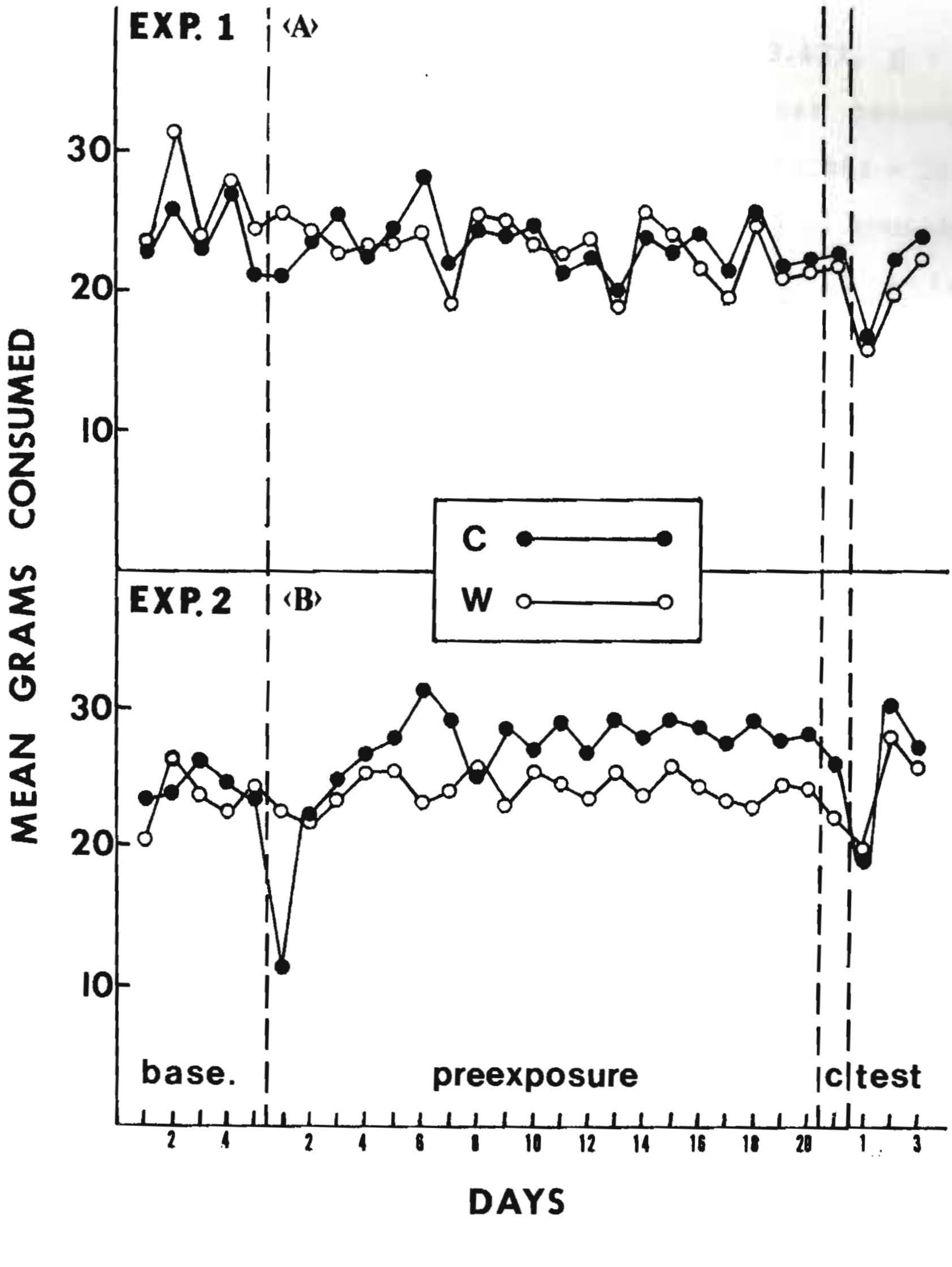

FIGURE 1: Part 1 - Group mean fluid consumption (grams) for Groups C and W during the Baseline, Preexposure, Conditioning and Testing phases of Experiment 1.

Part 2 - Group mean fluid consumption (grams) for Groups C and W during the Baseline, Preexposure, Conditioning and Testing phases of Experiment 2.

