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Specific and generalized adaptation of salivary conditioning in dogs

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The role of prior training on subsequent salivary conditioning in dogs was examined. The experiment investigated both the specific effect of nonreinforced stimulus presentations upon subsequent acquisition to the same stimulus, and the generalized effects of reinforced or nonreinforced stimulus presentations upon subsequent acquisition to a different stimulus. It was found that adaptation to the experimental apparatus, nonreinforced presentations of a different stimulus or nonreinforced presentations of the same stimulus all retarded subsequent classical conditioning. These results were in contrast to the performance of groups which received prior training consisting of reinforced presentations of a different stimulus alone or reinforced presentations of a different stimulus combined with nonreinforced presentations of the to-be-conditioned stimulus.

Nonreinforced presentations of a stimulus, prior to pairing of that stimulus with an unconditioned stimulus, result in slower subsequent classical conditioning to that stimulus (Carlton & Vogel, 1967; Konorski & Szwejkowska, 1952; Lubow, 1965; Lubow, Markman & Allen, 1968; Lubow & Moore, 1959; Pavlov, 1927; Schnur, 1971; Schnur & Ksir, 1969; Siegel, 1969). Explanations of this phenomenon, labeled latent inhibition by Lubow and Moore (1959), have invoked processes related to habituation, adaptation, or shifts in attention.

In addition to the direct effect of nonreinforcement upon subsequent acquisition, generalized effects of nonreinforcement upon subsequent acquisition have been observed. Konorski and Szwejkowska (1952) found that nonreinforced presentations of one stimulus resulted in slower subsequent conditioning to a second stimulus. Konorski and Szwejkowska (1952) stated that the functional properties of a given stimulus depend not only on training with that stimulus, but also on training with all other stimuli. On the other hand, Carlton and Vogel (1967), Schnur and Ksir (1969), and Schnur (1971) compared a group that was placed in the experimental apparatus without stimulus presentations with a group that was placed in the apparatus and presented with nonreinforced exposures of one stimulus; all failed to find statistically significant differences in the subsequent rate of acquisition to a novel stimulus.

Responding to any stimulus may be both a function of the organism's past history with that stimulus and a function of the organism's past history with other stimuli. In its simplest form, the investigation of these specific and generalized effects of prior experience may be conceptualized as involving two stimuli. Each of these stimuli has three possible prior states: A stimulus may be absent, present without reinforcement, or present with reinforcement. Given an interest in the effect of prior stimulus exposure on subsequent acquisition, the prior reinforcement of a to-be-conditioned stimulus is an irrelevant experimental treatment. Therefore, the present study employed a 2 by 3 factorial design. The to-be-conditioned stimulus was either absent or present without reinforcement in Phase I. Another stimulus was either absent, present without reinforcement, or present with reinforcement in Phase I. Table 1 shows the six possible conditions in which acquisition of a conditioned response to a stimulus may be studied with prior training which does not include reinforcement of the to-be-conditioned stimulus.

An additional group controlled for the number of presentation trials. All seven groups received the same acquisition training in Phase II.

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METHOD

Subjects

The subjects were 56 mongrel dogs obtained from the Emory University animal detention house. Subjects were housed in

Table 1
Factorial Representation of Experimental Design

CS	CS′		
	Absent	Present	
		Not Reinforced	Reinforced
Absent	Group 1	Group 2	Group 3
Present	Group 4	Group 5	Group 6
Not Reinforced			

individual stainless steel cages with water, but not food, continuously available.

Apparatus

The three experimental chambers were metal cubes, approximately 61 cm on a side (Lehigh Valley Electronics Model 1317). Each chamber had a ventilating fan, speaker, food tray, and houselight. A food magazine delivered 8 g of Wayne Bite Size dog food on each reinforced trial. Reinforced trials consisted of a 12-sec stimulus presentation which terminated with 2 sec of food presentation, i.e., the auditory stimulus was presented alone for 10 sec and simultaneously with food for 2 sec. Nonreinforced trials consisted of a 12-sec stimulus which terminated without food. Two auditory stimuli, a 1600-Hz tone and a white noise, each approximately 80 db, were used in the experiment. The sessions were conducted with the chambers in complete darkness. The mean intertrial interval was 8.5 min.

Surgical Preparation

The surgical preparation has been described in detail by Shapiro and Miller (1965). Briefly, a marker tube was inserted into the orifice of Stensen's duct on the left-hand side, and the duct was blunt dissected through an external incision. One end of a V-shaped polyethylene tube (Clay-Adams PE 50) was inserted into the duct, the duct ligated, and the tube sutured to the surrounding muscle. The other end of the tube was run underneath the dog's skin and out a small incision on the dorsal surface of the dog's neck. The external incision in the cheek was closed, penicillin administered and the dog returned to his home cage. The dog was run on the day following surgery.

