EFFECTS OF BEHAVIORAL HISTORY ON RESISTANCE TO CHANGE

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Abstract

Two experiments examined whether differential resistance to change would occur under identical variable-interval schedules as a function of a differential behavioral history. In Experiment 1, each of three pigeons first pecked at different rates under a multiple variable-ratio differential-reinforcement-of-low-rate schedule. In a subsequent condition, a multiple variable-interval variable-interval schedule operated in the presence of the same training stimuli, during which there were three 4-session prefeeding probes each occurring during a different stage of training. Pecking generally was more resistant to change in the presence of the stimulus previously correlated with the differential-reinforcement-of-low-rate schedule, and this result was more reliable during the earlier probes. In Experiment 2, each of three pigeons first was exposed to a multiple variable-interval extinction schedule, after which a variable-interval schedule replaced extinction. During three probes, each conducted during a different stage of multiple variable-interval variable-interval schedule training, food was delivered response independently between components. In the first probe, pecking was more resistant to change for each pigeon under the variable-interval schedule that had been in effect longer, but during the final two probes this differential resistance was absent. The present results, therefore, show that under identical schedules a behavioral history can influence resistance to change differentially, but that these history effects tend to dissipate with continued exposure to the identical schedules.
EFFECTS OF BEHAVIORAL HISTORY ON RESISTANCE TO CHANGE

Resistance to change has received considerable study in the experimental analysis of behavior, as it has been said to index response strength (see Nevin & Grace, 2000, for a review). Resistance to change refers to the persistence of responding in the face of disruption and has been examined in a relatively standard way. Responding, usually key pecking of pigeons, initially is reinforced under a multiple schedule in which a variable-interval (VI) schedule typically operates in each component. A response-rate-reducing operation (i.e., a disrupter) is introduced after responding has stabilized (e.g., prefeeding, response-independent food delivery between components). Resistance to change is measured by comparing response rates during disruption such that the response that decreases less, relative to its own baseline rate, is said to be more resistant. Several dimensions of the reinforcer influence resistance to change, including its rate (e.g., Nevin, 1974), immediacy (e.g., Grace, Schwendimen, & Nevin, 1998), magnitude (e.g., Harper, 1996), and quality (Mace, Mauro, Boyajian, & Eckert, 1997). In addition, dimensions of the response that influence resistance are its rate (e.g., Lattal, 1989) and variation (Doughty & Lattal, 2001).

The effects of the aforementioned reinforcer and response dimensions on resistance to change have been studied primarily in the context of current environmental conditions (but see Cohen, Pedersen, Kinney, & Myers, 1994). To illustrate, when examining different reinforcement rates on resistance to change, the reinforcement schedules that arrange the different rates are in effect immediately prior to the disruption test. Thus, there has been little examination on resistance to change of the effects of remote reinforcement contingencies, or behavioral history. Would, for example, differential response resistance occur under identical schedules following a history of exposure to non-identical schedules (cf. Cohen et al.)?
Broadly defined, behavioral history describes the effects of past reinforcement contingencies on present responding. In the most common experimental procedure for investigating behavioral history effects, either different groups of subjects (e.g., Urbain, Poling, Millam, & Thompson, 1978) or single organisms in the presence of different stimuli (e.g., Freeman & Lattal, 1992) initially are exposed to different reinforcement schedules. In a second condition, the subjects are exposed to an identical reinforcement schedule in the presence of the same training stimuli. Behavioral history effects are indexed by differential responding in the presence of the different stimuli during the second condition. For example, following the training of differential response rates under a multiple tandem VI fixed-ratio (FR) tandem VI differential-reinforcement-of-low-rate (DRL) schedule, Freeman and Lattal (Experiment 3) exposed pigeons to a multiple VI VI schedule in the presence of the same training stimuli. Despite the operation of identical VI schedules in the two components, differential response rates persisted for many sessions (i.e., 11, 18, 24, and 44 sessions for each of four pigeons). Behavioral history effects also may be indexed by differential response disruption when a disrupter is superimposed on the identical reinforcement schedules in the second condition. In the latter case, the effects have been labeled *latent* if responding appears identical, for example in rate, across components prior to the application of the disrupter (cf. Barrett, 1986; Tatham & Wanchisen, 1998).

At issue here, then, is whether behavioral history effects, indexed by differential resistance to change, can be observed under identical schedules following exposure to different reinforcement schedules. To our knowledge, only Cohen et al. (1994) has studied the relation between behavioral history and resistance to change. Pigeons initially were exposed, in separate groups, to an FR, variable-ratio (VR), or DRL schedule. Each pigeon then responded under a progressive-ratio (PR) schedule until stability was reached. Resistance tests in the form of
prefeeding and extinction subsequently were administered; however, there were no differences in resistance as a function of the earlier schedule experience across the groups. Four reasons as to why there were no differences in resistance across groups may be offered. First, as Cohen et al. suggested, the results might have occurred because ratio schedules more effectively eradicate history effects than do interval schedules. Second, and related to the first point, resistance to change is studied most often with interval-based schedules (i.e., VI schedules). Third, as typical resistance-to-change findings are obtained most reliably within subjects, Cohen et al. may have failed to find differences in resistance because of their between-subject design. Fourth, Cohen et al. only tested for history effects after the PR schedule had controlled responding (i.e., they only tested for latent history effects). It is unknown whether differences in resistance between the groups would have been observed if the tests had occurred earlier.

