In those cases in which a nonlittermate was presented and no actual attack occurred, other agonistic behaviors, such as "freezing" and "flight" by "intruders" and piloerection and aggressive posture by "home gerbils," were always observed in such instances. In no case did these behaviors occur during encounters between nonseparated littermates. "Foot-stomping" was occasionally observed when "home gerbils" were presented with nonlittermates. This rather unique behavior does not appear to be a signal toward aggression. In the most aggressive of the animals, the attack response was almost instantaneous. "Foot-stomping" was observed only when the actual attack was not immediate or when no attack response occurred within the 3-min presentation interval. Another observation of interest was that when a submissive posture was assumed by an intruder animal, attack by the home gerbil was allayed. This was especially true in the case where the intruder animal was a mouse. If any sudden movement by an intruder occurred, however, an aggressive posture, generally followed by subsequent attack, was immediately assumed by the home gerbil.

It should also be noted that a 6-week isolation period greatly increased aggressive behavior among littermates. Isolated littermates were not discriminated from nonlittermates in terms of aggressive behavior by home gerbils. This finding suggests the operation of habituation and dishabituation-like processess in the control of aggressive behavior in this species. Thiessen (1968) has pointed to the role of similar processes in explaining the apparent monogamous behavior of gerbils. A possible mechanism underlying the differential aggressive behavior observed in the present study might be attack-inhibiting and attack-exciting properties of familiar and unfamiliar olfactory cues, respectively. Whether or not such cues are as important as they appear to be in the case of mouse-killing behavior in rats (Myer, 1964) remains to be demonstrated.


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NOTES

1. Ginsburg, H. J., & Braud, W. G. Decrement and shock-induced increment in preference of a familiar litter environment in the Mongolian gerbil. In preparation.

2. We are indebted to Miss Diana Rosen for her assistance during this phase of the experiment.

# Comparison of taste aversion with various delays and Cyclophosphamide dose levels*


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A drug-induced sickness was paired with flavored water to induce a taste-aversion response in rats. Three Cyclophosphamide dosage levels and three time-delay intervals were used. Three pairings of the drug and flavored water were followed by three presentations of the flavored water alone. The drug-dose level, the time delay between drinking and injection, and the number of trials effected the acquisition and extinction portions of the learning curve. The rate of acquisition of the response was related to both the Drug-Dose Level by Trials interaction and the Time Interval by Trials interaction, while the rate of extinction was related only to the Drug-Dose Level by Trials interaction.


The acquisition of a response has been regarded as theoretically and practically limited by the amount of delay between the conditioned stimulus and the unconditioned stimulus or between the response and the reinforcer. Barnett (1963) described a "new object reaction" in wild rats, where avoidance to unfamiliar foods or familiar foods in a new place is observed (neophobia) and noted that this reaction was not observed in laboratory rats. When rats eat poisoned foods, the survivors quickly learn to avoid these foods on subsequent encounters. The interval between eating and sickness from poisoned food would suggest that the contiguity principle is not inviolate. Delay of punishment of up to 75 min after drinking flavored water has produced a drinking aversion (Garcia, Ervin, & Koelling, 1966), and delay of positive reinforcement up to 30 min has produced an increase in drinking flavored water (Garcia, Ervin, Yorke, & Koelling, 1967). Garcia, Ervin, & Koelling (1967) varied the amount of an illness-producing drug injected 5 min after drinking flavored water and found that the taste-aversion acquisition curve was related to the magnitude of the dose. In a set of experiments, Revusky (1968) also found that various delays (up to 6.5 h) and varying amounts of punishment (x-irradiation) produced differential aversions to drinking sucrose-flavored


*The authors wish to acknowledge the support of the National Science Foundation (Grant GJ274) and the John F. Kennedy Center for Research on Education and Human Development, George Peabody College, Nashville, Tennessee, for assistance in the data analyses.

