KNOWING BEFORE DOING: DISCRIMINATION BY RATS OF A BRIEF INTERRUPTION OF A TONE

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Eight rats' lever presses were reinforced after an interruption in a tone, provided the lever had not been pressed before the tone interruption. After a few sessions, long before the animals reliably refrained from lever pressing before the interruption, the latencies of postinterruption presses (time from the termination of the interruption to the moment of the lever press) dissociated into two classes: short ones for to-be-rewarded presses, and long ones for presses in the other trials, which contained no reward because one or more lever presses had occurred before the interruption. Thus discrimination of impending reinforcement in the current trial occurred before there was evidence of sensitivity to reinforcement in the reinforcement-producing aspect of behavior. This finding is related to Shimp's (1981) contention that the temporal properties of recent behavior are reinforceable, if remembered. The present finding shows that learning to discriminate whether one's behavior has met a contingency, and learning to carry out this behavior, need not go together, implying that memory of temporal properties is probably a necessary but not a sufficient condition for learning the latter.

Key words: discrimination, memory, lever press, rats

Shimp (1981) proposed that "reinforcement shapes the local temporal organization of behavior to the extent to which a subject remembers that organization when a reinforcer is delivered" (p. 310). According to this formulation, "representation of the temporal properties of recent behavior in working memory" is both a necessary and a sufficient condition to make these properties reinforceable. Shimp (1981) obtained some support for his hypothesis from an experiment in which he trained pigeons to emit IRTs (interresponse times) belonging to one

of two different classes (short and long), and, after completed training, tested by a "symbolic delayed matching-to-sample" procedure whether they remembered their most recently emitted IRT. He found that, provided the retention interval was not too long, the pigeons remembered to which of the two classes their just-emitted IRT belonged. Although this finding is consistent with Shimp's contention, it is not very informative about the acquisition process, because the test was not carried out before the behavior had stabilized. A later experiment (Shimp, 1983) produced inconclusive results (see Eisler, 1984).

An experiment by Reynolds (1966) seemed to show that remembering recently emitted behavior is not a sufficient condition for learning to change this behavior so that a contingency is met. In his experiment, pigeons were presented with a red key; after two pecks on this key its color changed to blue and pecks were reinforced on a variable-interval schedule, provided at least 18 s had elapsed between the two pecks on the red key. Although in 103 sessions the pigeons

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did not learn to lengthen the average IRT on the red key, their rate of responding on the blue key turned out to be a monotonic increasing function of the time interval between the two pecks on the red key, indicating that the pigeons remembered their recent behavior. This finding is at variance with Shimp's view. Shimp (1981) explained Reynolds' (1966) finding by assuming that the pigeons remembered the duration of the key being red rather than their IRT. However, the red key was lit for some time before the first key peck could take place. Shimp's explanation requires this period to show little or no variation—that is, a high correlation between the duration of red and the IRT over trials. We do not know whether this was the case.

At any rate, neither of the two experiments gives any information regarding the development of discrimination and behavior relative to each other during the acquisition process. Reynolds' (1966) does not because acquisition never took place, and Shimp's (1981) does not because the discrimination (or memory) test was carried out only when performance had been well established.

The present paper reports a finding from the second phase of a three-phase experiment—aimed at the scaling of subjective duration in rats—that may throw some light on the time course of a response coming to function as a discriminative event, and of the concomitant changes in probability of this response, based on differential reinforcement of nonresponding under certain conditions. The scaling was to be carried out by having eight rats reproduce 10 randomly presented durations, varying between 1.3 and 20 s (Phase 3), and applying the parallel-clock model (Eisler, 1975, 1976, 1981, in press) to the data. The durations were presented acoustically, and the end of the standard and the start of the reproduced duration were indicated by a 300 ms interruption of the sound. The aim of Phase 2, with which this paper deals, was to train the animals to discriminate ("to attend to") this interruption.

