Second-order conditioning: The importance of stimulus overlap on second-order trials

RICHARD MAISIAK and PETER W. FREY
Northwestern University, Evanston, Illinois 60201

Second-order conditioning was examined using the rabbit eyeblink paradigm and the gerbil CER paradigm. Pavlov's hypothesis that stimulus overlap on second-order trials produces conditioned inhibition and that nonoverlap leads to second-order conditioning was not confirmed. Our results also revealed that the manner in which first-order and second-order trials are intermixed has an important influence on the properties of the second-order CS. A within-session mixture of first- and second-order trials tended to produce second-order conditioning, and a between-session mixture tended to produce conditioned inhibition. Second-order conditioning was more prominent with the gerbil fear response than with the rabbit eyelid response.

Pavlov (1927) reported that a stimulus repeatedly followed by food not only comes to produce a conditioned salivary response, it can also be used as a reinforcer to establish conditioned salivation to another neutral stimulus. He termed the latter procedure "higher order" conditioning. He also reported that a novel stimulus which was repeatedly presented with an excitatory stimulus in the absence of reinforcement would become inhibitory. Pavlov termed this process "conditioned inhibition." The procedure of presenting nonreinforced presentations (second-order trials) of a serial CS and reinforced presentations (first-order trials) of the second component of that serial CS has been used by contemporary researchers to produce either of the above phenomena. Second-order conditioning has been produced in this manner with the fear response in rats (e.g., Davenport, 1966) and with the salivary response in dogs (e.g., Shapiro, Sadler, & Mugg, 1971). Conditioned inhibition has been reported with this procedure with the fear response in dogs (e.g., Rescorla & LoLordo, 1965) and with the rabbit nictitating membrane response (e.g., Mis, Lumia, & Moore, 1972).

Pavlov (1927) believed that the temporal relationship of the two serial components determined the associative polarity of the first component. He stated that stimulus overlap would lead to inhibition and that a nonoverlapping arrangement would produce excitation. There have been few experiments which have directly tested this hypothesis. Rescorla (1972) compared overlapping and coterminating components with nonoverlapping components. An overlapping second-order CS

acquired less excitation than a nonoverlapping second-order CS. Since the overlapping second-order CS did acquire some excitatory tendencies, the results failed to support the overlap hypothesis. Researchers employing an overlapping second-order CS have also demonstrated conditioned inhibition (e.g., Rescorla, 1971) as well as second-order conditioning (e.g., Rizley & Rescorla, 1972). Although employed infrequently, there is one case (Rescorla, 1973a) of a nonoverlapping second-order CS producing second-order conditioning and one (Rescorla & LoLordo, 1965) where it produced conditioned inhibition.

Another inhibition variable may be the method of mixing first-order and second-order trials. All reported demonstrations of conditioned inhibition have included many first- and second-order trials intermixed during the same session (less than 2 h in length). Second-order conditioning has been produced with this within-session mixture (e.g., Rescorla, 1973a) as well as with a between-session mixture (e.g., Rizley & Rescorla, 1972), i.e., the separation of first- and second-order trials into different sessions about 24 h apart. This variable was explicitly manipulated in our first experiment.

There is also evidence (Herendeen & Anderson, 1968; Holland & Rescorla, 1975; Rescorla, 1973b) from studies which intermixed first-order and second-order trials in each session that second-order CRs are temporary phenomena which precede the development of a conditioned inhibitor. The present studies provide additional information concerning whether the stage of training is the crucial variable in this regard or whether other aspects of the conditioning procedure are of equal or greater import.

EXPERIMENT 1

Our first study manipulated the degree of overlap of the two CSs on second-order trials using both between- and within-session mixtures of first- and second-order

This research was supported in part by National Science Foundation Grant BMS75-02313 to the second author and is based on a doctoral dissertation submitted by the first author to the Graduate School of Northwestern University in partial fulfillment of the requirements for the PhD degree. Reprints may be obtained from Peter Frey, Department of Psychology, Northwestern University, Evanston, Illinois 60201.

trials. According to the previous hypotheses, overlapping the stimuli on second-order trials should tend to produce conditioned inhibition, while separating the stimuli should tend to produce second-order conditioning. Also, mixing the first- and second-order trials within the same session should tend to produce conditioned inhibition while presenting them in different sessions should tend to produce second-order conditioning.

