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# The effects of stimulus duration and frequency of daily preconditioning stimulus exposures on latent inhibition in Pavlovian conditioning of the rabbit nictitating membrane response*

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Manipulation of the daily frequency and duration of the preconditioning stimulus exposure in Pavlovian conditioning of the nictitating membrane response of 32 New Zealand white rabbits suggested that the intensity of latent inhibition was related to the absolute frequency of preconditioning stimulus exposure trials, and apparently was a stepwise function of the frequency of daily preconditioning trials. Similarly, the intensity of latent inhibition was related to the absolute duration of the preconditioning stimulus exposure. However, latent inhibition accrued to the cumulative effect of all stimulus durations across days rather than only to the repetitive presentation of one stimulus.

Repeated presentations of a to-be-conditioned stimulus prior to conditioning decrease the effectiveness of this CS in eliciting CRs when it is subsequently paired with a US during conditioning. The decrement in CR performance due to the repeated nonreinforced preconditioning presentation of the intended CS is called latent inhibition (Lubow & Moore, 1959). A recent review identifies the operation of latent inhibition across a variety of species and learning tasks (Lubow, 1973).

Very little is known as to what extent latent inhibition is influenced by the variables known to determine the rate of Pavlovian conditioning, such as CS duration and frequency of daily conditioning trials. For example, it is not known whether latent inhibition accumulates in a monotonic increasing function, or a stepwise fashion, of the frequency of trials per day. Nor is it clear whether the accumulation of latent inhibition is parameter specific, requiring the repetitive presentation of one CS duration, or whether it is stimulation specific and is sensitive to the cumulative effect of several CS durations. Hence, it was the concern of this study to determine the effects of the daily frequency and duration of the preconditioning stimulus exposures on latent inhibition in the acquisition and extinction of the rabbit nictitating membrane response.

Siegel (1969) observed latent inhibition when conditioning the eyelid of rabbits receiving either 100 or 1300 preconditioning exposures of the intended CS. The rabbits presented with 1300 preconditioning stimulus exposures received the intended CS at a rate of 200 daily exposures for 6 days and 100 exposures on the 7th day. The rabbits with 100 preconditioning stimulus exposures received them all on the 7th day. This experiment, however, does not clarify the issue of whether the increment in latent inhibition over days yields a monotonically increasing learning curve as a function of the frequency of daily exposure trials or yields a stepwise function of the absolute frequency of exposure trials.

In order to attribute the effects of latent inhibition to either the absolute frequency or the daily frequency of preconditioning stimulus exposure trials, the rabbits in the present study received either 20 (20E) or 50 (50E) preconditioning stimulus exposure trials for 5 days. A third group of rabbits was confined in the apparatus for 3 days without stimulus presentations, but then received 50 preconditioning stimulus exposure trials (50C) on each of the subsequent 2 days.

If the frequency of daily preconditioning stimulus exposure trials is the critical factor, the CR performance of Group 50C during acquisition training was expected to be similar to that of Group 50E, which received the same frequency of daily preconditioning trials. If, however, the absolute frequency of preconditioning trials is the critical factor, the CR performance of Group 50C was expected to be similar to that of Group 20E, since both groups received a total of 100 preconditioning trials.

In order to determine whether the daily duration of the to-be-conditioned stimulus or the absolute preconditioning stimulus exposure time had an effect on the CR acquisition performance, rabbits received either 250-msec (250E) or 1000-msec (1000E) durations of the intended CS for 5 days of preconditioning trials. A third group of rabbits (250M) received 5 days of preconditioning trials, with half of the daily trials having a 250-msec duration of the intended CS and the

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remaining trials consisting of mixed random stimulus durations of 1000, 1500, 2000, and 2500 msec, with a mean duration of 1750 msec. Random presentation of a wide range of long stimulus durations minimized the accumulation of latent inhibition to any specific long stimulus duration. In this way, Group 250M received the same absolute duration of preconditioning stimulus exposure as Group 1000E, while being similar to Group 250E in the repeated presentation of the 250-msec stimulus. Thus, if the absolute total time of exposure of the to-be-conditioned CS is the critical factor, the CR performance of Group 250M was expected to be similar to Group 1000E. However, if the daily duration of the intended CS is the critical factor, Group 250M was expected to have a CR performance similar to that of Group 250E.

