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Habituation of cardiac components of the orienting reflex to stimuli repeated at fixed and variable intervals

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The purpose of this study was to determine the effects of fixed-interval (FI) stimulus repetition on cardiac components of the orienting reflex (OR). It was predicted that variable stimulus repetition would lead to habituation of the OR, whereas a fixed (temporal conditioning) interval paradigm would inhibit such habituation. Thirty-six Ss were employed. The main hypothesis concerning the effects of FI stimulus repetition was confirmed. In addition, the data supported the use of Lang & Hnatiow's (1962) peak-to-valley measure of the cardiac response, although the response appeared to be monophasically decelerative, not diphasic. The results suggest that stimuli having "signal functions" will continually elicit the OR, whereas stimuli not having such functions eventually lose their value as OR elicitors.

Experimental studies of heart rate (HR) generally have yielded contradictory findings concerning the directionality of response. These apparent contradictions were clarified in part by Lang & Hnatiow (1962), who suggested that the cardiac response is actually diphasic, showing initial acceleration followed by a longer latency deceleration. Thus, Es who measure the response immediately after stimulation should find *ac*celeration, whereas Es who measure it more than 5 sec after stimulation, should find *de*celeration.

Lang and Hnatiow proposed a "peak-to-valley" measure of HR, which takes into account both the accelerative and decelerative components of the response. This measure, the fastest of the first 6 beats following stimulus onset minus the slowest of the next 15 beats, was held to be a reliable index of the diphasic cardiac response. To substantiate their point, Lang and Hnatiow exposed Ss to repeated stimulation and compared the habituation curve obtained by their peak-to-valley method with habituation curves obtained by other methods of HR measurement. Their assumption, based on both association learning theory and Russian research on the orienting reflex (OR), was that the HR response should show extinction with stimulus repetition, and that the index producing the clearest habituation curves should be the most meaningful index of the cardiac response associated with the OR. As predicted, the peak-to-valley score yielded the most adequate curve of habituation.

Subsequent research by Geer (1964) on the measurement of the conditioned cardiac response supported Lang and Hnatiow's contention that the cardiac response was diphasic and also found that the peak-to-valley score habituated with stimulus repetition. Additionally, Geer demonstrated that, by pairing the repeated stimulus with a shock or noxious tone (UCS), the habituation of the OR to the first tone (CS) could be inhibited. Thus, Geer concluded that the effect of classical conditioning procedures was to inhibit the normally occurring habituation of the HR response to the CS.

On the assumption that the effects of the temporal conditioning paradigm are approximately the same as those of classical conditioning, it might be expected that stimulus repetition at a fixed time interval might also inhibit habituation of the OR to the UCS. Lang and Hnatiow did, in fact, utilize a fixed interval (FI), which thereby established a temporal conditioning paradigm; however, they did not obtain inhibition of habituation, as Geer did.

The purpose of the present experiment was to compare the effects of FI stimulus repetition and variable interval (VI) stimulus repetition on the HR response. On the assumption that the HR response is susceptible to temporal conditioning and that the effects of such conditioning are similar to those of classical conditioning, it was hypothesized that Ss in the FI condition would not show habituation of the response to a repeated stimulus, whereas Ss in the VI condition would show clear patterns of habituation.

In an attempt to evaluate the form of the response to different levels of stimulation, two stimuli of different intensities were employed. It was predicted that high-intensity stimulation was likely to elicit HR acceleration associated with what Sokolov (1963) might call the defense reflex (DR).

METHOD

Subjects

The Ss were 36 undergraduate students (30 female and 6 male) enrolled in the introductory psychology course at the State University of New York at Buffalo.

Apparatus

The Ss were run in a dimly illuminated soundproof chamber, seated in a comfortable lounge chair. HR was detected from arm to arm by silver electrodes and amplified by a Grass Instruments Co. Model 5P6 preamplifier. Both HR and respiration were recorded on a Grass Model 5 polygraph. Electrical stimuli were delivered to the finger by a 60-cycle ac stimulator ranging from 0 to 30 V, isolated from ground. The polygraph, amplifiers, and stimulator were all located outside the chamber.

Procedure

The Ss were assigned randomly to one of four experimental groups: VI, high intensity; VI, low intensity; FI, high intensity; or FI, low intensity.

For the first 7 min, no stimulation was administered. After that, each S received 20 electrical stimuli of 2 sec duration. The Ss in the two FI conditions received the stimuli at 30-sec intervals, and Ss in the two groups received them at intervals varying around 30 sec in 5-sec steps between 10 and 45 sec. The high-intensity stimuli were delivered at 30 V and the low-intensity stimuli were delivered at 18 V.

RESULTS

In order to determine if there were differences among the four experimental groups prior to stimulation, basal HR was evaluated for the last 2 min of the initial 7-min period, using the smoothed-peak-rate method suggested by Opton, Rankin, & Lazarus (1965). No initial differences in heart rate were found among the four groups.

The cardiac response to each of the stimuli was evaluated by Lang and Hnatiow's peak-to-valley score. After these scores were obtained for the 20 trials, they were grouped in five trial blocks of four trials each. Analysis of variance of these data indicated no main effect of stimulus intensity and no interactions of stimulus intensity with any other variable, but a significant interaction of ISI with trial blocks ($F = 2.99$, $df = 4/128$, $p < .025$), confirming the observation that, irrespective of stimulus intensity, the heart-rate response declined across trials for Ss in the VI conditions but not for Ss in the FI conditions. Postexperimental interview data indicated that the "high-intensity" stimulus was not perceived by Ss as being intense; hence, the failure to obtain stimulus intensity effects may be the result of inadequate stimulus selection.

