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Adaptation of the Original Response to a Conditioned Stimulus[1]

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Since the time of Pavlov, it has been a common observation that the conditioned stimulus (CS) in a classical conditioning situation is seldom, if ever, a completely neutral stimulus since, prior to learning, it usually elicits some response. However, in most conditioning studies only the change in the conditioned (learned) response has been studied, little systematic work having been conducted on the changes in the original (reflex) response to the CS. Hilgard and his students, mainly in the context of eyelid conditioning experiments (4, 5, 6), have reported some pertinent data, and there have also been some experiments, outside of a learning situation, concerned with the effects of repeated elicitation of a reflex (3, 7, 10). The results, generally speaking, have shown that the amplitude of the reflexes decreased as a function of the number of presentations of the stimulus and increased after rest periods. Little except observational data has been furnished with respect to the frequency measure, and little information has been provided concerning the variables affecting this measure.

The purpose of this paper is to report evidence concerning changes in the frequency of the reflex blink to a tone used as a CS and to report the effects of instructions on this measure.

Apparatus and Procedure

The data come from a study of eyelid conditioning which was originally conducted to study the effect of varying the time interval between the onsets of the CS and the unconditioned stimulus (US) on conditioning performance (8). The subjects (*S*s) were 90 students from the introductory course in psychology at the State University of Iowa, the proportion of women to men being fixed at 8 to 7 for each group. Three groups of 15 *S*s each were given 100 conditioning trials with intervals of either 250, 700, or 2500 msec. intervening between the onsets of the CS and the US; and 45 additional *S*s, with an interval of 450 msec. Fifteen of the latter *S*s returned the following day and were given an additional 100 trials with an inter-stimulus interval of 2500 msec.

[1]The data herein reported were obtained from the writer's doctoral research conducted under the direction of Professor Kenneth W. Spence.

The CS was a tone of 1000 cycles, 50 db above each *S*'s threshold; the US, a puff of air produced by the fall of a column of mercury through a distance of 80 mm., and delivered to the right cornea; the inter-trial interval averaged 20 sec., varying in a fixed irregular order of 15, 20, or 25 sec. The movement of the eyelid was recorded by a combination of electrical and mechanical means which has been described elsewhere (8).

The *S*s were seated in an adjustable dental chair which was in a semi-soundproof room adjoining that in which the recording apparatus and stimulus controls were located. After the *S* was seated, instructions designed to induce a neutral set with respect to the conditioning were read. Each *S* was told that there would be three presentations of a tone alone after which both a tone and a puff of air to the eye would be administered.

It was noted that the unlearned response to the auditory CS was of a very short latency (mean: 71 msec.); therefore, it was decided arbitrarily to count any eyeblink occurring within the first 100 msec. after the onset of the tone as an original response. It is only these original reflexes which are being considered in this paper.

Results

A simple analysis of variance was calculated to determine whether or not the number of original responses varied systematically with the interval intervening between the onsets of the CS and the US. The analysis was carried out on the first block of 10 trials. The obtained F-ratio ($F = .22$, with 3 and 86 df) was not significant. Therefore, the data of all the *S*s were pooled, resulting in an N of 90.

The effect of continued presentation of the CS on the frequency of original responses is shown in the first figure. The single closed circle represents the percentage of original responses made to the CS the three times it was presented alone unaccompanied by the US. The next point is the percentage of original responses on the first trial during which the puff of air was given. The difference between the proportions of responses at these two points was found, with a test of correlated proportions (9, p. 77), to be significant beyond the 1% level ($z = 2.73$). Since only responses occurring within the first 100 msec. were counted, the *S* had not received a puff of air at the time the original response occurred on the first trial. Therefore, the increase in the percentage of such responses from the pre-tests to the first trial cannot be attributed to the puff of air. The only difference between these trials was that the *S*s knew from the instructions that they were to be puffed in the eye

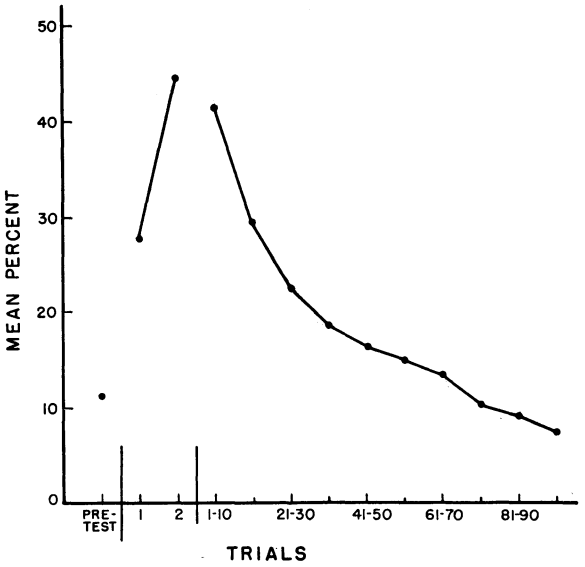

Figure 1. The percentage of original responses on the pretests, on each of the first two trials, and in blocks of 10 trials for the 100 presentations of the tone.

on the first trial. This significant increase probably indicates that the instructions increased the drive level of the *S*s, the increased drive level thus augmenting the frequency of occurrence of the eyelid reflex.

The difference between trials 1 and 2 was also evaluated with the test of correlated proportions and was found to be significant beyond the 1% level ($z = 2.86$). This increase probably indicates a still further increment in the drive level of the *S*s as the result of receiving the puff of air.

The fact that the percentage of original responses decreases steadily in a negatively accelerated manner, as shown in Fig. 1, is probably due to adaptation or extinction effects which may be affecting the strength of the reflex, the motivating effects of the puff of air, or the motivating effects of the instructions. The design of this particular experiment does not permit a choice between these alternatives.

