CHOICE AND RESPONSE CONTINGENCIES¹

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Two experiments investigated the extent to which response contingencies influence the choice between two schedules of reinforcement by exposing pigeons to a concurrent-chains procedure in which reinforcers in one terminal link were response-independent, and in the other terminal link, response-dependent. In Experiment 1, the pigeons were indifferent between an aperiodic, response-independent schedule and an aperiodic, response-dependent schedule that required a minimum rate of responding. This finding limits the generality of a required-rate contingency as a determinant of choice, which contingency had been previously demonstrated in a context of periodic reinforcement to evoke preference for an alternate schedule. In Experiment 2, the pigeons preferred a periodic, response-independent schedule to a periodic, response-dependent schedule that shared a feature with a required-rate schedule: there was a requirement to respond early in the interreinforcement interval, when responding produced reinforcement only later. The results of the two experiments suggest the following general interpretation: pigeons prefer a second schedule to the extent that the response contingencies of the first schedule must be satisfied during discriminable periods of nonreinforcement.

The present research investigated the extent to which choice between two schedules of reinforcement is systematically influenced by the response contingencies associated with each schedule. Most of the existing data suggest that response contingencies are not an important factor influencing choice between schedules. For example, Herrnstein (1964) presented pigeons with a choice between variable-interval (VI) and variable-ratio (VR) schedules of reinforcement, and found that their choice behavior was not influenced by the normally higher response rates generated by the VR schedules. Instead, their choice behavior could be well described simply by comparing the interreinforcement intervals (IRIs) of the respective schedules. In a more explicit test of whether response rate is a factor in choice, Killeen (1968) presented pigeons with a choice between a VI schedule and a comparable response-independent schedule (VT, after Zeiler, 1968). Despite large differences in the rates of re-

sponding under the two schedules, the pigeons were indifferent when each schedule yielded the same rate of primary reinforcement. Similarly, Neuringer (1969) examined choice between a fixed-interval schedule (FI) and a schedule in which reinforcement occurred independently of responding after a delay interval (FT, after Zeiler, 1968). When the schedules yielded the same rate of primary reinforcement, Neuringer found that the pigeons were indifferent, and when one schedule yielded a higher rate of reinforcement than the other, irrespective of whether the schedule was FT or FI, the pigeons preferred that schedule. These data support Neuringer's (1969) hypothesis that "... the time between a response and reinforcement controls the probability of a response, whether other responses intervene or not" (p. 382).

However, other data suggest that response contingencies may indeed influence choice between two schedules. The most notable of these data have been provided by Fantino (1968). Fantino presented pigeons with a choice between a simple FI schedule and a differential-reinforcement-of-high-rate schedule (DRH), in which reinforcement was contingent upon the emission of a large number of responses within a short time interval (*e.g.*, 35 responses in 15 sec). Fantino found that pigeons preferred the simple FI schedule, which he in-

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interpreted as preference for the schedule that did not *require* a high rate of responding. In addition, Arnett (1972) and Schuster (1969) each provided data consistent with Fantino's data, although they used somewhat different response contingencies. Schuster presented pigeons with a choice between two equal-valued VI schedules, responding during one of which also produced a brief stimulus according to a superimposed fixed-ratio schedule. Schuster observed that the pigeons' rate of responding was lower on the simple schedule than on the schedule with the superimposed brief stimuli, and more importantly that the pigeons preferred the simple schedule, *i.e.*, the schedule with the lower response rate. Arnett presented pigeons with a choice between two second-order schedules, responding during one of which produced brief blackouts when reinforcement had not been arranged. Arnett found that the pigeons' rate of responding was lower on the schedule that did not provide the blackouts, and that the pigeons preferred the schedule with the lower response rate. Thus, although Schuster and Arnett did not use a required-rate schedule *per se*, the pigeons in the three studies cited above nevertheless preferred the schedule with the lower rate of responding.

