Heart rate classical conditioning in rabbits^{1, 2}

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Comparisons of heart rate changes between experimental groups receiving paired presentations of tone (CS) and shock (US) and control groups that did not, indicated that conditioned responses occurred within 10 CS-US pairings, and were decelerative with latencies less than .5 sec. and durations of 8 sec. or more.

The purpose of the present study was to investigate heart rate (HR) classical conditioning in the rabbit as a general dependent variable. Our interest in HR conditioning of rabbits was aroused by observations that rabbits remained placid and showed few HR changes as a consequence of being restrained, whereas in similar situations several other species (e.g., rats and dogs) made overt struggling movements accompanied by pronounced changes in HR. Although a number of human and infrahuman HR studies have been recorded in the literature, none have incorporated within the same experiment controls for pseudoconditioning and sensitization with a delineation of the response topography of associative and non-associative HR responses to the conditioned stimulus (CS).

Method

Each of 56 albino rabbits was restrained in a box by an adjustable back plate, an adjustable head stock which comprised the front of the box, and a foam-rubber coated ear clamp. The electrocardiogram was recorded by an Offner Dynograph at a paper speed of 100 mm/sec. The CS was a 2.5 sec., 1000 cps tone of 72-dB SPL; the unconditioned stimulus (US) was a .5 sec., 1.5 ma a.c. shock delivered to the pinna of S's right ear; and the CS-US interval was 2 sec.

Ten Ss were assigned to each of four conditions, with paired and unpaired presentations of the CS and US, and the presence or absence of nine CS adaptation trials constituting the dimensions of a 2 by 2 factorial design. All groups received 15 min. of habituation to the experimental situation, following which Groups CS-US Paired received 45 CS-US trials, and Groups CS and US Random received 45 CS-alone and 45 US-alone trials randomly mixed. Four additional control groups of four Ss each were comprised of Groups CS Alone and Groups US Alone, with and without the nine CS adaptation trials. Test trials (CS alone) were given after 0, 9, 18, 27, 36, and 45 acquisition trials in all groups except for Groups CS and US Random, in which test trials were given after 0, 18, 36, 54, 72, and 90 trials. The intertrial intervals were randomized at 110, 120, and 130 sec. (mean of 120 sec.); except for Groups CS and US Random, in which intervals of 50, 60, and 70 sec. (mean of 60 sec.) were employed.

Results

During the six test trials records of the R-wave to R-wave interbeat interval (IBI) were obtained for each of the 75 beats following CS onset, and were then divided by the mean IBI of the first 10 beats preceding CS onset (baseline) to obtain the response topography. This response topography over test trials 2-6 for groups receiving CS adaptation trials is shown in Fig. 1. A pronounced HR deceleration was revealed in Group CS-US Paired; whereas Groups CS and US Random, CS Alone, and US Alone showed slight accelerations. Calculations of response latency and duration (based on the data presented in Fig. 1, and on a pre-CS baseline IBI of approximately .25 sec.) indicated that the CR latency was less than .5 sec. and the CR duration approximately 20 sec. in Group CS-US Paired with CS adaptation trials. In Group CS-US Paired without adaptation trials (not shown), the CR latency was also less than .5 sec., but the CR duration was about 8 sec.

In the groups receiving adaptation trials the original HR response to the CS was a deceleration. This decelerative response adapted within a half-dozen CS alone trials, and by the first test trial the response to

Fig. 1. The response topography of trials 2-6 for all groups which received CS-alone adaptation trials.

Fig. 2. The mean percent change from baseline of the 30 beats subsequent to CS onset on each test trial for groups receiving CS-alone adaptation trials.

the CS was a slight acceleration.

Figure 2 presents the mean percent change from baseline for all groups receiving CS alone adaptation trials. None of the groups revealed decelerations on test trial 1, and only the CS-US Paired group showed HR decelerations on test trials 2-6. An analysis of variance of percentage changes from baseline over test trials 2-6 indicated a significant source of variation between paired and unpaired CS and US conditions ($p < .001$); but the difference between adaptation and nonadaptation conditions was not reliable ($p > .05$). A significant interaction between dimensions ($p < .025$) reflected the fact that the decelerative HR responses of Group CS-US Paired receiving adaptation trials was greater than that of Group CS-US Paired which did not receive CS adaptation trials.

Discussion

The chief finding of the present experiment was that the HR CR in the rabbit conditioned within 10 trials and was readily discriminable from non-associative responses. The observation that HR conditioning occurred within 10 CS-US pairings contrasts with studies of eyelid and nictitating membrane conditioning in rabbits using an air puff or shock as the US (e.g., Gormezano et al, 1962; Papsdorf et al, 1965; Schneiderman et al, 1962). These latter studies had suggested that large numbers of CS-US pairings were necessary before reliable evidence of classical conditioning could be

obtained in rabbits.

The finding of a decelerative HR CR in the rabbit partially confirmed a previous report by Kosupkin & Olmsted (1943) who used ammonia fumes as the US and found that both the CR and UR were decelerative. Although a consistent UR was not observed in the present experiment, Schneiderman et al (1966) found that both the HR CR and the UR in the rabbit were decelerative when a 20 mamp. a.c. shock US was employed.

Taken together, the findings in the present investigation that: (a) the CR was a deceleration; and (b) few overt struggling responses were made during conditioning, appear to be consistent with the suggestion by Obrist (1965) and Obrist et al (1965) that accelerative components of HR conditioning may be related to gross overt bodily movements, whereas decelerative components may not. If this suggestion is correct, the HR CR in the rabbit may reflect an autonomic cardiac response essentially uncomplicated by somatic motor activity.

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Notes

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2. Portions of this paper were presented at the Midwestern Psychological Association meetings in May, 1964.