CONDITIONED TASTE AND VISUAL AVERSIONS IN CHICKS: EFFECTS OF SOCIAL TRANSMISSION OF ACQUIRED BEHAVIOR

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(ABSTRACT)

Studies involving social learning have shown that social interactions are influential in directing an individual's behavior toward relatively neutral stimuli. The present study investigated the possibility that social interactions direct an individual's behavior toward aversive stimuli. Following aversion conditioning to a visual (red water) or taste (3% vinegar) CS, 80 chicks individually observed an audience of two conspecifics ingest the aversive CS or observed a nondrinking audience in the presence of the CS. Observation of a drinking audience reduced the magnitude of the aversion to the visual CS but not to the taste CS. This effect was demonstrated in latency to respond and in log intake. The differences in observational training effects found for the visual CS but not for the taste CS may have been due to differences in visual appearance between red water and vinegar. Percent intake data revealed no differences in strength of conditioning between red water and vinegar. Subjects were retested five days following the last day of initial testing. No evidence was found for observational training effects in retention. Findings were interpreted by the classical conditioning model.

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INTRODUCTION

For some species, interactions with conspecifics influence many aspects of an individual's behavior. These interactions may determine an individual's habitat (e.g., Geist, 1971), routes of migration (Geist, 1971) and foods selected or avoided (Galef, 1976; Mason & Reidinger, 1981, 1982). The impact of social influences are so strong in some species that isolated intraspecific groups become behaviorally distinct and in some instances appear to have different cultures (Bonner, 1980). In the following sections three models of social influences on behavior are described. The impact of social influences on particular behaviors in food selection (e.g., food preference and food avoidance) is then presented.

Models of Social Influences on Behavior

Social Facilitation. The social facilitation model (Zajonc, 1980) specifies that the mere presence of a conspecific increases responding by an individual. For example, Levine and Zentall (1974) trained rats to barpress for water reinforcement. Rats were then deprived of water and tested in the presence of a naive conspecific or alone. Responding was greater for rats tested in the presence of a conspecific than for those tested alone. Similar findings have been reported for nondeprived animals (Strobel, 1972). According to Zajonc (1980) the mere presence of a conspecific results in an increase in arousal (drive) that energizes (facilitates) an individual's dominant response. If the dominant response is appropriate to the situation, performance will be facilitated. Conversely, if the dominant response is incorrect or inappropriate to the situation, performance will be impaired. Other researchers (e.g., Baron, Moore, & Sanders, 1978) proposed that the audience provides a distractive influence which increases an organism's level of arousal. That is, increased arousal results from a conflict between the organism's tendency to perform the previously entrained response and the organism's tendency to respond to the activities of conspecifics. Zajonc, however, argues that the ongoing activities of conspecifics play no role in facilitation of an organism's behavior. He states that behaviors of conspecifics, whether similar or dissimilar to those of the individual, affect that individual's behavior no differently than those conspecifics who are merely present.

Although Zajonc's theory appears to be a parsimonious explanation of social facilitation (Geen & Gagne, 1977), Rajecki, Kidd, and Ivins (1976) report that the drive view of social facili-

tation does not account for the possible directive influences of social stimuli. They observed that the familiarity (to the individual) of an audience of conspecifics elicited qualitative and quantitative differences in distress vocalizations, pecking and immobility responses of individual chicks.

Social Imitation. In social imitation, social stimuli occasioned by the behaviors of conspecifics influence an individual's responding. According to Armstrong (1965), the behavior of a conspecific may act as a releaser for similar behavior in an individual. Social imitation has been used synonymously with behavioral contagion (Armstrong, 1965) and mindless copying (Gould, 1982). Gould assumes a rather strong position for the notion of mindless copying in that he reports that in most cases of imitation the individual copies the response of the conspecific without regard to possible consequences of that behavior. For example, a chick will peck without food reinforcement in the presence of a conspecific that is exhibiting a similar response (Strobel & MacDonald, 1974). Herons that have been deprived of food will adopt the characteristic posture of sated herons in the presence of these conspecifics (Lorenz, 1961). These examples suggest that imitative behavior appears to occur in the absence of apparent reinforcement for responding.

In many instances, social interactions may result in both drive (e.g., social facilitation) and stimulus (e.g., social imitation) effects. Mason and Reidinger (1981, Exp. 1) reported an example of social facilitation effects mediated by social stimulus (imitative) factors. In their study, nondeprived pairs of red-winged blackbirds (*Agelaius phoneniceus*) which were tested with deprived pairs of conspecifics consumed and spilled more food during the first two hours of a six-hour test period than did nondeprived pairs which were tested with nondeprived pairs of conspecifics. When both pairs of blackbirds were deprived of food, consumption and spillage of food was significantly greater than that of nondeprived controls. According to Mason and Reidinger the deprived blackbirds provided stimuli which elicited ingestive behavior from nondeprived birds. However, since overall consumption and spillage for the deprived pair which was tested with a nondeprived pair was less than that when the former were tested together, perhaps the nondeprived blackbirds stopped ingestive behavior sooner and elicited similar behavior in the deprived birds. Franchina, Dyer, Zaccaro and Schulman (1986) reported that social facilitation effects and social stimulus effects are separable. In their study, social stimuli from conspecifics' drinking resulted in an individual's

greater intake of colored water than did the energzing effect of the presence of nondrinking conspecifics.

Social facilitation and social imitation effects are both dependent on the presence of conspecifics. In each case the behavioral changes exhibited were already in the individual's repertoire (Clayton, 1978). If the conspecific is removed, social facilitation and social imitation effects are attenuated (Klopfer, 1961). The effects of social influences on an individual's behavior in this case, may be transitory.

Social Transmission of Acquired Behavior. Another possible result of social interactions is that an individual's behavior may be modified through learning. In this learning situation, social interactions appear to influence not only the development of new behavior patterns (Kawai, 1965) but also the development of responses toward new stimuli (e.g., Mason & Reindinger, 1981). For example, Kawai (1965) reported that a troop of Japanese macaques apparently learned by to wash their food in the ocean following observation of that behavior in juvenile female macaque. Mason and Reidinger (1981) reported that social interactions may influence an individual organism's acceptance of new food sources.

Galef (1976) proposes three conditions that are necessary in order to distinguish socially transmitted behavior from other socially-mediated behavioral changes. First, social transmission does not include cases in which social interactions are necessary for the development of relatively invariant species-typical behavior patterns. Second, social transmission must result more in behavioral homogeneity than in heterogeneity. That is, if social transmission occurs, the responses of the individual should be more similar to those of the more experienced conspecific. Finally, the increased homogeneity of behavior should be relatively permanent and should be maintained by the individual even in the absence of the more experienced conspecific.

The three conditions for social transmission of acquired behavior appear similar to those for the occurrence of observational learning. Galef (1986) however, stated that terms such as observational learning are vague because of multiple meanings from their inconsistent use in the literature. Further, he stated that the labelling of socially-influenced behavior changes as facilitation, imitation, observational learning etc., implies separable and distinct processes and this distinction

has yet to be in terms of clear behavioral referents. Galef (1976) proposed that a multiplicity of processes may underlie social transmission of information. Finally, the transmission of information does not imply active participation (teaching) on the part of the conspecific, but that the individual extracts the information from the conspecific (Galef, 1986, personal communication).

Transmission of information may occur in a variety of ways. Social transmission of information may occur through the transfer of sensory information, for example, when the conspecific alters the environment in a way which modifies an individual's behavior (e.g., scent marking in wolves, Mech, 1970). Social transmission of information may result from an individual's observation of contingencies between a conspecific's behavior and the subsequent consequences. Palameta and Lefebvre (1985) reported that individual pigeons acquired a specific food-getting response only if the individual observed the contingency between the conspecific's response and subsequent reward. Individuals who observed a conspecific respond without reward did not emit the food-getting response. Social transmission of information may also influence an organsism's adaptation to changing environmental conditions. For example, Fisher and Hinde (1949) reported that most British tits, especially the Great tit (*Parus major*), the Blue Tit (*P. caeruleus*) and the Coal Tit (*P. ater*) acquired the behaviors of opening milk bottles and drinking the cream. These behaviors spread from a single location (thought to be near Stoneham, Southhampton) throughout England, Scotland and Ireland. Eventually the behaviors which were initially observed in *P. major* spread to other species, probably through social transmission processes.

Social interactions which result in the transfer of information has been demonstrated in parent-offspring interactions (Galef & Clark, 1971), bird song dialects (Nottebohm, 1972), antipredation behavior (Vieth, Curio, & Ernst, 1980) and foraging behavior (e.g., Kawai, 1965). In foraging behavior, particularly in food selection, social transmission of information appears to be an important and prevalent factor.

Foraging and Food Selection

In order to acquire energy, animals must forage for food. From a functional viewpoint, the more efficiently an animal forages, the greater the likelihood that it will survive and reproduce, that is, an increase in biological fitness (Pulliman, 1981 pp 382-383). Optimal foraging theory (OFT) maintains that organisms tend to maximize net energy per unit time (Krebs, 1979) and that this foraging behavior is a result of natural selection (MacArthur & Pianka, 1966). This maximization process results in the animal's making a series of decisions regarding when and where to forage, which search paths to take within and between foraging areas and which food types to select (Krebs, Houston, & Charnov, 1981). One possible proximal influence in the decision-making aspect of foraging may be learning, which for some organisms may be the proximal manner in which the functional goal of maximizing net gain per unit time is achieved.

For omnivores or food generalists, who select a broad range of food sources, behavioral systems that are used in foraging should exhibit plasticity in order to exploit potential food sources while avoiding toxins present in some foods. Conversely, specialists, who select one type of food or a single family of foods, probably need not exhibit behavioral plasticity since food selection may be under tighter genetic control (Rozin, 1976). Although omnivores may select food on the basis of certain physiological needs regardless of other factors such as learning (e.g., sodium hunger in rats, Nachman, 1962), a substantial portion of an omnivore's foraging behavior may reflect the influence of experiential factors (Rozin, 1976).

Social interactions may dictate omnivores' learning which foods to select and which to avoid. Examples of such social effects in food selection include potato washing in Japanese Macaques (Kawai, 1965), food handling in lions (Schaller, 1972), food selection in a variety of avian species (Hogan, 1966; Mason & Reidinger, 1981) and food selection in wild and domestic rats (Galef, 1979; 1983). If social interactions influence food selection, it may be possible that these social influences may dictate the development of food preferences.

Food Preference.

Preference behavior involves the organism's choosing between two or more stimuli (Hogan, 1979). In the case of food preferences, an organism may choose one food over another on the basis

of the food's hedonic value (Rozin, 1977), nutritive value (Rozin, 1977) or familiarity (Galef, 1983). Preference for particular foods may also develop through social interactions. For young organisms, initial occurrences of socially influenced food preference may result from parent-offspring interactions. Capretta, Petersik and Stewart (1975) showed that rat dams may influence an offspring's later selection of food by transmitting sensory information about the food through taste cues in milk during lactation. Tinbergen and Perdeck (1950) showed that parents may select food and bring it to the offspring thereby eliminating direct selection by the offspring. Galef (1976) and Hogan (1966) reported that a parent may focus the attention of the offspring to relevant food related stimuli in the environment by leaving olfactory cues at the the food site or eating in vicinity of offspring.

If young organisms cannot discriminate between food and nonfood items (Hogan, 1984) parent-offspring interactions may facilitate the development of these discriminatory abilities. According to Hogan (1966) young chicks typically select the food that is selected by the hen. Generally the hen directs the chick's attention to relevant food stimuli by emitting the hen's characteristic food call and intermittently pecking at and throwing the food item toward the chick. For example, chicks of Burmese jungle fowl (*Gallus gallus spadiceus*) which typically do not ingest mealworms would do so if their hen emitted the food call in the presence of mealworms. Food calls appear to be an important aspect of socially-transmitted food preferences. Marler, Dufty and Pickert (1986) found that food calls of male domestic chickens differed with the preference of a particular food. In addition, they found that hens were more likely to approach a male calling in the presence of a high-preference food than approach a male calling in the presence of a low-preference food.

In chickens, both vocalizations and visual appearance of conspecifics appear to be important for socially-transmitted food preferences. In a study by Kovach (1971) with domestic chickens, hens were conditioned to ingest a particular color of food. When chicks were tested with different colored food items in the presence of their hen, they would select only the color which was similar to that chosen by their dam. These studies demonstrate the influence of a conspecific on selection of food. However, it is uncertain whether this effect on food choice was transient and, therefore,

not a learned food preference because preference behavior was not assessed in the absence of responding conspecifics.

In a series of studies, Galef and Clark (1971) and Galef and Heiber (1976) reported some of the factors involved in socially-transmitted food preferences of young wild rats. Galef and Clark (1971) found that rat pups tend to select the diet selected by the adults of their colony. Apparently, infant rats receive gustatory cues through the female's milk during lactation and these taste cues are reflective of the dam's diet. When rats at weaning were presented with a choice between the dam's diet and a different diet, young rats selected the diet that was selected previously by the dam. Second, young rats at weaning tend to feed in close proximity of adult rats (Galef & Clark, 1971). Here, adult rats who are feeding may provide visual cues which influence young rats'approach and ingestion of a diet. Last, olfactory cues on the bodies of adult rats and cues left by adult rats at feeding sites may also facilitate diet selection of young rats (Galef & Heiber, 1976). According to Galef (1976) an increase in familiarity is responsible for the development of socially-influenced food preferences in young rats. That is, the social transmission of gustatory, olfactory and visual cues increase the young rat's familiarity with the adult diet.

Social influences contribute to food preferences of young and adult organisms. Mason and Reidinger (1981, Exp. 2) found that adult red-winged blackbirds developed a preference for a novel food following the observation of a conspecific ingesting that food. Red-winged blackbirds observed other conspecifics consuming and spilling either novel orange or novel green pastry. In later preference tests, the observer birds consumed and spilled significantly more of the pastry consumed by their conspecific counterparts than they did of the other pastry. Mason and Reidinger concluded that observation of conspecifics ingesting new food sources may lead individual organisms to exploit these sources.

Mason and Reidinger (1981) demonstrated the impact of social influences on preference behavior. They reported that the mode of transmission of information for some avian species appears to be based on visual cues. Galef and Wigmore (1983) reported that the mode for rats is based on olfactory cues. In Galef's (1983) basic experiments rats were deprived of food and then offered a cinnamon- or cocoa-flavored diet for 30 minutes. These rats (demonstrators) were then allowed to

interact with a naive conspecific for 15 minutes. When the naive rats were presented with a subsequent choice between the two diets, they exhibited a preference for the respective diet of the demonstrator.

Galef and Kennett (1985) proposed that for transmission of information to occur, olfactory cues must occur in a particular social context. For social influences to be maximally effective, the cues must be on the anterior portion of a live demonstator rat. The demonstrator, however, does not have to be active. Food cues placed on an anesthetized rat (Galef, Kennett, & Stein 1985) or on the anterior of a dead rat (Galef & Stein, 1985) was adequate to establish preference behavior in another rat. However, Galef and Kennett showed that a conspecific had to be present for the establishment of preference. The use of (rat-sized cotton swabs) did not promote subsequent preference behavior. Conversely, cues provided by inactive rats were not as effective in establishing preference as those provided by active rats. In any case, olfactory cues as a result of social interactions may have increased the familiarity of the novel food and, thus, these results seem be congruent with those of studies with infant and weanling rats.

If familiarity is a major determinant of an organism's selection of a particular food source, simple exposure (without social interactions) should be adequate to increase familiarity and thereby, the probability of a food's being selected. Galef, Kennet, and Stein (1985, Exp. 2) preexposed rats to cinnamon- and cocoa-flavored diets or to unadulterated laboratory rat chow for 24 hours. In testing for preference between cinnamon and cocoa flavored food, there was no evidence that exposure per se to a novel food source was sufficient to establish preference. Social interactions may be influential for food selection in that they facilitate the familiarity of new foods by providing exposure to a new food in a familiar social context, namely the presence of a conspecific. Organisms, however, tend to avoid new and unfamiliar food sources or objects in their environment (Rozin, 1977). In some cases, social interactions may overcome an organism's tendency to avoid novel food sources.

Poison Avoidance

Omnivores who select their diets from a variety of sources are at risk for contacting toxic substances. Domjan (1980, p. 276) specified two ways in which organisms may avoid being poisoned. Avoidance of toxins may occur because of a substance's relative novelty or unfamiliarity (neophobia). Avoidance may also occur because of aversion learning. In the latter case, ingested substances that accompany internal malaise acquire aversive properties and are subsequently avoided (conditioned aversions).