Groups X Days interaction, $F(2,20) = 13.423$, $p <$ 001. Simple main effects analysis showed that consumption scores for Group C were significantly, $F(1,30) = 18.29$, $p < .001$, lower on Day 1 of Preexposure than consumption scores of Group W. Further analyses revealed no significant differences beween groups for Days 2 and 3 of the Preexposure phase. Simple main effects analysis of Days 1-3 consumption scores of Group C yielded significance, $F(2,20) = 28.99$, $p < .001$. Newman-Keuls tests revealed that consumption scores for Group C were significantly ($p < .01$) lower on Day 1 of Preexposure than on Days 2 and 3, which did not differ. In addition, consumption scores for Group W did not differ over the first three days of Preexposure. These results clearly indicate that Group C showed a marked neophobic response to the presentation of the coffee solution on Day 1 of Preexposure. However, consumption scores of Group C did increase, as evidenced by no significant differences between groups on Days 2 and 3 of Preexposure. In looking at Part B of Figure 1, it is interesting to note that consumption scores of Group C increased and stabilized above those of Group W throughout the Preexposure phase. Analysis of the last three days of Preexposure yielded a significant Groups effect $F(1,10) = 7.17$, $p < .02$, indicating that Group C did consume more fluids than Group W on the last three days of preexposure. Consumption on the Conditioning day did not differ significantly between Groups C and W, $t(10) = 1.41$, $p > .05$. Examination of the three Test days (see Figure 1) shows a decrease in consumption for both groups on Test Day 1. Analysis of variance performed on the 3 test days yielded a significant Days effect, $\underline{F}(2,20) = 51$, $\underline{p} < 001$. Newman-Keuls tests revealed that consumption of both Groups C and W was significantly ($\underline{p} < 01$) lower on Test day 1 than on Test Days 2 and 3, while consumption on Test Day 3 was significantly ($\underline{p} < .05$) lower than consumption on Test Day 2. However, there were no significant differences between groups during the Test days.

It is clear from the statistical analysis that Group C exhibited a neophobic reaction to the coffee solution (Day 1 of Preexposure). Thus, it could be argued that the coffee solution was perceived as distinctly different from water. However, this did not appear to have any differential effect on subsequent taste aversion learning to water, since Group C did not differ from Group W during Testing. It is interesting that both groups decreased consumption on Test Day 1. These results replicate those of Experiment 1, and would seem to indicate that both groups may have learned an aversion to the water. On the other hand, it could be argued that the decreased consumption was, once again, due to sensitization effects, or chance fluctuations in daily consumption, as discussed in Chapter 2. If both groups acquired a taste aversion to water, then clearly there is no need to provide the subjects with a second, safe taste. However, this contention is not supported by the literature (Elkins, 1974; Garcia & Koelling, 1967; Nachman, 1970). One other possibility would be that Group C did learn an aversion to the water in both experiments, but did not demonstrate that learning under the single-bottle testing procedures that were employed in Experiments 1 and 2. Experiment 3 was designed to address this issue.

CHAPTER 4

EXPERIMENT 3

The results of Experiments 1 and 2 suggest that there was little, if any, actual taste aversion learning to water by Group C. Although both Groups C and W did decrease consumption subsequent to Conditioning, this decrease may be explained more parsimoniously by sensitization effects or chance fluctuations in consumption. Hence, it could be argued that the present procedures do not support taste aversion learning. However, there is a potential interpretation problem. It has been demonstrated (Dragoin, McCleary, & McCleary, 1971; Grote & Brown, 1971) that the single-bottle assessment of taste aversion learning is not a reliable measure of possible taste aversion learning. This research argues that the two-bottle preference test is a much more sensitive measure, and is more likely to detect any potential taste aversion learning. Therefore, one plausible explanation for the lack of conclusive evidence for aversion learning in Experiments 1 and 2 would be that the subjects DID acquire an aversion to water, but the single-bottle test employed in these experiments did not reveal that learning. Hence, the purpose of Experiment 3 was to replicate Experiment 2, with the exception that a two-bottle preference test be employed during the three Test days.

Method.

Subjects. Twelve, naive, male albino rats obtained from the Holtzman Co., Madison, Wisconsin served as subjects. All subjects were approximately 100 days old at the beginning of the experiment and weighed between 350 and 450 grams. Housing and feeding procedures were the same as those in the previous experiments.

Apparatus. All procedures were carried out in the home cage.

Procedure. All procedures were the same as those in Experiment 2 with the exception that a two-bottle preference test was employed on the three Test days. This consisted of simultaneously placing two bottles on the home cage for each 30 minute test. Thus, each animal had access to both the coffee solution and plain tap water.

Results and Discussion.

Group mean consumption scores (grams) for the Baseline, Preexposure, and Conditioning phases are shown in Figure 2, top panel. As can be seen from the graph, consumption on the last day of Baseline appeared to increase. This apparent increase was supported by the analysis, which revealed a significant Days effect, $F(2,20) = 10.26$, $p < .001$. Subsequent Newman-Keuls tests showed that consumption on Day 5 of Baseline was significantly ($p < .01$) greater than consumption on Days 3 and 4, which did not differ. The graph also reveals an apparent neophobic response on the first day of Preexposure in Group C. Analysis of the first three days of Preexposure yielded a significant Groups X Days