METHOD

Main Features of the Experiment

Phase 2 of the experiment consisted of a number of sessions, and each session consisted of a number of cycles. Each cycle in its turn consisted of four or five parts (see Figure 1): (1) a long pause P, (2) the first tone A continuing for one of the standard durations, possibly increased by "punishment times" (see below), (3) the interruption I, (4) the second tone B, being identical to the first and terminated by a lever press, and, provided the rat's behavior was correct (see below), (5) a feeding period F. The actual duration of these events (in seconds) is denoted by t with the pertinent subscript. The next cycle started immediately with the long pause either after the offset of the second duration—that is, at the lever press (unreinforced)—or after the end of the feeding period. Reinforcement occurred in a trial only if the rat did *not* press the lever during the first duration A (during the tone *before* the interruption). This was defined as correct behavior. Note that reinforcement was delayed until the final part of a correct sequence—no press/press—had occurred. Pressing the lever during the first duration was defined as incorrect behavior and carried the contingency, besides absence of reward, of a prolongation of the first duration by a "punishment time" S, in order to avoid superstitious chaining.

Fig. 1. Cycle with reinforced (upper panel) and nonreinforced (lower panel) behavior patterns. The thick lines indicate the ongoing tone, vertical arrows denote lever presses, P the long pause, A the presented standard duration (in the lower panel lengthened by the punishment time S), I the interruption of the tone, B the latency between offset of the interruption and the following lever press, and F the feeding period.

Subjects

Twelve male black-hooded rats, 51 days old and weighing 148 to 179 g, were obtained. They were kept in individual cages with free access to food and water for 10 days, their weights then being 205 to 230 g. On the tenth day, Rats 2, 5, 11, and 12 were singled out as weight controls; the remaining rats became experimental animals, and over a period of about 10 more days they were reduced to 80% of their ad-lib feeding weight, at which they were kept during the entire experiment. This weight was determined daily in the following way. On the last day of the free-feeding period, the ratio between each animal's weight and the mean weight of the four control rats was determined. On every subsequent day the four control rats were weighed and their mean weight was multiplied by the above-mentioned ratio. 80% of this amount defined the 80% ad-lib feeding weight for each individual rat.

Apparatus

The experiment was conducted in a transparent chamber (23.3 by 19.5 by 25.5 cm) placed in a wooden enclosure (90 by 55 by 44 cm) lined with 4-cm-thick Cryolite for soundproofing. The enclosure contained a fan and a small loudspeaker, and there was an observation hole (with cover) on the top. The chamber had a grid floor. The feeding mechanism (which gave the rat access to diluted sugar-sweetened condensed milk for a limited period by lifting a small spoon from the milk container) and the lever were on the same short wall.

The stimuli were tones from the loudspeaker with durations t_c . These durations were controlled by a punched mylar tape that was closed to form a loop. The other durations (see Figure 1) were set by knobs. Responses were registered on paper tape and counters.

Procedure

The following data were collected separately for each cycle: number of lever

presses for each of the five parts of the cycle, reward or not, latency (to the nearest 0.01 s) between offset of the interruption and the lever press that terminated the sound, and scheduled length of the standard duration (t_c) for the cycle in question.

A lever press during Period A disconnected the electronic clock measuring the duration t_c for the punishment time t_s ; this happened anew for each lever press irrespective of any previous lever presses during the ongoing Period A, so that the prolongation of A hardly exceeded t_s for two lever presses in quick succession, but was $2t_s$ if two lever presses were more than t_s s apart. After expiration of t_s , t_c resumed its course. (See Figure 1, lower panel.)

Neither the room containing the home cages nor the experiment room contained any windows. The day-night cycle was reversed by connecting the lights of the home room to a clock. This was done so that experiments could be carried out during the dark period, when the animals were most lively. The sessions were held daily and usually lasted 1 hr. Generally speaking, the sessions were terminated by time, because the other criterion for termination—50 feedings—was rarely achieved. During all transportations the rats were handled extensively. The commencement of a session lighted the houselight; at its termination the light went out.

Phase 1: Magazine training. Milk was presented at irregular, preprogrammed intervals. In addition, every lever press gave access to the milk. This phase lasted 4 days. There were only a few lever presses during the first day; during the last 2 days all milk was obtained from lever presses.

Phase 2: Interruption discrimination. The number of cycles per session varied, of course, both over sessions and among rats. A crude average was 60 cycles/session. After 68 (67 for two rats) sessions, Phase 2 was concluded.

Consider Figure 1 once more. The long pause P, which intervened between trials, was kept at 40 s during the first 40 sessions, and decreased to 30 s from the 41st session.

