Reflex sensitivity and the conditioned eyelid response

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It has often been claimed that the sensitivity of a reflex and the ease with which it can be conditioned are related. This experiment aimed to analyze some of the factors which may be involved in eyelid 'reflex sensitivity'. Of several measures only frequency of CS blinks showed a significant relationship with CR frequency and also predicted the level of conditioning. It is suggested that the response characteristics of the CS blink reflex resemble those of an orienting response.

The finding that the more sensitive a reflex is, the more easily it may be conditioned is relatively well documented for several response modalities (Campbell, 1938; Campbell & Hilgard, 1936; Martin, 1963; Pavlov, 1927). However, the fact that these studies have included a variety of measures of reflex sensitivity raises the problem of the operational definition of this term. As a preliminary step we have considered measures of reflex sensitivity as being intrinsic to the corneal/blink reflex system or extrinsic to it. Obvious intrinsic factors are the sensitivity of the receptor in the reflex arc and UCR characteristics of latency and amplitude. Measures of eyelid activity extrinsic to the corneal reflex system include blinks to nonspecific stimuli such as the low intensity tones and lights used as CSs in eyelid conditioning experiments.

Our purpose was to examine the inter-relationships among several measures of reflex sensitivity with the aim of defining more clearly its role in conditioning.

Procedure

Ss were normal adult male volunteers, age range 19 to 50 years ($N=72$) without previous experience in any psychological studies, conditioned for 48 trials by the procedures routinely used in our laboratory (Martin, 1963; Martin & Levey, 1966). The CS was a 1000 cps tone at 65 dB overlapping an air puff of 60 msec. duration. Ss were assigned randomly to the cells of a 2 by 2 by 2 factorial design representing puff intensities of 3 or 6 lb./in.², interstimulus intervals of either 400 or 800 msec., and continuous as opposed to partial (two-thirds) reinforcement. These various conditions allowed for a wider exploration of the relationship between reflex sensitivity and conditioned responses. Test trials were given prior to acquisition in the order T_{1-3} (CS tones), P_{1-3} (UCS air puffs), T_{4-6} (CS tones).

UCR latencies to the three air puff test trials were measured to the nearest 10 msec. from puff onset.

A CR was scored as any departure of 1 mm or more from the stable base-line occurring between 250 msec. and the termination of the air puff. A CS reflex blink was scored as any departure of 1 mm or more occurring within 100 msec. of tone onset.

Immediately prior to the conditioning procedure two thresholds, one for subjective awareness of the puff and one for reflex blinking, were determined for each S against a scale of minimal puff pressures. The measures were the average pressures over three ascending series at which (1) the S reported first feeling the air puff and (2) a reflex blink of less than 200 msec. latency and more than 1 mm in magnitude was first elicited.

Results

Sensory and blink thresholds were highly correlated ($r=0.654$, $p<.001$) but neither was significantly related to number of CRs given. Similarly there was no relationship between the threshold measures and frequency of CS reflex blinks. Rate of spontaneous blinking was unrelated to other variables.

A two-way analysis of variance was carried out on UCR latencies during test trials to consider the trials effect (Test Trial 1 vs. 3) and puff intensity effect. UCR latencies showed an overall decline from a mean of 107.6 msec. for Test Trial P_1 to 92.0 msec. for Trial P_3 ($F=45.01$, $df=1/70$, $p<.001$). UCR latencies for 3 and 6 psi stimuli were significantly different ($F=5.827$, $df=1/70$, $p<.05$), the stronger stimulus resulting in shorter latencies. There were no significant relationships between any of the measures of UCR latency and frequency of either CRs or CS reflex blinks, and no interaction effects. Nevertheless, the finding that there is a significant decrease in UCR latency over test trials is of interest in that a comparable decrease occurring over acquisition trials has been shown to relate to conditionability (Martin & Levey, 1966).

To consider the effects of experimental conditions on CR and CS reflex blink frequency, separate analyses of variance were performed on the arc sine transform of individual percentage frequencies of CR and CS reflex blinks occurring during acquisition trials. None of the main effects was significant for CR frequency. The only significant effect on CS reflex blinks arose from CS-UCS intervals, the 800 msec. group giving more responses (mean 18.01) than the 400 msec. group (mean 6.14; $F=16.93$, $df=1/64$, $p<.001$).

In view of the effect of the CS-UCS interval on CS reflex blinks, the 400 and 800 msec. groups were

Fig. 1. Fitted plots of mean frequencies of CS reflex blinks (abscissa) and CRs (ordinate).

treated separately in assessing the relationship between CS reflex blinks and CRs. The correlation between CRs and acquisition CS reflex blinks for the 400 msec. group was 0.344 ($p < .05$); this is comparable with the figure of 0.56 previously obtained from a group conditioned at a 500 msec. interval (Martin, 1963). For the 800 msec. group the correlation was -0.079 (NS). However, plots of these correlations suggested some departure from linearity and to examine the relationships more precisely curvilinear components were estimated by the method of orthogonal polynomials. In the 400 msec. group only linear and quadratic components were significant (SS linear $F = 11.53$, $df = 1/32$, $p < .05$; SS quadratic $F = 4.64$, $df = 1/32$, $p < .05$). In the 800 msec. group neither was significant, but the quadratic component approached significance. Data for a further 36 Ss, duplicating the original conditions, were treated in the same way. The values of the regression equation for this second group very closely approximated those observed for the first group, and when the groups were combined the curvilinear component proved to be significant. Figure 1 shows the fitted equations and the means on which they were based. The curve for the 800 msec. group is based on the original 36 Ss.

The relationship between blinks to CS Test Trials 1-6 and frequency of subsequent CRs was also examined. The obtained correlation calculated on all Ss was 0.297 (0.302 required for $p < .01$). There was no significant departure from linearity in these data, which demonstrate a substantial predictive element in the occurrence of CS reflex blinks before any conditioning schedule is commenced.

Discussion

The term "reflex sensitivity" has been applied to several independent functions, some of which appear to be more intrinsic to the corneal reflex system than others. The present findings suggest that thresh-

olds of the receptor within the reflex arc are not related to CR frequency. More important, apparently, is the effector side of the reflex arc. Earlier findings agree in demonstrating that strength of the UCR as measured by response amplitude is positively related to CR frequency (Pavlov, 1927; Razran, 1957), while the present study has demonstrated the role of CS reflex blinks.

It seems probable that the frequency of these reflex blinks (variously termed alpha blinks or primary blinks) can in turn be affected by extrinsic factors. This view is supported by the evidence both in our own and earlier data (McAllister, 1953) that CS reflex frequency declines over trials, and the suggestion has been made that CS blink frequency may be an index of overall adaptation to the novelty of the conditioning session (Prokasy & Truax, 1959). We have observed that the frequency of these blinks is increased by novelty or variation in the CS, as well as by increased CS intensity and duration (cf., the 400-800 msec. difference). These considerations, together with the fact that the likelihood of conditioning decreases beyond an optimal level of CS reflex blinking, suggest that the reflex blink to the CS may partake of some of the characteristics of the orienting response described originally by Pavlov (1927) and more recently by Sokolov (1963). If this is so, the relationship between frequency of CS reflex responding and CRs is presumably based on neural events extrinsic to the specific reflex arc rather than within it.

The evidence points, then, towards a convergence of both extrinsic and intrinsic influences on the effector side of the reflex system, the nature and extent of these influences being necessarily expressed through the physical properties of the effector itself.

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Note

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