Method

Subjects. The subjects were 48 male and female gerbils, aged 12 to 24 months, procured from Tumblebrook Farm, West Brookfield, Massachusetts. The animals were housed two to a cage with free access to water. Purina Rat Chow was available for 4 h after each daily experimental session. The animal colony room was maintained between 20° and 22°C and between 45% and 65% relative humidity. Overhead fluorescent lights were on from 6 a.m. to 10 p.m. each day. Six subjects were run simultaneously in a walk-in chamber (2.6 × 2.0 × 2.3 m) whose temperature (22°C) and humidity (65%) were kept relatively constant (±1%).

Apparatus. The apparatus, a narrow Plexiglas and aluminum runway, has been described previously (Frey, Eng, & Gavin, 1972). Photocell units were located at both ends of the runway. A gerbil head movement through a cylindrical opening at the foodwell end of the runway followed by a head movement through the opposite end triggered a magazine which dispensed a 45-mg Noyes pellet. A speaker mounted approximately in the center of one wall of each runway permitted the presentation of auditory stimuli. Electromechanical counters recorded the number of times the manipulandum and foodwell photobeams were broken and the number of pellets delivered.

The auditory CS was a clicking sound (approximately 2 clicks/sec) of 20 sec duration at 80 dB SPL (General Radio sound-level meter, Type 1565-A, scale Bs). The visual CS was a ceiling-mounted strobe light which flashed 7 times/sec and was either 20 or 40 sec in duration. The US was a 1-sec, 2-mA constant current ac shock delivered across the aluminum runway floor.

Procedure. Prior to magazine training, all animals learned to eat the Noyes pellets for 1 week on a 4-h/day feeding schedule. During magazine training, the animals were first given 15 20-min daily sessions in which food pellets were available on a FR 1 schedule. During the next 15 days, the animals were individually placed on FR schedules (FR 1-FR 3) which maximized their rate of manipulandum responding.

Animals which demonstrated a stable response rate were assigned to six groups of 6 animals each. The groups were constructed such that their mean response rates were approximately equal. The between-overlap (BO), between-nonoverlap (BN), within-overlap (WO), and within-nonoverlap (WN) groups were part of a 2 by 2 factorial design where overlap and trial mixture were manipulated. The between-control (BC) and within-control (WC) groups were included to assess nonassociative effects.

For all groups, the first-order CS was the click and the second-order CS was the light, and a first-order (F) trial was the presentation of US onset 19 sec after click onset. For the overlap groups, BO and WO, a second-order (S) trial was the presentation of the click 20 sec after the onset of the light (40 sec duration). Thus the click overlapped the last 20 sec of the light presentation. For the nonoverlap groups, BN and WN, an S trial was the presentation of click onset immediately after light (20 sec duration) offset. Thus the click immediately followed the light with no overlap. For the control groups, BC and WC, the light and click were paired in a backward relationship. The light (20 sec duration) was presented 10 sec after click offset. The between groups, BO, BN, and BC, received two F trials on all odd-numbered days and six S trials on all even-numbered days of the

14-day experimental phase. The within groups, WO, WN, WC, received one F trial after three S trials every daily session. The intertrial intervals during the 20-min sessions were randomly altered daily but remained the same for similar groups on any one day. One animal in the BN group died before completion of the experimental phase.

Following the experimental phase, half of the animals in each group received 2 days of retardation-of-acquisition testing (Rescorla, 1969). Four light-US trials were presented each day. Light duration was 20 sec and US onset was 19 sec after light onset. The remaining animals received a summation test in which the light and click were presented simultaneously four times each session for two sessions.

Results and Discussion

The dependent measure was the degree of suppression of the manipulandum response as monitored by the frequency of photobeam crossings. The suppression index (SI) for each subject was defined as $\alpha/(\alpha + \beta)$, where α was the number of manipulandum photobeam breaks/minute during the CS and β was the number of manipulandum photobeam breaks/minute during the entire non-CS period in the same session. When the light overlapped the click, the light SI was computed only for the nonoverlapping portion of the light (i.e., the first 20 sec).

A SI below .50 indicates that the CS had suppressive properties. The mean SIs for the click on first-order trials (F) computed across the last 6 days of the experimental phase for Groups BO, BN, WO, WN, BC, and WC were .04, .11, .10, .13, .07, and .08 respectively. A 2 by 3 analysis of variance (Overlap by Trial Mixture) revealed no significant effects of Overlap, Trial Mixture, or their interaction ($F_s < 1$).