It was hoped that through this lengthy pause the animals would experience a trial as a unit, with little or no carry-over between successive cycles.

There were ten different standard durations, t_C , in equal logarithmic steps: 1.3, 1.8, 2.5, 3.3, 4.5, 6.0, 8.1, 11.0, 14.8, and 20.0 s, presented three times each in pseudo-random order. The punishment time, added to t_C as described above, was 4 s. The interruption (I) was kept at 300 ms. This was considered to be the shortest possible pause that would be clearly discernible. Because the parallel-clock model (Eisler, 1975) makes no provision for this time interval, it had to be so short that it could be ignored. Finally, access to milk was allowed for 5 s, which was ample time for the spoon to be licked clean. The duration t_S of the variable Period B (second tone) was, of course, determined by the rat.

Lever presses during interruption I and feeding period F were rare.

RESULTS

Acquisition

Figure 2 shows acquisition curves for each of the eight rats. The proportion of cycles with correct behavior (no lever press during the first tone A) per session is plotted against session number in the lowermost of the three panels for each rat. The interested reader may note individual differences both in the slope of the learning function and in the level of asymptotic behavior. More interesting perhaps is the finding that in the first few sessions with the tone, lever presses were widely enough spaced to result in a comparatively good performance. In these sessions latencies in the order of magnitude of minutes could be observed, with 26 min the longest one. With the initial development of shorter and more regular postinterruption latencies, performance during A deteriorated.

Latencies

A latency is the time interval denoted by B in Figure 1. It starts at the offset of the inter-

ruption I (i.e., at the onset of the tone during B) and ends with the rat's lever press, which also terminates the tone and starts the feeding period F after correct behavior, or the next cycle with the long pause P, after incorrect behavior.

The main finding of Phase 2 was that latencies dissociated—into short ones, when food would be forthcoming, and long ones, when food would not be forthcoming—many sessions before good performance was achieved in terms of proportion of correct cycles.

In a general way this effect can be seen in Figure 2. The two upper panels for each rat show the mean latencies for to-be-rewarded and not-to-be-rewarded cycles for each session plotted against session number. It is clear that the two classes of latencies emerge at or before the lowest point of the performance curve in the lowermost panel. Table 1 gives more detailed information.

In order to obtain acceptably stable values, sequences of five sessions were pooled. The first sequence of sessions (e.g., 7 through 11 for Rat 1) started with the first session that had a higher "proportion correct" than the preceding one (not including the first two sessions), that is, at the very start of the acquisition process of refraining from lever pressing during the first tone. The second sequence of sessions (21 through 25 for Rat 1) could not be defined as distinctly as the first one. Its first session was the one in which latency differentiation could be considered complete. For slow-learning animals like Rats 4 and 6, a certain arbitrariness in choosing their sequences of sessions could not be avoided.

For these two sequences of sessions and all eight rats Table 1 shows (a) proportion correct cycles in total and for each standard, (b) the number of cycles on which each latency value is based, (c) mean latencies L_0 for nonreward trials (pooled over all durations and entered under the heading "Total"), and (d) the difference between latencies for nonreward and reward trials $L_0 - L_i$, where L_i denotes the mean latency for a reward trial with standard i (under the

Fig.2. Acquisition curves (proportion of correct cycles per session as a function of session number) and mean latencies with and without impending food as a function of session number for eight rats. Latencies exceeding 10 s are omitted (see, e.g., Session 30 with food for Rat 1); a latency of less than 10 s that is flanked by two latencies exceeding 10 s is denoted by a symbol (a small hexagon; see Rat 10).