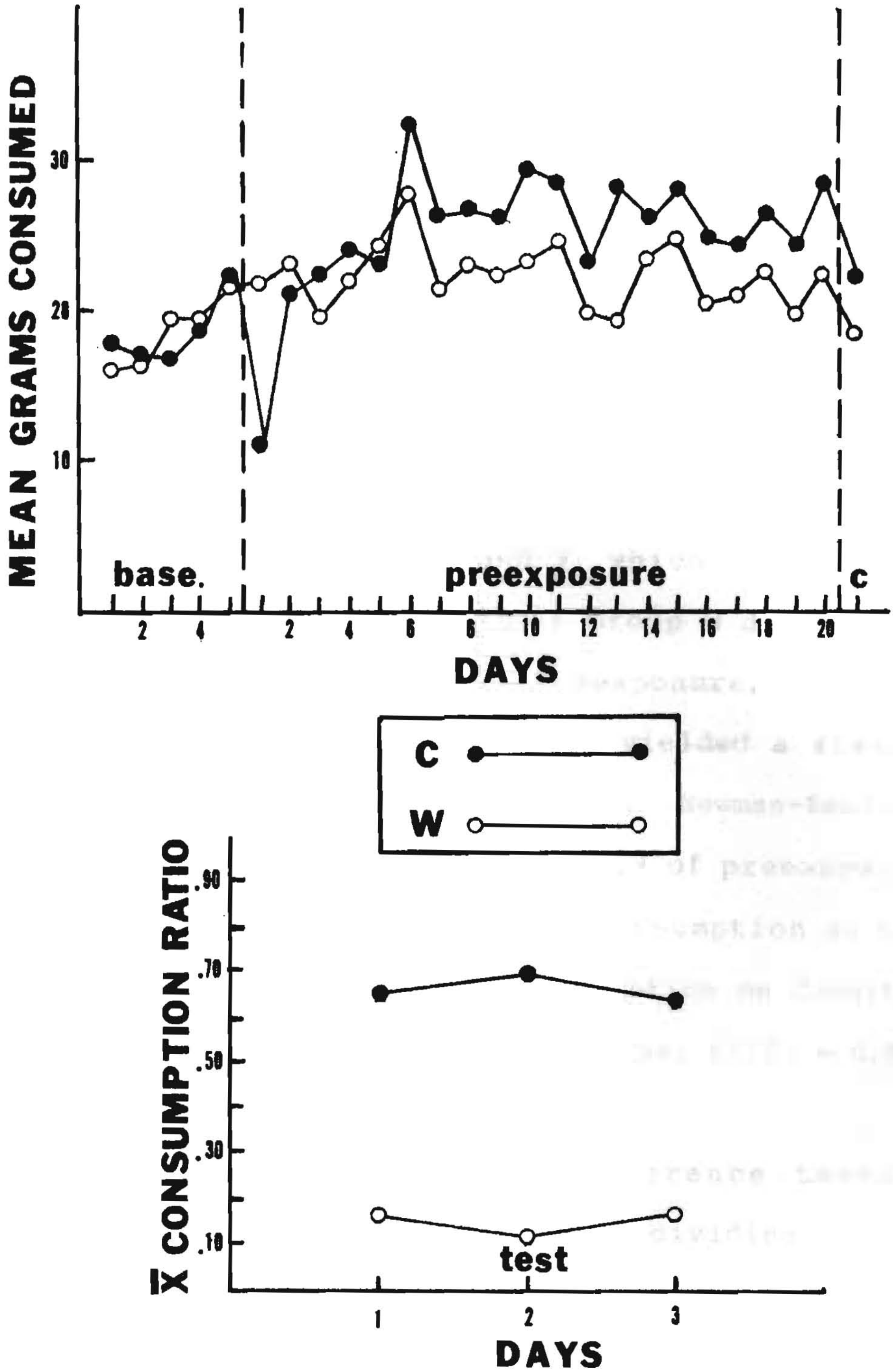

FIGURE 2: Group mean fluid consumption (grams) for Groups C and W during the Baseline, Preexposure, and Conditioning phases (top panel) and group mean consumption ratios during the Testing phase (bottom panel) of Experiment 3.

interaction, $F(2,20) = 50.88$, $p < .001$. Simple main effects analysis found that Group C consumed significantly, $F(1,30) = 28.99$, $p < .001$, less on Day 1 of Preexposure than Group W, while the groups did not differ on Days 2 and 3. Further, simple main effects analysis and subsequent Newman-Keuls tests revealed that Group C consumed significantly ($p < .01$) less on Day 1 of Preexposure than on Days 2 and 3, which did not differ, while the consumption scores of Group W did not differ across the first three days of Preexposure. Analysis of the last three days of preexposure yielded a significant Days effect, $F(2,20) = 11.94$, $p < .001$. Newman-Keuls tests indicated that consumption on Day 19 of preexposure was significantly ($p < .01$) less than consumption on Days 18 and 20, which did not differ. Consumption on Conditioning day also did not differ between groups, $t(10) = 0.96$, $p >$ 05.

The data from the three preference tests were converted into consumption ratios by dividing the amount of coffee consumed (grams) by the total volume (grams) of fluid consumed (i.e., coffee/coffee + water). Mean consumption ratios for the three days of Testing are shown in Figure 2, bottom panel. It should be noted that a score larger than 0.50 indicates a greater consumption of coffee, a score less than 0.50 indicates a greater preference for water, while a score of 0.50 would reflect equal consumption of coffee and water. Analysis of the mean consumption ratios yielded a significant Groups effect, $F(1,10) = 62.95$, $p < .001$, indicating that Group C had a significantly higher consumption ratio than Group W. In other words, water consumption by Group C was significantly less than water consumption by Group W.

