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KEY PECKING AS A FUNCTION OF RESPONSE-SHOCK AND SHOCK-SHOCK INTERVALS IN UNSIGNALLED AVOIDANCE[1]

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Five pigeons were exposed to an unsignalled avoidance procedure where key pecks were maintained through shock postponement. Functions obtained showed an inverse relationship between rate of responding and length of the response-shock interval, while changes in the shock-shock interval had no systematic effect on response rates. The rate of shocks delivered generally decreased with increases in length of both response-shock and shock-shock intervals. Results show that key pecking in pigeons, maintained through an unsignalled avoidance procedure, was affected by changes in response-shock and shock-shock intervals in the same manner as other responses in pigeons and in rats.

The reported difficulty of shaping and maintaining key pecking in pigeons through negative reinforcement (Hineline and Rachlin, 1969; Hoffman and Fleshler, 1959; Macphail, 1968; Rachlin and Hineline, 1967) has been interpreted as evidence against the notion of an arbitrary relationship between operants and their consequences (Bolles, 1970; Seligman, 1970; Smith and Keller, 1970; Staddon and Simmelhag, 1971). Smith and Keller suggested that the difficulty stems from the selection of the response. Key pecking would be incompatible with the unconditioned response elicited by shock. Smith, Gustavson, and Gregor (1972) presented data in support of this view, giving more weight to Bolles' (1970) species-specific defense theory of escape and avoidance behavior.

However, Ferrari, Todorov, and Graeff (1973) reported successful key-pecking avoidance of shock, arguing that the reported difficulties in shaping and maintaining key pecking through negative reinforcement may be more a result of the procedure used than of the characteristics of the response selected. The present experiment extends the work of Ferrari *et al.* to the systematic manipulation of response-shock and shock-shock intervals in an unsignalled avoidance procedure.

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METHOD

Subjects

Five adult, male domestic pigeons, from uncontrolled derivations of the species *Columba livia,* had an average weight of 300 g and average height of 20 cm. Subjects were kept in individual home cages and had free access to food and water there throughout the experiment. Subjects P-51, P-52, DL, and RV were trained in key-pecking avoidance of shock in a previous experiment (Ferrari *et al.*, 1973). Subject VG was experimentally naive.

Apparatus

A standard experimental chamber for operant conditioning with pigeons, described by Ferrari *et al.* (1973) was used. Shock was produced with a modified Foringer (USA) shock source, equipped with a 40-K ohm series resistor, and delivered through electrodes chronically implanted around the pubis bones (Azrin, 1959). A pulse former controlled shock duration (35 msec); shock intensity (10 mA) was measured in milliamperes by using a 1-K ohm resistor in place of the birds. Standard electromechanical equipment was employed for automatic scheduling and recording of events.

Procedure

The technique used to shape key pecking through negative reinforcement was described by Ferrari *et al.* (1973). The room and the experimental chamber were darkened, the only illumination coming from a red light behind the response key. At the beginning of the shaping session, a train of 35-msec shocks at 0.5-sec intervals was delivered, with intensity gradually increasing from 0 to 10 mA. Any movement of the bird toward the response key resulted in shock ceasing for 15 sec; the response requirement was slowly changed by the method of successive approximations until the first effective key peck occurred. Any movement away from the response key was followed by an increase in shock intensity (up to 10 mA). After the first key peck, the response-shock interval was increased to 30 sec and the session was continued until the one-hundredth response was emitted.

The order of variations in response-shock (RS) and shock-shock (SS) intervals is given in Table 1. For the RS intervals, increases and decreases in length alternated. Shock-shock intervals were presented in a decreasing order.

Subjects were studied for a minimum of 10 daily 2-hr sessions in each experimental condition. A change in RS or SS value was made when: (a) cumulative response records indicated rate stability for at least five consecutive sessions, and (b) the difference between the rate of responding in any one of the five sessions and the average rate of those sessions was less than 10% of that average. On those experimental conditions in which responding deteriorated, parameters were changed after three consecutive sessions without responses in the first 30 min. Table 1 also shows the number of sessions per subject in each experimental condition.