The present two experiments were conducted to provide additional data on the relation between choice and response contingencies. In each experiment, pigeons chose between a response-dependent schedule and a response-independent schedule that offered the same rate and distribution of reinforcement. To the extent that the pigeons deviated from indifference, this deviation was then presumed to be a function of the response contingencies associated with each schedule.

EXPERIMENT 1

The schedules presented for choice in the Fantino (1968), Herrnstein (1964), Killeen (1968), and Neuringer (1969) studies were analyzed according to the matrix in Figure 1. On the one hand, the schedules provided reinforcement that was either aperiodic or periodic. On the other hand, the more demanding of the schedules (as judged by reinforcements per response) provided reinforcement according to either a simple response-dependent schedule or a minimum required-rate sched-

APERIODIC	1 HERRNSTEIN (1964) KILLEEN (1968) INDIFFERENCE	3
PERIODIC	2 NEURINGER (1969) INDIFFERENCE	4 FANTINO (1968) PREFERENCE

NO REQUIRED RATE - REQUIRED RATE

Fig. 1. The general procedures and results of previous investigations of the relation between choice and response contingencies.

ule. The previous studies had found that when the schedules are either aperiodic or periodic, and when the more demanding of the schedules is a simple response-dependent schedule (Killeen, 1968; Neuringer, 1969), preference does not develop. However, when the schedules are periodic and one requires a minimum (high) rate of responding for a specified period of time (Fantino, 1968), then preference develops for the schedule that does not require the minimum rate. At present, no data are available on the fourth type of comparison: aperiodic schedules in which one requires a minimum (high) rate.

The present experiment provides data on the fourth comparison. The pigeons were presented with a choice between a VI schedule with a limited hold (LH) and a comparable VT schedule. With an LH, reinforcement is available for only a limited period of time, and if a response has not been made by the end of this limited period, the opportunity for reinforcement is withdrawn. This particular schedule was employed to assess the generality of Fantino's (1968) required-rate interpretation: if a required-rate contingency *per se* was responsible for the preference that Fantino (1968) observed in his study, then one would expect pigeons to prefer the response-independent, aperiodic schedule in the present condition. However, if the pigeons are indifferent between the schedules in the present condition, then either (a) the required-rate interpretation must be limited to periodic schedules, or (b) an alternative interpretation of Fantino's (1968) data must be formulated.

METHOD

Subjects

Two adult male, White Carneaux pigeons (4251 and 5986) were maintained at approximately 80% of their free-feeding weights. Both subjects had been previously trained to key peck, and had been exposed to a variety of procedures and schedules, including concurrent chains.

Apparatus

A two-key version of the standard experimental chamber was used (Ferster and Skinner, 1957). Conventional electromechanical apparatus, located in an adjacent room, controlled events within the chamber and recorded the relevant data.

Procedure

The concurrent-chains procedure. The pigeons' choice behavior was examined using the concurrent-chains procedure. Identical but independent VI 60-sec schedules arranged access to each of the terminal links of two chain schedules of reinforcement. When the terminal link associated with one key became available, the VI timer associated with that key stopped operating. Entry into a terminal link

occasioned three events: (1) the color changed on the key pecked; (2) the other key became dark and inoperative, *i.e.*, no longer produced feedback clicks when pecked, and (3) the initial-link timer associated with the other key stopped operating. If the terminal link entered were a response-dependent schedule, further responding on the lighted key produced food according to the appropriate schedule. If the terminal link entered were a response-independent schedule, key pecks produced feedback clicks and were recorded, but were otherwise ineffective; reinforcers were delivered when scheduled, independently of key pecks. If when one terminal link was entered access to the other terminal link had also been arranged, the latter terminal link remained available upon return to the initial links. The initial links were re-instated after one reinforcement (*cf. schedule details below*). No changeover delay was employed with respect to initial-link responding. For both pigeons, the key colors in the concurrently available initial links were white. The key color associated with the terminal link on the left key was always green, and on the right key, always red. The IRIs in the VI schedules were determined according to Segal's (1964) method. Reinforcement consisted of 3-sec access to mixed grain. Sessions were terminated after 50 reinforcements.