## METHOD

### Subjects

The Ss were 36 naive male albino New Zealand white rabbits, 45-65 days old at the beginning of the experiment. All rabbits had free access to food (Purina Rabbit Chow) and water.

### Apparatus

Each rabbit was restrained in Plexiglas boxes similar to those described by Gormezano (1966). Four rabbits were run simultaneously in four gray wooden boxes without a covering top, located within a sound-attenuated room, and separated from the E in an adjoining room with the programming equipment and recording instruments. Mounted on the wooden wall in front of each rabbit was a 10-cm speaker for presenting the CS, and a 5-cm speaker for presentation of continuous white noise. A rotary minitorque potentiometer (Giannini No. 85153) was mounted on the rabbit's head. A nylon loop was sutured into the nictitating membrane of the right eye and connected by a thread to a counterweighted lever on the shaft of the potentiometer. Movements of the membrane generated a dc signal which was amplified and recorded on a Beckman Type R dynograph at a paper speed of 100 mm/sec. Any positive deflection of the response pens, generated by lateral movement of the membrane, of at least 1 mm and at least 3-msec duration during the CS constituted a CR.

The CS was a 1000-Hz tone, of either 250-msec or 1000-msec duration, superimposed on continuous background white noise. Both the white noise and the CS were at an intensity of 70 dB (SPL at the position of the rabbit's head). The offset of the CS coincided with the onset of the US. Lab K (Digital Equipment Corporation) controlled the interstimulus interval. The US, a 2-mA shock of 50-msec duration, was administered through two stainless steel wound clips (Clay-Adams, 9 mm) attached to the skin 0.5 cm below and 0.5 cm posterior to the infraorbital region of the right eye. A motor-pulsed Tally tape transmitter controlled the intertrial interval of 50, 60, and 70 sec in a random order with a mean of 60 sec.

### Procedure

**Frequency of Daily Preconditioning Trials.** Sixteen rabbits were randomly assigned to four groups consisting of two experimental groups receiving either 20 (20E) or 50 (50E) daily preconditioning exposures of the to-be-conditioned stimulus for 5 days, and two control groups receiving either no (Group 0) preconditioning trials or 3 days of no preconditioning trials followed by 2 days of 50 daily stimulus exposure trials (50C). All groups were confined daily in the apparatus with continuous white noise for 50 min over 5 days because this is the duration required by Group 50E to complete all preconditioning stimulus presentations.

Following the 5 days of preconditioning exposures to the intended CS and/or the apparatus, all groups received 100 daily CS-US paired conditioning trials for 6 acquisition days, beginning immediately after the fifth preconditioning session. Three days of extinction trials (i.e., CS alone) began the day following Day 6 of acquisition training. The CS duration was 250 msec for all groups during preconditioning, acquisition, and extinction.

**Duration of CS Exposures.** Twenty naive rabbits were randomly assigned to five groups. Two experimental groups received 100 daily CS presentations of either 250-msec (250E) or 1000-msec (1000E) duration during preconditioning, acquisition, and extinction. Two control groups, confined daily for 100 min in the apparatus without preconditioning stimulus exposures for 5 days, received 100 daily CS presentations of either 250-msec (250C) or 1000-msec (1000C) duration during acquisition and extinction. During preconditioning, acquisition, and extinction, Group 1000E experienced CS exposure periods which were four times greater in total milliseconds than those of Group 250E. In order to control for this factor of total CS exposure time, a third control group (250M) received 100 daily stimulus presentation trials, in which half of the trials had CS durations of 250 msec and the remaining trials had a mixture of CS durations of 1000, 1500, 2000, and 2500 msec, with a mean duration of 1750 msec, during preconditioning, acquisition, and extinction. All other procedures were the same as described above.

