INTERMITTENT REINFORCEMENT OF A CONTINUOUS RESPONSE

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Six rats were trained with food deliveries contingent upon their pressing a lever and holding it down for either fixed or variable cumulative durations. Fixed-hold requirements ranged from 15 s to 90 s over experimental conditions; variable-hold requirements ranged from 15 s to 120 s. At most long and intermediate values, variable-hold requirements maintained more lever holding than fixed requirements. At the longest hold requirements studied, more lever holding was maintained by variable requirements than by fixed requirements of equivalent mean length for each rat. Postreinforcement-pause duration increased with lever-holding time for both fixed- and variable-hold requirements. At comparable lever-holding times per reinforcer, longer pauses typically were produced by fixed requirements than by variable requirements. Data from this study on the maintenance of responding, temporal response patterns, and postreinforcement pausing are comparable to those obtained with intermittent reinforcement of discrete responses. These findings suggest that the response-reinforcer relation specified by a reinforcement schedule is a fundamental determinant of responding, whether responding consists of discrete units or of continuous activity.

Key words: postreinforcement pause, time allocation, interreinforcement time, work time, fixed-ratio schedules, variable-ratio schedules, continuous response, lever holding, rats

The experimental analysis of behavior is characterized more by its methods of experimentation and analysis than by its subject matter (e.g., Ferster, 1953; Hinde, 1962; Honig, 1966; Skinner, 1938, 1966). A principal feature of free-operant methods (Ferster, 1953) is the use of discrete, repetitive responses, conducive to the calculation of response rate as a primary dependent variable. Given this tradition of experimentation, it is ironic that many theoretical developments in recent years have emphasized duration of responding or the allocation of time to various activities as a fundamental measure of behavior (e.g., Allison, 1976; Allison, Miller, & Wozny, 1979; Baum & Rachlin, 1969; Eisenberger, Karpman, & Trattner, 1967; Mazur, 1982; Premack, 1965, 1971; Rachlin, 1978; Rachlin & Burkhard, 1978; Shull, 1979; Timberlake & Allison, 1974). Some empirical evidence, in fact, suggests that time allocated to an activity may be a more basic unit of

measurement than actual numbers of discrete responses (Baum, 1973, 1975, 1976; Baum & Rachlin, 1969; Brownstein & Pliskoff, 1968).

Despite growing emphasis on the temporal structure of behavior, few studies have employed continuous responses, defined in terms of their duration, in a free-operant situation. Discrete responses, typically key pecks by pigeons or lever presses by rats, have been used in the preponderance of empirical studies. Such units of behavior require very little time to execute, thereby trivializing duration as a measure of response strength. Consequently, duration of behavior or time allocated to an activity often has been estimated by assuming that time allocated to a discrete response continues until some period of time passes without a response (e.g., Allison et al., 1979; Mazur, 1983), that time devoted to an activity continues from initiation of that activity until subsequent reinforcer delivery (e.g., Shull, 1979), or that each discrete response has a constant duration (e.g., Mazur, 1982; Rachlin & Burkhard, 1978). Others have used time-sampling techniques whereby some specified interval of time is considered to be devoted to responding if a designated response occurs during that interval (e.g., Dunham, 1972; Marmaroff, 1971, cited in Dunham, 1977; Premack, 1965).

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Table 1

Number of sessions each scheduled lever-holding requirement was in effect; order of presentation is given in parentheses. Conditions in which stable responding was not obtained are indicated by asterisks.

Rat	Hold requirements in seconds									
	Fixed						Variable			
	15	22	30	45	60	90	15	15 ^a	30	45
149	37 (1)	60 (8)	40 (2)	41 (9)*	22 (5)*		16 (6)		43 (3)	60 (7)
159	27 (1)	30 (8)	23 (5)	35 (9)	93 (7)*		13 (3)		29 (4)	
160	36 (1)	11 (9)	30 (6)	42 (7)*	21 (3)*		14 (5)		36 (2)	95 (8)
161	27 (1)	88 (12)	21 (4)	30 (6)	26 (3)*	36 (10)*	12 (8)		12 (7)	15 (5)
162	60 (1)	72 (8)	24 (5)	56 (4)*			20 (2)		16 (6)	41 (3)
163	25 (1)	37 (8)	89 (2)	46 (4)	79 (10)*		22 (7)	15 (9)	24 (5)	19 (3)

* Unstable.

^a Redetermination.