As would have been expected, Group C exhibited neophobia upon the initial presentation of the coffee solution on Day 1 of Preexposure. This result is comparable to Experiment 2, in which the same coffee solution also elicited a neophobic response. In addition, it is clear from Figure 2 (bottom panel) and the statistical analysis that Group C exhibited a preference for the coffee solution during the three days of preference testing. These results could be interpreted as implying that Group C demonstrated a learned taste aversion to water. As the only difference between Experiments 2 and 3 was the use of the two-bottle preference test, these results appear to support previous research (Dragoin, McCleary, & McCleary, 1971; Grote & Brown, 1971) showing that the preference test is a much more sensitive measure of an acquired aversion. In addition, these results also may indicate that prior experience with a substitute fluid and only one CS-US pairing of water with illness are sufficient to create a learned aversion to water. Yet, it could be argued that the difference between Groups C and W during preference testing might have been due to a neophobic reaction shown to the coffee solution by Group W on the three days of testing. Experiment 4 was designed to address this potential problem.

CHAPTER 5

EXPERIMENT 4

Although Group C in Experiment 3 appeared to display a learned aversion to water, there is another possible explanation. The difference between Groups C and W, which has been interpreted as taste aversion learning to water by Group C, could just as easily be interpreted as a neophobic reaction to the coffee solution by Group W. This contention can be supported by two points. First, as Group C displayed a marked neophobic reaction upon its initial experience with the coffee solution, it is highly probable that Group W would exhibit a similar reaction upon its first exposure to the coffee solution. Second, as a necessary condition of the preference test is to "choose" the preferable taste, it seems likely that Group W would prefer familiar water over the unfamiliar coffee solution. Hence, it could be argued that the difference between Groups C and W during the three days of preference testing was due to a neophobic reaction to the coffee solution and a preference for familiar water by Group W. It is still possible that Group C did learn and exhibit an aversion to water by prefering the coffee solution; however, adequate assessment of this contention requires an appropriate control comparison. Therefore, the purpose of Experiment 4 was to replicate Experiment 3 with the addition of a Familiarity phase prior to the preference testing. The purpose of the Familiarity phase was to give Group W experience with the coffee solution prior to testing so that any differential consumption between groups during testing could NOT be attributable to neophobia.

Method.

Subjects. Twelve, naive, male albino rats obtained from the Holtzman Co., Madison, Wisconsin served as subjects. All subjects were approximately 90 days old at the beginning of the experiment and weighed between 350 and 450 grams. Housing and feeding procedures were the same as those in the previous experiments.

Apparatus. All procedures were carried out in the home cage.

Procedure. All procedures were identical to those in Experiment 3 except for the addition of the Familiarity phase. This phase occurred subsequent to Conditioning, but prior to preference testing, and consisted of access to the coffee solution for 30 minutes for both Groups C and W. The Familiarity phase, which was concluded when consumption scores had stabilized, lasted 3 days and was immediately followed by the three days of preference testing.

Results and Discussion.

Group mean consumption scores (grams) for the Baseline, Preexposure, Conditioning and Familiarity phases are shown in Figure 3, top panel. Examination of Figure 3 reveals some interesting trends. Both Groups C and W appeared to exhibit neophobia upon the initial