Stability and reversal. Choice between the schedules was examined in the following manner. A response-dependent schedule was arranged in the terminal link on one key, and a response-independent schedule in the terminal link on the other key. These schedules remained in these locations until the pigeon's choice behavior (*i.e.*, the choice proportion, computed by dividing the total number of responses on one key in the initial links by the total number of responses on both keys in the initial links) satisfied a stability criterion. This stability criterion required that the pigeon perform in at least 15 sessions. The last nine sessions were divided into three blocks of three sessions each, and a choice proportion was then computed for each block of sessions. When the choice proportions of the blocks of sessions differed by no more than 5% and showed no monotonically increasing or decreasing trends, the choice behavior was considered stable. The terminal-link schedules were then reversed with respect to their loca-

Fig. 2. Pictorial representation of the experimental procedure. The left panel indicates the sequence of events when the left terminal link was entered. The right panel represents the analogous sequence when the right terminal link was entered.

tion on the keys. That is, the terminal-link schedule formerly arranged on the left key was now arranged on the right key, and *vice versa*. Indifference was designated arbitrarily as an average choice proportion (*i.e.*, the choice proportion of a particular schedule when it was on the left key plus the choice proportion when it was on the right key, divided by two) in the range of 0.45 to 0.55.

Schedule details. The required-rate schedule was arranged by setting an LH of 5 sec on a response requirement (FR 5) added to the end of a basic VI schedule. If the pigeon satisfied the response requirement before the LH elapsed, the first response after the LH interval was reinforced. However, if the pigeon did not satisfy the requirement within the specified time period, it was returned to the initial links at the conclusion of the interval without a reinforcement. The response-independent schedule was arranged by having an identical VT period initiate a short FT period. The duration of the FT period was then adjusted as necessary to maintain comparable IRIs in the two schedules. Behavior following the reversal in this condition was facilitated by relaxing the LH aspect of the schedule for the first few sessions. Generally, once the pigeon had produced a few response-dependent reinforcers, its rate of responding increased to a level high enough to satisfy the requirements of the schedule.

RESULTS AND DISCUSSION

Table 1 presents the relevant data from Experiment 1.² As the table shows, the general logic of the experiment was satisfied in that terminal-link response rates were lower under the response-independent schedule than under the response-dependent schedule. Given this discrimination in terms of terminal-link response rate differences, what may be said of the initial-link choice responding?

The initial-link responding of the pigeons shows clearly that the required-rate contingency did not influence choice in a context of aperiodic reinforcement: both pigeons were indifferent. Examination of the IRI data for both pigeons indicates that the pigeons did, in fact, come into contact with the required-

rate contingency. Had the pigeons performed optimally, their IRIs under the required-rate schedule would have been 65 and 125 sec. However, the average IRI under the required-rate schedule for Pigeon 4251 was approximately 73 sec, indicating a failure to satisfy the contingency on approximately 11% of its exposures to the schedule; for Pigeon 5986, it was approximately 138 sec, indicating a failure to satisfy the required-rate contingency on approximately 10% of its exposures to the schedule.

EXPERIMENT 2

Integrating the results of Experiment 1 and of the experiments cited in Figure 1 yields the following set of conclusions regarding choice between schedules differing in terms of response contingencies: (1) a simple difference in rate of responding does not influence choice between two schedules; (2) in order to induce a pigeon to depart from indifference between two schedules, one of the two schedules must require a (high) rate of responding; (3) however, the contingency of a required rate of responding apparently does not affect choice when it is imposed upon aperiodic schedules, but only when it is imposed upon periodic schedules. Experiment 2 was concerned with determining why the required-rate contingency affects choice on periodic but not on aperiodic schedules.