These practices are useful in obtaining estimates of the overall time allocated to discrete responses. Nonetheless, such estimates of time allocation are based on an assumption that the time between discrete responses, or a portion of the interresponse time, is uniformly devoted to the same activity. This assumption is arbitrary, as are various formulations for calculating response duration from frequency of discrete responses. Moreover, standard procedures make reinforcer deliveries contingent on the execution of discrete responses, and not on the allocation of time to responding. Consequently, time allocation under such procedures, even if estimated reliably, is a by-product of reinforcement contingencies that stipulate nothing in the way of time allocation.

Rider and Kametani (1984) reinforced a continuous response, lever holding by rats, according to cumulative fixed-duration requirements. These requirements were analogous to conventional fixed-ratio (FR) schedules of reinforcement contingent upon discrete responses: Whereas FR schedules require the emission of a fixed number of responses, the fixed-duration schedules require the allocation of a fixed amount of time to a response. Postreinforcement-pause duration was positively related to the scheduled hold requirement and to the obtained interreinforcement time. The temporal pattern of lever holding within interreinforcement intervals resembled that generated by FR schedules for discrete responses. These findings suggested that the response-reinforcer relation specified by a reinforcement schedule is more fundamental

than the unit of behavior required for reinforcement.

Schedules that provide reinforcement aperiodically, such as variable-interval (VI) and variable-ratio (VR) schedules, generate relatively short postreinforcement pauses (e.g., Ferster & Skinner, 1957). Some evidence suggests that postreinforcement-pause duration is controlled by the shortest obtainable time to reinforcement, at least under schedules that impose only two different requirements for reinforcement (e.g., Alferink & Crossman, 1975; Catania & Reynolds, 1968; Harzem, Lowe, & Spencer, 1978). Postreinforcement-pause duration has been found to increase with the mean ratio under random-ratio schedules (Farmer & Schoenfeld, 1967; Mazur, 1983) and with the mean interval under random-interval schedules (Lachter, 1971). It is unclear, however, whether differences in postreinforcement-pause duration across experimental conditions resulted from differences in the mean schedule requirements or from differences in the shortest time to reinforcement obtained from those schedules. Few quantitative data on pausing under variable schedules are available, and the relation between pause length and schedule parameters is unclear.

The present study extends the procedure of Rider and Kametani (1984), in which reinforcer deliveries were contingent on cumulative lever-holding durations. Whereas Rider and Kametani scheduled only fixed lever-holding requirements, the present experiment provides a direct, within-subjects comparison of postreinforcement-pause duration and time

Table 1 (Continued)

Hold requirements in seconds				
Variable				
60	60*	75	90	120
75 (4)				
39 (2)	12 (6)	26 (10)*		
70 (4)				64 (10)
26 (2)			34 (9)	22 (11)*
40 (7)	59 (9)			11 (10)*
27 (6)				

allocation under fixed and variable lever-holding requirements. Data from these lever-holding requirements permit an assessment of the comparability of findings from standard schedules of reinforcement contingent upon discrete responses with findings from schedules of reinforcement contingent upon a continuous response.

METHOD

Subjects

Six experimentally naive male albino Sprague-Dawley rats were maintained at 80% of their free-feeding weights. The rats, 4 months old at the start of the experiment, were housed individually under a cycle of 15-hr light and 9-hr darkness.

Apparatus

An experimental chamber constructed of Plexiglas and stainless steel was enclosed in a Coleman ice chest. The chamber was 23.5 cm long, 20.5 cm wide, and 19.4 cm high. A Gerbrands G6312 Rat Lever, 5.1 cm wide and 1.3 cm thick, was situated midway between the side walls of the chamber. The lever protruded 1.4 cm from the front wall of the chamber, 4.7 cm above the grid floor. A downward force of 0.44 N on the lever was sufficient to close a microswitch, which constituted a lever-holding response. Reinforcers were 45-mg Noyes Precision Food Pellets, which were dispensed into a food tray 7.1 cm to the right of the lever. A houselight, 9.5 cm directly above the lever, provided illumination during experimental sessions. A fan attached to the ice chest ventilated the experimental space. White noise inside the ice chest helped to mask extraneous

sounds. Electromechanical equipment, located in the same room as the experimental chamber, controlled reinforcement contingencies and collected data.

Procedure

The rats initially received two 60-min sessions in which each lever press was reinforced and in which a reinforcer was delivered at 60-s intervals independently of responding (conjoint fixed-ratio 1 fixed-time 60 s), followed by one session in which FR 1 was in effect. Subsequently, all reinforcers were obtained by holding the lever down for a specified cumulative period of time. The hold requirements for the fourth and fifth sessions were 5 s and 10 s, respectively.