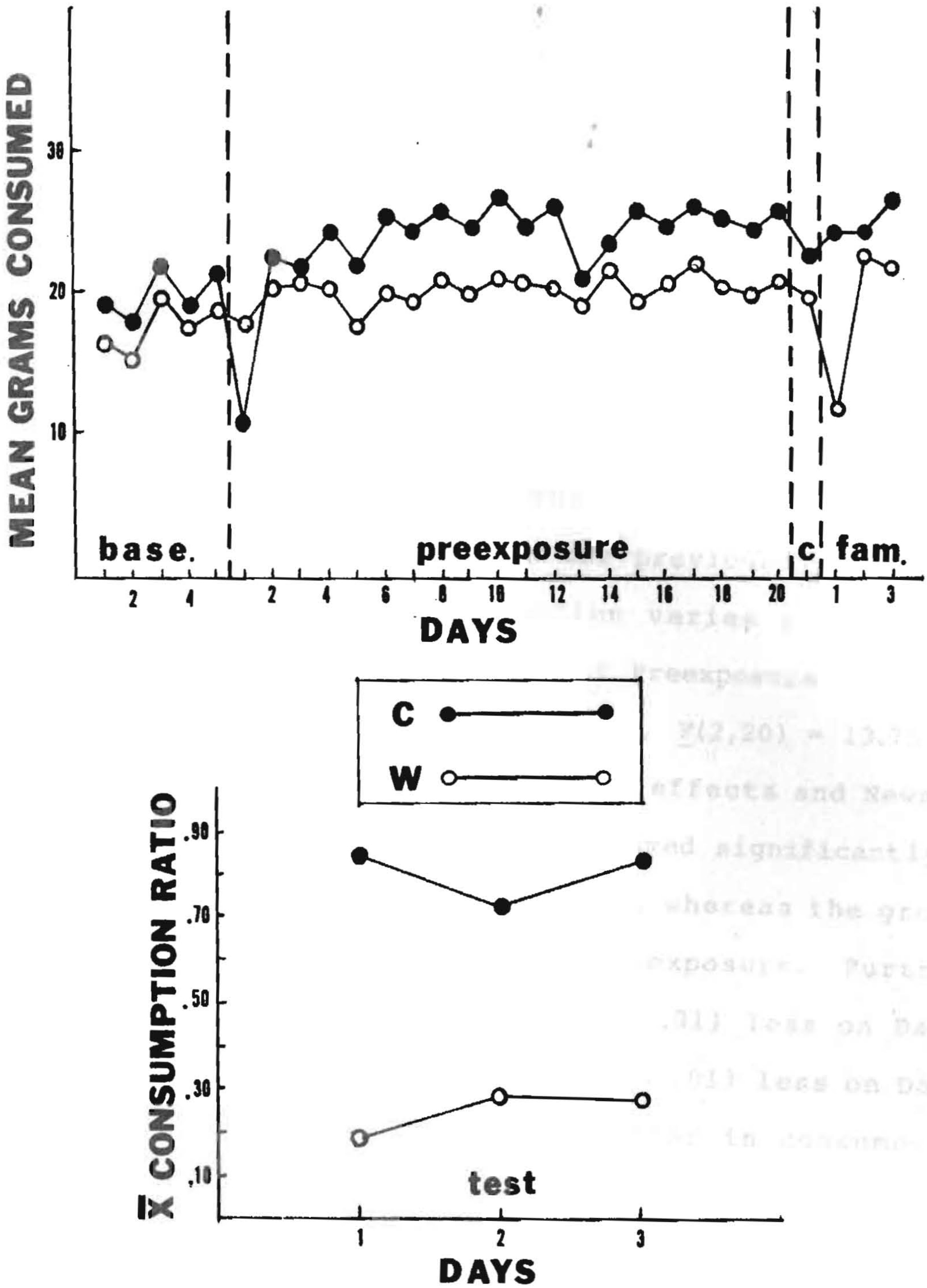

FIGURE 3: Group mean fluid consumption (grams) for Groups C and W during the Baseline, Preexposure, Conditioning, and Familiarity phases (top panel) and group mean consumption ratios during the Testing phase (bottom panel) of Experiment 4.

presentation of the coffee solution, and Group C appeared to consume more fluid than Group W throughout Preexposure. Analysis of the last three days of Baseline yielded a significant Days effect, $F(2,20) = 6.054$, $p <$ 008, with subsequent Newman-Keuls tests indicating that consumption of both Groups C and W was significantly ($p < .01$) lower on Day 4 than on Days 3 and 5, which did not differ. These results, which are similiar to the previous experiments, seem to indicate that consumption varies across days. Analysis of the first three days of Preexposure yielded a significant Groups X Days interaction, $F(2,20) = 13.739$, $p < .001$. Analysis of the simple main effects and Newman-Keuls tests showed that Group C consumed significantly ($p < .01$) less than did Group W on Day 1, whereas the groups did not differ on Days 2 and 3 of Preexposure. Further, Group C consumed significantly ($p < .01$) less on Day 1 than on Day 2, and significantly ($p < .01$) less on Day 2 than on Day 3. Group W did not differ in consumption across the first three days of Preexposure. One interesting trend, as evidenced from Figure 3, is that consumption of Group C appeared to stabilize above that of Group W throughout Preexposure. This trend was supported by statistical analysis of the last three days of Preexposure, which yielded a significant Groups effect, $F(1,10) = 6.302$, $p < .029$. However, consumption on the Conditioning day did not differ between groups, $t(10) = 1.29$, $p > .05$. In looking at Figure 3, it also seems evident that Group W exhibited neophobia to the coffee solution on the first day of the Familiarity phase. Analysis of the 3-day Familiarity phase yielded a significant Groups X Day interaction, $F(2,20) = 16.336$, $p < .001$. Simple main effects analysis yielded results showing that consumption scores of Group W were significantly less than those of Group C on Day 1, $F(1,30) = 25.37$, $p < .001$, and Day 3, $F(1,30) = 5.17$, $p < .05$, while consumption scores were equivalent for both groups on Day 2 of Familiarity. Further, simple main effects and Newman-Keuls tests revealed that Group C did not differ in consumption across the three days of Familiarity, while Group W consumed significantly ($p < .01$) less on Day 1 than on Days 2 and 3, which did not differ. These results do indicate that Group W exhibited a neophobic reaction to the coffee solution on Day 1 of Familiarity, but that consumption of the coffee solution stabilized on Days 2 and 3.

The data from the three days of preference testing were converted to consumption ratios (see Chapter 4) and are graphed in Figure 3, bottom panel. Analysis of these data yielded a significant Groups effect, $F(1,10) = 112.478$, $p < .001$, thus indicating that the consumption ratios for Group C were significantly greater than those for Group W throughout Testing. In other words, water consumption by Group C was significantly less than water consumption shown by Group W.

The results of Experiment 4 clearly seem to indicate that Group C demonstrated taste aversion learning to plain tap water. Group C showed a strong preference for the coffee solution, whereas Group W demonstrated a preference for the water. These results appear to agree with the results of Experiment 3. However, as Group W had experience with the coffee solution prior to testing in Experiment 4, this preference for water cannot be attributed to a neophobic reaction to the coffee solution. Familiarity with the coffee solution, subsequent to Conditioning, did not appear to affect Group W's preference for water. This finding is in agreement with the Riley, Jacobs and Mastropaolo (1983) data. Extensive preexposure of a taste can attenuate any aversion learning to that taste if the animals are not given experience with a second taste. On the other hand, it appears that exposure to a safe, substitute fluid prior to conditioning of another familiar taste greatly enhances aversion learning. This is clearly evidenced by the results of Group C in Experiments 3 and 4, and is in agreement with Nachman (1970). Thus, it could be concluded that taste aversion learning to water is dependent upon experience with a second, "safe" taste, and that this second taste should elicit a neophobic response as an indicator of its differentation from water. However, the role of the neophobic response to a second taste in predicting subsequent aversion learning to a familiar taste is unclear. Experiment 5 was designed to evaluate this issue.