The mean SIs for the light (the second-order CS) computed across the last 6 days of the experimental phase are presented in Figure 1. Both the control groups and the between-session groups showed SIs very close to .50, while the within groups showed lower SIs. A 2 by 2

Figure 1. Mean light suppression index during second-order trials for each group.

analysis of variance on trial mixture and overlap indicated that the within-session groups produced a lower SI to the light than the between-session groups, $F(1,19) = 4.44$, $p < .05$. There was no effect due to Overlap or the interaction of Overlap and Trial Mixture. The combined within-session groups also produced a lower mean SI than the within-control group, $t(15) = 2.20$, $p < .05$. These results indicate that second-order conditioning was present in the within-session groups but not in the between-session groups. The absence of suppression in the control group indicates that the observed excitatory effect was the result of an associative process. The observed lack of effect of the stimulus overlap variable is not consistent with Pavlov's hypothesis.

The click SIs during S and F trials for all groups are presented in Figure 2. Suppression to the click was greater on F trials than on S trials. Difference scores were computed by subtracting the click SI on F trials from the click SI on S trials. A 2 by 2 analysis of variance (Trial Mixture by Overlap) on the difference scores indicated that the between-session groups produced a greater decrease in suppression on S trials than the within-session groups, $F(1,19) = 16.00$, $p < .001$. A second analysis indicated that the combined between-session groups produced greater difference scores than the between-session control group, $t(15) = 2.23$, $p < .05$. The mean difference score for the within-session groups was not significantly different from the within-control group, $t(15) = 0.87$. This decrease in responding to the first-order CS on second-order trials for the between-session groups indicates that the second-order CS was not being ignored by the animals (i.e., no attention deficit).

The trial of the second complete suppression of responding to the light during the retardation-of-acquisition test is presented in Figure 3. The between-session groups acquired more slowly than the within-

Figure 2. Mean click suppression index during first- and second-order trials for each group.

Figure 3. Mean trial of the second complete suppression of the light during the retardation of acquisition test for each group.

session groups. A 2 by 2 analysis of variance indicated a reliable effect of Trial Mixture, $F(1,19) = 11.80$, $p < .01$, but not of Overlap or the interaction of Overlap and Trial Mixture. The between-session groups also acquired more slowly than the between-control group, $t(8) = 2.90$, $p < .02$, but the within-session groups were not different from the within-session control group ($t < 1$). The summation test indicated no significant group differences.

These results suggest that an inhibitory effect may occur when the first-order and second-order trials are presented in different sessions. Groups receiving this treatment acquired more slowly than their control group in the retardation-of-acquisition test and showed a decreased level of suppression to the first-order CS on second-order trials. This latter outcome rules out a lack-of-attention explanation.

EXPERIMENT 2

In the first experiment, second-order conditioning was not observed when first-order and second-order trials occurred in different sessions. Our second experiment employed a within-session trial mixture in an attempt to produce second-order conditioning with the rabbit eyelid response. The intertrial interval (ITI) variable was manipulated to determine if the time relationship between first-order and second-order trials would influence the associative properties of the second-order CS. In addition, the overlap relationship of the two CSs on second-order trials was manipulated.

Method

Subjects. The subjects were 48 New Zealand White rabbits, 1.8 to 2.3 kg, procured from Scientific Small Animals, Inc.,

Arlington Heights, Illinois. The animals were housed in individual cages with free access to food and water. The colony room was maintained between 20° and 22°C and between 45% and 65% relative humidity. The overhead fluorescent lights were on from 6 a.m. to 10 p.m. each day.

Apparatus. The apparatus and methods of restraint were similar to those described previously (Frey, Englander, & Roman, 1971), except that a photoelectric unit replaced the potentiometer system. This new method (described by Vandecar, Swadlow, Elster, & Schneiderman, 1969) permitted polygraphic recording of eyelid movements without contacting the eyelid directly. Four to six subjects were run simultaneously in a walk-in chamber (2.6 × 2.0 × 2.3 m) in which the temperature (20°C) and humidity (50% relative) were kept relatively constant (±1%).

The second-order CS was a 1,000-Hz tone delivered by an audiooscillator at 80 dB SPL (General Radio sound-level meter, Type 1565-A, scale Bs) through four speakers located in the upper four corners of the chamber. The tone was superimposed on a constant white noise background of 70 dB SPL. The first-order CS was a vibration of the floor of the stock-like restraining unit produced by a solenoid-spring device located underneath the floor.