After these five sessions of pretraining, a fixed-hold requirement of 15 s was imposed for all rats. Several different cumulative fixed- and variable-hold requirements then were imposed in irregular order over experimental conditions. Hold requirements were programmed with a punched-tape interval timer (see Clark & Caudill, 1960), operated through the normally open circuit of the lever, so that the punched tape advanced whenever the lever was held down. A reinforcer was delivered each time the microswitch lever on the interval timer dropped into a hole on the tape. Fixed-hold requirements were programmed with tapes of evenly spaced holes. Variable-hold requirements were programmed with tapes of 15 holes, representing 15 different individual hold requirements derived from the constant-probability formula of Catania and Reynolds (1968, Appendix B).

For all hold requirements, cumulative lever holding was reinforced. Thus, it was not necessary that the lever be held continuously to meet a particular hold requirement. A hold requirement of 30 s, for example, could be met with either a single 30-s lever-holding response or 30 separate 1-s lever-holding responses, or with any other combination of durations that summed to 30 s.

Most (50) experimental conditions were changed only when stable postreinforcement pausing was obtained under a particular hold requirement, such that the mean postreinforcement-pause duration in any of five consecutive sessions did not deviate by more than 15% of the mean of those five daily means and no consistent trend was evident. A few (12)

Fig. 1. Proportion of session time spent lever holding. Data points denote means and vertical lines denote ranges from the last five sessions of scheduled hold requirements. Unconnected points indicate redeterminations for particular hold requirements.

conditions were changed when lever holding was not maintained uniformly throughout experimental sessions, after extended exposure to a particular hold requirement. Table 1 presents the sequence of hold requirements and the number of sessions each requirement was in effect; it also indicates which hold requirements did not maintain stable responding.

Lever-holding time and postreinforcement-pause time were recorded on separate running-time meters. Postreinforcement pauses were measured as time from a reinforcer delivery until the next lever-holding response. Because reinforcers were delivered while the lever was held down, some latency between reinforcer delivery and release of the lever was

Fig. 2. Proportion of post-pause time spent lever holding. Data points denote means and vertical lines denote ranges from the last five sessions of scheduled hold requirements. Unconnected points indicate redeterminations for particular hold requirements.

Fig. 3. Postreinforcement-pause duration plotted against interreinforcement time. Data are means from the last five sessions of each condition in which stable responding was obtained. The straight lines are least-squares fits for the indicated sets of points, with the corresponding linear-regression equation shown adjacent to each line.

inevitable. To prevent the termination of a measured postreinforcement pause by relatively slow reaction time to reinforcer delivery, programming circuitry prevented responses

within 0.5 s after reinforcer delivery from terminating a postreinforcement pause. Postreinforcement-pause time also included the time between the start of a session and the first

Fig. 4. Postreinforcement-pause duration plotted against time spent lever holding per reinforcer. Data are means from the last five sessions of each condition in which stable responding was obtained. Least-squares fits and corresponding linear-regression equations are supplied, as for Figure 3.

lever-holding response, and this time was included in calculating mean postreinforcement-pause durations.

Cumulative records of lever holding were

obtained by routing pulses, generated at 0.5-s intervals, through the normally open circuit of the lever to the stepping pen of a cumulative recorder. Thus, a response was registered

Fig. 5. Representative cumulative records of lever holding by Rat 159. The response pen advanced once per half second whenever the lever was held down, and deflected with reinforcer deliveries. Each record chronicles one of the last five sessions at a particular hold requirement.

on the cumulative recorder each time a pulse was generated while the lever was down. Lever-holding responses with durations shorter than 0.5 s did not necessarily register on the cumulative recorder.

Experimental sessions terminated with the first reinforcer delivery after 60 min, or after 75 min if no reinforcer had been obtained after 60 min had elapsed. This latter session-ending criterion was met only rarely, under

Fig. 6. Representative cumulative records of lever holding by Rat 160. The response pen advanced once per half second whenever the lever was held down, and deflected with reinforcer deliveries. Each record chronicles one of the last five sessions at a particular hold requirement.

relatively long requirements that typically did not maintain stable responding. With few exceptions, sessions were conducted 7 days per week at approximately the same time each day.