The following line of reasoning was pursued as a possible interpretation of the data. It is well known that in cases of periodic reinforcement, temporal discriminations often develop regarding the availability of reinforcement (*e.g.*, Skinner, 1938, Ch. 4). That is, responding under a periodic schedule is generally biphasic within the IRI: no responding occurs immediately after schedule onset, but then there is an initiation and rapid acceleration of responding to a terminal level, which is sustained until reinforcement. A comparable temporal discrimination is typically absent on aperiodic schedules (Catania and Reynolds, 1968, p. 357). That is, responding under an aperiodic schedule is generally moderate and uniform throughout the IRI: there are no temporal cues to indicate an initial period of nonreinforcement, and consequently responding is generated immediately upon schedule onset. Now, what must the pigeon do to satisfy

²Unpublished data are available from the first author that replicate with generically similar schedules the findings cited in Figure 1, cells 1, 2, and 4.

Table 1

The data from Experiment 1 are summarized. The data represent averages over the final nine initial and final nine reversal determinations. Included for each subject are the response-dependent (Dep) and the response-independent (Ind) terminal-link schedules (interval values in seconds), the choice proportion for the response-independent schedule, the terminal-link response rate (responses per minute), the obtained terminal-link inter-reinforcement intervals (IRI) in seconds, and the number of sessions in the initial determination and in the reversal.

Subject	Terminal-Link Schedules (in sec)	Choice Proportion (for resp-) independent schedule)	Terminal- Link Resp/Min	Terminal- Link IRI (in sec)	Sessions
4251	Dep <i>tand</i> VT 60 FR 5 (LH 5)		60	73	
	Ind VT 65	0.52	9	65	26/26
5986	Dep <i>tand</i> VT 120 FR 5 (LH 5)		61	138	
	Ind VT 125	0.46	9	125	29/15

the requirements of a required-rate, periodic schedule? It must initiate responding immediately upon schedule onset, even though responding does not produce reinforcement until some discriminably later time. Thus, the pigeon must respond during a time (early) when it would not ordinarily respond. Is there a comparable situation on the required-rate, aperiodic schedule? In a trivial sense there is, because the pigeon must also initiate responding immediately upon schedule onset. However, in a more important sense, the situation is not comparable, because there is no comparable temporal discrimination of reinforcement. It is not appropriate to say that with an aperiodic schedule the pigeon must respond early when responding produces reinforcement only later, because with an aperiodic schedule the terms "early" and "later" are not meaningful. There is a constant probability that reinforcement is available, and consequently the pigeon's behavior under an aperiodic schedule is moderate and uniform throughout. Therefore, it was thought that preference in the required-rate, periodic comparisons of Fantino (1968) may not have been related to the minimum required-rate aspect of the schedule, but that preference was instead a function of requiring the pigeon to respond at a time (early) when temporal cues indicated that reinforcement was not ordinarily forthcoming.

To test this interpretation, pigeons were given a choice between, in Condition 1, a tandem fixed-ratio fixed-interval schedule

(*tand* FR FI) and an FT schedule, and in Condition 2, a modified chain fixed-ratio fixed-interval schedule (*chain* FR FI) and a *chain* FT FT schedule. The *tand* FR FI schedule in Condition 1 was used because it generated responding (according to the FR component) that was discriminably distant (by the duration of the FI component) from reinforcement. The *chain* FR FI schedule in Condition 2 was used for the same reason, and also because it provided feedback for completion of the early response requirement, thereby making the onset of the FI component more discriminable. The *chain* FT FT schedule in Condition 2 assured that there was a comparable stimulus change between schedule onset and presentation of the reinforcer. Both the *tand* FR FI and *chain* FR FI schedules, then, preserved what was thought to be the essential feature involved in the preference, namely, the feature of early responding, but eliminated the so-called required-rate aspect of the schedule. If the analysis and reasoning regarding the schedules were correct, then preference should be observed for the response-independent schedules in both conditions, even though the response-dependent schedules do not require a minimum rate of responding.

