A vigilance-like decrement without vigilance

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Two pigeons were given repeated sessions on a schedule of reinforcement which combined a 1-sec limited hold with a sequence of intervals commonly used to program signals in vigilance experiments (the Mackworth schedule). The proportion of possible reinforcements obtained showed a within-session decrement resembling those familiar from vigilance work. Analysis of Ss' responses suggests that the decrement can be produced by either reduction in response rate or an altered temporal spacing of responses.

An important account of vigilance is that first proposed by Holland (1957, 1958). Holland proposed that when an observer monitors a display for infrequently occurring signals he is actively responding to it, and that his observing behavior is controlled by the signal detections in the same way that food reinforcement controls the operant responding of animals. Observing responses have been defined (Wyckoff, 1952) as any responses which result in exposure to discriminative stimuli. Because human visual observing responses are not readily measurable, Holland used a task requiring an additional overt response of his Ss to gain information about the distribution of these observing responses. In his series of experiments Ss seated in the dark were provided with a key, which, when pressed, produced a brief flash of light, and were instructed to report deflections of a pointer. Holland was able to point to resemblances between the cumulative response curves of animal Ss and his human Ss when the schedules of food reinforcement and pointer deflections were the same.

While Holland's experiments demonstrate that detections can act like reinforcing stimuli, in only one experiment was a decline in detections reported. In this experiment short (1¼-sec) signals were presented according to the sequence of intervals originally used by Mackworth (1950). In Holland's (1958) other experiments, the signals remained present until reset by S. Mackworth's (1950) schedule has the unusual property of a 45-sec minimum intersignal interval, whereas the variable interval schedules commonly used with animals have a very short minimum interreinforcement time in order to eliminate a postreinforcement pause in responding (Ferster & Skinner, 1957).

The decline in the proportion of signals detected as a function of time in vigilance tasks has been regarded as their most significant characteristic. The above considerations suggest that properties of the schedule of reinforcement may be important in producing this decrement. If a similar decrement in number of reinforcements obtained could be produced in animal Ss responding for food reinforcement on an appropriate schedule of reinforcement, a stronger case could be made for an interpretation of vigilance in terms of active perceptual responding to the display which is reinforced by occasional signal detections. This would provide a closer parallel to ordinary human vigilance in that reinforcement (paralleled in human vigilance by detection) would result from a single operant, a key-peck (observing response in human vigilance), eliminating the illumination response which is not normally present. Thus, it is conceived that in each case S is engaged in sampling the environment for brief events by means of his responses (key-pecks or observing responses), with knowledge of the coincidence of a response with an event provided by reinforcement or detection. The purposes of the present experiment were (1) to see whether this decrement could be produced and (2) to collect some data on the relation between the number of responses made and reinforcements obtained.

SUBJECTS AND APPARATUS

Two adult pigeons were run in a standard Grason-Stadler pigeon chamber. Each had a previous history of variable interval responding under multiple schedules. They were maintained throughout the experiment at 80% (±15 g) of their free-feeding body weight.

SCHEDULE

The schedule of reinforcement used employed the sequence of intervals reported by Mackworth (1950) to produce a reliable vigilance decrement with human Ss. In each session the program was run four times without a break as in Mackworth's (1950) and Holland's (1958) experiments. In formal terms, it constitutes a tandem schedule in which a 45-sec extinction component is succeeded by a variable interval component of mean interval 105 sec. Thus, the Ss could never receive reinforcement until at least 45 sec had elapsed since the previous reinforcement, and there was no stimulus change to indicate which of the two components was in effect. An additional "limited hold" contingency was imposed to take account of the transience of the signals in a vigilance task; this means that the reinforcement is delivered only if a response is made within a specified brief interval of the reinforcement being programmed. Responses occurring outside this interval are unreinforced until the next reinforcement is scheduled.

PROCEDURE

Subjects received one 2-h session per day, seven days per week except as noted below. Reinforcement consisted of 3-sec access to wheat. The limited-hold contingency was progressively reduced from 30 sec (S1) and 20 sec (S4) on Day 1 to 1 sec on Day 5 at which value it remained for the rest of the experiment. The Ss were given training on the schedule until Day 28 when an apparatus failure occurred. Until the breakdown was repaired on Day 33, they were maintained in their home cages. The analyses following refer only to data collected on Days 38-58.

RESULTS AND DISCUSSION

For analysis, the task was divided into four ½-h blocks. Fig. 1 shows the number of reinforcements obtained by each S as a function of time since the beginning of the daily session and represents the analogue of the number of signals detected in an ordinary vigilance experiment. Analysis of variance

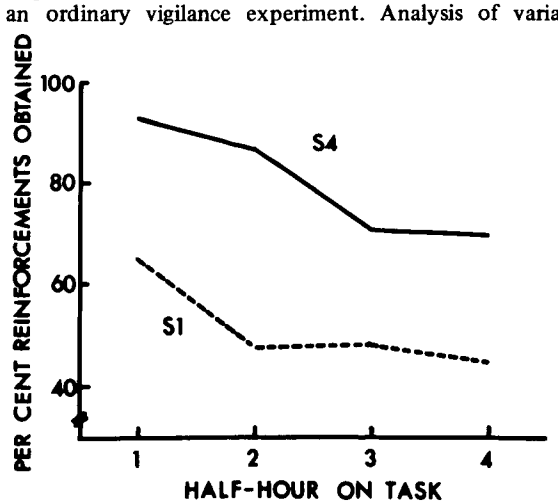

Fig. 1. Per cent of possible reinforcements obtained as a function of time on task.