RESULTS

Figure 1 shows the proportion of time spent lever holding over the last five sessions of each scheduled hold requirement. These propor-

Fig. 7. Representative cumulative records of lever holding by Rat 161. The response pen advanced once per half second whenever the lever was held down, and deflected with reinforcer deliveries. Each record chronicles one of the last five sessions at a particular hold requirement.

tions reflect the total amount of measured responding divided by the total session time, and so are analogous to overall rates of discrete responding. For both fixed- and variable-hold

requirements, the proportion of time spent lever holding tended to decrease as the hold requirement increased. Variable requirements maintained more lever holding than fixed re-

quirements at most long and intermediate hold requirements. At the longest hold requirements, consistently more lever holding was maintained by variable requirements than by fixed requirements of equivalent mean length. Hold requirements that did not maintain stable responding are indicated by asterisks in Table 1.

Figure 2 shows the proportion of postpause time spent lever holding over the last five sessions at each hold requirement. These proportions are analogous to running response rates in that they exclude postreinforcement-pause time and the time from session onset until the first lever-holding response. For both fixed and variable requirements, postpause lever holding tended to decline with increasing hold requirements. More postpause time was spent lever holding under relatively long variable-hold requirements than under fixed-hold requirements of equivalent mean length. No consistent differences in postpause lever holding were evident at shorter hold requirements.

Figure 3 shows mean postreinforcement-pause duration plotted with respect to mean interreinforcement time. The solid and dashed lines through data points were derived by the method of least squares relating postreinforcement-pause duration to interreinforcement time for fixed- and variable-hold requirements, respectively. The corresponding least-squares linear-regression equations are shown in the upper left (for fixed-hold requirements) and lower right (for variable-hold requirements) portions of individual panels. The proportion of variance in postreinforcement-pause duration that is accounted for in terms of variation in interreinforcement time is indicated by the coefficient of determination, r^2 .

Postreinforcement-pause duration increased as time between reinforcer deliveries increased, for both fixed- and variable-hold requirements. Postreinforcement pauses typically were longer under fixed-hold requirements than under variable-hold requirements with comparable mean interreinforcement times. For each rat, the slope of the regression line relating postreinforcement-pause duration to interreinforcement time was steeper with fixed-hold requirements than with variable-hold requirements.

Mean postreinforcement-pause duration is plotted with respect to mean lever-holding time per reinforcer in Figure 4. Least-squares lin-

ear-regression lines are drawn through data points and the corresponding equations and coefficients of determination are provided.

At comparable lever-holding times per reinforcer, longer postreinforcement pauses were produced by fixed-hold requirements in virtually every case. Postreinforcement-pause duration tended to increase with lever-holding time for both fixed-hold and variable-hold requirements, although exceptions are apparent. Whether the hold requirements were fixed or variable, interreinforcement time accounted for more variance in each rat's postreinforcement-pause duration than did lever-holding time.

Cumulative records of lever holding by Rats 159, 160, and 161 are presented in Figures 5, 6, and 7, respectively. These records are representative of lever holding over the range of fixed- and variable-hold requirements used in the present study. Rats 159 and 160 showed the smallest and largest differences, respectively, in lever-holding time between fixed- and variable-hold requirements. Cumulative records for Rat 161 contrast stable responding under very small hold requirements with unstable responding under relatively large hold requirements.

Under fixed-hold requirements, discernible breaks in lever holding immediately after reinforcer deliveries alternated with fairly steady lever holding until the next reinforcer delivery. Variable-hold requirements did not produce a comparable break-run pattern of responding. Under variable-hold requirements, breaks in lever holding followed reinforcer deliveries, but these postreinforcement pauses were not usually any longer than other, secondary pauses subsequent to the postreinforcement pause.

These secondary breaks in lever holding occurred at all hold requirements for all rats. A hold requirement rarely was met with a single lever-holding response. The lever typically was held down and released several times per reinforcer, although lever releases frequently were so brief that they were not documented by cumulative records. For example, postpause lever holding by Rat 159 under the 30-s fixed-hold requirement (Figure 5) appears to be virtually continuous. However, Rat 159 pressed and released the lever 639 times during that session, a mean of 7 times per reinforcer. The frequency and duration of these

Table 2

Time spent lever holding per session, postreinforcement-pause duration per reinforcer, and session time, all in seconds, and number of reinforcers and responses per session. All entries are means over the last five sessions at each scheduled hold requirement. Hold requirements that did not maintain stable responding are indicated by asterisks.