Neophobia. Neophobia refers to the natural hesitancy of omnivores at ingesting substantial amounts of a novel food. Neophobia may limit the initial intake of a new substance until the animal identifies the substance as "safe" (Kalat & Rozin, 1973) or uncorrelated (Rozin, 1977) with negative internal consequences such as, illness. Neophobia is presumably mediated by the aversive properties of novelty (Domjan, 1980). For example, Braveman (1978) reported that exposure to novel tastes reduced a rat's neophobic response to a different novel taste.

Domjan (1980) contended that neophobic reactions may depend upon the distinctiveness of the particular stimulus, that is, the magnitude of the difference between that stimulus and a familiar stimulus within the same stimulus dimension. Novel stimuli may differ in the amount of distinctiveness from the familiar and thus, in the magnitude of neophobia or aversiveness which they evoke. For example, one method of manipulating the relative aversiveness of a stimulus is to use different concentrations of the same substance. Domjan and Gillan (1976) used increasing concentrations of saccharin and found corresponding increases in neophobic responses of rats. Similar results were found by Gillette, Thomas and Bellingham (1983) using chickens.

Ingestional Aversion Learning in Mammals. Ingestional aversion learning is the avoidance of a substance after its ingestion was accompanied by internal malaise (Domjan, 1980). This type of learning is viewed as a basic process (Cheney & Eldred, 1980) and it is exhibited in over 30 species (Gustavson, 1977). Most researchers place ingestional aversion learning within the classical conditioning paradigm. The stimulus that is ingested is viewed as the conditioned stimulus (CS), the toxin is the unconditioned stimulus (UCS) and subsequent postingestional distress is the unconditioned response (UCR). The association between the CS and UCS is formed rapidly. It is retained

over long periods, is highly resistant to extinction and occurs even when the presentation of the UCS is delayed several hours after ingestion (Logue, 1979). Seligman (1970) maintains that organisms are "prepared" to form these types of associations since minimal training is involved. Ingestional aversion learning seems to transcend species differences. Thus it may be a general mode of responding which maximizes the organism's chances of survival (Rozin & Kalat, 1973).

Several variables influence ingestional aversion learning. Aversion effects occur more readily to novel than to familiar stimuli (Ahlers & Best, 1971). Aversion effects depend upon the specificity of the CS to the UCS. Garcia and Koelling (1966) showed that aversion effects occurred with interoceptive (e.g. taste) cues more readilily than with exteroceptive (e.g. audiovisual) cues. Aversion effects depend on the intensity of the CS and UCS. Kalat and Rozin (1970) showed that not all stimuli are equally associable in conditioning in that more "salient" stimuli produce stronger aversions. Dragoin (1971) reported that stronger aversions are produced with a more intense UCS.

Social Influences in Aversion Learning in Mammals

Learning to avoid foods occur for an individual as a result of the food's being paired with illness or from observation of this contingency in a conspecific. Lavin, Freise and Coombes (1980) investigated the social transfer of flavor aversions in rats. Rats were placed together in pairs and were allowed to consume a novel substance. After two hours, one rat in each pair was injected with LiCl and was immediately returned to its nonpoisoned partner. They observed that nonpoisoned rats developed an aversion to the novel flavor if its partner became ill. They also found that the transfer of flavor aversions occurred when the nonpoisoned rat consumed the substance alone and then was later presented with the LiCl-injected rat. Coombes, Revusky and Lett (1980) reported that the transfer of flavor aversions occurred even when six hours intervened between ingestion of the novel substance by the nonpoisoned rat and presentation of the sick rat. They concluded that after an individual's ingestion or exposure to a novel substance, the presence of a sick rat was an effective UCS for aversion learning.

Ingestional Aversion Learning in Aves

Ecological differences may predict differences in learning (Kamil & Yoerg, 1982, p. 348). The dominant sensory modalities which a species uses in selecting food should be the more conditionable sensory modalities in ingestional aversion learning. For example, rats select food on the bases of gustation and olfaction, and gustatory and olfactory cues are the dominant stimuli for ingestional aversion learning (Kamil & Yoerg, 1982). For avian species who select food on the basis of vision, vision should be the dominant sensory modality in ingestional aversion learning with aversions readily established to visual cues. See Martin and Bellingham (1979).

Martin and Lett (1985) investigated visual and taste aversions in five avian species and all species exhibited aversions to visual and taste stimuli. However, ducks and geese who rely more on taste than on color in food selection showed greater aversions to taste than to visual stimuli. Conversely, chickens and quail who rely more on visual cues in the selection of food showed greater aversions to visual stimuli than to taste stimuli.

Gillette, Martin, and Bellingham (1980), Logue (1980) and Martin and Bellingham (1979) have shown that visual aversions can be established in some avian species and that they obey principles similiar to those for gustatory aversions in rats (Czaplicki, Borrebach, & Wilcoxin, 1976; Martin & Bellingham, 1978). The use of gustatory or taste stimuli has resulted in significant aversion effects when the mode of ingestion is drinking. Gillette, Martin and Bellingham (1980) found robust flavor aversions which, persisted over several test days in chicks. Westbrooke, Clarke and Provost (1980) reported flavor aversions which were established over long delays in pigeons.

Social Influences in Aversion Learning in Aves

Ingestional aversion learning and learning through social interactions in avian species appear to be similar to those forms of learning in mammals. Klopfer (1957) trained individual Muscovy (*Cairina moschata*) and Mallard (*Anas platyrhyncos*) ducks to avoid a particular food dish which was paired with electric shock. Ducks who observed the individuals in this contingency situation subsequently avoided the food dish. Mason and Reidinger (1982) reported the establishment of food avoidance in red-winged blackbirds as a result of social observation. Individual blackbirds observed a conspecific consume food in the presence of a novel color cue (CS) and then become

ill. Nonpoisoned individuals tested with a choice between the CS and another color avoided the color CS.

Present Experiment

Most studies on the effects of social interactions have demonstrated that these interactions are influential in directing an individual's responding toward relatively neutral stimuli. In some cases, social interactions may facilitate approach behavior toward these stimuli. If so, it is conceivable that social interactions which facilitate approach responding may attenuate avoidance behavior to previously conditioned aversive stimuli.

Recently, Galef (1985) showed that social interactions with conspecifics reduced an individual's rat's avoidance of an aversively conditioned stimulus. He reported an attenuation of a conditioned aversion in rats when they encountered the aversive cue on the body of a conspecific. If direct social contact can attenuate an individual's avoidance of an aversive stimulus, perhaps a reduction in conditioned aversion effects will occur after an individual observes conspecifics contacting the CS, for example, in an observational training situation (e.g., Mason & Reidinger, 1982). The present experiment investigated this possibility. Specifically, chickens received aversion conditioning to a visual or a taste CS, and then observed conspecifics consuming the CS or they observed conspecifics simply in the presence of the CS. Subsequently, the observers were tested for aversion effects to the conditioned stimulus.

The experimental hypotheses for the present Experiment were:

1. Following conditioning procedures, individuals who observed conspecifics consuming the taste or visual CS should exhibit a greater attenuation of the aversion than should subjects who observed conspecifics simply in the presence of the CS.

2. Relative to controls, groups that received conditioning procedures should exhibit greater aversion effects to the taste CS than that to the color CS.

3. Relative to controls, the attenuation of the aversion between the two observational training conditions should be greater to the less conditionable stimulus than to the more conditionable stimulus.

METHOD

Subjects.

The subjects were 224 White Leghorn chicks (*Gallus domesticus*) hatched from eggs obtained from the Poultry Research Center at Virginia Polytechnic Institute and State University. Upon arrival at the laboratory, the eggs were placed in a room at 22 C for five hours to allow them to come to room temperature prior to incubation in a Humidare Incubator (Model No. 50) at 37.6°+ 1°C and 70 + 5% relative humidity as measured by a Abbeon Hygrometer (Model No. AB167). On the 18th day of incubation, the eggs were transferred to a Leahy Hatcher (Model No. 416) where they remained until chicks hatched. The temperature of the hatcher was 37.2°C and the relative humidity was 75% + 5.

Due to the importance of social interactions during the observation and test phases (to be described later), chicks were socially reared for the first 21 days after hatching. Approximately 12 hours after hatching (Day 1), chicks were transferred to a heated room and placed in groups of four into Hoeltge wire mesh double cages (41.8 X 25.0 X 17.9 cm). The cage floors were lined with crinoline to prevent leg and foot injury. Chicks remained in this room for the first seven days posthatch. Room temperature was 32.2°C for the first two days, 29.4°C for the second two days 26.6°C for the last two days. On the seventh day after hatching, room temperature was 23.3° + 1° C which approximated the temperature of the other rooms used in the laboratory. On the eighth day, chicks were transferred to a different laboratory room and were housed in groups of three for the remaining 12 days prior to experimental procedures. Procedures started 21 days after hatching (Day 1). To attenuate possible social influences during aversion conditioning, on Day 1 chicks were placed individually into Hoeltge cages (25.0 X 17.9 X 17.9 cm) and remained there for the duration of the experiment. Illumination was 240 lx with the daily photoperiod commencing at 0600 hr and terminating at 2000 hr. Food and water were available ***ad libitum*** except during experimental procedures. Of the 224 chicks, 80 served as individual subjects; 144 served as audience conspecifics.

Materials and Apparatus.

The test apparatus consisted of two (51.3 X 30.8 X 25.7 cm) cages with the sides and back surfaces constructed of white plexiglas and wire mesh floor and front. Cages were attached with the front surfaces spaced 5.1 cm apart to permit placement of Ritcher-type drinking tubes. In each cage an aperture was made in the center of the wire mesh partition to accommodate the spouts of Richter-type drinking tubes.

Procedures.

On Day 1 chicks were randomly assigned to a 2 X 2 X 2 design (n = 8). There were two CS conditions (red colored water or vinegar solution), two conditioning procedures (CS paired with LiCl injection or CS paired with saline injection), two observational training conditions (observation of a drinking or nondrinking audience) and three test trials. For the drinking audience condition (DA) individual subjects observed two conspecifics consume red colored water (Red) or a vinegar solution (Vin) that had been used as the CS during aversion conditioning for the individual. For the nondrinking audience condition (NA) individual subjects observed two nondrinking conspecifics in the presence of the CS. To control for the possibility that the conspecifics' drinking behavior might attenuate aversion effects in the individual without regard to CS characteristics two additional observational training groups were used. Individual subjects who had received a Red CS paired with LiCl injection (n = 8) or paired with saline injection (n = 8) observed two conspecifics consume water out of a clear tube (DAW).

The experiment consisted of the following sequence: deprivation and habituation, conditioning, recovery, deprivation and habituation, observational training, testing, deprivation and retention tesing. Deprivation and habituation procedures occurred on Days 2-3 and on 8-9, respectively. To start the deprivation phase water was removed from the home cages of the individual subjects at 1600 hr on Day 1. During the deprivation phase, individual subjects received daily access to distilled water in Richter type drinking tubes for 10 minutes at 0900 hr and for 30 minutes at 1530 hr daily. After the morning access period on Day 3, fluid intakes and body weights were obtained for each individual subject chick. At 1600 hr on Day 7 water was removed from the home cages of individual subjects and deprivation resumed under the same procedures as those

previously presented. After the morning access period on Day 9, fluid intakes were obtained for each subject. For habituation, individual subjects received 10 minutes access to the test apparatus beginning at 0900 hr. For the habituation period, an individual subject was placed into one side of the apparatus with a drinking tube filled with distilled water. To facilitate the subject's acclimation to the test apparatus, two other chicks were placed in the opposite compartment without a drinking tube. The same two conspecifics were used as the audience in all habituation periods. These chicks were not used at any other time during the experiment. There was one habituation period for each individual subject chick per day.

Injection Procedures. Days 4-5 were injection days. At approximately 0830 hr on each day food was removed from home cages of each individual subject. The subject was allowed 10 minutes access to the CS on Day 4 and to distilled water on Day 5. Each access period was followed, within five minutes, by an intraperitoneal (i.p.) injection at 2% of the chick's body weight. Chicks in the conditioning groups (CS-LiCl) received injections of .4 M LiCl on Day 4 and a .9% saline on Day 5. Chicks in the ingestion-toxin control groups (ITC) received the saline injection on Day 4 and the LiCl injection on Day 5. On each injection day, food was returned to the chick's cage at 1530 hr and each subject was allowed 30 minutes access to distilled water at that time. The Recovery period extended from 0900 hr on Day 6 to 1600 hr on Day 7. During recovery, individual subjects were provided with food and distilled water ***ad libitum*** in their home cages.

Observational Training. Observational training occurred on Days 10-12. At 0900 hr a subject was placed into one compartment of the test apparatus simultaneously with placement of a drinking or nondrinking audience into the other compartment. The apparatus permitted visual and auditory contact between the subject and the audience but not physical contact. Duration of the observation period was 10 minutes. After 10 minutes, all chicks were returned to their home cages and two hours later each received 10 minutes access to distilled water. At 1530 hr on each observational training day, subject chicks received 30 minutes access to distilled water.

Aversion Testing. Aversion testing occurred on Days 13-15, one trial per day. On each test day starting at 0800 hr, an individual subject was placed into one compartment of the apparatus; two nondrinking conspecifics unfamiliar to the subject were placed into the other compartment. A

timer was started when the subject was placed into the apparatus. The individual subject's compartment contained a drinking tube CS of red colored water or vinegar solution. Each trial lasted 10 minutes after which, chicks were returned to their home cages. At 1530 hr on each test day, subjects received 30 minutes access to distilled water in their home cage.

Retention Testing.

To investigate the retention of observational training effects, DA-LiCl, NA-LiCl and DA-ITC groups in both CS conditions were retested on Days 22-23. After the completion of testing on Day 15, these groups received food and water ***ad libitum*** until 1400 hr on Day 16. Deprivation procedures were reinstated at this time according to procedures previously described. Chicks remained on deprivation for five days and retention testing began on Day 22. Procedures for retention testing were the same as those for aversion testing on Days 13-15.

Audience Procedures. Conspecifics that served as drinking and nondrinking audiences were individually housed beginning on Day 1. For those that served as drinking audiences, deprivation procedures occurred on Days 2-5 and on Days 8-9. These chicks received 10 minutes access to their assigned solution (red colored water or vinegar solution) at 0900 hr and 30 minutes access to distilled water at 1530 hr. Nondrinking audiences were not deprived. Audience conspecifics received habituation procedures on Days 2-3 and on Days 8-9. Habituation provided 10 minutes access to the apparatus beginning at 0900 hr. During habituation, drinking tubes filled with red colored water or vinegar solution were available for drinking audiences; no tubes were available for nondrinking audiences.

On Days 4-5 drinking audiences remained on the deprivation schedule and on Days 6-7 they received continuous access to their assigned solutions. Deprivation and habituation procedures for all audience chicks were reinstated on Days 8-9. The procedures were the same as those previously described.

For the observation phase, drinking audiences were presented with a Richter-type drinking tube of red colored water or vinegar solution. The particular solution presented was the same as that presented on deprivation days. A drinking tube which contained red colored water or vinegar

was present in the test apparatus for the nondrinking audience but the spouts of these tubes were sealed with parafilm to prevent the audience chicks from drinking. To prevent approach and pecking behavior from the nondrinking audience, these chicks were unfamiliar with fluid access from drinking tubes. Only the nondrinking audiences were used during aversion testing and retention testing.

The CS color solution was 1% (v/v) McCormik's Red Food Coloring mixed with distilled water. The CS flavor solution was 3% (v/v) vinegar (Heinz Distilled White Vinegar) mixed with distilled water.

The measures of performance were latency to start drinking and amount consumed. Latency to start drinking was calculated as the time which elapsed from the placement of the subject chick into the apparatus to the subject's first drinking response. Amount consumed was calculated as the difference between pre- and posttest tube weights. The study was run in four replications.

Statistical Analyses

The data were analyzed with analysis of variance (ANOVA) for repeated measures (Winer, 1962). The Between factors were CS condition (red-colored water or vinegar solution), Conditioning Procedure (CS-LiCl or CS-ITC) and Observational Training Condition (drinking audience or nondrinking audience). Trials was the Within factor. Interactions were analyzed using simple effects ANOVAs and Tukey tests. Alpha level was 0.05.

To minimize baseline differences in intake between red water and vinegar, data were transformed into percent intake as appropriate. Percent intake was calculated by dividing the score of each subject in conditioning groups by the mean score of its ingestion-toxin control group.

RESULTS

Body Weights

Table 1 presents mean body weight (g.) on Day 3 for groups that subsequently received conditioning procedures with a red water or vinegar CS and observational training with a drinking or nondrinking audience. For groups subsequently conditioned with the Red CS mean body weights were similar across groups. For groups subsequently conditioned with the Vin CS mean body weights were lower for the NA-LiCl and DA-ITC groups than for the NA-ITC and DA-LiCl groups. Body weights for the latter two groups were similar to each other.