Fifteen of the 90 *S*s who contributed to the points in Fig. 1 returned the next day for 100 additional trials. The percentage of original responses made by these 15 *S*s on each day is shown in the second figure. The two isolated circles represent the percentage of original responses on the first trial of each day—the solid circle for day one, the open circle for day two. Although the *S*s had not yet experienced the puff of air on the first trial of the second day,

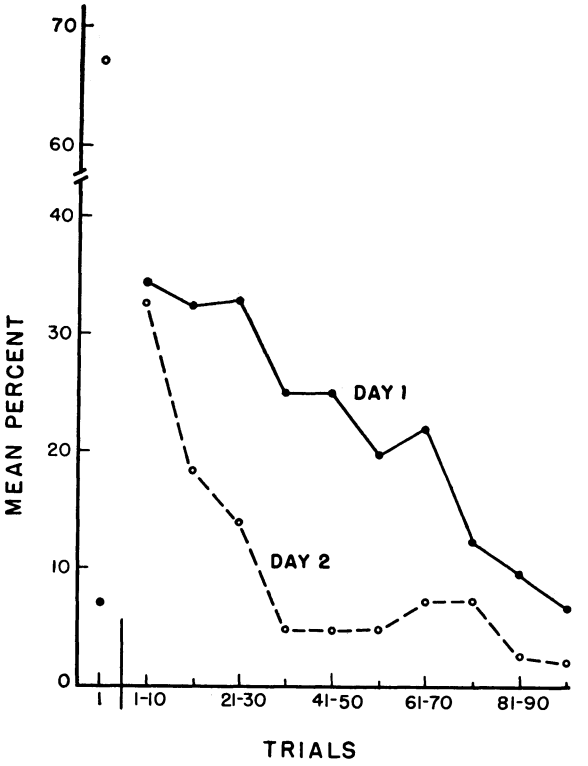

Figure 2. The percentage of original responses on the first trials and in blocks of 10 trials for the 100 presentations of the tone on two successive days.

the number of eyeblinks was much greater than it had been on the first trial of the first day and on the last trials of the first day. This fact cannot be attributed to the effects of the puff stimulus as such, since presumably such effects would have dissipated in the 23-hour interval between sessions. Neither can it be explained entirely by the spontaneous recovery of the strength of the reflex since the performance is higher than on the first trial of the first day at which time adaptation of the reflex had not occurred. Nor can the differences be accounted for by the recovery of the effects of the instructions since the performance is higher than on the first trial of the first day when the *S*s knew they were to be puffed in the eye just as they did on the first trial of the second day. However, the increase in performance may be attributable to self-instructions resulting from the experience of the puff on the first day. These self-instructions, elicited upon re-entering the experimental situation, would possibly serve to increase the drive level of the *S*s and thus the number of responses to the tone (1).

Beyond the first block of 10 trials, the decrease in the percentage of original responses is evident, but on the second day the decrease is much more rapid. To check on the rate of decrease, the difference between the measures on the first block of 10 trials and the fifth block of 10 trials was found for each *S*. The difference between these difference scores was evaluated by Wilcoxson's nonparametric test for related measures (11) and was found to be significant beyond the 5% level. These results support the notion that the rate of adaptation is faster the second day and are consistent with previous experiments (7, 10).

These findings suggest that instructions can act as motivating agents, that the frequency of original responses to the onset of a tone decreases in a negatively accelerated manner, that performance recovers over a 23-hour period, and that adaptation a second time is more rapid than originally. It is felt that the most important consequence of these results may be the development of a technique for studying the effects of instructions and other sources of motivation on human *S*s while minimizing the possibility of voluntary control by the *S*s over the response which is being measured. This methodology is analagous to that developed by Brown, Kalish, and Farber (2) in studying the acquisition of fear through changes in the startle response in rats.

Miscellaneous Results

1. The suggestion has been made in the past that the conditioned response grew in strength only when the original response to the CS had become adapted. If this hypothesis were true, the number of conditioned responses would be inversely related to the number of original responses. To check on this possibility, a product-moment correlation was computed between the total mean percentage of conditioned responses and the total mean percentage of original responses for the 100 trials ($N = 90$). This correlation coefficient was $+.182$ which is significant at the 8% level of confidence. When, however, the correlation was computed for only those *S*s run under the 250 and 450 msec. CS-US intervals, the conditions under which conditioning was optimal, the obtained correlation was $+.087$ which was significant at the 50% level. There is, thus, little evidence for a relationship (either positive or inverse) between the number of original responses and the number of conditioned responses.

2. It was thought possible that people scoring high on a test of manifest anxiety might make a significantly greater number of unconditioned blinks than people scoring low. Of the 90 *S*s, there

were 24 scoring in the upper 20% on a test of manifest anxiety and 19 scoring in the lower 20%. To check on the hypothesis, a non-parametric test devised by Mann and Whitney was used to evaluate the difference between the number of unconditioned blinks of the two groups of *S*s. Although the more anxious *S*s made more original responses, the null hypothesis could be rejected at only the 32% level.

3. A third hypothesis tested was that women *S*s would give more reflex blinks than men. Of the 90 *S*s, there were 48 women and 42 men. Although the women gave more original responses, the difference between the mean percentage of original responses for the 100 trials was found to be significant at only the 10% level ($t = 1.628$, with 88 *df*). Thus, there is no unequivocal evidence that the women made more original responses than the men.

In summary, evidence has been presented demonstrating that instructions and a puff of air to the eye influence the number of eyelid reflexes which *S*s make to a tone. The strength of conditioning, scores on a scale of manifest anxiety, and sex probably are unrelated to the number of original responses. A possible new technique for studying the influence of instructions and other variables affecting motivation was suggested.

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