The cheek shock US was delivered through suturing wire (26 g) electrodes surgically placed in the animals cheek. The shock US was the discharge of a .1 MFD capacitor which had been charged during the intertrial interval of 200 V. Electronic timers controlled the duration of the CSs and US, their temporal relationship, and the intertrial interval.

Procedure. All 48 animals were surgically prepared by embedding two bolts into the top of the skull and by attaching two cheek electrodes beneath the right eye. Three days after surgery and 1 day prior to conditioning, each animal was given a 75-min adaptation session in the stock-like restrainer.

The animals were then divided into eight groups of six animals each in accordance with a 2 by 4 factorial design. Four groups received a constant 30-sec intertrial interval (ITI) and the remaining four groups received a constant 180-sec ITI. During the 6 days of Stage 1, all animals received 24 daily trials of acquisition training to the vibratory stimulus (V). CS duration was 500 msec and the CS-US interval was 400 msec. Animals which did not achieve a 50% response rate on Days 5 and 6 were excluded from the remainder of the experiment. On Day 6, the first-order CS was reinforced on only 50% of the trials.

During the 10 days of Stage 2, the animals received 24 daily trials, one-third of which were vibration-US (V+) trials, one-third were vibration alone (V-) trials, and the remaining one-third were second-order (S) trials, pairing the tone (T) with the vibration. The daily trial sequence consisted of the repetition of V+, S, V-, S, V+, V- four times. Both S and V- trials were preceded by reinforced trials an equal number of times. All groups received the same events daily except that the temporal relationship of T and V on second-order trials was manipulated for each of the four groups experiencing a particular ITI.

On second-order trials, the onset of T always preceded the onset of V and V was always 500 msec in duration. For two of the groups, V onset came 10 sec after T (duration = 400 msec) offset. For two others groups, V onset came 0.4 sec after T (duration = 400 msec) offset. Two groups received V 0 sec after T (duration = 400 msec) offset. For the last two groups, V onset came 400 msec after T (duration = 900 msec) onset so that the two stimuli overlapped for the final 500 msec of T.

In the third stage, all animals were given a threshold test (Frey, Maisiak, & Dugue, 1976) in one 12-trial day. In the threshold test, each animal was first given four preliminary cheek shocks, during which the shock intensity was decreased in intensity to a level at which the UR was barely elicited (less than 30% of the normal UR amplitude). The tone was then paired with the low-intensity shock (tone duration = 400 msec, tone-US interval = 300 msec) for four trials, another US-alone trial was given, and finally three more tone-US trials were presented. The UR amplitude on tone-US trials was compared with the UR

amplitude on US-alone trials. During the final stage of the experiment, a retardation test was given which consisted of the presentation of 24 tone-US trials each day for 6 days (tone duration = 400 msec, tone-US interval = 300 msec) to all groups at their original ITI.

Results and Discussion

Stage 1. A conditioned response (CR) was defined as a 1-mm or greater deflection of the recording pen between 120 and 420 sec after CS onset in a direction indicating eyelid closure. The gain control of the recording system was adjusted so that a full eyelid closure produced a 20-25-mm pen deflection.

In acquisition, the 180-sec ITI groups acquired faster than the 30-sec ITI groups. The 180-sec ITI groups reached the trial of the 10th CR ($\bar{X} = 36$) faster than the 30-sec ITI groups ($\bar{X} = 48$), $t(32) = 2.81$, $p < .01$.

Stage 2. The V+ trials were always preceded by non-reinforced trials. Because of this, a relatively low, but stable, response rate of approximately 55% CRs on V+ trials was observed for all groups throughout the experimental phase. Responding to the vibration during V- and S trials averaged 65% CRs and 73% CRs over the experimental phase for all groups. The increased responding to V on S trials indicated that T was not acting as a conditioned inhibitor. Evidence of second-order conditioning, however, was minimal. Very few CRs (less than 2%) occurred to the tone or during the time between T offset and V onset. Those CRs that did occur were of small magnitude (less than 3-mm pen deflection).

Stage 3. For the threshold test, the mean UR amplitude for each subject was computed when the low-intensity shock was presented by itself (not including preliminary adjustment shocks) and on trials when the tone preceded the low-intensity shock. Average UR magnitude ratios for each subject were computed by dividing the average UR amplitude on tone-US trials by the average UR amplitude on US-alone trials for each subject. The means of the average UR magnitude ratios for all groups are presented in Figure 4. Most ratios were

Figure 4. Mean UR magnitude ratio computed by dividing the tone-US UR magnitude by the US-alone UR magnitude for each group in the threshold test.

close to or greater than 1.0, suggesting that the tone had not acquired inhibitory properties. The 30-sec ITI groups produced a significantly larger mean UR ratio than the 180-sec ITI groups, $t(32) = 3.11$, $p < .01$. A Newman-Keuls multiple comparison test ($\alpha = .05$) revealed that the mean UR ratio of the overlap group was significantly higher than all other group mean ratios except the 0.0-sec group ratio and that the mean UR ratio of the 10-sec group was no different from all other group ratios except the overlap group ratio.