Table 1
Proportion Correct Trials, Latencies, and Latency Differences in Seconds

<i>Rat</i>	<i>Session</i>		<i>Total</i>	<i>1.3</i>	<i>1.8</i>	<i>2.5</i>
1	7-11	Proportion correct	0.21	0.77	0.45	0.30
		Number of trials	183	20	9	6
		Latency (differences)	2.5	1.4	1.3	1.1
	21-25	Proportion correct	0.28	1.00	0.81	0.70
		Number of trials	219	30	26	21
		Latency (differences)	4.7	4.2	4.1	4.1
3	5-9	Proportion correct	0.23	0.81	0.73	0.20
		Number of trials	177	22	16	3
		Latency (differences)	3.5	2.3	0.8	1.6
	16-20	Proportion correct	0.45	0.88	0.97	0.87
		Number of trials	174	28	32	27
		Latency (differences)	4.3	3.7	3.8	3.7
4	9-13	Proportion correct	0.19	0.76	0.43	0.29
		Number of trials	207	19	10	8
		Latency (differences)	4.8	3.7	4.0	3.2
	20-24	Proportion correct	0.58	0.94	0.90	0.97
		Number of trials	134	32	28	30
		Latency (differences)	3.9	3.1	3.1	3.2
6	5-9	Proportion correct	0.19	0.75	0.52	0.16
		Number of trials	188	21	11	3
		Latency (differences)	3.2	1.5	0.7	0.9
	16-20	Proportion correct	0.51	0.97	0.97	0.94
		Number of trials	153	31	30	31
		Latency (differences)	6.4	5.6	5.8	5.8
7	6-10	Proportion correct	0.12	0.63	0.38	0.04
		Number of trials	205	12	11	1
		Latency (differences)	3.3	2.2	-1.7	-0.1
	14-18	Proportion correct	0.13	0.66	0.18	0.33
		Number of trials	278	21	6	11
		Latency (differences)	2.6	1.8	1.8	1.8
8	5-9	Proportion correct	0.22	0.81	0.64	0.28
		Number of trials	185	17	14	8
		Latency (differences)	4.0	3.2	3.1	3.3
	13-17	Proportion correct	0.41	1.00	0.81	0.69
		Number of trials	188	30	26	22
		Latency (differences)	4.6	3.4	4.2	4.1
9	6-10	Proportion correct	0.20	0.76	0.43	0.27
		Number of trials	187	22	10	4
		Latency (differences)	3.5	1.9	1.5	2.0
	11-15	Proportion correct	0.18	0.54	0.44	0.30
		Number of trials	248	15	14	9
		Latency (differences)	2.9	1.6	1.5	1.1
10	5-9	Proportion correct	0.31	0.83	0.68	0.46
		Number of trials	154	15	19	12
		Latency (differences)	5.0	2.0	2.4	-1.9
	21-25	Proportion correct	0.52	0.97	1.00	0.90
		Number of trials	146	30	30	27
		Latency (differences)	10.4	9.2	9.3	9.7

Table 1—continued
Proportion Correct Trials, Latencies, and Latency Differences in Seconds

<i>3.3</i>	<i>4.5</i>	<i>Standard</i> <i>6.0</i>	<i>8.1</i>	<i>11.0</i>	<i>14.8</i>	<i>20.0</i>
0.12	0.13	0.13	0.10	0.07	0.06	0.00
3	3	3	2	2	1	0
0.7	-16.0	1.3	1.7	-17.3	0.1	--
0.13	0.10	0.00	0.03	0.00	0.00	0.00
4	3	0	1	0	0	0
4.3	3.8	--	2.8	--	--	--
0.18	0.05	0.00	0.18	0.04	0.04	0.00
4	1	0	4	1	1	0
1.7	2.0	--	-18.8	-24.3	2.1	--
0.61	0.52	0.42	0.23	0.00	0.06	0.00
20	16	13	7	0	2	0
3.4	3.2	3.2	3.6	--	3.2	--
0.15	0.07	0.08	0.04	0.04	0.00	0.04
4	2	2	1	1	0	1
3.2	3.2	-5.5	3.7	-5.7	--	2.8
0.84	0.68	0.45	0.50	0.36	0.13	0.06
26	21	17	15	12	4	2
3.2	3.2	3.3	2.4	3.2	3.3	3.0
0.04	0.05	0.04	0.20	0.00	0.05	0.08
1	1	1	4	0	1	2
1.7	2.6	0.9	-12.9	--	2.1	-27.8
0.88	0.65	0.43	0.17	0.06	0.03	0.03
28	20	13	5	2	1	1
5.6	6.0	5.9	5.5	5.8	-10.4	0.6
0.05	0.04	0.00	0.00	0.00	0.03	0.05
1	1	0	0	0	1	1
2.3	1.2	--	--	--	1.7	0.8
0.03	0.00	0.03	0.00	0.06	0.00	0.00
1	0	1	0	2	0	0
1.5	--	0.4	--	1.9	--	--
0.16	0.11	0.10	0.08	0.11	0.00	0.00
4	3	2	2	3	0	0
2.3	2.2	2.4	1.5	1.6	--	--
0.38	0.44	0.29	0.25	0.06	0.15	0.00
12	14	9	8	2	5	0
4.1	-0.1	4.3	2.9	4.2	-0.1	--
0.09	0.05	0.04	0.20	0.00	0.12	0.00
2	1	1	4	0	3	0
-8.1	2.1	2.6	0.9	--	0.7	--
0.13	0.07	0.17	0.09	0.00	0.00	0.07
4	2	5	3	0	0	2
2.0	2.1	1.8	1.2	--	--	2.0
0.24	0.40	0.11	0.18	0.06	0.00	0.05
4	10	2	5	1	0	1
3.6	-30.7	-9.9	2.6	2.7	--	-2.3
0.61	0.57	0.40	0.28	0.32	0.17	0.00
19	17	12	9	10	5	0
10.1	6.8	9.5	7.9	9.1	5.4	--