RESULTS

The data from the last five sessions in each experimental condition were used in the analysis of results. Table 1 gives the values of RS and SS intervals used, their order of presentation, the number of sessions to meet the criterion of stability, and rates of responses and shocks in each condition.

Figure 1 presents response rates on those conditions in which RS interval was varied. For all birds, the logarithm of response rate was an inverse, approximately linear function of the logarithm of RS interval. Shock rates generally decreased with increases in RS length, as can be verified in Table 1.

Variations of the SS interval had no systematic effect on response rate. Figure 2 shows that when the RS was kept constant, variability in rate of key pecks was unrelated to changes in SS interval. The data on rate of shocks (Table 1) show that shocks delivered generally increased with decreases in SS length.

Table 1

Response-shock and shock-shock intervals, order of introduction of each value, number of sessions per experimental condition, and mean response and shock rates taken from the last five sessions in each condition.

Subject	*RS*	*SS*	*Order*	*Sess.*	*R/Min*	*Sh/Min*
RV	5.0	2.0	4	46	20.8	9.6
	7.5	2.0	5	14	16.0	8.5
	10.0	2.0	2	20	14.3	4.2
	15.0	2.0	3	35	11.4	2.4
	20.0	2.0	6	19	6.0	3.9
	30.0	2.0	1	27	4.6	2.4
	30.0	0.3	10	16	9.0	2.7
	30.0	0.5	9	62	10.5	1.9
	30.0	1.0	8	23	2.8	5.9
	30.0	5.0	7	47	3.2	3.0
P-51	5.0	2.0	4	46	15.8	13.3
	10.0	2.0	2	36	11.7	6.0
	15.0	2.0	3	10	8.2	4.0
	30.0	2.0	1	30	3.4	3.6
	40.0	2.0	5	39	3.6	1.8
	30.0	0.5	9	20	4.2	13.4
	30.0	1.0	8	25	6.8	3.5
	30.0	2.0	7	37	7.3	1.9
	30.0	5.0	6	22	4.1	2.2
DL	5.0	2.0	4	38	28.6	9.1
	7.5	2.0	5	24	19.0	7.2
	10.0	2.0	2	16	11.2	12.0
	15.0	2.0	3	31	8.8	5.8
	30.0	2.0	1	25	3.4	3.7
P-52	30.0	0.1	6	22	8.0	5.1
	30.0	0.3	5	17	6.8	2.6
	30.0	0.5	4	24	7.3	2.5
	30.0	1.0	3	25	7.0	2.2
	30.0	2.0	2	25	5.0	1.2
	30.0	5.0	1	19	4.4	0.7
VG	30.0	0.1	6	26	4.1	70.1
	30.0	0.3	5	16	3.0	42.2
	30.0	0.5	4	20	3.2	26.1
	30.0	1.0	3	29	2.7	17.6
	30.0	2.0	1	40	3.7	5.6
	30.0	5.0	2	46	1.6	6.5