Analysis of variance over the body weight data excluding DAW groups revealed a significant effect of CS X Injection Condition X Observational Training Condition interaction (Table 2). Simple effects ANOVAS (Tables 3, 4, 5 and 6) revealed that for groups assigned to Red CS conditions which included DAW groups showed that DAW groups did not differ from DA and NA groups. Thus, there were no reliable differences in mean body weight for subjects which later received a Red CS in conditioning. Simple effects ANOVA for the Vin CS condition showed a significant Injection Condition X Observational Training Condition interaction. Differences in mean body weight for groups which later received a Vin CS should not affect subsequent findings since lighter groups, NA-LiCl and DA-ITC, were represented in both injection conditions and in both observational training conditions (i.e., conditions were crossed).

Preinjection Intake

Preinjection intakes of distilled water were measured to evaluate whether intake performance was similar across groups prior to aversion training. Figure 1 shows mean intake of distilled water for all groups. Groups which subsequently received the Red CS in training showed generally similar

Table 1.

Mean Body Weights (g.) for Groups which were to Receive Conditioning (Li) or Ingestion-Toxin Control (ITC) Procedures with Red or Vin CSs and then Observational Training (OT) under Drinking (DA or DAW) or Nondrinking (NA) Conditions

	CS = Red		CS = Vin	
OTC	LI	ITC	LI	ITC
DA	173	181	183	167
NA	182	174	161	189
DAW	188	178		

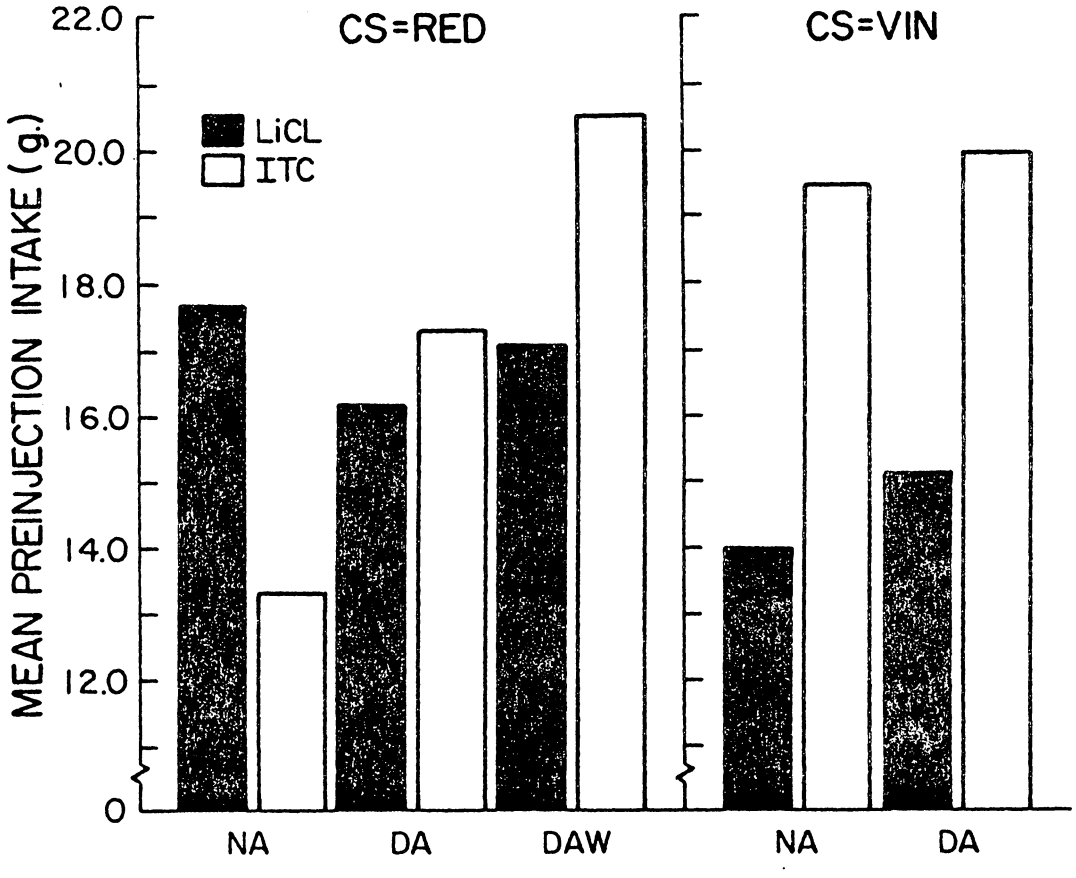

Figure 1. Mean preinjection intake (g.) for groups that were to receive conditioning (Li) or ingestion-toxin control (ITC) procedures and to receive observational training (OT) procedures.

intakes of distilled water across conditions. Groups which subsequently received the Vin CS in training drank less distilled water in the LiCl condition than in the ITC condition. ANOVA (Table 7) of the data in Figure 1, excluding DAW groups revealed a significant CS X Injection Condition interaction. Subsequent simple effects ANOVAS (Tables 8 and 9) for each CS condition revealed no differences in intake for groups in the Red CS condition. For the Vin CS condition results showed differences for Injection Conditions. ANOVA (Table 10) of intakes for the Red CS condition also showed that groups which were to receive DAW training did not differ from DA and NA groups.

Injection Day Intakes

Figure 2 shows mean intake of red water and of vinegar on Injection Day 1 for groups conditioned with Red or Vin CSs and for groups which received ingestion-toxin control procedures. OTC (DA, NA and DAW) conditions represent dummy variables in these analyses for injection day intakes and for pretest intake because OTC procedures occurred after these measures were taken. Intake of vinegar was generally lower than that of red water. For both CS groups intake was generally lower for ITC conditions than for LiCl conditions.

ANOVA (Table 11) for CS groups in DA or NA Observational Training Conditions revealed reliable effects for CS and Injection Condition. ANOVA (Table 12) for groups in the Red CS condition, including groups to receive DAW training showed that DAW groups did not differ from DA or NA groups. The finding of a reliable difference in intake for Injection Conditions was not problematic since ingestion-toxin control groups exhibited the lower intakes. Lower intakes by injection toxin control groups would minimize the likelihood of attaining significance in aversion effects.

Figure 3 presents mean intake of distilled water on Injection Day 2 for groups which had received a pairing of the Red or Vin CS with an injection of LiCl or saline. Intake of distilled water for Red-LiCl groups was greater than for Red-ITC groups in DA and NA conditions. The reverse was true for LiCl and ITC groups in the DAW condition. For Vin CS groups distilled water intake

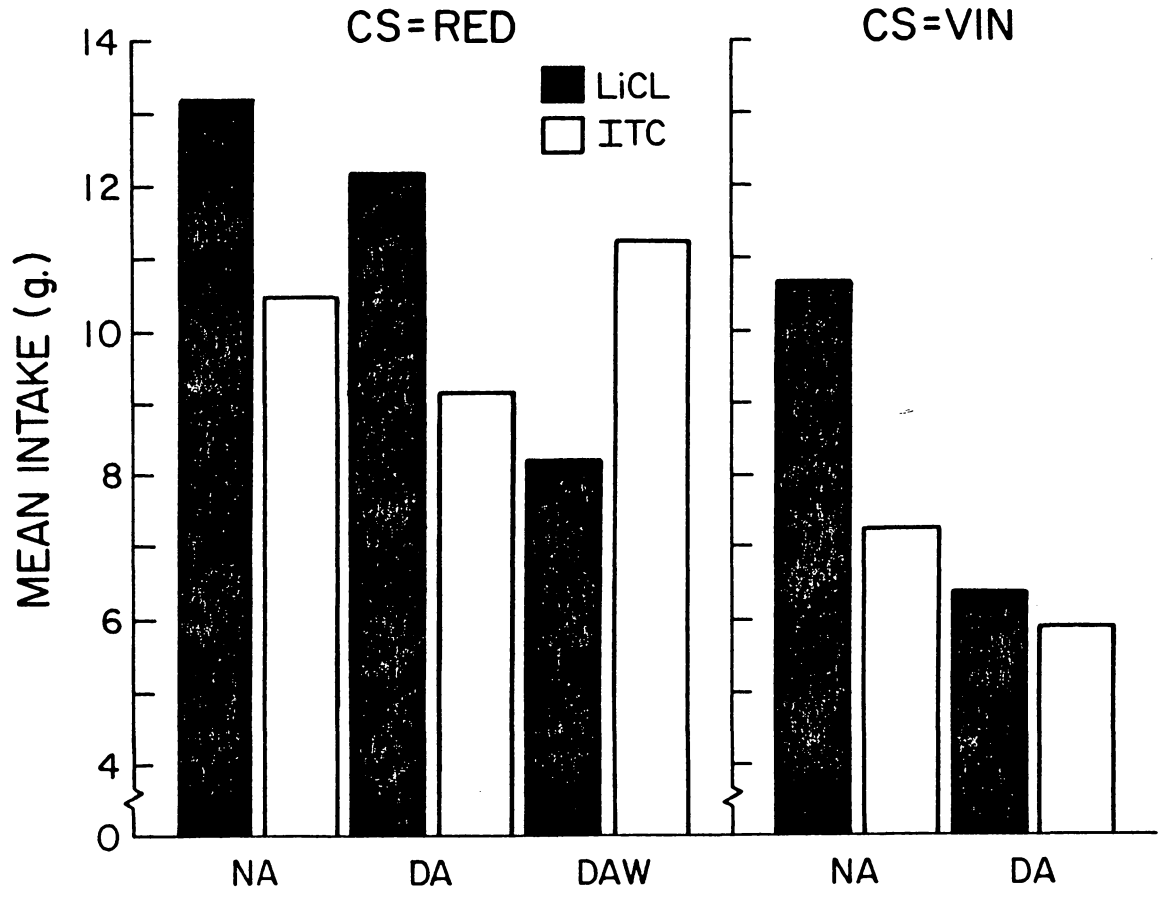

Figure 2. Mean intake (g.) of red water or vinegar CSs on Injection Day 1 for groups to receive Li or ITC procedures.

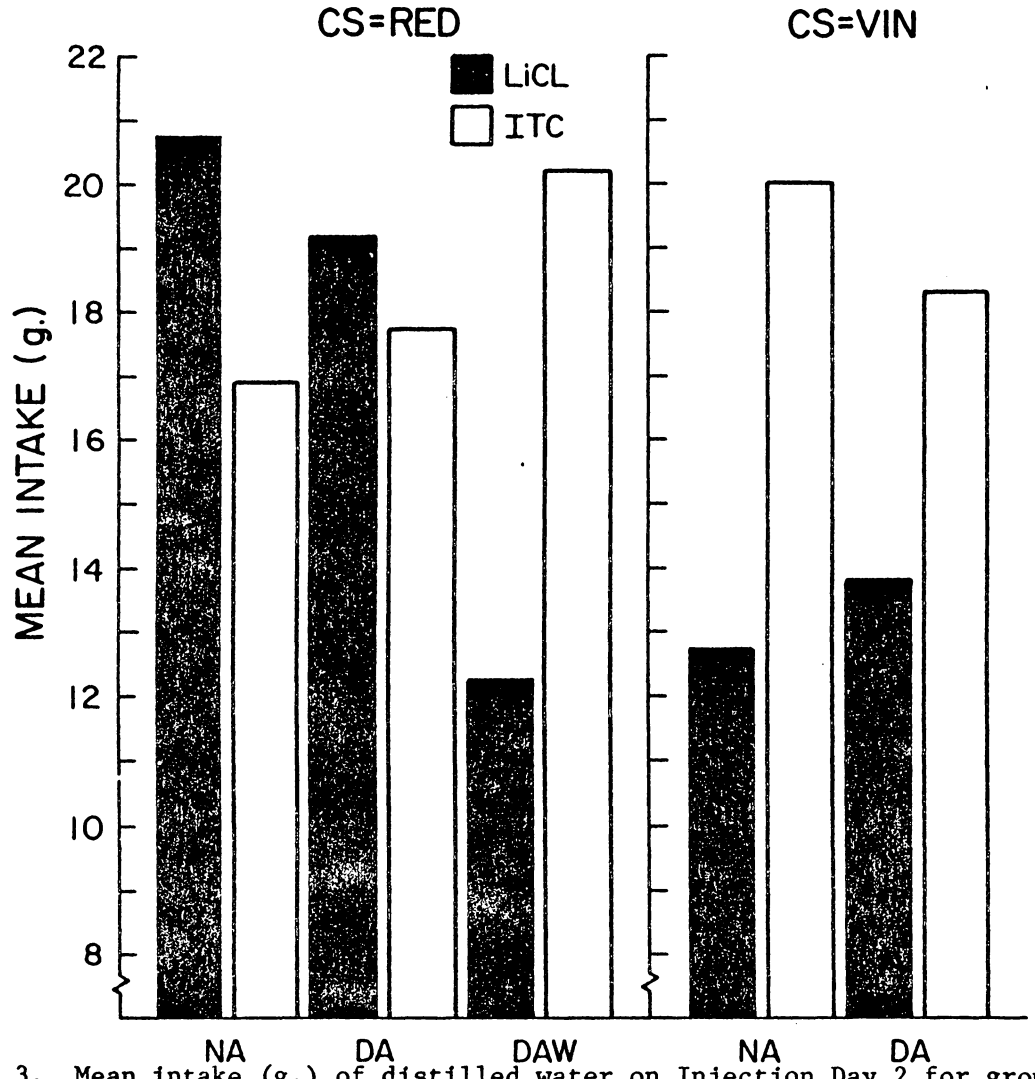

Figure 3. Mean intake (g.) of distilled water on Injection Day 2 for groups which received Li or ITC procedures with a red water or vinegar CS.

was lower for LiCl groups than for ITC groups. Distilled water intake for Vin-LiCl groups was lower than that for the Red-LiCl groups in DA and NA conditions and similar to that of Red-LiCl in the DAW condition. The ITC groups showed similar intake of distilled water across CS conditions. ANOVA (Table 13) for groups for the DA and NA conditions revealed a significant CS X Injection Condition interaction. ANOVA (Tables 14 and 15) for each CS condition revealed no differences in intake between LiCl and ITC groups for the Red CS condition. For Vin CS groups intake of distilled water was less for LiCl groups than for ITC groups. ANOVA (Table 16) for the Red CS condition including DAW groups revealed a reliable Injection Condition X Observational Training Condition interaction. Simple effects ANOVAS (Table 17) revealed a significant effect for OTC conditions for LiCl groups. OTC condition was not reliable for ITC groups. Subsequent Tukey tests revealed that the LiCl-DAW group drank less distilled water than did LiCl groups for DA and NA conditions. The latter two groups did not differ.

Pretest Intake

This intake measure was to assess the extent of recovery of ingestion following toxicosis before aversion testing. Figure 4 presents mean pretest intakes of distilled water for groups conditioned with a Red or Vin CS and for ingestion-toxin controls. For both CSs, intakes were similar across Injection and OTC conditions. ANOVA (Table 18) of the data in Figure 4 revealed no differences in pretest intakes. ANOVA (Table 19) for the Red CS condition including DAW groups showed no reliable differences.