heading "Standard"). For trials with reward, the difference between latencies was chosen rather than the latencies themselves because the sign of the difference clearly shows which one of the latencies was the longer, and the direction and magnitude of that difference is the variable of interest, especially when compared with the mean latencies for cycles with reward. These were for the second sequences of sessions 0.6, 0.7, 0.8, 0.8, 0.8, 0.7, 1.3, 1.0 s, in order, for each of the eight rats. (The strongly deviant values for standards 4.5 and 14.8 s for Rats 8 and 10 have been excluded in the computations. The corresponding large latency values indicate that at least these rats avoided pressing the lever during certain time intervals. This finding will be dealt with in another context.)

Table 1 confirms the more general indications of Figure 2—that latency differentiation, implying discrimination of whether food would be forthcoming (i.e., of whether the rat had been pressing the lever during the first tone), occurred before there was evidence of learning to refrain from lever pressing during the first tone (A in Figure 1). An alternative interpretation—that the absolute tone length during A was the basis of the discrimination—was considered and rejected as a basis for the observed differentiation of latencies (see Appendix for details). Hence it appears that the latency differentiation reflects a discrimination of the animal's own prior responding. It follows that the two acquisition processes involved here—learning to discriminate the correctness of one's own behavior and learning to carry out the correct behavior—occurred independently.

For both sequences of sessions, proportion correct shows a decreasing trend with increasing standard, which is hardly surprising, considering that the correct behavior involved waiting for the interruption and that with greater standards the animals had to wait longer. It also appears that the acquisition of discrimination had started even before the first sequence of sessions—that is, during the first 4 to 8 sessions—because most differences are positive. They are, however, irregular. No systematic relationship

is evident between lengths of standards and size or magnitude of latency differences for correct versus incorrect trials. In the second sequence of sessions it is clear that learning of the discrimination has been completed. With three exceptions, one of which is based on a single cycle, the differences are positive and nearly constant, independent of the standard duration.

A comparison with the corresponding performances (proportion correct for all standard durations) supports the conclusion that behavior and discrimination based upon that behavior are learned independently. The first point is that the latencies of all eight rats had differentiated into two classes long before performance reached the asymptotic level (see Figure 2). Second, for a number of rats the improvement in terms of proportion correct was small between the two sequences of sessions (see Rats 1, 7, and 9) as opposed to latency differentiation. Third, there are great individual differences in level of performance at the completion of discrimination learning (i.e., for the second sequence of sessions).

DISCUSSION

The present results show that discrimination of the correctness of own behavior may be learned before the correct behavior itself. "Correct behavior" denotes behavior that meets a contingency. Here, the problem is whether this is stagewise learning—first learning to discriminate whether one's behavior has met the contingency of refraining from lever pressing during A, and then learning to carry out this behavior—of possibly independent stages. If it is indeed stagewise learning, the memory of own behavior could be considered a necessary but not a sufficient condition for learning an act. In the present experiment, the rats may have learned that a lever press that did not terminate the ongoing tone would not be followed by reward. Having learned this "external" cue (stage 1), the rat could learn how to decrease the frequency of this cue by refraining from lever pressing during the first tone (stage 2). An

interruption of the experiment after, say, Session 7 would have shown a result similar to Reynolds' (1966): discrimination of own behavior with respect to a contingency (stage 1) without the behavior being contingency controlled (stage 2).