If the preparation failed during the course of the experiment, the right-hand duct was prepared and used for the remainder of the experiment.

Recording System

The salivary response was recorded by connecting the dog's tube to a second tube (Clay-Adams PE 100) which was run through the top of the chamber; this second tube was connected to a specially prepared glass L-shaped tube, .93 cm in diam, containing approximately 100 cc of 90% water and 10% alcohol. The bottom of the glass tube was connected to a drop counting device located 1.5 m below the level of the chamber top. Each drop of saliva closed a gap between a 22-gauge stainless steel hypodermic needle and a brass rod, activating a pulse former which operated printout and electromechanical counters.

Procedure

During the course of the experiment, all dogs received the same amount of food each day. Food not delivered in the experimental chamber was available in the home cage. All dogs were magazine trained for 1.5 h per day, for 10 days, prior to the start of the experiment.

Eight dogs were randomly assigned to each of seven groups (Table 2). Each subject was trained for 10 days in Phase I and 10 days in Phase II. The treatment of the groups differed only during Phase I. All groups were counterbalanced for stimuli. For one-half of the subjects in each group the stimulus to be conditioned in Phase II was a tone, and for the other one-half of the subjects in each group the stimulus to be conditioned in Phase II was a white noise.

Phase I training. All groups were placed in the apparatus for the same amount of time during each session of Phase I. Group 1 received neither auditory stimuli nor food; this group received adaptation to the experimental chamber in Phase I prior to classical conditioning in Phase II. Group 2 received six nonreinforced trials per day of one of the stimuli; the stimulus presented in Phase I was different from the stimulus which was subsequently reinforced in Phase II. Group 3 received six reinforced trials per day of one of the stimuli; the stimulus presented in Phase I was different from the stimulus which was subsequently reinforced in Phase II. Group 4 received six nonreinforced trials per day of one of the stimuli; the stimulus presented in Phase I was the same as the stimulus which was subsequently reinforced in Phase II. Group 5 received six nonreinforced trials with each of two stimuli in unsystematic order in Phase I; one of the stimuli in Phase I was subsequently reinforced in Phase II. Group 6 received discrimination training consisting of six trials with each of two stimuli in unsystematic order. One stimulus was reinforced and the other stimulus was not; the stimulus which was not reinforced in Phase I was the stimulus which was subsequently reinforced in Phase II. Group 7 differed from Group 4 only in the number of trials per day, 12 nonreinforced trials per day instead of six; the stimulus presented in Phase I was the same as the stimulus which was subsequently reinforced in Phase II.

Table 2
Experimental Design

Group	Phase I		Phase II	
	Stimulus Presentation	Number of Trials	Stimulus Presentation	Number of Trials
(1) Nonspecific Adaptation	No Stimuli		CS – US	6
(2) Different Stimulus Adaptation	CS′ – 0	6	CS – US	6
(3) Different Stimulus Reinforcement	CS′ – US	6	CS – US	6
(4) Direct Adaptation	CS – 0	6	CS – US	6
(5) Direct and Different Stimulus Adaptation	CS – 0 & CS′ – 0	6 6	CS – US	6
(6) Discrimination	CS – 0 & CS′ – US	6 6	CS – US	6
(7) Direct Adaptation II	CS – 0	12	CS – US	6

CS: to-be-continued stimulus (tone or noise) *CS′: different stimulus* *US: food* *0: no food* *–: is followed by*

Phase II training. Phase II trials were the same for all subjects. There were six reinforced trials per day of one of the stimuli (tone or white noise).

RESULTS

On each trial, drops of saliva were counted during the 10-sec period preceding the conditioned stimulus presentation, during the 10-sec period in which the conditioned stimulus was presented alone, and during the 10-sec period which began with the presentation of food. For purposes of analysis, the conditioned response was defined as the number of drops of saliva during the 10-sec conditioned stimulus interval minus the number of drops in the 10-sec interval immediately preceding the onset of the conditioned stimulus.

Analyses of variance were used to analyze the data; orthogonal comparisons were employed to test more specific hypotheses. An analysis of asymptotic performance showed that all groups obtained the same level of salivation to the conditioned stimulus by Day 10. The effects of Phase I training upon subsequent acquisition in Phase II were most clearly reflected in the performance on Day 1 of Phase II. Figure 1 shows the mean conditioned salivary response for Groups 1 through 6 on Day 1 of Phase II in three blocks of two trials. The figure indicates that there were no initial differences among the groups. However, by the third block of trials, there was a difference between the groups that received reinforcement in Phase I and the groups that received no reinforcement in Phase I. Reinforcement of one stimulus in Phase I for Groups 3 and 6 resulted in faster conditioning to the other stimulus in Phase II, even though for Group 6 the stimulus reinforced in Phase II had been presented without reinforcement in Phase I.