CHAPTER 6

EXPERIMENT 5

The results of Experiment 4 demonstrate that a taste aversion to water can be conditioned with the design employed. These results also seem to imply that a neophobic response to the second, safe taste is imperative to subsequent conditioning. However, it is conceivable that the occurrance of the neophobic response to the second taste may not prove to be a good indicator of subsequent taste aversion learning. In order to clearly specify that the neophobic response is a critical factor, it would be necessary to provide data indicating that without a neophobic response to the second taste, there would be no taste aversion learning as measured by a two-bottle preference test. Hence, the purpose of Experiment 5 was to replicate Experiment 4, employing the Familiarity phase and the two-bottle preference test, but using the weak coffee solution employed in Experiment 1. This coffee solution did not elicit neophobia upon its initial presentation in Experiment 1, and it was argued that the weak coffee solution was not discriminably different from water. However, it is possible that neophobia is not an indicator of such discriminations. Hence, Experiment 5 should define the role of neophobia in labeling discriminable tastes and subsequent aversion learning to a familiar taste.

Method.

Subjects. Twelve, naive, male albino rats obtained from the Holtzman Co., Madison, Wisconsin, served as subjects. All subjects were approximately 90 days of age at the beginning of the experiment and weighed between 350 and 450 grams. Housing and feeding procedures were the same as those in the previous experiments.

Apparatus. All procedures were carried out in the home cage.

Procedures. All procedures were identical to those described in Experiment 4, with the exception of the strength of the coffee solution presented during Preexposure, Familiarity and Preference Testing. For Experiment 5, 7.59 grams Brim Decaffienated coffee per liter of water comprised the coffee solution.

Results and Discussion.

Group mean consumption scores (grams) for the Baseline, Preexposure, Conditioning and Familiarity phases are shown in Figure 4, top panel. As can be seen, consumption scores for Groups C and W appear to be relatively equivalent throughout the duration of the experiment. Analysis of the last three days of Baseline indicated no significant differences, $F(1,10) = 3.323$, $p >$ 05, between groups or across days. Likewise, analysis of the first three days of Preexposure indicated no significant differences $F(1,10) = .041$, $p > .05$, between groups or across days. These results are in agreement with the data from Experiment 1 and indicate that Group C did not display neophobia upon the initial presentation of the