METHOD

Subjects

Six pigeons were used. Two had served in Experiment 1, and four with comparable experimental histories were added. Pigeons 6242, 4835, and 6045 served in Condition 1, and

Pigeons 5986, 6392, and 4251 served in Condition 2.

Apparatus

Same as Experiment 1.

Procedure

The stability criterion and reversal procedure described in Experiment 1 were also used in Experiment 2.

In Condition 1, the response-dependent schedule was tandem fixed-ratio fixed-interval (*tand* FR FI). In this schedule, the pigeon was required to complete a small FR before an FI schedule would come into effect. The first response after the fixed interval produced grain. The key color remained the same throughout. The response-independent FT schedule in the alternate terminal link was adjusted daily to approximate the obtained IRI of the response-dependent terminal link, computed from the previous day's performance.

In Condition 2, the response-dependent schedule was a modified chain fixed-ratio fixed-interval (*chain* FR FI). In this schedule, the terminal link was divided into two successive components of equal duration. If the pigeon completed the FR before time elapsed in the first component, the key color changed immediately and when time elapsed in the first component, the second component began automatically; the first response after this second time interval had elapsed was reinforced. If the pigeon did not complete the FR before time elapsed in the first component, the key color remained the same until the FR was completed. Upon completion of the FR, the key color changed and the second component commenced; the first response after this second interval had elapsed was reinforced. The response-independent schedule in this comparison was *chain* FT FT, adjusted daily as described above to maintain equivalent IRIs on both schedules. On the left key, the terminal-link stimulus colors were amber followed by green, and on the right key, blue followed by red. Sessions were terminated after 2 hr if 50 reinforcers had not yet been obtained.

RESULTS AND DISCUSSION

Table 2 presents the relevant data from Experiment 2. The choice proportion for each of the six subjects indicates that the response-independent schedule was preferred to the re-

sponse-dependent schedule when the latter required responding early in the IRI. This finding was observed in every initial and in every reversal comparison, or in a total of 12 of 12 comparisons. Rate of responding was consistently higher under the response-dependent schedule, although some subjects (e.g., 4251) did develop an appreciable rate of responding under the response-independent schedule as well. These high response rates were attributed to stimulus-reinforcer conditions resembling autoshaping and automaintenance. Relative rate of entry into the response-independent terminal-link schedule averaged 0.52 for all pigeons. Pigeons 4835 and 6045 evidenced a slightly higher relative rate of entry into the response-independent terminal-link schedule, but as shown in Table 2, the response-independent terminal-link schedule also involved a slightly longer IRI. Indeed, it is noteworthy that for five of the six pigeons, the IRI in the response-independent schedule was actually longer than in the response-dependent schedule. In particular, Pigeon 4835 chose between a response-dependent schedule averaging 79 sec in length and a response-independent schedule averaging 96 sec in length. The choice proportion for this pigeon, 0.72, indicates that responding in the early portion of the IRI is a substantial variable, substantial enough to offset this difference in the IRI. For the sixth pigeon, 6392, the IRI of the response-dependent schedule was 31 sec and of the response-independent schedule, 30 sec. In light of the choice proportion of 0.64, it is unlikely that the pigeon's preference is a function of this relatively slight difference in IRI. In general, the performance of the pigeons under the response-dependent schedules was consistent with that observed by Shull (1970), who examined performance under a single-key, *tand* FR 1 FI schedule.