To assess intake performance and thus, the extent of recovery following conditioning relative to that prior to injection, pretest intakes were compared with preinjection intakes. ANOVA (Table 20) over preinjection and pretest (PRE) intakes revealed a reliable Injection Condition X PRE interaction. Simple effects ANOVAS (Table 21) showed a reliable CS X PRE interaction for LiCl groups. Preinjection distilled water intake was less for Vin CS groups than for Red CS groups. Pretest distilled water intakes did not differ across CS conditions. There were no differences in preinjection and pretest distilled water intakes for ITC groups. ANOVA (Table 22) for Red CS

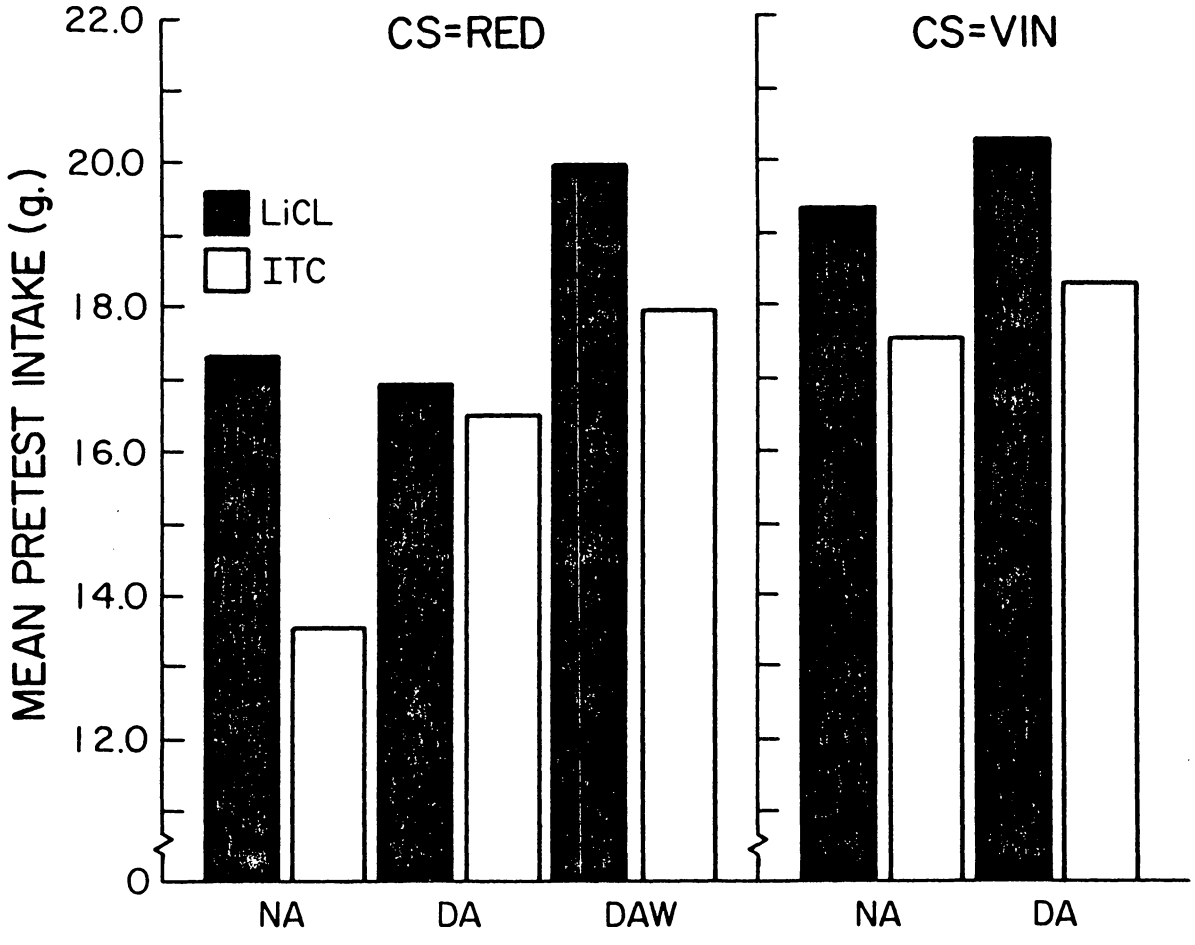

Figure 4. Mean pretest intake (g.) for groups which received Li or ITC procedures with a red water or vinegar CS.

condition which included DAW groups showed no differences between preinjection and pretest intakes. Although preinjection intakes differed from pretest intakes for the Vin-LiCl groups, the increase of pretest intakes to a level comparable to those of the ITC groups showed that Vin-LiCl groups had recovered from injection procedures prior to testing.

Aversion Testing

Latency to Drink. Figure 5 shows mean latency to start drinking red water or vinegar for conditioning groups and for ITC groups that received observational training with a drinking or nondrinking audience. For the Red CS condition, LiCl groups generally exhibited longer latencies to drink than did ITC groups. For the DA-LiCl groups, however, latency to drink was similar to that of ITC groups and shorter than that of NA-LiCl and DAW-LiCl groups. For the Vin CS condition, all groups showed similar latencies to drink on Trial 1, but LiCl groups exhibited increasingly longer latencies to drink from Trial 2 onward. Latency to drink was longer for group DA-LiCl than for group NA-LiCl.

ANOVA (Table 23) for the Red CS condition across DA and NA conditions showed a reliable Injection Condition X Observational Training Condition interaction. Simple effects ANOVAS (Table 24) for each Observational Training Condition revealed that for NA groups, latency to drink was slower for the LiCl group than for the ITC group. For DA groups there were no differences in latency to drink between LiCl and ITC groups. ANOVA (Table 25) for the Red CS condition across DA and DAW groups revealed an Injection Condition X Observational Training Condition X Trial interaction. Simple effect ANOVAS (Table 26) for each Injection Condition revealed a significant Observational Training Condition X Trial interaction for LiCl groups but not for ITC groups. Simple effect ANOVAS (Table 27) for each Trial revealed reliable differences in latency to drink between OTC groups on Trial 1 and 3 but not on Trial 2.

ANOVA (Table 28) for the Vin CS condition revealed a significant Injection Condition X Trial interaction. Simple effects ANOVAS (Table 29) revealed that LiCl groups exhibited longer latencies to drink from Trial 2 onward; ITC groups showed no reliable change in latency over trials.

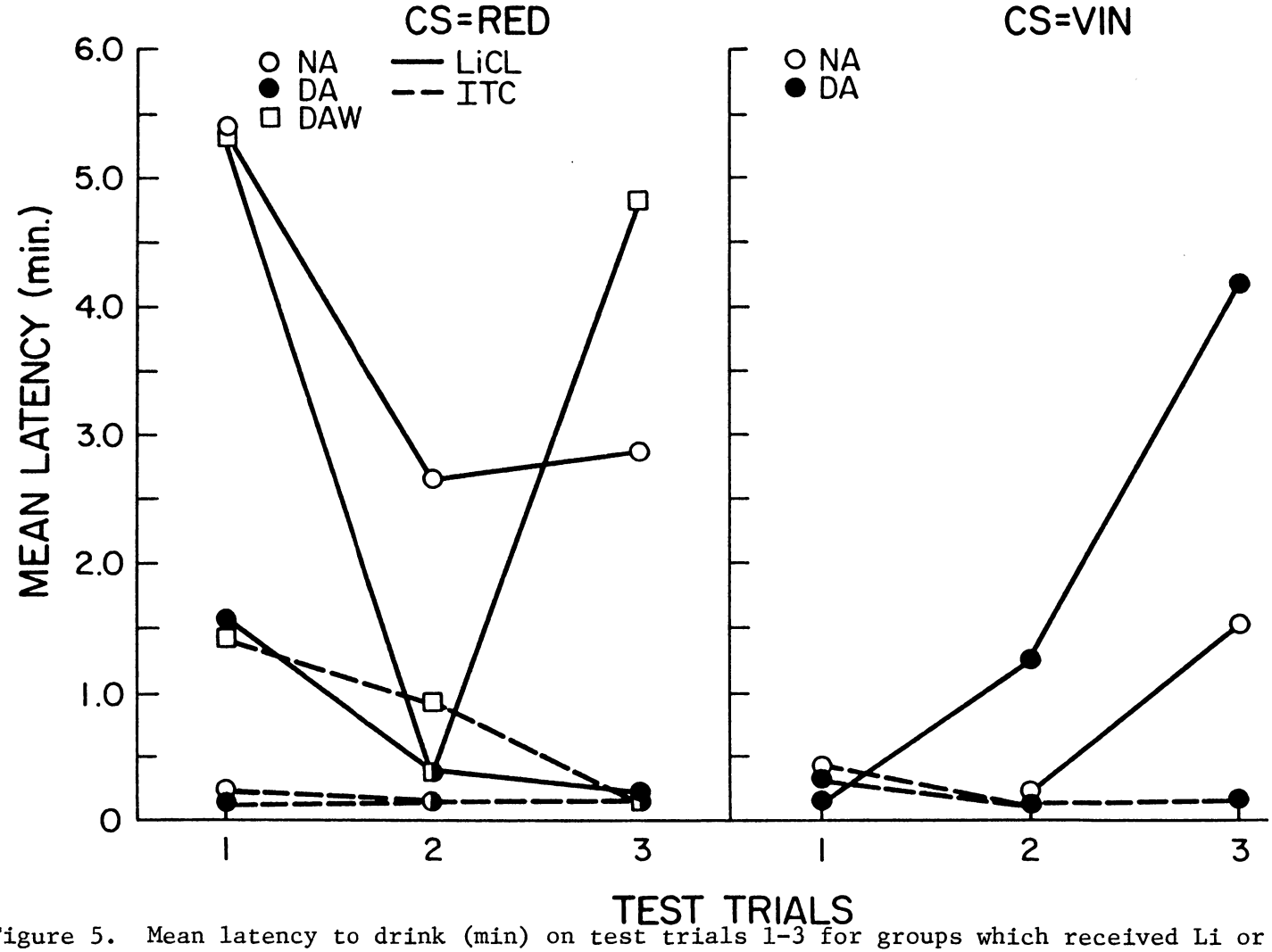

Figure 5. Mean latency to drink (min) on test trials 1-3 for groups which received Li or ITC procedures with a red water or vinegar CS and received OT under NA, DA or DAW conditions.

In summary, the latency data showed that for the DA-LiCl group, the observation of conspecifics ingesting the CS reliably reduced latency to respond for the Red but not for the Vin condition. This effect was greater for DA than for DAW and NA groups in the Red CS condition.

Intake. Figure 6 presents mean intake of Red and Vin CSs for conditioning and for ITC groups that received observational training with a drinking or nondrinking audience. For each CS, intake of LiCl groups was lower than that of ITC groups. For each CS aversion effects on Trial 1 were similar across observational training conditions. For the Red CS condition, observational training with a DA audience resulted in an apparently greater intake from Trial 2 onward than did observational training with a NA audience, all relative to ITC groups. DAW groups were intermediate. For the Vin CS condition, relative to ITC groups, observational training apparently did not affect intakes for either injection procedure.

ANOVA (Table 30) for the Red CS condition across DA and NA groups revealed reliable effects for Injection Condition and Trial but for no other comparisons. ANOVA (Table 31) for the Red CS condition across DA and DAW groups showed significant effects for Injection Condition and Trial. ANOVA (Table 32) for the Vin CS condition revealed a reliable effect only for Injection Condition.

The lack of significant differences in intake across observational training conditions in the preceeding analyses may have been due to the high degree of variability in the data (Fmax $(10,7) = 936.20$, $p < .01$). To decrease this variability log transformations of the intake data were used. The transformed data are presented in Figure 7. ANOVA (Table 33) for the Red CS condition across DA and NA groups revealed reliable effects for the interactions, Injection Condition X Observational Training Condition interaction and Injection Condition X Trial interaction. Simple effects ANOVAS for each injection condition (Table 34) revealed significant effects for Observational Training Condition and Trials for LiCl groups. For ITC groups, the effect of Observational Training procedures was not reliable. ANOVA (Table 35) for the Red CS condition across DA and DAW groups showed a reliable effect for Injection Condition X Trial interaction but not for Observational Training Conditon. Simple effects ANOVAS (Table 36) showed a significant difference in log intake over trials for LiCl groups whereas log intake did not change over

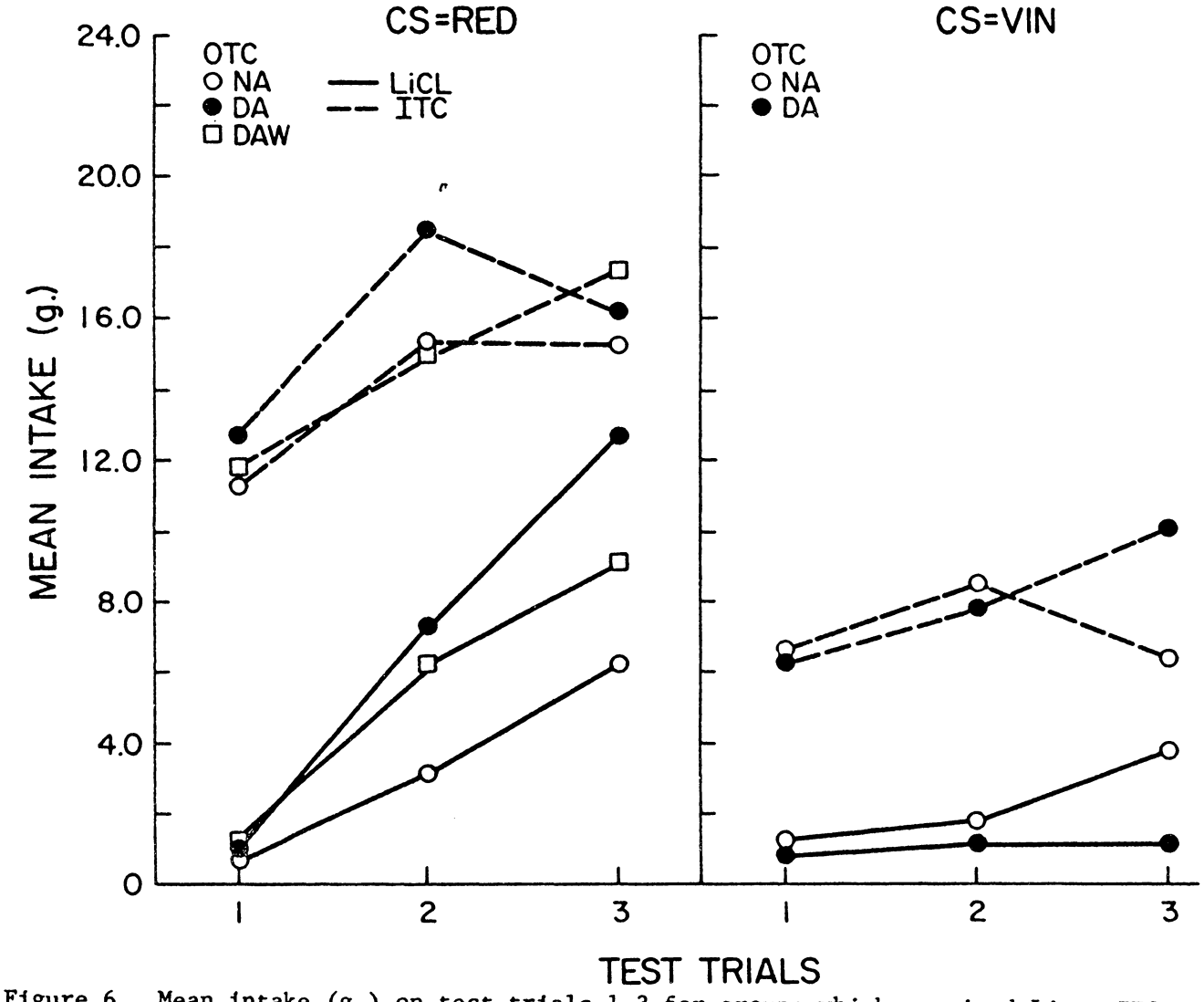

Figure 6. Mean intake (g.) on test trials 1-3 for groups which received Li or ITC procedures with a red water or vinegar CS and received OT under NA, DA or DAW conditions.

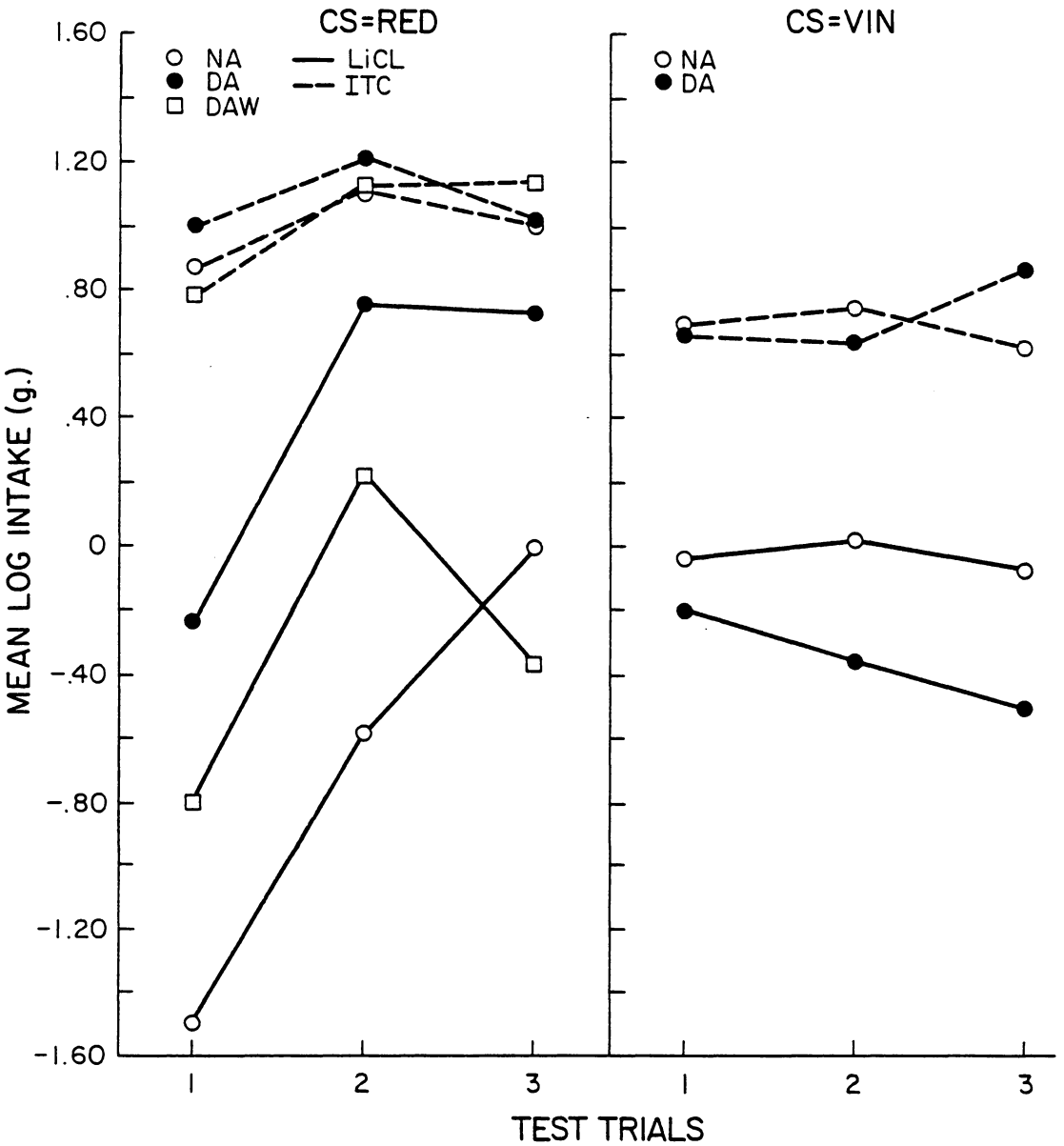

Figure 7. Mean intake (log) on test trials 1-3 for groups which received Li or ITC procedures with a red water or vinegar CS and received OT under NA, DA or DAW conditions.

trials for ITC groups. ANOVA (Table 37) for the Vin CS revealed essentially the same results as those found with the raw intake data.