Rat	Measure	Hold requirements in seconds					
		Fixed					
		15	22	30	45	60	90
149	Lever holding	2,157	1,784	1,941	13*	600*	
	Pause duration	9.1	16.1	18.1	102.6	163.4	
	Session time	3,617	3,630	3,631	4,500	4,500	
	Reinforcers	143.6	81.2	65.0	0.0	8.4	
	Responses	538	626	657	16	128	
159	Lever holding	2,586	2,461	2,735	2,117	426*	
	Pause duration	5.7	9.8	8.4	22.4	114.4	
	Session time	3,613	3,680	3,611	3,651	4,417	
	Reinforcers	172.4	111.6	93.2	48.6	7.0	
	Responses	414	472	621	335	98	
160	Lever holding	2,156	800	806	55*	222*	
	Pause duration	7.2	56.2	76.7	761.8	508.5	
	Session time	3,623	3,652	3,726	4,198	4,500	
	Reinforcers	142.4	36.8	27.8	1.2	3.8	
	Responses	2,782	580	981	54	207	
161	Lever holding	2,399	1,041	1,258	2,658	68*	737*
	Pause duration	7.1	36.6	37.5	15.5	135.5	188.5
	Session time	3,618	3,640	3,863	3,684	4,500	4,500
	Reinforcers	160.0	47.8	42.0	60.2	1.0	8.0
	Responses	195	821	230	340	28	300
162	Lever holding	2,664	2,142	2,224	522*		
	Pause duration	5.0	13.4	18.7	284.2		
	Session time	3,583	3,653	3,683	4,489		
	Reinforcers	173.6	97.6	75.4	11.4		
	Responses	1,069	1,347	385	87		
163	Lever holding	2,021	1,376	2,081	705	60*	
	Pause duration	10.4	30.2	19.5	142.6	1,037.6	
	Session time	3,633	3,664	3,679	4,025	4,209	
	Reinforcers	135.6	62.4	69.4	16.0	0.8	
	Responses	312	238	214	115	17	

* Unstable.
° Redetermination.

secondary breaks in lever holding tended to increase with the scheduled hold requirement and typically they were more pronounced under variable-hold requirements than under fixed-hold requirements.

Figure 7 includes cumulative records for Rat 161 under hold requirements that did not maintain stable responding (second and fourth records). For both fixed- and variable-hold requirements, lever holding typically occurred early in each session but ceased before the end of a session. This pattern of responding typified performance of all rats under hold requirements that did not maintain stable responding.

Table 2 provides summary data on time spent lever holding, on postreinforcement-pause duration, and on session time, all in seconds, and on the number of reinforcers and responses (number of times the lever was pressed and then released). Mean postreinforcement-pause duration per reinforcer was calculated for individual sessions; the tabled values are means of those daily means over the last five sessions of each condition. All other entries are means per session over the last five sessions of each condition. Conditions in which stable responding was not maintained, indicated by asterisks, often included sessions that were terminated during a postreinforcement

Table 2 (Continued)

Hold requirements in seconds								
Variable								
15	15*	30	45	60	60*	75	90	120
1,704		2,357	1,596	1,187				
6.9		5.6	13.4	26.2				
3,628		3,667	3,666	4,066				
116.0		77.4	36.2	20.8				
694		712	465	330				
2,352		2,107		1,728	1,724	845*		
4.7		6.2		8.8	9.6	27.5		
3,628		3,734		3,664	3,986	4,171		
158.4		70.2		29.2	29.4	11.6		
402		344		400	326	207		
2,157		2,565	1,154	1,509				1,413
8.3		7.5	46.5	26.2				46.3
3,640		3,699	3,675	3,675				3,860
146.8		85.6	25.2	25.6				11.8
563		1,159	310	874				491
2,514		2,572	2,615	2,374			1,669	256*
6.5		9.3	9.7	13.1			22.6	627.4
3,628		3,633	3,653	3,600			3,908	4,500
171.4		84.2	59.6	39.4			19.8	2.8
333		386	302	420			948	115
2,661		2,593	1,988	742	1,368			230*
4.4		9.7	18.1	70.3	42.5			1,221.2
3,622		3,663	3,674	4,331	4,019			4,500
181.4		88.8	44.6	13.2	22.4			1.8
1,334		231	411	131	207			40
2,333	2,305	2,524	2,626	1,581				
5.5	5.8	5.0	5.5	15.8				
3,620	3,624	3,649	3,798	3,740				
158.2	156.0	85.0	59.2	26.8				
311	318	352	336	204				

pause. These incomplete pauses were included in the calculation of mean postreinforcement-pause durations.