Another interpretation of the delay between learning to discriminate the correctness of own behavior and learning to carry out the correct behavior—one that I find more appealing and one that also is more in line with Shimp's contention than the two-stage hypothesis—I would like to call *knowing before doing*. This expression is not meant to refer to "knowing" as a mental state (cf. Hineline, 1983); it is only an attempt to epitomize the finding of the present study: Latency differentiation, based on discrimination of the correctness of own behavior, precedes contingency control of that behavior. Also according to this interpretation, it appears that discrimination of one's behavior having met a contingency is a necessary but not a sufficient condition for one's behavior being controlled by the contingency.

According to Thompson and his co-workers (Thompson, 1976; Thompson et al., 1980), "there is a very early and marked increase in hippocampal neuron activity that precedes and predicts the development of behavioral learning" (1980, Abstract). Although Thompson worked with classical conditioning of the rabbit's nictitating membrane, in which experiments he found hippocampal neuron activity after only a few trials, long before the conditioning of the reflex showed up in the behavior, an erroneous lever press in the present experiment might likewise have evoked a specific internal activity ("knowledge") before the animal had acquired the skill to suppress its

lever presses ("doing"). In the present case, the rat's "knowledge" would find expression in the differential latencies. This distinction between "knowing" and "doing" has its counterpart in artificial intelligence in the distinction between "declarative and procedural knowledge" (e.g., Anderson, 1976).

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APPENDIX

Duration of Period A was not a discriminandum for whether reinforcement would be obtained.

One possible cue for discriminating whether reward would be forthcoming in the procedure reported here was the absolute tone length of Period A. When the rat pressed the lever during A, the duration of A was lengthened and at the same time reward was canceled for the lever press that would terminate B in the given cycle. At the acquisition stage of the second sequence of sessions (Table 1), reinforcement after long standard times was still rather rare and was

therefore perhaps inefficient to counteract duration of A as the discriminandum. However, this interpretation of the data is probably incorrect. First, during the initial sessions, with comparatively good performance, reinforcement after long standards was more frequent, a fact that should have prevented learning to associate long A periods with nonreinforcement. This argument is strengthened by the observation that, as mentioned in connection with the first sequence of sessions in Table 1, latency differentiation (i.e., learning of the discrimination) had already started during these initial sessions. Second, if length of Period A

Table 2
Mean Latencies in Seconds for Cycles Without Lever Presses and for Cycles with a Single Lever Press During A

Rat	ML ^a (all)	t _A (no l.p.) t _A (one l.p.)	4.5	5.3	5.8	6.0	6.5	7.3
1	0.6	Latency (no l.p.)	0.9			--		
	4.7	Latency (one l.p.)		--	0.6		2.4	4.6
		Number of trials	3	0	1	0	5	14
3	0.7	Latency (no l.p.)	1.1			1.1		
	4.3	Latency (one l.p.)		4.7	11.1		1.2	1.9
		Number of trials	16	4	1	13	4	8
4	0.8	Latency (no l.p.)	0.7			0.6		
	3.9	Latency (one l.p.)		--	1.0		--	--
		Number of trials	21	0	3	17	0	0
6	0.8	Latency (no l.p.)	0.4			0.5		
	6.4	Latency (one l.p.)		0.6	1.3		1.6	0.3
		Number of trials	20	1	1	13	1	4
7	0.8	Latency (no l.p.)	--			2.2		
	2.6	Latency (one l.p.)		0.8	1.4		2.2	1.6
		Number of trials	0	10	23	1	15	25
8	0.7 ^b	Latency (no l.p.)	4.7			0.3		
	4.6	Latency (one l.p.)		--	0.8		1.8	3.8
		Number of trials	14	0	5	9	9	19
9	1.3	Latency (no l.p.)	0.8			1.1		
	2.9	Latency (one l.p.)		2.0	2.9		1.7	3.4
		Number of trials	2	11	15	5	17	19
10	1.0 ^b	Latency (no l.p.)	3.6			0.9		
	10.4	Latency (one l.p.)		1.0	--		8.5	10.1
		Number of trials	17	1	0	12	3	9

Notes. Data for the second sequence of sessions in Table 1. l.p. = lever press.