In summary, the log transformation data showed that observation of conspecifics ingesting the CS reduced aversion effects to the Red but not to the Vin CS relative to observation of non-drinking audiences. The results of the latency and log intake data supported Hypothesis 1.

Percent Intake

Figure 8 presents mean percent intake of red water and vinegar for groups that received observational training with DA or NA audiences. Percent intake was generally less for vinegar than for red water. Percent intake was greater for Red-DA than for Red-NA groups. The reverse was found for Vin-NA and Vin-DA groups.

ANOVA (Table 38) of percent intake for Red- and Vin-NA groups revealed no reliable differences. ANOVA (Table 39) over all the data in Figure 8 revealed a reliable CS Condition X Observational Training Condition X Trial interaction. ANOVAS (Table 40) for each Trial revealed that on Trial 1 percent intake was significantly greater for vinegar than for red water. On Trial 3 results revealed a reliable a CS X Observational Training Condition interaction.

To reduce variability of the percent intake data, Arcsin transformations were used. ANOVA (Table 41) of the transformed data for NA groups that received Red or Vin CSs showed a marginal effect for CS condition ($p = .06$). ANOVA (Table 42) over all the transformed data revealed a significant CS X OTC interaction. Simple effects ANOVAS (Table 43) by CS condition showed reliable effects for OTC Condition and Trial for the Red CS groups. Intake performance by the DA group was greater than that by the NA group. For Vin CS groups, results revealed no differences in intake performance. In summary, the results of percent intake data did not support Hypothesis 2 or 3.

Retention Testing

Latency to Drink. Figure 9 shows mean latency to drink red water or vinegar on Test Trial 3 and on Retention Trials 1 and 2 for conditioning groups that received DA or NA observational

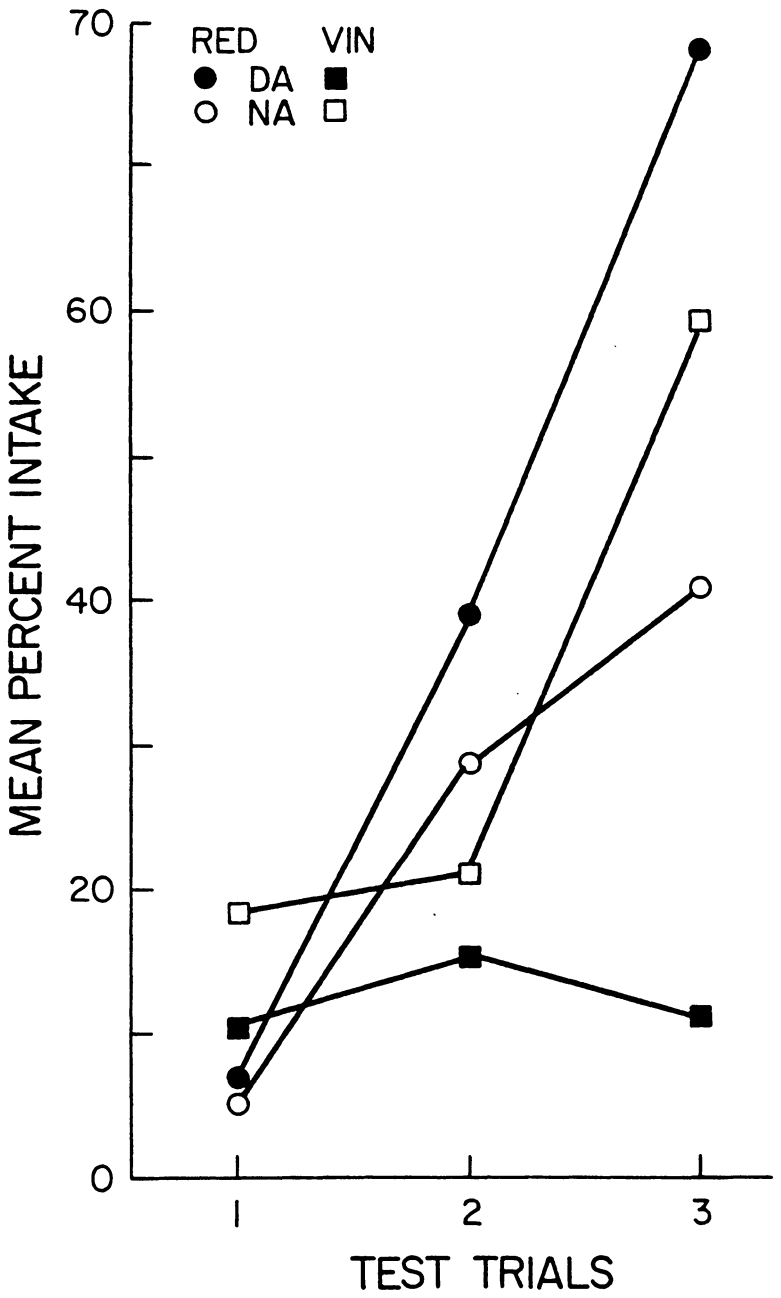

Figure 8. Mean percent intake (%) on test trials 1-3 for groups conditioned with red water or vinegar and received OT under DA or NA conditions.

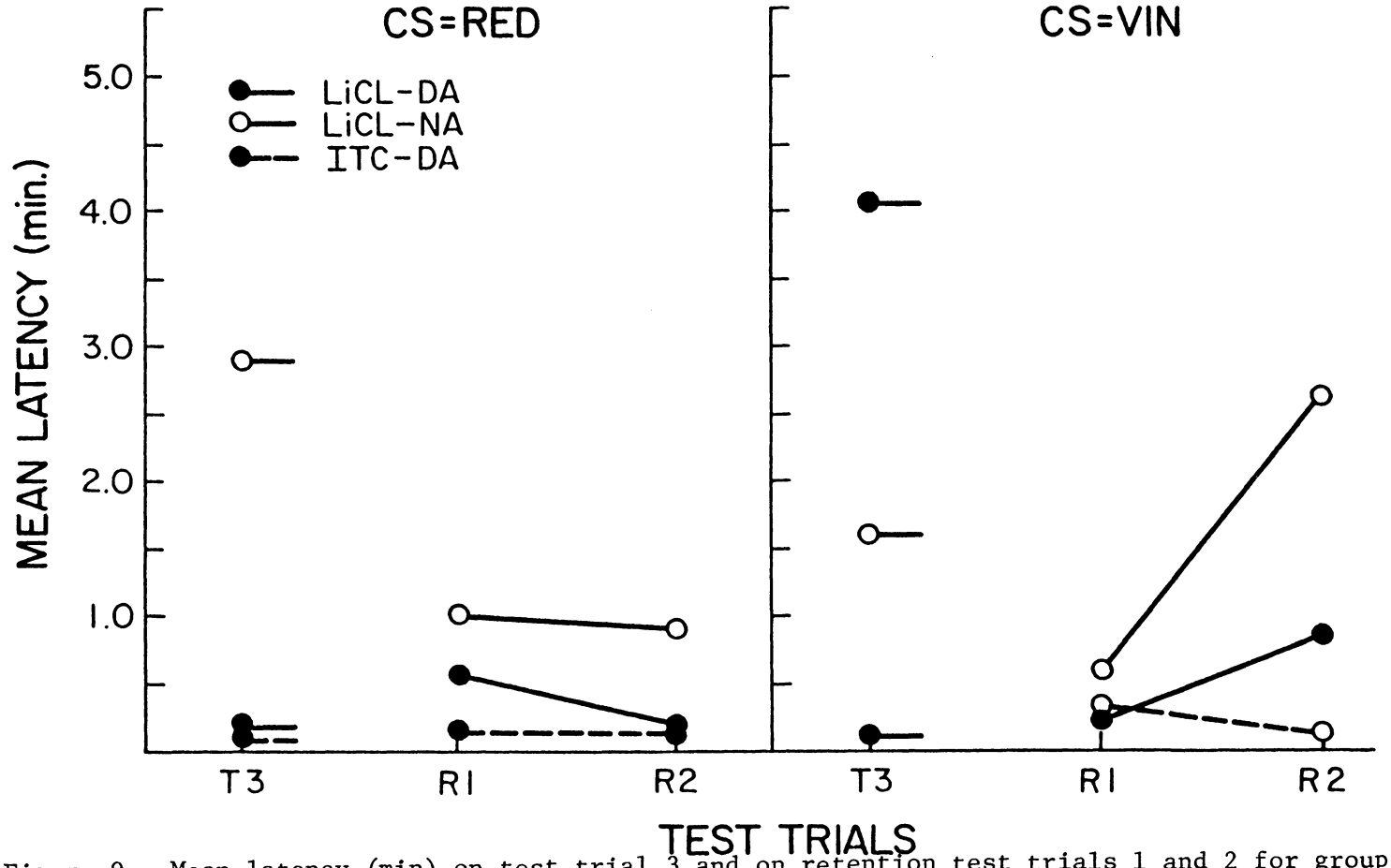

Figure 9. Mean latency (min) on test trial 3 and on retention test trials 1 and 2 for groups conditioned on red water or vinegar that received OT under DA or NA conditions and for ITC groups that received OT under the DA condition.

training procedures and for ingestion-toxin controls that received DA observational training procedures. For the Red CS condition, the NA-LiCl group responded more slowly on Test Trial 3 than did DA-LiCl and DA-ITC groups. Latency to respond decreased from Test Trial 3 to Retention Test Trial 1 (Rtrial) for the NA-LiCl group. DA-LiCl and NA-LiCl groups responded more slowly than did DA-ITC on Rtrial 1. The DA-LiCl group was comparable to DA-ITC on Trial 2. For the Vin CS condition on Test Trial 3, DA-LiCl and NA-LiCl groups responded more slowly than did the DA-ITC group. Latency to respond decreased from Test Trial 3 to Rtrial 1 for DA-LiCl and NA-LiCl groups. All groups responded similarly on Rtrial 1. DA-LiCl and NA-LiCl groups showed increased on Rtrial 2 relative to that of DA-ITC. ANOVA for each CS condition revealed no effect for observational training condition for the Red CS condition (Table 44) and a reliable OTC (DA-ITC, DA-LiCl and NA-LiCl) X Trial interaction for the Vin CS condition (Table 45). The latency data suggest that the previously demonstrated observational training effects were not retained after a five-day interval.

Intake. Figure 10 presents mean intake of Red or Vin CSs for conditioning groups that received DA or NA observational training procedures and for ingestion-toxin controls that received DA observational training procedures. For the Red CS condition, the NA-LiCl group drank less red water on Test Trial 3 than did DA-LiCl and DA-ITC groups. Mean intake increased from Test Trial 3 to Rtrial 1 for the NA-LiCl group. For the Vin CS condition, intakes of DA-LiCl and NA-LiCl groups were similar from Test Trial 3 to Rtrial 1. The DA-ITC group, however, showed a decrease from Test Trial 3 to Rtrial 1. For both CS conditions, DA-LiCl and NA-LiCl groups drank less than did DA-ITC groups on Rtrial 1. On Rtrial 2 the groups were similar in amount consumed.

ANOVA for each CS condition revealed no significant effect for observational training for the Red CS (Table 46) and a reliable effect for OTC (DA-ITC, DA-LiCl and NA-LiCl) for the Vin CS (Table 47). The retention data were transformed into logarithms. See Figure 11. ANOVA for the Red CS condition (Tables 48) revealed no effect of observational training condition. These

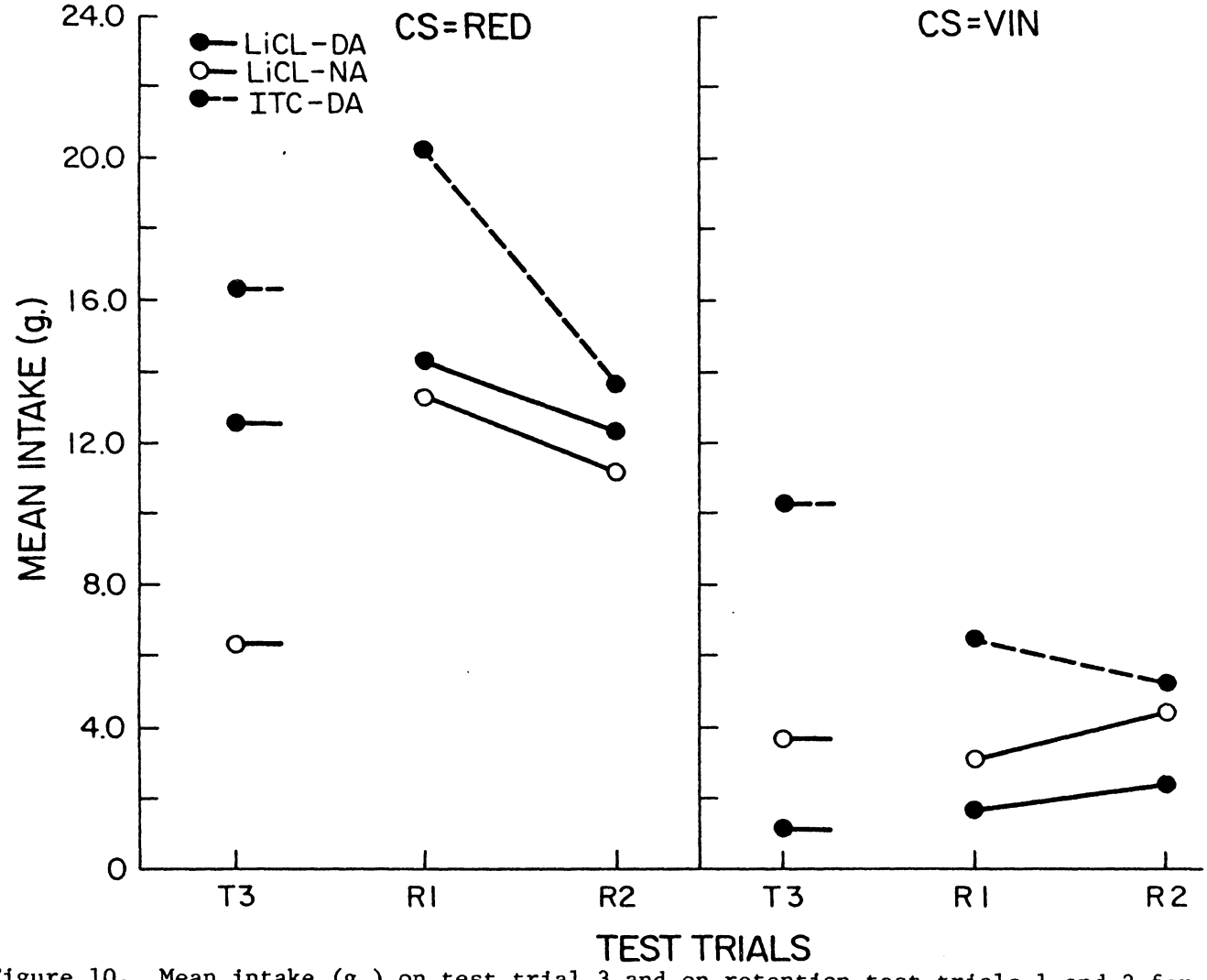

Figure 10. Mean intake (g.) on test trial 3 and on retention test trials 1 and 2 for groups conditioned on red water or vinegar that received OT under DA or NA conditions and for ITC groups that received OT under the DA condition.