The significant ISI by Trial Blocks interaction is depicted in Fig. 1. Since further analyses indicated that there was no difference between groups during the initial trial block, the data have been plotted as difference scores between the initial trial block and succeeding blocks. Negative scores indicate habituation, and positive scores indicate facilitation. Inspection of Fig. 1 reveals that reduction of responses to an asymptotic level for Ss in the VI group took place between the first and second trial blocks.

Although the present findings substantiate the value of the peak-to-valley score as an index of the HR response, it is still a moot question whether the results obtained were a result of systematic changes in both the accelerative and decelerative components of the response or in either of them alone. In order to evaluate this further, all peak-to-valley scores were broken down into their component parts, so that for each S, five "slow" scores and five "fast" scores were obtained, one for each trial block. An analysis of variance of "habituation scores" obtained in this manner for Ss in the two ISI groups indicated that differential habituation as a function of ISI was statistically significant only for the total peak-to-valley score, and not for either of its components. Each of the records was scrutinized to determine if the HR response was diphasic in all cases. The results indicated that 24 Ss showed a stable decelerative response, 10 showed an accelerative response, and 2 showed no response. There was no relationship between wave form and stimulus intensity.

On the assumption that the differential effects obtained between Ss in the FI and the VI groups might have been accounted for by a temporally conditioned anticipatory HR response occurring for Ss in the FI group, the data for the 12 sec immediately preceding each stimulus onset for Ss in both the FI and the VI groups were examined. Both accelerative and decelerative components were scrutinized, and difference scores between the first 6-sec period and the second 6-sec period preceding onset of the stimulus were obtained first for peak heart rates and then for valley heart rates. Analysis of variance indicated that there were no anticipatory heart-rate changes of an accelerative, decelerative, or biphasic nature for any Ss, irrespective of experimental group.

DISCUSSION

The main findings of the present study may be summarized as follows. First, repeated FI stimulation inhibits habituation of the cardiac component of the OR, but has no discernible effect on the anticipatory HR response. Second, in the present study, the HR response was decelerative for most Ss, accelerative for some, but rarely a stable diphasic response; furthermore, neither the form of the response nor its habituation were related to the two different levels of stimulus intensity employed.

The finding that a fixed-interval paradigm inhibited habituation of the OR, at least as it is reflected in Lang and Hnatiow's peak-to-valley measure of cardiac responding, but did not result in anticipatory HR changes indicative of temporal conditioning is consistent with Geer's report that the classical conditioning paradigm resulted in no acquisition of a "new" conditioned response, but did inhibit habituation of the UCR.

Data bearing on the separate accelerative and decelerative components of the response substantiate further the use of the peak-to-valley score, for no consistent intergroup differences were obtained when either the accelerative or decelerative component of the response was analyzed separately. Although these findings are consistent with assumptions derived from Geer's work, and they support the utility of the peak-to-valley score, they are in distinct contradiction to Lang and Hnatiow's original findings with a 60-sec FI. To be sure, there are many differences between their experiment and the present one, and future studies should address themselves to these differences. They used male Ss, we used predominantly female Ss. They used a 60-sec interval, we used 30. They used auditory stimulation, and we used tactile stimulation.

It is significant to note that, in the present study, the peak-to-valley score appeared to be a useful and valid measure of the cardiac response, although the diphasic response it was designed to measure failed to materialize. This is not surprising, for the peak-to-valley score will yield a reliable positive score under any of the following conditions: (1) if the response is diphasic, (2) if the response is a monophasic, long-latency deceleration, and (3) if the response is a monophasic, short-latency acceleration. In the first and second conditions, there would be little difference in score, for the decelerative component which appears more than five beats after stimulus presentation is subtracted from a prior faster heart rate, whether this faster rate was at base level or was accelerated from base level. In the third case, if the HR accelerates rapidly, and then returns to base level, the result is the same—a positive peak-to-valley score. Thus, it can be seen that the measure is remarkably robust, and is not dependent upon a diphasic response for its application. Yet, it appears that, in the present study, the peak-to-valley score was operating most frequently as an index of a decelerative response.

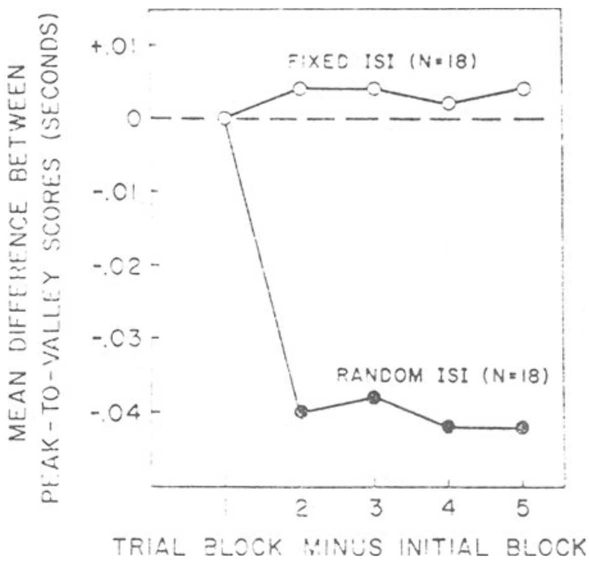

Fig. 1. Mean peak-to-valley scores for Ss in the combined FI and VI groups across five trial blocks.

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