Stage 4. The trial of the 10th CR for each group during the retardation testing is presented in Figure 5. The 30-sec ITI groups produced a lower mean trial of the 10th CR than the 180-sec ITI groups, $t(32) = 3.60$, $p < .01$. A Newman-Keuls multiple comparison test ($\alpha = .05$) revealed that the mean trial of the 10th CR for the overlap group was significantly lower than all other group mean trials of the 10th CR except that of the 0.0-sec group and that the mean trial of the 10th CR of the 10-sec group was no different from that of all other groups except the overlap group.

These results are not consistent with Pavlov's hypothesis. When the second-order CS and first-order CS overlapped, a weak excitatory effect was observed. When the first-order and second-order stimuli were separated in time, neither excitatory nor inhibitory effects were observed. This general pattern of results was consistent for both ITIs.

The facilitation of the rate of first-order conditioning with the longer ITI during the initial phase of the experiment is consistent with previous eyeblink studies (Brelsford & Theios, 1965; Frey & Misfeldt, 1967; Frey & Ross, 1969). The opposite effect in the retardation test in which the shorter ITI led to superior performance suggests that different processes are involved in the early and late stages of the experiment. The nonassociative effects of the short ITI (see Frey & Butler, 1977) are probably the predominate factor in the retardation test.

These results are different from those of Marchant, Mis, and Moore (1972), who also employed a within-session procedure in a rabbit eyelid paradigm and reported strong evidence of conditioned inhibition. Their procedure differed from the present procedure in that first- and second-order CSs were both paired with shock prior to the intermixture of first- and second-order trials, no first-order CS alone trials were given during the intermixture sessions, 350 second-order trials were given rather than the 80 of the present procedure, and their first-order CS was a light rather than a vibration. The vibration may be a more "dynamic" CS since CR acquisition to the vibration normally occurs within the first two sessions and muscular movements other than the eyeblink are often elicited. These movements may become associated with the tone on second-order trials and mediate CR elicitation.

Figure 5. Mean trial of the 10th CR for each group in the retardation of acquisition test.

GENERAL DISCUSSION

The main findings of the present study were (1) that second-order conditioning was most probable when the first-order and second-order CSs overlapped, (2) that a within-session mixture of first-order and second-order trials was more conducive to second-order conditioning than a between-session trial mixture, and (3) that second-order conditioning was more prominent in fear conditioning than in eyelid conditioning.

The first finding is inconsistent with Pavlov's notion that the separation of the second-order stimulus and the first-order stimulus in time is necessary for second-order conditioning. This finding is consistent with the commonly observed facilitation of first-order conditioning when the CS and US overlap (e.g., Schneiderman, 1966). This result is also inconsistent with Pavlov's report that stimulus overlap is a prerequisite for conditioned inhibition.

The second finding was that excitatory effects were minimized when the first-order and second-order trials were presented in different sessions. This effect may result from an unavoidable property of the between-session procedure. When alternate sessions can be easily differentiated into US and non-US periods, the animals may form a discrimination in which the second-order CS is a signal for sessions in which the US is never presented. The present outcome is similar to that reported by Rescorla (1973a). The present results suggest that the stimulus-overlap variable and the trial-mixture variable are at least as important in the establishment of second-order conditioning as the stage-of-training variable.

The virtual absence of second-order CRs at any stage of training with the rabbit eyelid response suggests that this paradigm is not well suited for second-order condi-

tioning. The eyeblink response involves a discrete muscle movement which is precisely timed to occur just prior to US onset (see Martin & Levey, 1969). Because of these timing characteristics, the eyeblink may not occur to CS₂ even though the subject is aware of the CS₂-CS₁ relationship.