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the effects of increasing postreinforcement delay in G1 simultaneous with an incomplete reduction of reward in the present study are in a direction opposite to the effects of simultaneous prereinforcement delay increase and reward reduction, consideration of total detention time becomes superfluous, its only possible descriptive use being the ordering of cell means in a pre- by postreinforcement increase factorial study. In view of the present results, then, it would appear that previous demonstrations of enhanced performance following simultaneous increases in prereinforcement delay and decreases in reward magnitude (McHose, 1966b, 1968) reflect the effects of increased prereinforcement delay rather than increases in total detention time in G1.

REFERENCES

BARRETT, R. J., PEYSER, C. S., & McHOSE, J. H. Effects of complete and incomplete reward reduction on a subsequent response. Psychonomic Science, 1965, 3, 277-278.

DALY, H. B. Excitatory and inhibitory effects of complete and incomplete reward reduction in the double runway. Journal of Experimental Psychology, 1968, 76, 430-438.

McHOSE, J. H. Incentive reduction: Delay increase and subsequent responding. Psychonomic Science, 1966a, 5, 213-214.

McHOSE, J. H. Incentive reduction: Simultaneous delay increase and magnitude reduction and subsequent responding. Psychonomic Science, 1966b, 5, 215-216.

McHOSE, J. H. Incentive reduction: Varied simultaneous reductions and subsequent responding. Psychonomic Science, 1968, 11, 313-314.

WAGNER, A. R. The role of reinforcement and non-reinforcement in an "apparent frustration effects." Journal of Experimental Psychology, 1959, 57, 130-136.

WINER, B. *Statistical principles in experimental design.* New York: McGraw-Hill, 1962.

NOTE

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confirmed the apparent effects, showing significant effects for a linear decline in proportion of possible reinforcements obtained as a function of time on task ($F = 17.50$, $df = 1/3$, $p < .05$) and a significant difference between Ss ($F = 52.02$, $df = 1/3$, $p < .01$). The decrement resembles that found in human Ss in vigilance situations and supports Holland's suggestion that signal detections parallel conventional reinforcers.

The other significant main effect, that for Ss, can be seen (Fig. 2) to be associated with a difference in the response rates of the two Ss. Analysis of variance of number of responses showed significant effects for Ss ($F = 86.17$, $df = 1/3$, $p < .01$) and for an interaction between Ss and time on task ($F = 4.72$, $df = 3/160$, $p < .01$). Fig. 3 shows the effect of adjusting by analysis of covariance the number of reinforcements obtained while holding constant the number of responses. When this is done, S1 shows a decreasing efficiency of performance and S4 an increasing efficiency, with this interaction being the only significant effect ($F = 4.20$, $df = 1/159$, $p < .01$). Thus, the decline in response rate shown by S4 is sufficient to offset this gain in efficiency, resulting in the overall decline in number of reinforcements shown in Fig. 1. This suggests that there may be two mechanisms at work, each capable of producing a diminution in number of reinforcements obtained as a function of time on task. Both a reduction in response rate and a rise in the proportion of responses emitted during the extinction component would tend to decrease the probability that a response would coincide with the brief period of the limited hold. The availability of different response strategies to S would by itself be sufficient to account for the consistently reported individual differences in vigilance performance. This suggests the possibility of improving detection performance by training procedures specifically designed to alter the observing rate.

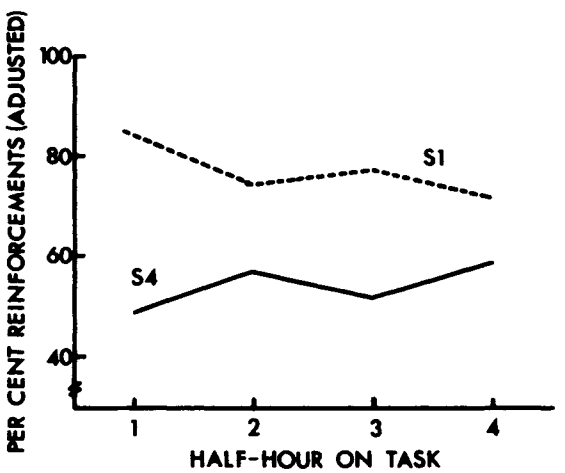

Fig. 3. Per cent of possible reinforcements obtained, adjusted for number of responses, as a function of time on task.

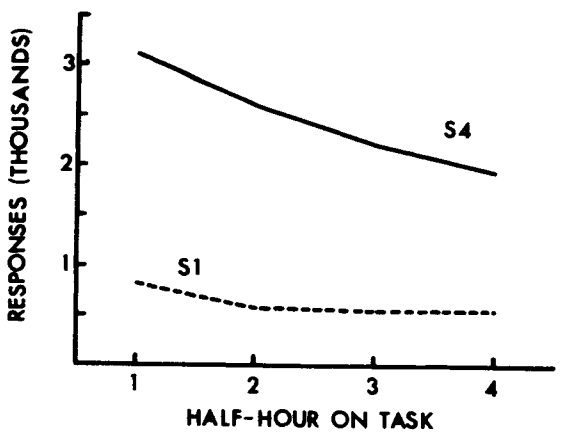

Fig. 2. Response rate as a function of time on task.

REFERENCES

FERSTER, C. B., & SKINNER, B. F. *Schedules of reinforcement.* New York: Appleton-Century-Crofts, 1957.

HOLLAND, J. G. Technique for behavioral analysis of human observing. Science, 1957, 125, 348-350.

HOLLAND, J. G. Human vigilance. Science, 1958, 128, 61-67.

MACKWORTH, N. H. Researches on the measurement of human performance. Medical Research Council Special Report Series, No. 268. London: HMSO, 1950.

WYCKOFF, L. B. The role of observing responses in discrimination learning. Part 1. Psychological Review, 1952, 59, 431-442.