The major implication of Experiment 2 is that the notion of a required (high) rate of responding as a determinant of choice be reconsidered, and that attention be given instead to the molecular, temporal relation between initiation of responding and the subsequent presentation of the reinforcer. This implication follows from an analysis of a required-rate schedule. Typically, the schedule requires that N responses be emitted with respect to some set of temporal constraints. However, as soon as the schedule requires these N responses

Table 2

The data from Experiment 2 are summarized. The data represent averages over the final nine initial and final nine reversal sessions. Included for each subject in each condition are the response-dependent (Dep) and response-independent (Ind) terminal-link schedules (interval values in seconds), the choice proportion for the response-independent schedule, the terminal-link response rate in terms of responses per minute, and the obtained interreinforcement interval (IRI) in seconds. For the response-dependent schedules in both Conditions 1 and 2, the columns headed S2 and S1 refer to those portions of the terminal-link schedules when the FR and FI schedules were in effect. For the response-independent schedule in Condition 2, the columns headed S2 and S1 refer to the first and second components of the terminal links, each signalled by a characteristic color. The number of sessions required to attain stability in both the initial determination and in the reversal are given at the right of the table, and are separated by a diagonal.

Choice Condition	Subject	Terminal-Link Schedules (in sec)	Choice Proportion (for resp-independent schedule)	Terminal-Link Resp/Min		Terminal-Link IRI (in sec)		Sessions
				S2	S1	S2	S1	
1	6242	Dep <i>tand</i> FR 5 FI 25		22	67	14	25	
		Ind FT	0.61		16		41	24/34
1	4835	Dep <i>tand</i> FR 15 FI 45		28	35	34	45	
		Ind FT	0.72		6		96	36/74
1	6045	Dep <i>tand</i> FR 15 FI 45		23	93	37	45	
		Ind FT	0.65		24		90	39/47
2	5986	Dep <i>chain</i> FR 10 FI 15		33	99	17	17	
		Ind <i>chain</i> FT FT	0.60		7		18	23/17
2	6392	Dep <i>chain</i> FR 10 FI 15		45	35	13	18	
		Ind <i>chain</i> FT FT	0.64		8		15	25/25
2	4251	Dep <i>chain</i> FR 30 FI 30		51	178	34	32	
		Ind <i>chain</i> FT FT	0.64		17		32	39/63

within the temporal context, it has then arranged for relatively periodic reinforcement. The schedule may then become aversive, not so much because of its arduous properties, such as a short interresponse time, but rather because it requires the pigeon to initiate responding in advance of the time when responding ultimately produces reinforcement. That is, the response requirements of the schedule necessitate a response pattern that is at variance with the response pattern ordinarily produced by the temporal parameters of a periodic schedule. When reinforcement is aperiodic, there are no periods of temporally discriminated extinction, and even though a high rate may be required, the pigeon may still satisfy the schedule without disrupting its naturally occurring response pattern. Accordingly, the pigeon is indifferent. However, when reinforcement is periodic and when the pigeon must respond at a time that is discriminably distant from reinforcement, for example under *tand* FR FI or a *chain* FR FI schedules, then the pigeon must go against the temporal cues inherent in a periodic schedule. Apparently, it is responding during the

period when temporal cues indicate the non-availability of reinforcement that makes the schedule less preferred.

GENERAL DISCUSSION

The existing data relating choice to response contingencies may now be summarized as follows: (1) when response contingencies, including required-rates, are imposed upon aperiodic schedules, in which there are no periods of (temporally) discriminated extinction (Killeen, 1968; Experiment 1), then pigeons are indifferent to the contingencies; (2) when response contingencies may be satisfied on a periodic schedule without emitting responses during a period of (temporally) discriminated extinction (Neuringer, 1969), then pigeons are indifferent to the response contingencies; (3) however, when the response contingencies of a schedule must be satisfied early in the IRI of a periodic schedule, then pigeons typically prefer the alternate schedule. These data suggest the following general interpretation: pigeons tend to prefer a second schedule to the extent that the response contingencies of the

first schedule must be satisfied when it is discriminable, for example on the basis of the inherent temporal cues associated with the early portion of the IRI on a periodic schedule, that reinforcement is not ordinarily available.