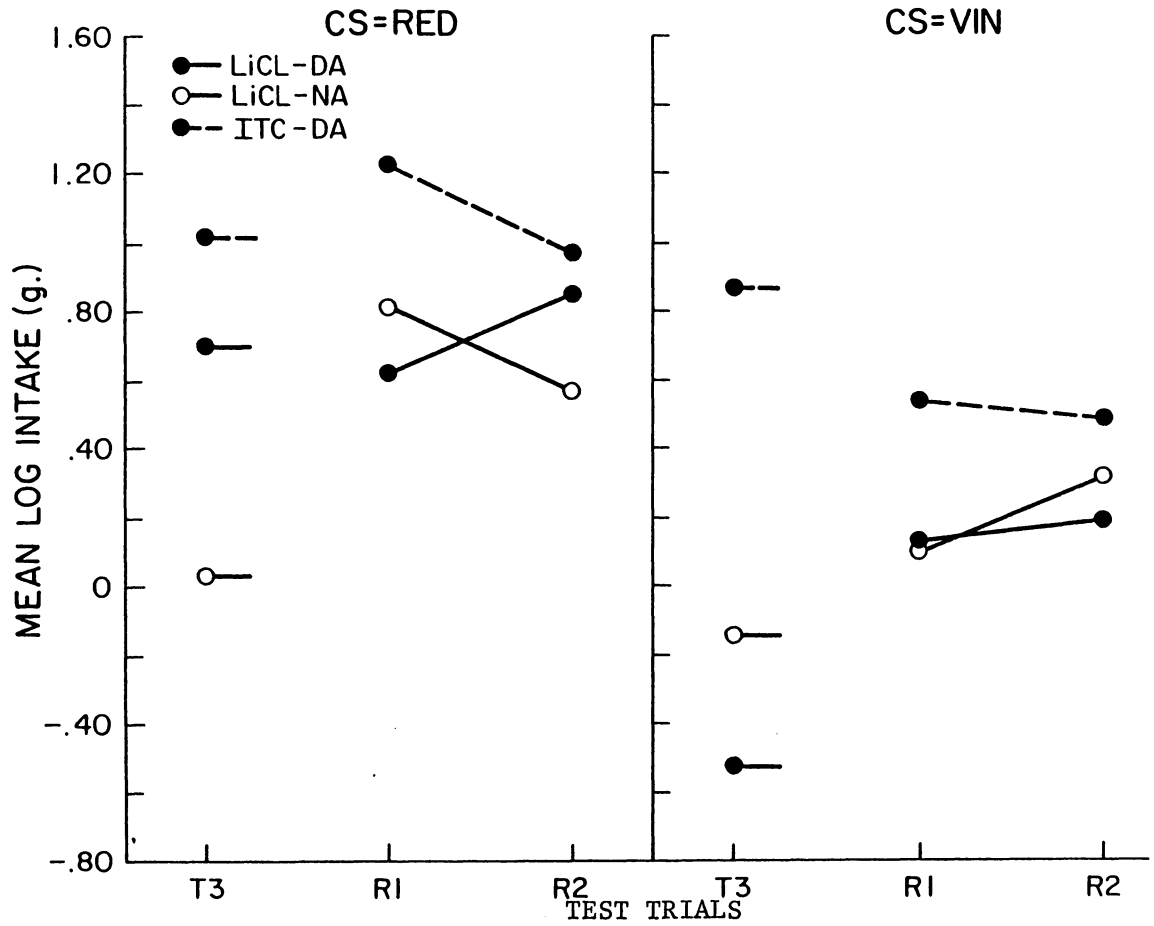

Figure 11. Mean intake (log) on test trial 3 and on retention test trial 1 and 2 for groups conditioned with red water or vinegar that received OT under DA or NA conditions and for ITC groups that received OT under the DA condition.

results revealed that the previously demonstrated observational training effects were not retained after a five-day interval.

DISCUSSION

The results of this study provided reliable evidence for the attenuation of aversion effects following observational training in which conditioned chicks observed conspecifics ingest a distinctively colored solution on which they (the observer) had previously been poisoned. This effect was demonstrated for latency to respond and in log intake of groups conditioned with red water but not for groups conditioned with vinegar. (The lack of observational training effects for groups conditioned with vinegar will be discussed later.)

Relative to ingestion-toxin control groups, subjects who observed an audience ingesting red water (DA group) exhibited shorter latencies to respond and greater log intakes than did subjects who observed a nondrinking audience (NA group). These differences in latency to respond and in log intake between DA and NA groups presumably occurred because observation of conspecifics ingesting, what for conditioned chicks was an aversive stimulus, may have reduced the aversion to red water. Subsequently when the red cue was presented in testing, the DA group exhibited more rapid approach and greater log intake relative to that for conditioned chicks who observed a non-drinking audience. These data supported Hypothesis 1.

The possible influence of the red color as a discriminative cue for attenuating the aversion was indicated in the results for groups DA and DAW. Chicks in DA and DAW groups observed drinking conspecifics during observational training, but DA groups observed conspecifics ingesting red water, while DAW groups observed conspecifics ingesting clear water. Differences in latency to respond between DA and DAW chicks suggest that aversion to red water was attenuated more by observing conspecifics drinking the aversively conditioned CS which was later presented in testing than by observing conspecifics ingesting clear which was not later presented in testing.

Log intake data, however, failed to show a difference in amount ingested between conditioned DA and DAW groups. The lack of differences here may have been due to the possibility that latency and intake measure different aspects of responding. According to Spence (1956), responding

may involve at least two aspects: time to start responding (response initiation) and duration of responding once it has started (response maintenance). In the present study, latency to respond and amount ingested could be viewed as being analogous to response initiation and response maintenance. The presence of observational training differences in latency to respond and the lack of these effects in amount ingested may be due to differences between these measures. For example, Spence reported that in response initiation, time to start may be long if the task is not well learned, if the organism has competing responses or if motivation is low. On the other hand, response maintenance is influenced by factors such as the presence of reinforcement, number of reinforced trials and stage of training. Perhaps for the present study, latency to start responding may actually be a more sensitive measure of social training effects than is response maintenance (at least on the first trial) because with measures of amount ingested, factors other than social interactions (e.g., reinforcement) may influence an individual's performance.

In contrast with results obtained for groups conditioned with red water, there were no effects for observational training procedures for groups conditioned with vinegar. The lack of such effects here may have reflected the the failure of the Vin CS groups to discriminate between the vinegar solution and familiar distilled water, or the greater strength of conditioning to the vinegar CS than to the red CS. For vinegar CS groups, the visual appearance of the stimulus presented during observational training was essentially similar to that of familiar distilled water. The lack of differences in latency to respond between conditioning and ingestion toxin control groups on Trial 1 coincided with the view that animals may not have discriminated between the appearance of vinegar from that of water during observational training. The presence of observational training effects for groups conditioned with red water and the lack of these effects for groups conditioned with vinegar may have been due to differences in the visual appearance between red water and vinegar. That is, the responses of drinking conspecifics toward the red water CS may have served as a discriminative cue whereas those of drinking conspecifics toward the vinegar CS did not. Thus, effects of observational training to the red cue generalized more readily from observational training to testing.

Another explanation for the lack of observational training effects for groups conditioned with vinegar may be the greater strength of the aversion conditioning to vinegar. Galef (1985) reported

that the effects of social interactions on the attenuation of a conditioned aversion depended on the strength of conditioning produced by the intensity of the UCS. He found that social interactions with a single conspecific reduced a mild aversion to a novel food (produced by a lower dosage of LiCl) but were not influential in reducing stronger aversions (produced by higher dosages of LiCl). Strength of conditioning may also be influenced by the salience (conditionability) of the CS (Kalat & Rozin, 1970). The lack of observational training effects for Vin CS groups and the presence of these effects for Red CS groups may have reflected stronger conditioning effects to vinegar than to red water. For example, vinegar can be thought of as a compond/complex stimulus in that vinegar has both taste and olfactory components. The smell of vinegar may not be important for the results of the present study since olfaction does not appear to influence the behavior of chickens (Kare & Rogers, 1976). Vinegar, however, may be a trigeminal stimulus in that close contact results in irritation of the face, beak and palate (Bubien-Waluszewska, 1981). Irritation of these areas in combination with taste may have resulted in vinegar's being more conditionable than red water. Comparisons of NA groups revealed no differences in percent intake across red and vinegar CS conditions. The lack of differences here, may reflect a floor effect due to the depressed intake of vinegar by both conditioning and ingestion-toxin control groups. Transforming the data into percent intake, minimizes the likelihood of a floor effect since the intake of conditioning groups are taken proportionally to the intake of their control groups. The Arcsin transformations of percent intake data, however, revealed only marginal CS differences in intake. Therefore, due to the lack of significant differences in percent intake and in arcsin transformations for strength of conditioning, Hypotheses 2 and 3 were not supported.

Conceptual Models of Social Learning

Results for the attenuation of aversion to the Red CS through observational training may be interpretable from conceptual models of matched-dependent behavior (Miller & Dollard, 1941), vicarious extinction (Bandura, 1968), stimulus enhancement (Spence, 1937) or classical conditioning (Mineka, Davidson, Cook, & Keir, 1984).

Matched Dependent Behavior. Miller and Dollard (1941) proposed that learning through the observation of conspecifics is the result of matched dependent behavior. In matched-dependent

behavior the behavior of a more experienced conspecific serves as a discriminative cue that occasions reinforcement for the observer following a response by the observer. The observer then comes to match its behavior to that of the conspecific. The procedures employed in the current study make it unlikely that the findings can be explained in terms of matched dependent behavior. For example, in order for a stimulus to become an effective discriminative stimulus, the organism must first be reinforced for differential behavior in response to the discriminative cue. In order for the more experienced conspecific to become a discriminative cue, the observer must be reinforced during the time of observation. In the present study, no reinforcement was directly available to observers during observational training. According to Galef (1986) socially-induced behavioral change should not be exhibited by the observer once the discriminative cue is no longer present. Therefore, matched-dependent behavior can not explain the group differences found in testing because in the present study the discriminative stimulus (drinking behavior of conspecifics) was not present in testing.

Vicarious Extinction. Bandura and Menlove (1968) found that children's avoidance behavior of an aversive stimulus (i.e., a dog) was attenuated following the child's observation of a model (an adult) interacting with a dog in the absence of negative consequences (e.g.,being bitten). These researchers proposed that the attenuation of aversion resulted from vicarious extinction. In vicarious extinction the subject observes the presentation of the CS (e.g., a dog) in the absence of the UCS (e.g., the model's being bitten) which yields an attenuation of the originally conditioned avoidance response. In the present study, observational training procedures may have constituted extinction procedures for the observer. Subjects were presented the CS (i.e., red water) in the absence of the UCS (i.e., toxic effects to the observer and apparently to conspecifics) which produced a decrement in the conditioned aversion.

Stimulus Enhancement. The attenuation of aversion to red water may be due to socially-induced stimulus enhancement (Spence, 1937). Stimulus enhancement refers to the increased exposure to a stimulus because of the activities of conspecifics in the presence of that stimulus. Perhaps, for the conditioning group that observed an audience ingest red water, the behaviors of the audience was directed toward the red water. Audiences' direct interaction with red water may

have "enhanced" or increased exposure to that stimulus more than to other stimuli in the environment. Conversely, for the conditioning group that observed a nondrinking audience, the behaviors of conspecifics may have been indifferent toward the red water. Galef, Kennett and Stein (1985) reported that exposure to novel food cues on the body of another rat increased an individual's rat's preference for that food over that for exposure to novel food cues alone. Further, these researchers reported that stimulus exposure, per se, was not sufficient to promote preference behavior. Accordingly, for the present study, DA groups may have received increased stimulus exposure during observational training. Although, the CS was placed in the center of the apparatus to control for differential stimulus exposure, the specific location of the audiences was not monitored. It was possible that audience location increased stimulus exposure for groups that observed an audience ingesting red water over that from those which observed a nondrinking audience.

Classical Conditioning. The present results may also be interpreted in terms of classical conditioning of approach behavior. Curio, Ernst and Vieth (1978) showed that the behavior of a conspecific could serve as an effective cue for eliciting similar behavior in an observer. They also showed that the response of the observers could transfer to a neutral stimulus which did not initially evoke that response. Curio, Ernst and Vieth placed blackbirds into separate compartments so that while they had visual contact with each other, visual contact with whatever stimuli might be presented to either group was precluded. For one blackbird, a stuffed owl was presented. Visual contact with the owl stimulus elicitited mobbing behaviors. The other blackbird was presented with an Australian honeyguide which did not elicit mobbing behavior. The blackbirds which were presented with the honeyguide observed other blackbirds exhibit mobbing behaviors (toward the stuffed owl). In testing, blackbirds presented with the honeyguide exhibited mobbing behaviors in the absence of other blackbirds exhibiting these behaviors. Thus, the honeyguide was the CS (initially did not elicit mobbing behaviors), the mobbing behavior of a conspecific blackbird was the UCS which elicited similar behavior,the UCR, from the observer. In testing,the CS (i.e., honeyguide) elicited mobbing behaviors (CR) from the observer.

In a study for observational training of aversive responding, Mineka, Davidson, Cook and Keir (1984) found that young Rhesus monkeys acquired fear responses toward snakes as a result

of observing older monkeys (their parents) exhibit similar fear responses in the presence of snakes. The young monkeys did not initially exhibit fear responses toward snakes before observational training. Thus, the snake served as the CS (initially neutral to fear responses). The behavior of the older monkey served as the UCS which elicited similar behavior, the UCR, from the offspring. After observing the snake and the fear responses exhibited by the older monkeys, presentation of the snake alone (CS) was sufficient to elicit similar fear responses (CR) from the offspring. Mineka,et al. reported that acquiring fear responses through observation were rapid and that they were retained when the animals were tested three months later. In addition, fear behaviors exhibited by offspring were positively correlated in quantity and intensity with those exhibited by their parents. Mineka et al. concluded that parents' behaviors were not only effective UCSs but those UCSs differed in intensity which produced UCRs of corresponding intensity from younger monkeys.

The results of the present experiment may be explained in classical conditioning terms. In the observational training phase, subjects observed conspecifics approach and ingest a stimulus which was previously made aversive to the observer. Responses by the conspecific may have served as an effective UCS for the occurrence of similar behavior in the observer (UCR). The behavior of the observer may have been approach toward the aversive cue (i.e., red water) or to conspecifics in the presence of the aversive cue. In this situation, avoidance was reduced by the presence of the competing approach response for DA groups. The approach response may have been evoked in the presence of the originally aversive stimulus during observational training. The occurrence of approach behavior thus reduced the originally conditioned avoidance response to the red water. Transfer of observational training effects from observational training to testing may due to the representation of the audience as a CS for approach behavior in testing. For groups that received a nondrinking audience during observational training, the presence of conspecifics was not a functional CS for approach in testing.

The classical conditioning model offers a more parsimonious explanation of the current data than does the model of vicarious extinction model for two reasons. First, the functional CS, for approach, the presence of conspecifics, is placed in the organism's external environment rather than within the organism. The presence of the CS may provide the basis for the transfer of reduced

aversion effects from observational training to testing. For example, perhaps, during observational training the presence of conspecifics (i.e., the CS) was paired with conspecifics' drinking behavior (i.e., the UCS). In testing, the presence of conspecifics, the CS, elicited approach behavior from the individual subject. Secondly, if conspecifics' drinking behavior constitutes a UCS which elicits similar behavior from the subject, the subject's responses allow identification of empirical referents for the modeling response by the observer. In contrast, vicarious extinction lacks parsimony and operational specificty. For example, there is no measure of vicarious extinction independent of the effects of vicarious extinction, namely, performance in testing. In addition, the model of vicarious extinction places the functional CS within the subject and thus the CS is not directly observable.

Retention

The present experiment provided evidence of the attenuation of an aversion by observational training procedures. Whether these results can be categorized as a representation of social learning, in which learning is based on transmission of behavior from conspecifics to observer may be debatable. If socially-induced behavioral change reflects social learning, the change in behavior must be relatively permanent (Galef, 1976). To assess this criteriom for learning, chicks in the present study were retested five days after completion of initial testing. Procedures for retention testing were essentially the same as those for initial testing. Briefly, the chicks received 10 minutes access to vinegar or to red water in the presence of two nondrinking conspecifics. Latency and intake measures of retention revealed no differences between NA and DA groups conditioned with red water.