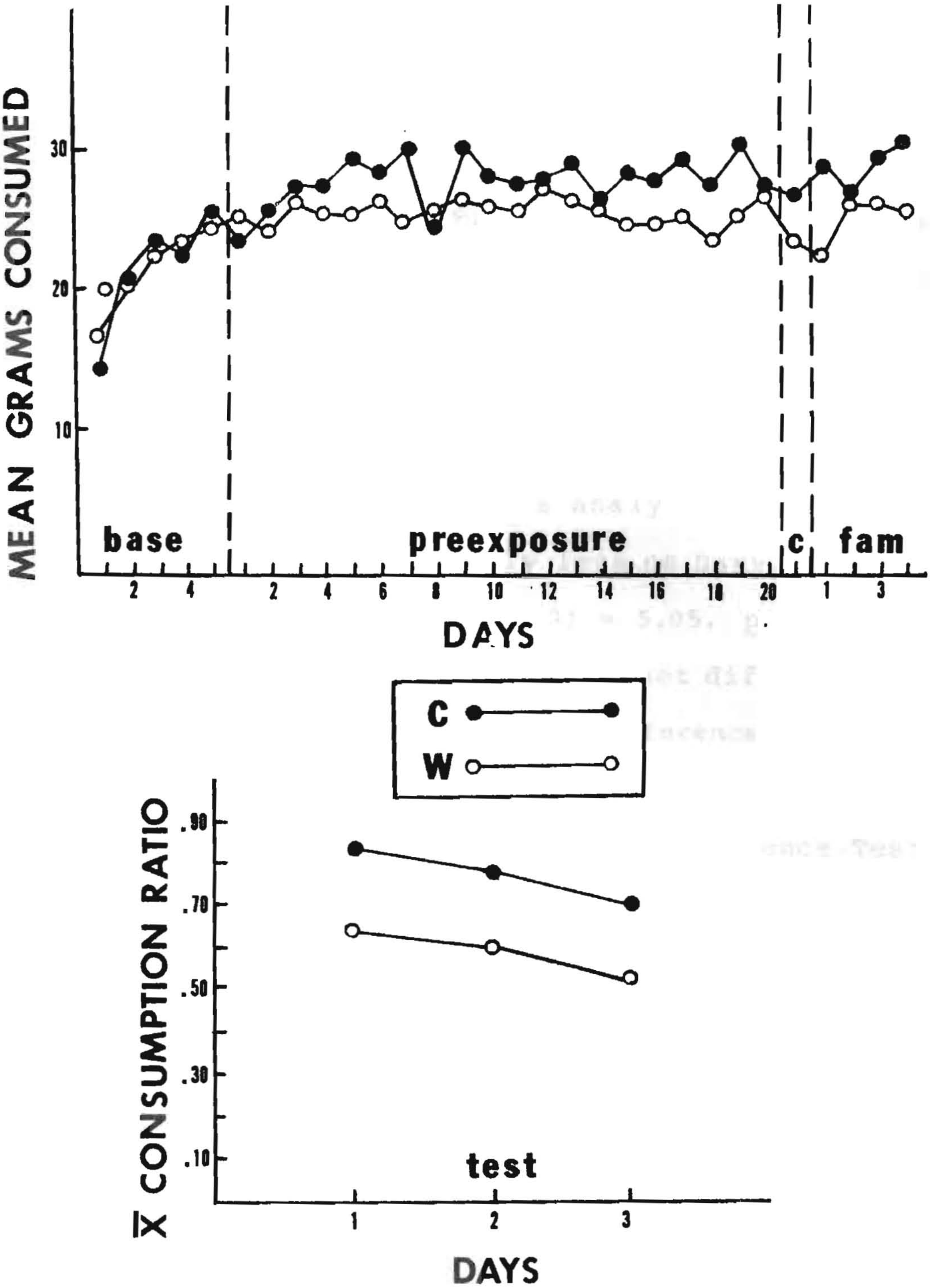

FIGURE 4: Group mean fluid consumption (grams) for Groups C and W during the Baseline, Preexposure, Conditioning, and Familiarity phases (top panel) and group mean consumption ratios during the Testing phase (bottom panel) of Experiment 5.

coffee solution on Day 1 of Preexposure. Analysis of the last three days of Preexposure also indicated no significant differences, $F(1,10) = 3.215$, $p > .05$ between groups or across days. Further, Groups C and W did not differ on Conditioning day, $t(10) = 0.96$, $p > .05$. Analysis of the Familiarity phase yielded a significant Groups X Days interaction, $F(3,30) = 2.99$, $p < .045$. Subsequent simple main effects analysis revealed that Group W consumed significantly less on Days 1, $F(1,40) = 5.85$, $p < .025$, and 4, $F(1,40) = 5.05$, $p < .05$, than Group C. However, the two groups did not differ on Days 2 and 3. In addition, there were no differences across days for either Group C or W during the Familiarity phase.

The data from the three days of Preference Testing were converted into mean consumption ratios (see Experiment 3) and are graphed in Figure 4, bottom panel. Analysis of the data revealed a significant Groups effect, $F(1,10) = 7.47$, $p < .02$, indicating that Group C had a significantly higher consumption ratio relative to Group W on all days of preference testing. Thus, Group C appears to have drunk significantly less water than Group W during testing.

As was predicted, from the results of Experiment 1, Group C did not display neophobia upon the initial presentation of the coffee solution on Day 1 of Preexposure. Hence, it is clear that Group C did acquire an aversion to water. These data are in agreement with the results of Experiment 4. As the subjects in Group C did not display a neophobic response to the coffee solution upon its initial presentation (Day 1 of Preexposure), it appears that neophobia to a substitute taste is not necessary to insure conditioning to the familiar taste. It is apparent from Figure 4 that Group W also displayed an aversion to the water. These results are somewhat surprising since taste aversion learning is usually severely attenuated by extensive CS preexposure (Misanin, Guanowsky, & Riccio, 1983). Further, these results appear to dispute the notion that taste aversion learning to a familiar taste is dependent upon experience with a substitute taste prior to conditioning. It is conceivable, however, that experience with a safe, substitute taste subsequent to conditioning would have the same effect, i.e., enhancing taste aversion learning. The animals in Group W did have experience with the coffee solution after Conditioning, during the Familiarity phase. Another possible explanation may be that this type of learning does occur, but only becomes apparent when employing a very sensitive measure such as the two-bottle preference test. It should be noted, however, that Group W never displayed as great a preference for the coffee solution as Group C did, indicating that aversion learning was weak, if present at all. On the other hand, the results of Group W may simply be due to an overall preference for the coffee solution, which may or may not have been affected by Conditioning. One line of evidence for this latter explanation could be derived from the mean consumption scores during Preexposure. Although there were no significant differences between groups during preexposure, it is evident from Figure 4 that Group C consumed more of the coffee solution than Group W consumed of their respective fluid. This could indicate a general preference for the coffee solution by Group C and also would support the notion that the Group W exhibited a preference for the coffee solution when given a choice. Finally, it is possible that Group W consumed more coffee during the preference test because of a greater overall preference for the coffee solution and because of a learned aversion to the water. Clearly, further research examining a general preference comparison of the coffee solution and water would be needed to clarify this discrepancy.

CHAPTER 7

GENERAL DISCUSSION

To reiterate, the present studies were conducted to clarify a number of discrepant issues concerning single-trial taste aversion learning to plain tap water. More specifically, Experiment 1 examined the parameters involved in creating a learned taste aversion to water; Experiment 2 examined the role of the neophobic response to a second taste on subsequent aversion learning; Experiment 3 clarified the advantages of using a two-bottle preference test; Experiment 4 equalized the two groups prior to testing in order to evaluate the results of the two-bottle preference test; and Experiment 5 re-examined the role of neophobia and subsequent taste aversion learning when the two-bottle preference test was employed.