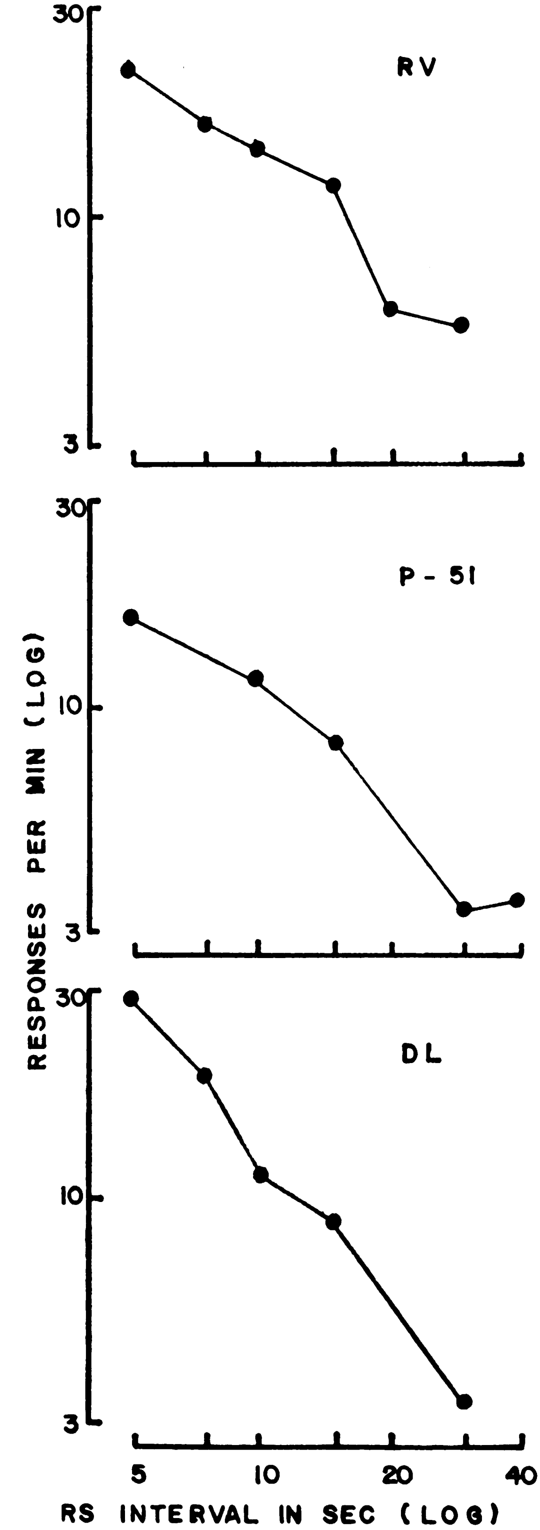

Fig. 1. Logarithm of response rate as a function of the logarithm of the response-shock interval. The shock-shock interval was constant at 2 sec.

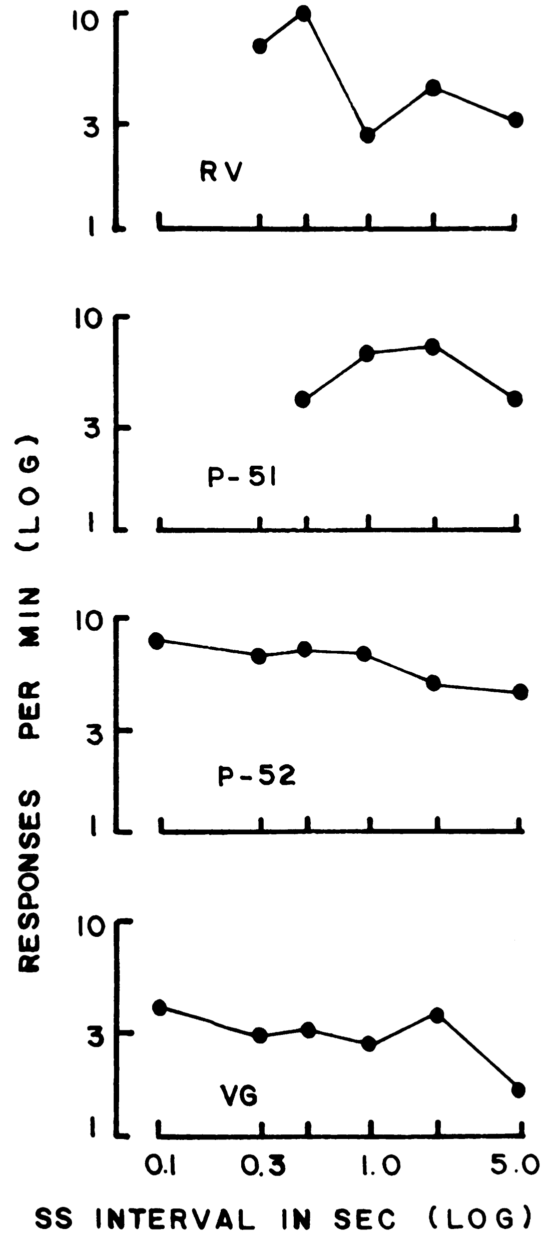

Fig. 2. Logarithm of response rate as a function of the logarithm of the shock-shock interval. The response-shock interval was constant at 30 sec.