## RESULTS AND DISCUSSION

### Frequency of Daily Preconditioning Trials

Figure 1 depicts the mean percentage of CRs for acquisition and extinction days as a function of the daily frequency of preconditioning stimulus exposure trials. In agreement with previous research (e.g., Siegel, 1969), the CR performance during acquisition was depressed in relation to the absolute frequency of preconditioning stimulus exposures. The CR performance was highest for Group 0, intermediate for Group 20E and Group 50C, and lowest for Group 50E. This differential CR performance was reflected in a statistically significant Trials by Days interaction [$F(15,60) = 2.29$, $p < .02$].

The accumulation of latent inhibition was due to the absolute frequency of preconditioning exposure trials rather than a monotonic increasing function of the frequency of daily stimulus exposure trials. The mean percent CR performance of Group 50C on the first 2 days of acquisition (12% and 77%) was more similar to that of Group 20E (4% and 62%) than to the performance of Group 50E (0% and 34%). Contrary to expectation and the general trend in the results was the finding that the CR performance of Group 50C was slightly higher than that of Group 20E. The statistical nonsignificance of this difference between the two groups places it within the margin of error traditionally acceptable to psychologists.

The similarity in CR performance of Group 50C, which received 100 preconditioning trials spread over 2 days at 50 trials per day, to Group 20E, which also received 100 preconditioning trials, but spread over 5 days at 20 trials per day, suggests that latent inhibition accrues in a stepwise fashion over days. In other words, rabbits are affected by the absolute frequency of preconditioning trials; however, the total number of

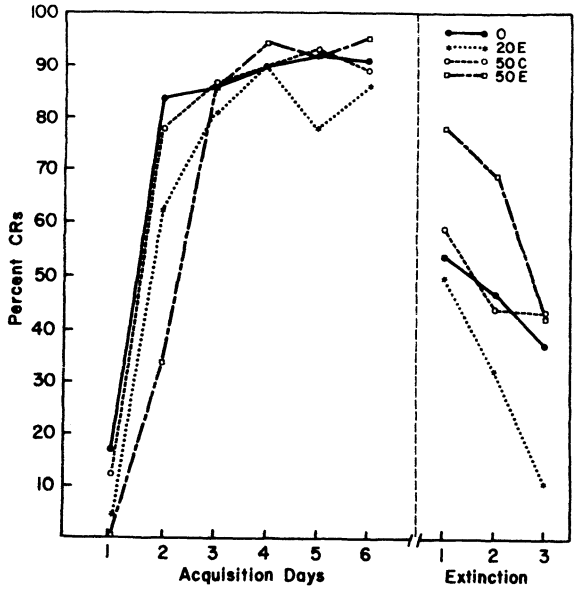


Fig. 1. Mean percentage of CRs for acquisition and extinction days as a function of the daily frequency of preconditioning stimulus exposure trials.