Taken collectively, the results of these experiments clarify some of the previously raised issues. First, the present data address the issue of employing a single CS-US pairing versus multiple CS-US pairings to obtain a learned aversion to water. Second, as water was a highly familiar taste to the subjects, the effects of CS preexposure, or familiarity, on subsequent aversion learning was examined. Third, the presentation of a second, safe taste prior to conditioning to the familiar taste was assessed in relation to the issue of CS preexposure. Fourth, the predictive value of a neophobic response to the second, safe taste on subseqeunt aversion learning was discussed;

and finally, the importance of employing an effective measurement strategy was demonstrated.

First, it is interesting to note that substantial aversion learning to plain tap water was shown by Group C in Experiments 3, 4, and 5, even though only one CS-US pairing of water with illness was employed. Although Nachman (1970) employed only a single CS-US pairing, Elkins (1970) and Garcia and Koelling (1967) employed multiple CS-US pairings to obtain an aversion to water. Clearly, there is a positive correlation between the number of CS-US pairings and the strength of conditioning (Mackintosh, 1983). However, the present data would suggest that multiple CS-US pairings are unnecessary to acquire a taste aversion to water. Further, one-trial taste-aversion learning to water argues for the robustness of the paradigm.

A second major discrepancy in the current literature has involved the effects of CS preexposure (familiarity) upon subsequent aversion learning. Although certain researchers (Elkins, 1974; Garcia & Koelling, 1967; Nachman, 1970) concluded that extensive preexposure to a taste did not affect subsequent aversion learning to that taste, many other researchers (Domjan, 1972; Fenwick, Mikulka, & Klein, 1975; Misanin, Guanowsky, & Riccio, 1983; Revusky, 1971; Riley, Jacobs & Mastropaolo, 1983) suggested that extensive CS preexposure did attenuate subsequent aversion learning. The results of the present research seem to suggest that preexposure to a taste has little affect on subsequent aversion learning. In other words, a learned taste aversion can be acquired to a familiar taste. In Experiments 3, 4, and 5, Group C drank significantly less water than coffee, indicating a learned taste aversion to familiar tap water. This is particularly interesting in light of the previous discussion concerning one-trial aversion learning. Certainly, one-trial aversion learning to a highly familiar taste demonstrates the strength of the learned taste aversion paradigm.

However, it is possible that the one-trial aversion learning to familiar water may be the result of a third factor. The present data imply that presentation of a second, safe taste prior to conditioning may enhance subsequent aversion learning. Hence, in the experiments reported, presentation of the coffee solution to Group C may have overridden the attenuating effects of familiarity to water and enhanced one-trial aversion learning. In the research arguing against the attenuating effects of CS preexposure (Garcia & Koelling, 1967; Nachman, 1970; Elkins, 1974), the subjects were provided with a safe, substitute taste prior to conditioning to the familiar taste. Thus, it may be concluded that attenuation of aversion learning to a familiar taste will not be evident if a second, safe taste is presented prior to conditioning procedures. Whether this effect is a result of "learned safety," "learned irrelevance," "latent inhibition," or discrimination learning is unclear.

In addition, the present research examined the role of neophobia in relation to the second, safe taste. It was initially hypothesized that a neophobic response to the second taste demonstrated a perceptual difference from the familiar taste, and thus might act as an indicator of subsequent aversion learning. In other words, the perceptual difference between the two tastes (as indicated by neophobia) guaranteed the subjects would distinguish between the "safe" taste and the conditioned taste, i.e. discrimination learning. However, the results of Experiment 5 demonstrated substantial aversion learning to water by Group C, even though Group C did not react neophobically to the initial presentation of the second taste. Hence, it can be concluded that neophobia to the second taste may indicate a perceptual difference between the two tastes, but that the reaction is not a necessary or valid indicator of subsequent aversion learning.

The present data also support the findings that the two-bottle preference test is a much more sensitive measure of taste aversion learning than the single bottle test (Dragoin, McCleary, & McLeary, 1971; Grote & Brown, 1971). Experiments 1 and 2 employed the single bottle measure, and apparent aversion learning was fragile, at best. However, Experiments 3, 4 and 5 employed the two-bottle preference test and taste aversion learning was highly evident. As the only difference between

Experiments 2 and 3 was the use of the two-bottle test, it would seem plausible that the single-bottle test is not an effective measure of potential taste aversion learning.

As noted, the results of the present studies appear to have clarified some of the discrepant issues in the taste-aversion literature. However, further questions have been suggested by these data. For instance, it would be of potential interest to more clearly delineate the temporal boundaries of the second taste. Although Group C received 20 days preexposure to the second taste, it is possible that extensive preexposure of the second taste is not necesary. Further, it would be interesting to examine the effects of experience with the second taste in temporal relation to the conditioning trials. Does exposure to the second taste 20 days prior to conditioning enhance aversion learning when compared to experience 2 hours prior to conditioning, or three days subsequent to conditioning? In other words, what is the operational definition of "previous experience or preexposure" to the the second taste? Further research is needed to shed additional light on these issues.

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