DISCUSSION

A continuous response, lever holding, was reinforced intermittently according to fixed and variable schedules. The patterns of responding under these schedules were comparable to those maintained by fixed and variable schedules of reinforcement contingent upon discrete responses. Rather substantial breaks from lever holding coincided with reinforcer deliveries and alternated with fairly continuous lever holding when reinforcement was contingent upon fixed durations of holding.

This pattern of responding is analogous to the break-run pattern commonly obtained under FR schedules but not under VR schedules (e.g., Ferster & Skinner, 1957). In contrast, VR schedules are characterized by shorter postreinforcement pauses than are FR schedules with equivalent mean ratios of responses per reinforcer (Ferster & Skinner). Similarly, postreinforcement-pause durations in the present experiment typically were shorter under variable-hold requirements than under fixed-hold requirements in which equivalent mean lever-holding durations were required. Postreinforcement-pause duration increased with the schedule requirement under each scheduling arrangement, a finding that corresponds to pausing under schedules for dis-

crete responses (e.g., Farmer & Schoenfeld, 1967; Felton & Lyon, 1966; Lachter, 1971; Lowe & Harzem, 1977; Lowe, Harzem, & Spencer, 1979; Powell, 1968; Schneider, 1969). Finally, lever holding was maintained at longer mean holding times per reinforcer by variable-hold requirements than by fixed-hold requirements. Similarly, responding is maintained at higher mean ratios of discrete responses per reinforcer by VR schedules than by FR schedules (Ferster & Skinner, 1957; Zeiler, 1979).

The present research extends the findings of Rider and Kametani (1984) to variable lever-holding requirements. Postreinforcement-pause duration was positively related to the scheduled hold requirement and, in most cases, was well correlated with the mean time between reinforcer deliveries in both studies. The longest fixed-hold requirement that maintained stable responding in the present experiment was 45 s, whereas Rider and Kametani obtained stable responding in 5 of 6 rats under fixed-hold requirements as long as 60 s. The source of this discrepancy is unknown; the apparatus, the strain of rat subjects, and the deprivation conditions of subjects all differed between the two studies. Nonetheless, under hold requirements that did not maintain stable responding, lever holding tended to occur only early in sessions in each study.

Previous research with fixed schedules has revealed an approximate linear relationship between postreinforcement-pause duration and interreinforcement time, at least over a limited range of schedule parameters (Berryman & Nevin, 1962; Nevin, 1973; Rider, 1980; Rider & Kametani, 1984). Results of the present study suggest that this relationship may hold with variable schedules, as well.

The present findings support Mazur's (1982) model of responding under ratio schedules. In particular, that model predicts increasing postreinforcement-pause duration as a function of increasing ratio size for both fixed- and variable-ratio schedules, longer postreinforcement pauses and less time engaged in responding under fixed ratios than under variable ratios, and increasing disparity in postreinforcement-pause duration generated by fixed and variable ratios as a function of increasing ratio size. To the extent that lever-holding duration requirements correspond to ratio size, the present results confirm these predictions.

The present results are also consistent with Shull's (1979) account of pausing, which considers postreinforcement-pause duration to be controlled by the response requirement or the remaining time to reinforcement after the pause. With few exceptions, good linear fits were obtained between postreinforcement-pause duration and the actual time spent lever holding, although none were as good as those obtained between postreinforcement pause duration and interreinforcement time. However, inasmuch as interreinforcement time contains the postreinforcement pause, correlations between those two variables are inflated somewhat.

Both postpause time and lever-holding time are apt to deviate systematically from the actual time devoted to "terminal" activities (see Staddon & Simmelhag, 1971). Both measures exclude time spent positioning or orienting toward the response lever during the postreinforcement pause. Such activities are considered terminal because they are preparatory to pressing (Shull, 1979). Furthermore, time spent in nonterminal activities after the postreinforcement pause is included in the postpause time. Lever-holding time properly excludes such nonterminal activities, but also excludes subsequent positioning or orienting activities. These two sources of error, unmeasured terminal activities and nonterminal activities incorrectly measured as terminal activities, are indigenous to methods used previously for estimating time allocated to discrete terminal responses. Whatever its limitations, lever-holding time is an unambiguous measure of time allocated to an activity and, therefore, would seem to be preferable to measures of time allocation that are estimated from other features of responding (e.g., Allison et al., 1979; Mazur, 1982, 1983; Rachlin & Burkhard, 1978; Shull, 1979).

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