REFERENCES

- BRELSFORD, J., & THEIOS, J. Single-session conditioning of the nictitating membrane in the rabbit: Effect of intertrial interval. *Psychonomic Science*, 1965, **2**, 81-82.
- DAVENPORT, J. W. Higher-order conditioning of fear. *Psychonomic Science*, 1966, **4**, 27-28.
- FREY, P. W., & BUTLER, C. S. Extinction after aversive conditioning: An associative or nonassociative process? *Learning and Motivation*, 1977, **8**, 1-17.
- FREY, P. W., ENG, S., & GAVIN, W. Conditioned suppression in the gerbil. *Behavioral Research Methods & Instrumentation*, 1972, **4**, 245-249.
- FREY, P. W., ENGLANDER, S., & ROMAN, A. Interstimulus interval analysis of sequential CS compounds in rabbit eyelid conditioning. *Journal of Comparative and Physiological Psychology*, 1971, **77**, 439-446.
- FREY, P. W., MAISIAK, R., & DUGUE, G. Unconditional stimulus characteristics in rabbit eyelid conditioning. *Journal of Experimental Psychology: Animal Behavior Processes*, 1976, **2**, 175-190.
- FREY, P. W., & MISFELDT, T. J. Rabbit eyelid conditioning as a function of the intertrial interval. *Psychonomic Science*, 1967, **9**, 137-138.
- FREY, P. W., & ROSS, L. E. Rabbit eyelid conditioning: Effects of age, interstimulus interval, and intertrial interval. *Developmental Psychobiology*, 1969, **1**, 276-279.
- HERENDEEN, D., & ANDERSON, D. C. Dual effects of a second-order conditioned stimulus: Excitation and inhibition. *Psychonomic Science*, 1968, **13**, 15-16.
- HOLLAND, P. C., & RESCORLA, R. A. Second-order conditioning with food unconditioned stimulus. *Journal of Comparative and Physiological Psychology*, 1975, **88**, 459-467.
- MARCHANT, H. G., III, MIS, F. W., & MOORE, J. W. Conditioned inhibition of the rabbit's nictitating membrane response. *Journal of Experimental Psychology*, 1972, **95**, 408-411.
- MARTIN, I., & LEVEY, A. B. *The genesis of the classical conditioned response*. London: Pergamon Press, 1969.
- MIS, F. W., LUMIA, A. R., & MOORE, J. W. Inhibitory stimulus control of the classically conditioned nictitating membrane response of the rabbit. *Behavior Research Methods & Instrumentation*, 1972, **4**, 297-299.
- PAVLOV, I. P. *Conditioned reflexes: An investigation of the physiological activity of the cerebral cortex* (Trans. G. B. Anrep). London: Oxford University Press, 1927.
- RESCORLA, R. A. Pavlovian conditioned inhibition. *Psychological Bulletin*, 1969, **72**, 77-94.
- RESCORLA, R. A. Variation in the effectiveness of reinforcement and nonreinforcement following prior inhibitory conditioning. *Learning and Motivation*, 1971, **2**, 113-123.
- RESCORLA, R. A. Informational variables in Pavlovian conditioning. In G. Bower (Ed.), *The psychology of learning and motivation* (Vol. 6). New York: Academic Press, 1972.
- RESCORLA, R. A. Effect of US habituation following conditioning. *Journal of Comparative and Physiological Psychology*, 1973, **82**, 137-143. (a)
- RESCORLA, R. A. Second-order conditioning: Implications for theories of learning. In F. J. McGuigan & D. B. Lumsden (Eds.), *Contemporary approaches to conditioning and learning*. Washington, D.C: Winston, 1973. (b)
- RESCORLA, R. A., & LoLORDO, V. M. Inhibition of avoidance behavior. *Journal of Comparative and Physiological Psychology*, 1965, **59**, 406-412.
- RIZLEY, R. C., & RESCORLA, R. A. Associations in second-order conditioning and sensory preconditioning. *Journal of Comparative and Physiological Psychology*, 1972, **81**, 1-11.
- SCHNEIDERMAN, N. Interstimulus interval function of the nictitating membrane response of the rabbit under delay versus trace conditioning. *Journal of Comparative and Physiological Psychology*, 1966, **62**, 397-402.
- SHAPIRO, M. M., SADLER, E. W., & MUGG, G. J. Compound stimulus effects during higher order salivary conditioning in dogs. *Journal of Comparative and Physiological Psychology*, 1971, **74**, 222-226.
- VANDERCAR, D. H., SWADLOW, H. A., ELSTER, A., & SCHNEIDERMAN, N. Nictitating membrane and corneo-retinal transducers for conditioning in rabbits. *American Psychologist*, 1969, **24**, 262-264.

(Received for publication June 24, 1976;
revision received May 2, 1977.)