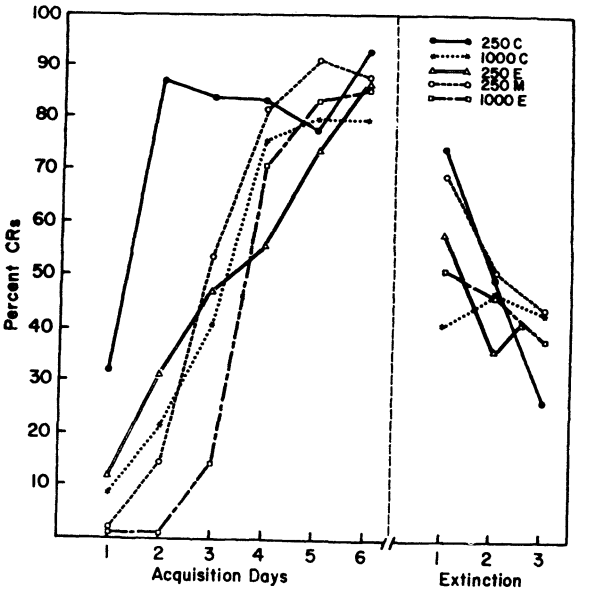


Fig. 2. Mean percentage of CRs for acquisition and extinction days as a function of the CS duration during preconditioning stimulus exposure, acquisition, and extinction trials.

preconditioning trials may be presented in one day or spread across several days.

The mean frequency of CRs during the 300 trials of extinction for Groups 0, 20E, 50C, and 50E were 46, 31, 49, and 62, respectively, yielding a statistically significant trials main effect [$F(3,12) = 4.00$, $p < .05$]. The slow rate of extinction of Group 50E in comparison to the other groups conflicts with the finding of Siegel (1969) that a higher frequency of preconditioning exposure trials leads to more rapid extinction. At this time, we can offer no plausible explanation for our extinction data.

### Duration of CS Exposures

Figure 2 depicts the mean percentage of CRs for acquisition and extinction days as a function of the CS duration during preconditioning stimulus exposure, acquisition, and extinction trials. As expected on the basis of recurrent demonstrations in the literature, the two control groups (250C and 1000C) each had a CR performance higher than their respective experimental groups (250E and 1000E), which is reflected in a statistically significant Duration by Days interaction [$F(20,75) = 3.75$, $p < .01$] computed on the mean percentage of CRs during acquisition for the five groups.

The major differences among the groups occurred during the first 2 days of acquisition [$F(4,15) = 7.41$, $p < .005$]. On the first day of acquisition, the mean percent CR performance of Group 250M (2%) was more similar to that of Group 1000E (1%) than to that of Group 250E (12%). On Day 2 the effect of CS preconditioning exposure trials began to fade out with the moving of the CR performance of Group 250M (15%) midway between Groups 250E (32%) and 1000E (1%). From Day 4 on through extinction, the performance of all five groups was relatively similar. No relevant source of variance was statistically significant during extinction.

Thus, the absolute exposure time to the intended CS during preconditioning appeared to be more important in inhibiting the CR performance during acquisition than the repetitive presentation of one specific stimulus duration over days. This is supported by the similarity in initial CR acquisition performance of Group 250M to Group 1000E, with which it shared the same absolute exposure time, and the disparity of Group 250M in initial CR acquisition performance with Group 250E, with which it shared the same specific daily CS duration.

The similarity in CR performance of Group 250M to Group 1000E suggests that the accumulation of latent inhibition in rabbits was not parameter specific, but stimulation specific. That is to say, rabbits did not associate inhibitory properties with one temporal duration. Instead, the rabbits were sensitive to the cumulative effect of stimulus duration across days. Whether the absolute duration of stimulus exposure is attained in 1 day or spread across several days, or presented with one constant stimulus duration or various stimulus durations, apparently is of equal consequence on the CR performance.

Further evidence of the importance of the absolute preconditioning stimulus exposure time is available in the finding that Group 1000E showed a greater degree of latent inhibition than did Group 250E, relative to

their respective control groups. If the daily mean percentage of CRs for the experimental group is taken as a fraction of the daily mean percentage of CRs for their respective control groups, it can be seen that for the first 3 days of acquisition, the CR performance of Group 1000E amounts to only 0.114, 0.047, and 0.350 of the CR performance for Group 1000C, while the CR performance of Group 250E amounts to 0.372, 0.365, and 0.564 of the CR performance of Group 250C. Since Group 1000E elicited a smaller fraction of mean CR responses relative to its control group than did Group 250E, Group 1000E can be said to have shown the greatest relative retardation of learning and, hence, the greatest relative amount of latent inhibition.

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