The acquisition data from Day 1 of Phase II, were statistically analyzed as a function of training in Phase I. There was no significant difference ($F < 1$, $df = 1/42$) between the three groups (1, 2, 3) in which the to-be-conditioned stimulus had not been presented in Phase I and the three groups (4, 5, 6) in which the to-be-conditioned stimulus had been presented without reinforcement in Phase I. Presenting the to-be-conditioned stimulus without reinforcement did not retard subsequent acquisition to that stimulus in comparison to groups for which the to-be-conditioned stimulus was absent.

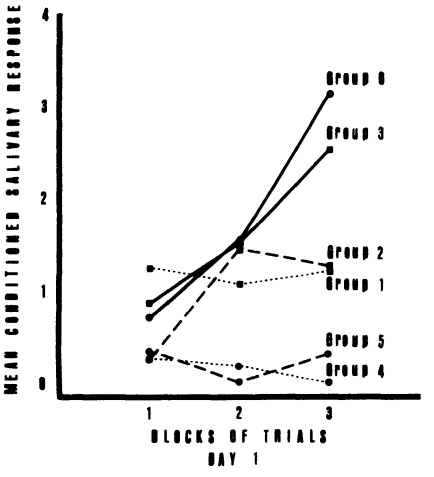

Figure 1. Phase 2, blocks of two trials each, Day 1, mean conditioned salivary responses for Groups 1 through 6.

There were no differences on Day 1 of Phase II among the groups (1, 4) in which a second stimulus had not been presented during Phase I, the groups (2, 5) in which a second stimulus was presented but not reinforced in Phase I, and the groups (3, 6) in which a second stimulus was presented and reinforced in Phase I ($F = 2.08$, $df = 2/42$). The magnitude of the conditioned response increased over blocks ($F = 4.89$, $df = 2/84$, $p < .05$), and there was a significant interaction between blocks and the three sets of groups ($F = 3.43$, $df = 4/84$, $p < .05$). This interaction was partitioned; acquisition during Day 1 of Phase II for the two groups (3, 6) which had received reinforcement during Phase I was compared to the acquisition of the four groups (1, 2, 4, 5) that had not received reinforcement during Phase I. The groups (3, 6) which had received reinforcement during Phase I showed faster acquisition on Day 1 of Phase II than the groups (1, 2, 4, 5) which received no reinforcement in Phase I ($F = 6.26$, $df = 2/84$; $p < .01$). Groups 1 and 2 were also compared with Groups 4 and 5; they were not significantly different ($F < 1$, $df = 2,84$).

The performance on Day 1 of Phase II was compared among the groups (5, 6, 7) that received 12 trials per day in Phase I. The groups were statistically different ($F = 4.46$, $df = 2,21$; $p < .05$). Partitioning of this difference indicated that the discrimination group (6) was statistically different ($F = 8.82$, $df = 1,21$; $p < .01$) from the combined results of the group (5) which received six nonreinforced trials of the to-be-conditioned stimulus and six nonreinforced trials of a second stimulus and the group (7) which received 12 nonreinforced trials of the to-be-conditioned stimulus. Groups 5 and 7 were not different from each other ($F < 1$, $df = 1,21$). Group 6 showed faster acquisition on Day 1 of Phase II than Groups 5 and 7, although all three groups received nonreinforced trials of the to-be-conditioned stimulus in Phase I.

The data from the two groups (3, 6) that received reinforcement in Phase I were analyzed in an attempt to answer two questions. The first question concerned the effect of acquisition of a conditioned response to one stimulus upon the subsequent acquisition of a conditioned response to a second stimulus. The second question concerned the effect of discrimination training on subsequent conditioning to the previously nonreinforced stimulus. The Day 1 acquisition data in Phases I and II were compared for both Groups 3 and 6. The comparison of salivation in Phases I and II did not show any learning to learn effect. Acquisition of a conditioned

response to the second stimulus did not differ significantly from that to the first stimulus (for Group 3, $t = 1.08$, $df = 7$; for Group 6, $t = 72$, $df = 7$).

The performance of Group 3 in Phase I reflected only the effect of prior experience with magazine training. Some researchers might have considered the performance of Group 3 in Phase I a more appropriate baseline or experimental control. The performance of Group 3 in Phase I was highly consistent with the performance of Group 3 in Phase II. If the Phase I performance of Group 3 was substituted for the Phase II performance of Group 3 in each of the preceding analyses, the resulting F values would not differ by more than a factor of 1.3 from the previously reported F values. Wherever a significant difference existed between the Phase II performance of Group 3 and any other group's Phase II performance, a significant difference also existed between the Phase I performance of Group 3 and any other group's Phase II performance.