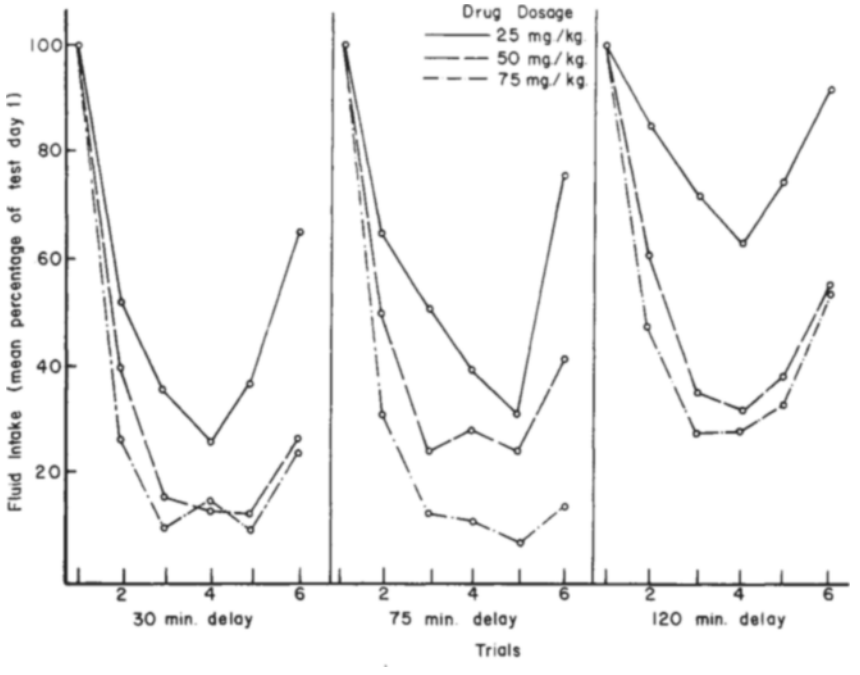


**Fig. 1. Differential effects of dose level and amount of delay on acquisition (Trials 1-3) and extinction (Trials 4-6) of a taste-aversion response.**

water. However, no attempt was made to evaluate interaction effects.

The purpose of the present study was to replicate findings of the delay studies and to investigate the interaction of time-delay and dose-level variables.

## SUBJECTS

Experimentally naive male albino rats were used as Ss. The Ss had an age range of 80-110 days, with a weight range of 243-367 g at the beginning of the experiment. As soon as the animals arrived at the laboratory, they were housed individually without water bottles and with Purina Laboratory Chow ad lib. Five Ss (all except one from the high-drug-level/short-time-interval group) died prior to the last testing day and were replaced. Two additional Ss from this group died on the last test day, and group means were used for their terminal datum in the analyses.

## PROCEDURE

The Ss were deprived of water, except for a 10-min drinking period between 9:45 and 11:00 a.m. each day. On test days the water was flavored by the addition of 1 g of saccharin per liter of water. Tests were administered every 3 days, providing 2 recovery days between test sessions. Only distilled water was used throughout the experiment. The Ss were habituated to the watering schedule for 1 week prior to the experimental treatments.

The time between the removal of the bottles containing flavored water and injection, and the amount of drug injected were varied. Three trials with injection were followed by three trials without injection to study the effects on acquisition and extinction of the "taste-aversion" response to flavored water. Cyclophosphamide (Cytoxan$^R$, Mead Johnson Laboratories, Evansville, Indiana) was used as the sickness-inducing agent for the reasons discussed by Garcia et al (1967). The treatment conditions were three levels of drug dosage (25, 50, and 75 mg/kg of S body weight) at three intervals between the removal of the saccharin-flavored water bottles from the cages and the intraperitoneally injected drug dosage (30, 75, and 120 min for a total of nine groups of six Ss each). Before each test, each S was weighed to determine the amount of drug dosage he was to receive. The volume of water (ccs) that each S drank was recorded each day. Only data for the 6 test days were used for the statistical analyses. A three-way analysis of variance with repeated measures on trials was used for the data analyses.

## RESULTS AND DISCUSSION

The recorded data was transformed into percentage scores by dividing the amount drunk on each subsequent test day by the amount drunk on Test Day 1 for each S. Therefore, each S had a score of 100% on the first test day. Figure 1 presents the mean percentages of flavored water drunk on each test day for the nine treatment conditions.

Analysis of variance of these data (Drug Level by Time Interval by Trials) indicates statistically significant ($p < .001$) main effects of drug-dosage level, time interval, trials, and interaction effects of Drug Level by Trials and Time Interval by Trials. An analysis of variance using the actual amount of saccharin-flavored water drunk instead of the transformed percentage scores yielded the same significant effects as did the analysis of percentage scores.

The percentage scores for Trials 1-3 were submitted to a separate analysis of variance in order to investigate the nature of the acquisition phase of the experiment. This analysis yielded significant ($p < .001$) effects of drug level, time interval, trials, Drug Level by Trials, and Time Interval by Trials. A separate analysis was also performed on the data for Trials 4-6 to investigate the extinction phase of the learning curve, and the results were the same as those in the acquisition phase, except that the Time Interval by Trials interaction effect was not statistically significant. Since there was no control group that received sickness without prior consumption of saccharin, some of the aversion might be simply a sickness effect and not due to learning. The interval of 2 days between test days may or may not have provided adequate time for completely discounting this possibility.

The results indicate that the "taste-aversion" response is enhanced by greater dose level of drug, shorter time intervals between drinking the flavored water and drug injection, and the number of trials given. There was no significant relationship between dose level and time interval. The rate of both acquisition and extinction is related to the interaction of Dose Level by Trials. High-dose-level animals learn faster and extinguish more slowly than do lower-dose-level animals. The Time Delay by Trials interaction was related only to rate of acquisition. Animals with shorter delays between response and drug injection learn faster than do animals with longer delays, but they do not differ significantly on rate of extinction.

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