Analysis of the data from other studies suggests that variables similar to those noted here, *i.e.*, a requirement to respond during a period of discriminated nonreinforcement, may also be operative. For example, Gollub (1958) in a classic single-key study found that behavior was not maintained with extended (four- and five-link) chains when the component schedules were FI, but was relatively well maintained when they were VI. On a chained schedule composed of FI (as opposed to VI) components, successive stimuli reliably signal an extended period during which primary reinforcement is unavailable. Hence, on a schedule of chained FIs (but not VIs), there is a requirement to make a response in the presence of a stimulus that signals that reinforcement is not ordinarily forthcoming (see Schuster, 1969, p. 222, for a similar discussion).

An analysis in terms of comparable variables may also account for the apparently contradictory conclusions regarding the chaining operation reached by Duncan and Fantino (1972) and Schneider (1972) in two-key choice studies. Duncan and Fantino presented pigeons with a choice between a *chain* FI FI schedule and a simple FI schedule, and found that pigeons preferred the unsegmented IRI (the simple FI schedule). They concluded that "... an organism's choice for a schedule will be substantially lowered by the chaining operation" (p. 23). Schneider presented pigeons with a choice between a *chain* VI VI schedule and a *tand* VI VI schedule, and found that pigeons were indifferent between the segmented IRI (the *chain* schedule) and the unsegmented IRI (the *tand* schedule). He concluded that "... choice is ... not affected by intervening sequences of stimuli and schedule components" (p. 56). The different results in each study are presumably related to the differential control exerted by the stimuli associated with the components of the chained terminal-link schedules. The differential control probably came about because of the temporal properties of the chained schedules: the first link of the chained FIs was always reliably distant from reinforcement, whereas the first link of

the chained VIs was occasionally in close temporal association with reinforcement. Indeed, this differential control is suggested by the differences in absolute response rates in the two components of the chained schedules: for Duncan and Fantino's subjects, there was pronounced discriminative control in the first component, *i.e.*, rate of responding in the first component was lower than in the second; however, for Schneider's subjects, there was little evidence of comparable discriminative control, *i.e.*, rate of responding across both components was essentially constant. Thus, in the *chain* FI FI (but not in the simple FI) terminal link of Duncan and Fantino's study, it was necessary for subjects to respond in the presence of cues associated with nonreinforcement and Duncan and Fantino noted preference for the simple FI schedule. In the *chain* VI VI terminal link of Schneider's study, however, comparable responding during a period of discriminated nonreinforcement did not take place because the stimulus conditions did not promote a comparable discrimination of an extinction period; hence, Schneider obtained indifference.

The present analysis suggests that for schedules differentiated in terms of response measures, choice is a function of the temporal relation between responding and reinforcement, rather than a function of whether one schedule generates a higher rate of responding than another or whether one schedule requires a minimum rate of responding while another does not. It should be acknowledged, however, that data reported by Schuster (1969) and by Arnett (1972) may indicate that a difference in rate of responding affects choice even when the responses need not be emitted in the presence of cues associated with the unavailability of reinforcement. In each of these studies, stimulus manipulations (for Schuster, a superimposed schedule of brief-stimulus presentations; for Arnett, blackouts arranged on a second-order schedule) induced a higher rate of responding in one of two equal, aperiodic terminal-link schedules of a concurrent-chains procedure, and preference was observed for the terminal-link schedule with the lower response rate. Since higher response rates *per se* do not ordinarily constitute a sufficient condition for affecting choice, as shown by the studies cited in Figure 1, the critical variable in these two studies is apparently related to the way in

which the higher response rates were generated, *i.e.*, to the stimulus manipulations. Indeed, Schuster mentioned the possibility of frustrative nonreward in discussing his study (1969, p. 233). In any case, the present study provides a reasonably clear example of how response contingencies, under some conditions at least, may influence the choice between two schedules of reinforcement.

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