In retention, there are two possible reasons for the lack of differences in latency to respond and intake. First, the aversion to red water was apparently not retained by the conditioning group that observed a nondrinking audience (NA). Comparison of test trial 3 with retention test trial 1 revealed that the conditioning group under NA procedures showed a significant decrease in latency to respond, [$t(5,5) = 13.18$, $p < .05$] to a level similar to that of the conditioning group that observed an audience drinking red water (DA). The conditioning group under DA procedures showed little change from test trial 3 to retention test trial 1. These results suggest that the apparent absence of observational training effects in retention may have been due to the decrement in the strength

of aversion for the NA conditioning group. Another possible reason for the apparent lack of retention for observational training effects may have been due to memory interference. According to Spear (1973), proactive interference or interference after training may reduce retention of training effects. At the time of retention testing, groups had already experienced three trials with the CS which may have interfered with the demonstration of observational training effects.

According to Galef (1976), social learning effects are relatively permanent. The lack of observational training effects in retention seems to argue against the likelihood that social learning (as defined) occurred since observational training effects appeared to be transient. On the other hand, to argue that social learning did not occur in the present study may be incorrect. That is, measures in retention were suspect due to the possible decrement in strength of aversion and due to the possible memory interference. Thus, the intervention of a test period prior to retention testing may have affected later assessment of observational training effects. In order to properly assess observational training effects in retention, groups should have been tested eight days after observational training with no intervening test period.

Summary

The results of this study showed that social transmission of acquired behavior can alter subsequent responses to aversive stimuli. Specifically, an individual's observation of conspecifics ingesting the conditioned stimulus (red water) significantly reduced aversion effects to that cue. In contrast with results obtained for groups conditioned with red water, there were no effects for observational training procedures for groups conditioned with vinegar. The lack of such effects here may be due to the failure of groups conditioned with vinegar to discriminate between vinegar and familiar distilled water during observational training. The attenuation of aversion effects by observational training were interpreted by the classical conditioning model. In retention, results revealed no effects for observational training procedures. The lack of these effects in retention may have been due to a weakening of the strength of the aversion for the NA conditioning group or to sources of memory interference between observational training and retention testing.

Future Studies

The results of the present study suggested several interesting areas for future research. One possible avenue for future research is the role of classical conditioning in observational training. In the present study, it was hypothesized that the behavior of a conspecific served as a UCS which elicited similar behavior from an observer. If this analysis is correct, perhaps a change in the characterisitics of the audience may alter the efficacy of its properties as a UCS. For example, an audience of a different species or of a different strain from that of the observer might reduce the effectiveness of their behavior as a UCS. Furthermore, if drinking responses by conspecifics act as a UCS, varying conspecifics' drinking behavior would vary UCS characterisitcs. Perhaps, a greater number of drinking responses by conspecifics would produce stronger observational training effects as a result of the greater intensity of the UCS.

The role of species typical behavior patterns in observational training provides another interesting line of research. It is possible that these behavior patterns may enhance observational training effects. For example, Marler, Dufty and Pickert (1986) reported that food calls in domestic male chickens were a determinant of approach behavior by hens. Perhaps food calls in combination with other behaviors (e.g., drinking) may enhance observational training effects especially in cases where the probability of approach behavior is low.

Lastly, the social transfer of behavior may depend on the specificity of information that is transmitted by conspecifics during observational training. The present study showed that the presence of observational training effects for groups conditioned with red water and the absence of these effects for groups conditioned with vinegar may have been due to the difference in visual cues transmitted by conspecifics during observational training. That is, CSs were presented in familiar Richter-type drinking tubes. These drinking tubes were used for all distilled water access periods. Thus, the visual cues of the vinegar CS may not have differed from those of distilled water. One method to investigate whether the difference in visual cues between vinegar and red water influenced the present results would be to alter the visual cues of vinegar. Vinegar could be made more visually explicit by placing it in a novel clear drinking container or by adding a color cue for conditioning, observational training and test days.

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APPENDIX A

Tables 2-48

Table 2.

Grand Means (GM) and Analysis of Variance Summary Table of Mean Body Weight (g.) for Groups which were to Receive Li or ITC Procedures with Red or Vin CSs and then OT under DA or NA Conditions

SOURCE	df	SS	F
CS	1	180.50	F<1
GM Red=178.0			
GM Vin=176.0			
INJ	1	312.50	F<1
GM Li=175.0			
GM ITC=178.0			
OTC	1	3.13	F<1
GM DA=177.0			
GM NA=177.0			
INJ X OTC	1	1568.00	1.41
CS X INJ	1	253.13	F<1
CS X OTC	1	4.50	F<1
CS X INJ X OTC	1	7503.13	6.75*
ERROR	56	62273.00	

*$p < .05$

Table 3.

Analysis of Variance Summary Table of Mean Body Weight (g.) for Groups which were to Receive Li or ITC Procedures with a Red CS and OT under DA or NA Conditions

SOURCE	df	SS	F
INJ	1	2.34	F<1
OTC	1	11.34	F<1
INJ X OTC	1	1658.34	F<1
ERROR	28	48442.12	

*$p < .05$

Table 4.

Analysis of Variance Summary Table of Mean Body Weight (g.) for Groups which were to Receive Li or ITC Procedures with a Vin CS and then OT under DA or NA Conditions

SOURCE	df	SS	F
INJ	1	846.09	F<1
OTC	1	0.09	F<1
INJ X OTC	1	11948.34	7.44*
ERROR	28	44967.38	

*$p < .05$

Table 5.

Analysis of Variance Summary Table of Mean Body Weight (g.) by Li and ITC Injection Conditions for Groups which were to Receive Li or ITC Procedures with a Vin CS and then OT under DA or NA Conditions

SOURCE	df	SS	F
		LiCl	
OTC	1	2002.56	3.76
ERROR	14	22384.13	
		ITC	
OTC	1	5940.75	3.68
ERROR	14	22583.25	

Table 6.

Grand Means (GM) and Analysis of Variance Summary Table of Mean Body Weight (g.) for Groups which were to Receive Li or ITC Procedures with a Red CS and then OT under DA or DAW Conditions

SOURCE	df	SS	F
INJ	1	234.38	F<1
GM Li=181.0			
GM ITC=180.0			
OTC	2	645.58	F<1
GM DA=178.0			
GM DAW=183.0			
INJ X OTC	2	1672.75	F<1
ERROR	42	48586.25	

Table 7.

Grand Means (GM) and Analysis of Variance Summary Table of Preinjection Intake (g.) of Distilled Water for Groups which were to Receive Li or ITC Procedures with Red or Vin CSs and then OT under DA or NA Conditions

SOURCE	df	SS	F
CS	1	26.10	F<1
GM Red=16.1			
GM Vin=17.0			
INJ	1	90.79	1.17
GM Li=15.7			
GM ITC=17.4			
OTC	1	32.20	F<1
GM DA=17.0			
GM NA=16.1			
CS X INJ	1	338.65	4.37*
CS X OTC	1	2.26	F<1
INJ X OTC	1	43.48	F<1
CS X INJ X OTC	1	71.10	F<1
ERROR	56	4335.33	

*$p < .05$

Table 8.

Analysis of Variance Summary Table of Preinjection Intake (g.) of Distilled Water for Groups which were to Receive Li or ITC Procedures with a Red CS and then OT under DA or NA Conditions

SOURCE	df	SS	F
INJ	1	39.38	F<1
OTC	1	25.76	F<1
INJ X OTC	1	112.90	1.47
ERROR	28	2150.48	

Table 9.

Analysis of Variance Summary Table of Preinjection Intake (g.) of Distilled Water for Groups which were to Receive Li or ITC Procedures with a Vin CS and then OT under DA or NA Conditions

SOURCE	df	SS	F
INJ	1	195.03	5.00*
OTC	1	4.35	F<1
INJ X OTC	1	0.85	F<1
ERROR	28	1092.43	

*$p < .05$

Table 10.

Grand Means (GM) and Analysis of Variance Summary Table of Preinjection Intake (g.) of Distilled Water for Groups which were to Receive Li or ITC Procedures with a Red CS and then OT under DA, NA or DAW Conditions

SOURCE	df	SS	F
INJ	1	0.08	F<1
GM Li=16.7			
GM ITC=18.9			
OTC	2	91.90	1.20
GM NA=15.5			
GM DA=16.8			
GM DAW=18.9			
INJ X OTC	2	121.95	1.60
ERROR	42	1602.14	

*p < .05

Table 11.

Grand Means (GM) and Analysis of Variance Summary Table of Intake (g.) of Red Water or Vinegar on Injection Day 1 for Groups which were to Receive Li or ITC and then OT under DA or NA Conditions

SOURCE	df	SS	F
CS	1	420.50	9.58**
GM Red=11.2			
GM Vin=7.6			
INJ	1	192.08	4.38*
GM Li=10.6			
GM ITC=8.2			
OTC	1	134.48	3.06
GM DA=10.4			
GM NA=8.4			
CS X INJ	1	8.00	F<1
CS X OTC	1	23.81	F<1
INJ X OTC	1	14.05	F<1
CS X INJ X OTC	1	19.22	F<1
ERROR	56	2457.09	

*$p < .05$
**$p < .01$

Table 12.

Grand Means (GM) and Analysis of Variance Summary Table of Intake (g.) of Red Water on Injection Day 1 for Groups which were to Receive Li or ITC Procedures and then OT under DA or DAW Conditions

SOURCE	df	SS	F
INJ	1	23.01	F<1
GM Li=10.2			
GM ITC=10.2			
OTC	2	70.96	F<1
GM NA=11.8			
GM DA=10.6			
GM DAW=9.7			
INJ X OTC	2	186.64	1.50
ERROR	42	2605.51	

Table 13.

Grand Means (GM) and Analysis of Variance Summary Table of Intake (g.) of Distilled Water on Injection Day 2 for Groups which Received Li or ITC Procedures with Red or Vin CSs and then OT under DA or NA Conditions

SOURCE	df	SS	F
CS GM Red=18.7 GM Vin=16.3	1	178.13	1.97
INJ GM Li=16.7 GM ITC=18.3	1	81.60	F<1
OTC GM DA=17.3 GM NA=17.6	1	2.59	F<1
CS X INJ	1	561.96	6.22*
CS X OTC	1	030	F<1
INJ X OTC	1	1.24	F<1
CS X INJ X OTC	1	56.45	F<1
ERROR	56	5063.30	

*$p < .05$

Table 14.

Analysis of Variance Summary Table of Intake (g.) of Distilled Water on Injection Day 2 for Groups which Received Li or ITC Procedures with a Red CS and then OT under DA or NA Conditions

SOURCE	df	SS	F
INJ	1	161.46	F<1
OTC	1	3.49	F<1
INJ X OTC	1	30.71	F<1
ERROR	28	4899.65	

Table 15.

Analysis of Variance Summary Table of Intake (g.) of Distilled Water on Injection Day 2 for Groups which Received Li or ITC Procedures with a Vin CS and then OT under DA or NA Conditions

SOURCE	df	SS	F
INJ	1	535.92	8.35*
OTC	1	0.56	F<1
INJ X OTC	1	37.21	F<1
ERROR	28	1796.87	

*$p < .01$

Table 16.

Grand Means (GM) and Analysis of Variance Summary Table of Intake (g.) of Distilled Water on Injection Day 2 for Groups which Received Li or ITC Procedures with a Red CS and then OT under DA, NA or DAW Conditions

SOURCE	df	SS	F
INJ	1	24.00	F<1
GM Li=15.6			
GM ITC=19.0			
OTC	2	133.34	F<1
GM NA=18.9			
GM DA=18.5			
GM DAW=16.2			
INJ X OTC	2	640.40	3.34*
ERROR	42	4025.80	

*$p < .05$

Table 17.

Analysis of Variance Summary Tables of Intake (g.) of Distilled Water by Li and ITC Injection Conditions for Groups which Received Li or ITC Procedures with a Red CS and then OT under DA, NA or DAW Conditions

SOURCE	df	SS	F
		LiCl	
OTC	2	1018.13	3.61*
ERROR	21	2958.53	
		ITC	
OTC	2	142.47	F<1
ERROR	21	3080.17	

*p <.05

Table 18.

Grand Means (GM) and Analysis of Variance Summary Table of Pretest Intake (g.) of Distilled Water for Groups Conditioned with Red or Vin CSs and for ITC Groups, which were to Receive OT under DA or NA Conditions

SOURCE	df	SS	F
CS	1	253.13	2.92
GM Red=16.1			
GM Vin=18.9			
INJ	1	139.45	1.61
GM Li=18.5			
GM ITC=16.4			
OTC	1	35.70	F<1
GM DA=18.0			
GM NA=17.0			
CS X INJ	1	0.08	F<1
CS X OTC	1	1.05	F<1
INJ X OTC	1	20.80	F<1
CS X INJ X OTC	1	27.75	F<1
ERROR	56	4850.91	

Table 19.

Grand Means (GM) and analysis of Variance Summary Table of Pretest Intake (g.) of Distilled Water for Groups Conditioned with a Red CS and for ITC Groups, which were to Receive OT under DA, NA or DAW Conditions

SOURCE	df	SS	F
INJ	1	104.17	F<1
OTC	2	206.24	F<1
GM NA=15.4			
GM DA=16.7			
GM DAW=19.0			
INJ X OTC	2	48.44	F<1
ERROR	42	4423.87	

Table 20.

Grand Means (GM) and Analysis of Variance of Preinjection and Pretest Intake (g.) of Distilled Water for Groups Conditioned with Red or Vin CSs and for ITC Groups, which were to Receive OT under DA or NA Conditions

SOURCE	df	SS	F
CS	1	110.45	1.91
GM Red=16.1			
GM Vin=18.0			
INJ	1	1.30	F<1
GM Li=17.1			
GM ITC=17.0			
OTC	1	33.93	F<1
GM DA=17.5			
GM NA=16.5			
CS X INJ	1	87.29	1.51
CS X OTC	1	1.60	F<1
INJ X OTC	1	31.11	F<1
CS X INJ X OTC	1	46.92	F<1
ERROR	56	3230.75	
PRE	1	24.59	1.01
GM Pre1=16.6			
GM Pre2=17.5			
PRE X CS	1	29.17	1.20
PRE X INJ	1	113.82	4.68*
PRE X OTC	1	0.02	F<1
PRE X CS X INJ	1	82.08	3.37

Table 20 (cont.)

PRE X CS X OTC	1	0.06	F<1
PRE X INJ X OTC	1	1.03	F<1
PRE X CS X INJ X OTC	1	2.50	
ERROR	56	1362.37	

*p < .05

Table 21.

Analysis of Variance Summary Tables of Preinjection and Pretest Intake (g.) of Distilled Water by Li and ITC Injection Conditions for Groups Conditioned with Red or Vin CSs and for ITC Groups, which were to Receive OT under DA or NA Conditions

SOURCE	df	SS	F
		LiCl	
CS	1	o.68	F<1
OTC	1	0.03	F<1
CS X OTC	1	15.60	F<1
ERROR	28	1450.77	
PRE	1	122.10	7.76**
PRE X CS	1	104.55	6.64*
PRE X OTC	1	0.68	F<1
PRE X CS X OTC	1	0.90	F<1
ERROR	28	1450.77	

Table 21 (cont)

		ITC	
CS	1	197.05	3.10
OTC	1	65.00	1.02
CS X OTC	1	32.92	F<1
ERROR	28	1779.99	
PRE	1	16.30	F<1
PRE X CS	1	6.70	F<1
PRE X OTC	1	0.38	F<1
PRE X CS X OTC	1	1.66	F<1
ERROR	28	921.71	

*p <.05
**p <.01

Table 22.

Analysis of Variance Summary Table of Preinjection and Pretest Intake (g.) of Distilled Water for Groups Conditioned with a Red CS and for ITC Groups, which were to Receive OT under DA, NA or DAW Conditions

SOURCE	df	SS	F
INJ	1	24.00	F<1
OTC	2	194.81	1.50
INJ X OTC	2	112.16	F<1
ERROR	42	2731.07	
PRE	1	0.03	F<1
PRE X INJ	1	28.17	1.09
PRE X OTC	2	0.21	F<1
PRE X INJ X OTC	2	34.02	F<1
ERROR	42	1083.00	

Table 23.

Grand Means (GM) and Analysis of Variance Summary Table of Latency to Drink (sec) for Groups which Received Li or ITC Procedures with a Red CS and OT under DA or NA Conditions

SOURCE	df	SS	F
INJ	1	370401.69	15.86**
GM Li=132			
GM ITC=7			
OTC	1	200284.88	8.58**
GM DA=24			
GM NA=115			
INJ X OTC	1	173646.59	7.44*
ERROR	28	653818.27	
TRIAL	2	76774.43	1.99
GM Tr11=109			
GM Tr12=49			
GM Tr13=50			
INJ X TRIAL	2	66257.17	1.72
OTC X TRIAL	2	11053.97	F<1
INJ X OTC X TRIAL	2	9282.95	F<1
ERROR	56	1079835.81	

*$p < .05$
**$p < .01$

Table 24.