DISCUSSION

Stable key pecking was maintained in five pigeons through shock postponement, confirming and extending the results of Ferrari *et al.* (1973). The inverse relationship between response rate and response-shock interval was similar to those obtained by Sidman (1953) with rats pressing a bar, and by Klein and Rilling (1972) with pigeons pressing a treadle. This similarity in functions indicates that the characteristics of the response may be important as far as shaping avoidance behavior is concerned. Once the control over the response is established through negative reinforcement, pigeons will peck a key or press a treadle at a rate that is a function of the response-shock interval.

The lack of a relationship between response rate and shock-shock interval is consistent with Sidman's (1953) data obtained from rats. Sidman reported that for long response-shock intervals, variations in the shock-shock interval had no effect on response rate. One interpretation for the lesser importance of the SS interval in the maintenance of unsignalled avoidance behavior might suggest that the SS interval was only rarely sampled once the birds began to avoid. Since variations in SS length never enter into contact with behavior, it would be futile to expect a relationship between SS duration and response rate. However, the data from Subject VG suggest that the SS interval was sampled quite frequently. If the bird responded right after each shock (and never received a shock scheduled by the SS interval), the rate of shocks delivered would be about two shocks per minute on RS 30-sec. Since the rate of shocks per minute for Subject VG varied from 5.6 to 70.1, it is fair to conclude that response rate did not vary with changes in SS length, in spite of the fact that the subject received shocks scheduled by the SS interval. The data from the other three subjects support the same notion. Thus, the present results show that (a) key pecking in pigeons is not affected systematically by changes in shock-shock interval when a long (30 sec) response-shock interval is used, and (b) this lack of relationship is similar to the results obtained from rats pressing a bar. For both species, when RS > SS, response rate is a function of the RS interval and does not depend on SS length.

REFERENCES

Azrin, N. H. A technique for delivering shock to pigeons. *Journal of the Experimental Analysis of Behavior,* 1959, **2,** 161-163.

Bolles, R. C. Species-specific defense reactions and avoidance learning. *Psychological Review,* 1970, **77,** 32-48.

Ferrari, E. A. M., Todorov, J. C., and Graeff, F. G. Nondiscriminated avoidance of shock by pigeons pecking a key. *Journal of the Experimental Analysis of Behavior,* 1973, **19,** 211-218.

Hineline, P. N. and Rachlin, H. Escape and avoidance of shock by pigeons pecking a key. *Journal of the Experimental Analysis of Behavior,* 1969, **12,** 533-538.

Hoffman, H. S. and Fleshler, M. Aversive control with the pigeon. *Journal of the Experimental Analysis of Behavior,* 1959, **2,** 213-218.

Klein, M. and Rilling, M. Effects of response-shock interval and shock intensity on free-operant avoidance responding in the pigeon. *Journal of the Experimental Analysis of Behavior,* 1972, **18,** 295-303.

Macphail, E. M. Avoidance responding in pigeons. *Journal of the Experimental Analysis of Behavior,* 1968, **11,** 629-632.

Rachlin, H. C. and Hineline, P. N. Training and maintenance of key-pecking in the pigeon by negative reinforcement. *Science,* 1967, **157,** 954-955.

Seligman, M. E. On the generality of the laws of learning. *Psychological Review,* 1970, **77,** 406-419.

Sidman, M. Two temporal parameters of the maintenance of avoidance behavior by the white rat. *Journal of Comparative and Physiological Psychology,* 1953, **46,** 253-261.

Smith, R. F. and Keller, F. R. Free-operant avoidance in the pigeon using a treadle response. *Journal of the Experimental Analysis of Behavior,* 1970, **13,** 211-214.

Smith, R. F., Gustavson, C. R., and Gregor, G. L. Incompatibility between the pigeon's unconditioned response to shock and the conditioned key-peck response. *Journal of the Experimental Analysis of Behavior,* 1972, **18,** 147-153.

Staddon, J. E. R. and Simmelhag, V. L. The "superstition" experiment: a reexamination of its implications for the principles of adaptive behavior. *Psychological Review,* 1971, **78,** 3-43.

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