^aMean latencies for all reinforced and all unreinforced cycles, respectively.

^bLatencies for 4.5 and 14.8 s not included.

were the discriminandum, latencies for long durations of Period A should belong to the class of long latencies, irrespective of whether the duration was long because of a long standard without lever presses during A, or because a shorter standard was lengthened by punishment time(s). Although the duration of A was not registered, it is known for cycles with just a single lever press. For these $t_A = t_C + t_S$ (i.e., $t_C + 4$ s). The shortest A duration with one lever press is thus $1.3 + 4.0 = 5.3$ s. Table 2 makes it possible to compare latencies for about the same durations (4.5 to 20.0 s for cycles without lever

presses, and 5.3 to 18.8 s for cycles with one lever press.) The data derive from the second sequence of sessions, the one in which latencies had already dissociated into two classes. The results are not as clear-cut as one would have liked, in part because the numbers of short standard durations with nonreward and long ones with reward were comparatively small. Disregarding latencies based on a single trial as well as latencies for 4.5 and 14.8 s for Rats 8 and 10, the picture is the following: For durations 5.3 and 5.8 s, no clear trend can be seen; Rats 3 and 9 show long latencies (compare with the means

Table 2—continued
Mean Latencies in Seconds for Cycles Without Lever Presses and for Cycles with a Single Lever Press During A

8.1	8.5	10.0	11.0	12.1	14.8	15.0	18.8	20.0	Mean
1.9	2.8	4.1	--	2.6	--	16.6	3.7	--	1.1
1	17	8	0	10	0	32	3	0	4.0
0.7	3.2	4.3	--	4.7	1.1	5.1	5.3	--	1.0
7	11	13	0	15	2	19	8	0	4.2
1.5	9.5	4.3	0.7	6.6	0.6	5.2	3.2	0.9	0.8
15	4	15	12	7	4	8	8	2	4.9
0.9	3.0	4.5	0.6	3.8	16.8	8.2	10.5	5.8	1.0
5	9	15	2	22	1	19	8	1	5.3
--	1.6	2.0	0.7	3.3	--	2.9	2.8	--	1.2
0	24	24	2	16	0	16	14	0	2.0
1.7	4.1	4.1	0.4	5.0	4.7	4.3	3.5	--	0.9 ^b
8	15	12	2	17	5	12	12	0	3.8
1.7	3.1	2.0	--	2.5	--	1.6	4.8	0.9	1.2
3	22	16	0	18	0	10	11	2	2.7
2.5	14.2	14.2	1.3	8.4	5.0	7.9	16.0	--	1.5 ^b
9	11	16	10	18	5	16	11	0	11.2

in column 2); Rats 4, 7, and 8 show short latencies. With few exceptions (e.g., the value of 0.3 s for $t_A = 7.3$ s for Rat 6), the remaining latencies for trials with a single lever press seem to belong to the class of long latencies. Almost all of the latencies for trials with reward belong to the class of short latencies, including four of the five latencies for the longest standard, 20 s (Rats 4 and 9). Rat 10 with its long latencies for nonreward trials gives the clearest evidence: Mean latencies for cycles without lever press vary

between 0.9 and 2.5 s; those with one lever press vary between 8.5 and 16 s.

Thus it seems very improbable that absolute duration of Period A was the discriminandum that controlled the latencies of postinterruption lever presses. It should perhaps be pointed out that the long latencies for reward trials for standards 4.5 and 14.8 s in Rats 8 and 10 cannot be explained by the duration of Period A, because the same animals showed short latencies for standards lying between these two values.

EDITORIAL COMMENT

The foregoing article suffered double jeopardy through a change of editors, and encountered the additional burden of a closely relevant report appearing during its revision. The resulting deliberations and communications led to an Appendix having been added to the article and to the author's additional commentary which follows. The issues addressed here are crucial to behavior-analytic interpretation of situations in which one might speak of knowing or of being aware of one's own behavior. If this domain is to be dealt with adequately—as behavior analysts such as Skinner have asserted that it can—we must deal with it in the context of experiments such as those reported here, where the relevant behavior can be analyzed through manipulation of the operative variables.

Philip N. Himeline
Editor