Analysis of Variance Summary Tables of Latency to Drink (sec) for each OT Condition for Groups which Received Li or ITC Procedures with a Red CS and OT under DA or NA Conditions

SOURCE	df	SS	F
		DA	
INJ	1	18412.25	2.39
ERROR	14	107755.43	
TRIAL	2	15567.20	1.10
TRIAL X INJ	2	13556.63	F<1
ERROR	28	198467.69	
		NA	
INJ	1	525636.02	13.48*
ERROR	14	546062.84	
TRIAL	2	72261.20	1.15
TRIAL X INJ	2	61983.49	F<1
ERROR	28	881368.11	

*p <.01

Table 25.

Analysis of Variance Summary Table of Latency to Drink (sec) for Groups which Received Li or ITC Procedures with a Red CS and OT under DA or DAW Conditions

SOURCE	df	SS	F
INJ	1	251791.38	8.35**
OTC	1	276351.15	9.16**
INJ X OTC	1	96032.48	3.18
ERROR	28	844669.81	
TRIAL	2	155642.26	4.90*
TRIAL X INJ	2	142421.21	4.48*
TRIAL X OTC	2	76599.20	2.41
TRIAL X INJ X OTC	2	113733.92	3.58*
ERROR	56	889591.77	

*$p < .05$
**$p < .01$

Table 26.

Analysis of Variance Summary Tables of Latency to Drink (sec) for each Injection Condition for Groups which Received Li or ITC Procedures with a Red CS and OT under DA or DAW Conditions.

SOURCE	df	SS	F
		LiCl	
OTC	1	349098.80	6.66*
ERROR	14	733868.08	
TRIAL	2	285645.84	6.41**
TRIAL X OTC	2	178804.80	4.02*
ERROR	28	623409.72	
		ITC	
OTC	1	23284.83	2.94
ERROR	14	10801.72	
TRIAL	2	12417.62	F<1
TRIAL X OTC	2	11528.33	F<1
ERROR	28	266182.05	

*$p < .05$

Table 27.

Analysis of Variance Summary Tables of Latency to Drink (sec) by Trial for Groups Conditioned with a Red CS and for ITC Groups, which Received OT under DA or DAW Conditions

SOURCE	df	SS	F
	Trial=1		
INJ	1	219370.32	6.44*
OTC	1	190174.86	5.58*
INJ X OTC	1	50490.48	1.48
ERROR	28	954112.88	
	Trial=2		
INJ	1	290.41	F<1
OTC	1	6199.41	1.25
INJ X OTC	1	6260.81	1.26
ERROR	28	139256.89	

Table 27 (cont)

		Trial=3	
INJ	1	174551.86	7.63**
OTC	1	156576.08	6.84*
INJ X OTC	1	153015.12	6.69*
ERROR	28	640891.81	

*p <.05
**p < .01

Table 28.

Grand Means (GM) and Analysis of Variance Summary Table of Latency to Drink (sec) for Groups Conditioned with a Vin CS and for ITC Groups, which Received OT under DA or NA Conditions

SOURCE	df	SS	F
INJ	1	110012.50	5.65*
GM Li=74.1			
GM ITC=6.4			
OTC	1	29288.11	1.50
GM DA=57.7			
GM NA=22.8			
INJ X OTC	1	35351.05	1.82
ERROR	28	545108.39	
TRIAL	2	107840.30	4.37*
GM Tr11=8.9			
GM Tr12=25.1			
GM Tr13=86.7			
INJ X TRIAL	2	115063.55	4.66*
OTC X TRIAL	2	22422.30	F<1
INJ X OTC X TRIAL	2	23708.64	F<1
ERROR	56	691233.27	

*$p < .05$

Table 29.

Analysis of Variance Summary Table of Latency to Drink (sec) for each Injection Condition for Groups which Received Li or ITC Procedures with a Vin CS and OT under DA or NA Conditions

SOURCE	df	SS	F
		LiCl	
OTC	1	64496.67	1.66
ERROR	14	54410.60	
TRIAL	2	222532.45	4.52*
TRIAL X OTC	2	46064.80	F<1
ERROR	28	689202.59	
		ITC	
OTC	1	142.49	1.82
ERROR	14	1097.78	
TRIAL	2	371.40	2.56
TRIAL X OTC	2	66.14	F<1
ERROR	28	2030.68	

*$p < .05$

Table 30.

Grand Means (GM) and Analysis of Variance Summary Table of Intake (g.) in Testing for Groups which Received Li or ITC Procedures with a Red CS and OT under DA or NA Conditions

SOURCE	df	SS	F
INJ	1	2288.33	16.93*
GM Li=1.7			
GM ITC=7.8			
OTC	1	173.61	1.28
GM DA=4.5			
GM NA=4.8			
INJ X OTC	1	20.26	F<1
ERROR	28	3783.93	
TRIAL	2	686.40	9.11*
GM Tr11=3.7			
GM Tr12=4.9			
GM Tr13=5.4			
INJ X TRIAL	2	148.93	1.98
OTC X TRIAL	2	44.01	F<1
INJ X OTC X TRIAL	2	41.93	F<1
ERROR	56	2109.76	

*$p < .01$

Table 31.

Grand Means (GM) and Analysis of Variance Summary Table of Intake (g.) in Testing for Groups which Received Li or ITC Procedures with a Red CS and OT under DA or DAW Conditions

SOURCE	df	SS	F
INJ	1	1921.57	13.97*
GM Li=6.3			
GM ITC=15.3			
OTC	1	34.68	F<1
GM DA=11.4			
GM DAW=10.2			
INJ X OTC	1	0.25	F<1
ERROR	28	3852.08	
TRIAL	2	912.86	14.65*
GM Tr11=6.7			
GM Tr12=11.8			
GM Tr13=14.0			
INJ X TRIAL	2	137.60	2.21
OTC X TRIAL	2	19.07	F<1
INJ X OTC X TRIAL	2	50.26	F<1
ERROR	56	1744.20	

*$p < .01$

Table 32.

Analysis of Variance Summary Table of Intake (g.) in Testing for Groups which Received Li or ITC Procedures with a Vin CS and OT under DA or NA Conditions

SOURCE	df	SS	F
INJ	1	844.90	28.31*
OTC	1	1.60	F<1
INJ X OTC	1	26.04	F<1
ERROR	28	835.62	
TRIAL	2	48.75	1.80
INJ X TRIAL	2	5.95	F<1
OTC X TRIAL	2	6.32	F<1
INJ X OTC X TRIAL	2	51.80	1.91
ERROR	56	757.75	

*$p < .01$

Table 33.

Grand Means (GM) and Analysis of Variance Summary Table of Log Intake (g.) in Testing for Groups which Received Li or ITC Procedures with a Red CS and OT under DA or NA Conditions

SOURCE	df	SS	F
INJ	1	34.55	36.61**
GM Li=-0.1			
GM ITC=1.1			
OTC	1	8.13	8.61**
GM DA=0.7			
GM NA=0.2			
INJ X OTC	1	6.28	6.65*
ERROR	28	26.43	
TRIAL	2	8.78	13.34**
GM Tr11=0.1			
GM Tr12=0.6			
GM Tr13=0.7			
INJ X TRIAL	2	5.95	9.04**
OTC X TRIAL	2	0.74	1.12
INJ X OTC X TRIAL	2	0.43	0.66
ERROR	56	757.75	

*$p < .05$
**$p < .01$

Table 34.

Analysis of Variance Summary Tables of Log Intake (g.) in Testing for each Injection Condition for Groups which Received Li or ITC Procedures with a Red CS and OT under DA or NA Conditions

SOURCE	df	SS	F
		LiCl	
OTC	1	14.34	8.73*
ERROR	14	22.99	
TRIAL	2	14.41	12.52**
OTC X TRIAL	2	1.15	1.00
ERROR	28	16.12	
		ITC	
OTC	1	0.06	F<1
ERROR	14	3.44	
TRIAL	2	0.31	1.91
OTC X TRIAL	2	0.02	F<1
ERROR	28	2.30	

*$p < .05$
**$p < .01$

Table 35.

Grand Means (GM) and Analysis of Variance Summary Table of Log Intake (g.) in Testing for Groups which Received Li or ITC Procedures with a Red CS and OT under DA or DAW Conditions

SOURCE	df	SS	F
INJ	1	24.30	15.40*
GM Li=0.1			
GM ITC=1.1			
OTC	1	3.65	2.31
GM DA=0.7			
GM DAW=0.4			
INJ X OTC	1	2.43	1.54
ERROR	28	44.19	
TRIAL	2	7.34	17.38*
GM Tr11=0.2			
GM Tr12=0.8			
GM Tr13=0.6			
INJ X TRIAL	2	2.22	5.26*
OTC X TRIAL	2	0.11	F<1
INJ X OTC X TRIAL	2	0.89	2.11
ERROR	56	11.82	

*$p < .05$

Table 36.

Analysis of Variance Summary Tables of Log Intake (g.) for each Injection Condition for Groups which Received Li or ITC Procedures with a Red CS and OT under DA or DAW Conditions

SOURCE	df	SS	F
	LiCl		
OTC	1	18.80	2.29
ERROR	14	16.87	
TRIAL	2	9.20	7.63*
TRIAL X OTC	2	1.50	1.25
ERROR	28	16.87	
	ITC		
OTC	1	0.01	F<1
ERROR	14	9.84	
TRIAL	2	0.82	3.0
TRIAL X OTC	2	0.47	1.71
ERROR	28	3.82	

*p <.01

Table 37.

Grand Means (GM) and Analysis of Variance Summary Table of Log Intake (g.) in Testing for Groups which Received Li or ITC Procedures with a Vin CS and OT under DA or NA Conditions

SOURCE	df	SS	F
INJ	1	21.52	31.27*
GM Li=-0.2			
GM ITC=0.7			
OTC	1	0.53	F<1
GM DA=0.2			
GM NA=0.3			
INJ X OTC	1	0.67	F<1
ERROR	28	19.27	
TRIAL	2	0.12	F<1
GM Tr11=0.3			
GM Tr12=0.3			
GM Tr13=0.2			
INJ X TRIAL	2	0.36	F<1
OTC X TRIAL	2	0.14	F<1
INJ X OTC X TRIAL	2	0.33	F<1
ERROR	56	17.85	

*$p < .01$

Table 38.

Grand Means (GM) and Analysis of Variance Summary Table of Percent Intake (%) of Red and Vin CSs in Testing for Groups which Received Li Procedures and OT under the NA Condition

SOURCE	df	SS	F
CS	1	1392.35	F<1
GM Red=22.5			
GM Vin=33.2			
ERROR	14	55596.79	
TRIAL	2	12867.41	5.18*
GM Tr11=11.7			
GM Tr12=21.4			
GM Tr13=50.3			
TRIAL X CS	2	598.33	F<1
ERROR	28	34757.17	

*p <.05

Table 39.

Grand Means (GM) and Analysis of Variance Summary Table of Percent Intake (%) of Red and Vin CSs in Testing for Groups which Received Li Procedures and OT under DA or NA Conditions

SOURCE	df	SS	F
CS	1	1992.01	F<1
GM Red=32.0			
GM Vin=22.9			
OTC	1	12.97	F<1
GM DA=27.1			
GM NA=27.8			
CS X OTC	1	9487.19	3.52
ERROR	28	75471.93	
TRIAL	2	22601.02	11.56**
GM Tr11=10.4			
GM Tr12=24.5			
GM Tr13=47.6			
TRIAL X CS	2	4475.91	2.29
TRIAL X OTC	2	575.40	F<1
CS X OTC X TRIAL	2	6213.35	3.18*
ERROR	56	54751.95	

*p <.05
**p < .01

Table 40.

Analysis of Variance Summary Tables of Percent Intake (%) of Red and Vin CSs for each Trial for Groups which Received Li Procedures and OT under DA or NA Conditions

SOURCE	df	SS	F
	Trial=1		
CS	1	609.66	4.92*
OTC	1	62.14	F<1
CS X OTC	1	181.49	1.46
ERROR	28	3470.64	
	Trial=2		
CS	1	1080.99	1.05
OTC	1	289.75	F<1
CS X OTC	1	1293.26	1.25
ERROR	28	28900.35	

Table 40 (cont)

Trial=3			
CS	1	4777.27	1.37
OTC	1	236.49	F<1
CS X OTC	1	14225.80	4.07*
ERROR	28	97852.90	

*p <.05

Table 41.

Analysis of Variance Summary Table of Intake (Arcsin) of Red and Vin CSs in Testing for Groups which Received Li Procedures and OT under the NA Condition

SOURCE	df	SS	F
CS	1	0.429	4.16
ERROR	14	1.444	
TRIAL	2	0.126	F<1
TRIAL X CS	2	0.0843	F<1
ERROR	24	1.779	

Table 42.

Grand Means (GM) and Analysis of Variance Summary Table of Intake (Arcsin) of Red and Vin CSs in Testing for Groups which Received Li Procedures and OT under DA or NA Conditions

SOURCE	df	SS	F
CS	1	0.006	F<1
GM Red=0.17			
GM Vin=0.17			
OTC	1	0.091	F<1
GM DA=0.19			
GM NA=0.15			
CS X OTC	1	0.812	7.41*
ERROR	28	3.017	
TRIAL	2	0.772	3.90*
GM Trl1=0.30			
GM Trl2=0.19			
GM Trl3=0.16			
TRIAL X CS	2	0.435	2.20
TRIAL X OTC	2	0.352	1.78
CS X OTC X TRIAL	2	0.443	2.24
ERROR	49	4.730	

*$p < .05$

Table 43.

Analysis of Variance Summary Tables of Intake (Arcsin) for each CS Condition for Groups which Received Li Procedures with a Red or Vin CS and OT under NA or DA Conditions

SOURCE	df	SS	F
	CS=Red		
OTC	1	0.717	5.86*
ERROR	14	1.713	
TRIAL	2	1.142	4.43*
TRIAL X OTC	2	0.772	3.06
ERROR	23	2.902	
	CS=Vin		
OTC	1	0.171	1.83
ERROR	14	1.304	
TRIAL	2	0.043	F<1
TRIAL X OTC	2	0.006	F<1
ERROR	26	1.828	

*$p < .05$

Table 44.

Analysis of Variance Summary Table of Latency to Drink (sec) on Test Trial 3 and Retention Test Trials 1 and 2 for Groups which Received Li Procedures with a Red CS and OT under DA or NA Conditions and for the ITC Group which Received OT under the DA Condition

SOURCE	df	SS	F
OTC	2	97303.12	2.87
ERROR	15	254198.22	
TRIAL	2	18561.03	1.96
TRIAL X OTC	4	44403.98	2.34
ERROR	30	142350.62	

Table 45.

Analysis of Variance Summary Table of Latency to Drink (sec) on Test Trial 3 and Retention Test Trials 1 and 2 for Groups which Received Li Procedures with a Vin CS and OT under DA or NA Conditions and for the ITC Group which Received OT under the DA Condition

SOURCE	df	SS	F
OTC	2	149753.81	1.38
ERROR	15	811290.67	
TRIAL	2	130767.38	4.43*
TRIAL X OTC	4	187653.21	3.18*
ERROR	30	442821.70	

*$p < .05$

Table 46.

Analysis of Variance Summary Table of Intake (g.) on Test Trial 3 and Retention Test Trials 1 and 2 for Groups which Received Li Procedures with a Red CS and OT under DA or NA Conditions and for the ITC Group which Received OT under the DA Condition

SOURCE	df	SS	F
OTC	2	254.95	F<1
ERROR	15	4334.16	
TRIAL	2	208.61	1.37
TRIAL X OTC	4	119.25	F<1
ERROR	30	2285.63	

Table 47.

Analysis of Variance Summary Table of Intake (g.) on Test Trial 3 and Retention Test Trials 1 and 2 for Groups which Received Li Procedures with a Vin CS and OT under DA or NA Conditions and for the ITC Group which Received OT under the DA Condition

SOURCE	df	SS	F
OTC	2	206.43	5.45*
ERROR	15	283.96	
TRIAL	2	7.52	F<1
TRIAL X OTC	4	40.41	1.17
ERROR	30	257.97	

*$p < .05$

Table 48.

Analysis of Variance Summary Table of Log Intake (g.) on Test Trial 3 and Retention Test Trials 1 and 2 for Groups which Received Li Procedures with a Red CS and OT under DA or NA Conditions and for the ITC Group which Received OT under the DA Condition

SOURCE	df	SS	F
OTC	2	3.58	1.10
ERROR	15	24.46	
TRIAL	2	1.74	3.59*
TRIAL X OTC	4	1.50	1.54
ERROR	30	7.27	

*$p < .05$

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