DISCUSSION

The present experiment investigated specific and generalized effects of prior experience on subsequent salivary conditioning in dogs. It was found that exposure to the experimental apparatus alone, with neither food nor other stimuli presented, retarded subsequent acquisition of a conditioned response. This result is interesting because this treatment has been used as a control procedure in previous experiments. Schnur (1971), Schnur and Ksir (1969), and Carlton and Vogel (1967) concluded that the latent inhibition effect was specific to the stimulus presented without reinforcement and was not the result of a lowered general tendency to respond. The behavior of Group 1 in this experiment suggests that the treatment which Group 1 received is not an appropriate control for testing the effects of experimental treatments. An alternative control might have been a group without any prior training (Group 3 in Phase I). The Phase II performance of the Groups (1, 2, 4, 5) which had not received reinforcement during Phase I differed significantly from the Phase II performance of Group 6 and either the Phase I or Phase II performance of Group 3. The performance of the four groups not receiving reinforcement during Phase I provides strong evidence for a general, as well as a specific, effect upon subsequent conditioning. Konorski and Szwejkowska (1952) have previously stated that the functional properties of a given stimulus, at least under some circumstances, depend not only on the specific training with that stimulus, but also on the general training with all other stimuli. This statement should include the effect of prior exposure to the experimental apparatus.

A second interesting finding of this experiment was that the group given reinforced presentations of a different stimulus combined with nonreinforced presentations of the to-be-conditioned stimulus during Phase I did not show retardation of acquisition during Phase II. Although both the adaptation group (4) and the discrimination group (6) received nonreinforced presentations of the to-be-conditioned stimulus, only the adaptation group showed retarded acquisition in Phase II. One possible explanation for this difference utilizes an attentional hypothesis which states that a stimulus is attended to only when there is some reinforcement contingency within the experimental situation. In an adaptation paradigm there is no reinforcing stimulus present and the animal ceases to attend. In discrimination training the situation is somewhat different. Since reinforcement is presented with one of the two stimuli involved in the discrimination, attention is maintained. The discrimination procedure requires that the animal attend to stimuli. Maintenance of attention throughout Phase I facilitates conditioning in Phase II.

The effects of the experimental manipulations were upon the rate of acquisition and not upon the asymptotic level. By the end of Phase II, all differences among groups had disappeared. An attentional hypothesis would predict that the presence of reinforcement in Phase II would ultimately reinstate attention. Conditioning would then be expected to occur within all groups and all groups would achieve comparable levels of responding.

REFERENCES

Carlton, P. L., & Vogel, J. R. Habituation and conditioning. *Journal of Comparative and Physiological Psychology*, 1967, **63**, 348-351.

Konorski, J., & Szwejkowska, G. Chronic extinction and restoration of conditioned reflexes: IV. The dependence of the course of extinction and restoration of conditioned reflexes on the "history" of the conditioned stimulus (the principle of the primacy of first training). *Acta Biologae Experimentalis*, 1952, **16**, 95-113.

Lubow, R. E. Latent inhibition: Effects of frequency of non-reinforced pre-exposure of the CS. *Journal of Comparative and Physiological Psychology*, 1965, **60**, 454-457.

Lubow, R. E., Markman, R. E., & Allen, J. Latent inhibition and classical conditioning of the rabbit pinna response. *Journal of Comparative and Physiological Psychology*, 1968, **66**, 688-694.

Lubow, R. E., & Moore, A. U. Latent inhibition: The effect of non-reinforced pre-exposure to the conditional stimulus. *Journal of Comparative and Physiological Psychology*, 1959, **52**, 415-419.

Pavlov, I. P. *Conditioned Reflexes.* G. V. Anrep (trans.) Oxford: University Press, 1927.

Schnur, P. Selective attention: Effect of element pre-exposure on compound conditioning in rats. *Journal of Comparative and Physiological Psychology*, 1971, **76**, 123-130.

Schnur, P., & Ksir, C. J. Latent inhibition in human eyelid conditioning. *Journal of Experimental Psychology*, 1969, **80**, 388-389.

Shapiro, M. M., & Miller, T. M. On the relationship between conditioned and discriminative stimuli and between instrumental and consummatory responses. In W. F. Prokasy (Ed.), *Classical conditioning: A symposium. New York: Appleton-Century-Crofts, 1965.*

Siegel, S. Effect of CS habituation on eyelid conditioning. *Journal of Comparative and Physiological Psychology*, 1969, **68**, 245-248.

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