Experiment 1

The purpose of Experiment 1 was to study the effects of behavioral history on resistance to change using procedures that differed from those employed by Cohen et al. (1994). Pigeons first responded at differential rates under a multiple VR DRL schedule before being exposed to a multiple VI VI schedule with the same training stimuli. At different stages of training under the multiple VI VI schedule, resistance to prefeeding was measured. Thus, by using these procedures, the effects of a behavioral history on resistance to change could be assessed (1) with individual subjects, (2) responding under identical VI schedules, (3) both before and after response rates converge across components.
Method

Subjects

Three experimentally naïve White Carneau pigeons were maintained at approximately 80% of their free-feeding body weights. Each was housed individually with water and health grit continuously available in the home cage. Each was given supplemental feeding, if necessary, to maintain its target weight. Lights were on in the home colony from 7 am to 7 pm.

Apparatus

A standard operant conditioning chamber was enclosed in a sound-attenuating box and had a work area of 38 cm by 31 cm by 31 cm. Two response keys (2-cm diameter) located on the front wall could be transilluminated by 28V-DC bulbs. The keys were 25 cm above the floor and 21 cm apart. Two 28V-DC bulbs located on the ceiling of the chamber provided general illumination throughout the session (i.e., houselight) except during 30-s blackouts (see below) and reinforcer delivery. The key lights also were darkened during reinforcer delivery, which was 3-s access to mixed grain provided in a food hopper located behind a 6-cm² food aperture centered on the front wall with the lower edge of the aperture 11.5 cm above the floor. The aperture was illuminated only during food delivery. Programming and data recording were controlled by a computer in an adjacent room using MED-PC© software (MED Associates, Inc. & Tatham, 1991). Two Ralph Gerbrands Co. Model C3 cumulative recorders also were used.

Procedure

For each pigeon, hand shaping of the key peck followed magazine training. Each pigeon then was exposed to a multiple VR DRL schedule with the VR schedule correlated with the right, red key and the DRL schedule with the left, white key. The values of the two schedules were increased across sessions until a multiple VR 45 DRL 8-s schedule was reached. Each
schedule component was 2 min in duration and was preceded by a 30-s blackout in which the
key lights and houselight were darkened. The VR and DRL schedules alternated quasirandomly
such that no more than three successive components of the same schedule occurred. Fifteen
components of each schedule constituted a session, and two sessions occurred per day with
approximately four hours separating each session. Sessions occurred six days per week. Table 1
shows the number of sessions in this initial condition for each pigeon.

After a minimum of 45 sessions under the multiple VR DRL schedule and when
responding stabilized, identical VI 90-s schedules were effected in each component in the
presence of the same key lights as in the first condition (i.e., right red and left white). Stability
was defined by the absence of a systematically increasing or decreasing trend in response rate, in
either component, across at least six consecutive sessions, as assessed visually. Each VI schedule
consisted of 20 intervals arranged according to the distribution described by Fleshler and
Hoffman (1962).

Three 4-session prefeeding probes occurred in the multiple VI VI schedule condition.
Sixty min prior to a prefeeding session, each pigeon was fed grain in an amount equaling 5% of
its free-feeding body weight. Table 1 shows the number of multiple VI VI schedule sessions that
preceded each probe, excluding prior prefeeding sessions. The number of sessions preceding the
probes were selected so that the probes occurred relatively early in training (Probe 1), when rates
more closely approximated each other but had not converged (Probe 2), and when rates had
converged (Probe 3). Probe 3 occurred for Pigeons 2636 and 8127 when the mean response rate
in each component for six consecutive sessions was within 1% of the mean from all 12
components. Pigeon 2631 received Probe 3 without this criterion being satisfied because it was
not satisfied after 126 multiple VI VI schedule sessions.
Results

Figure 1 shows response rates for each pigeon in different parts of training, separated by solid vertical lines. The leftmost data points show mean response rates from the last 6 sessions of the multiple VR DRL schedule. The next three sets of points are from the six sessions of the multiple VI VI schedule that preceded each probe. Relatively high and low response rates occurred under the VR and DRL schedules, respectively. For each pigeon, prior to Probe 1, response rates were higher to the former VR schedule key than to the former DRL schedule key. This response-rate difference also was present prior to Probe 2 but was smaller. Response rates converged prior to Probe 3 for Pigeons 2636 and 8127 and, as noted above, still were discrepant for Pigeon 2631, even after 126 multiple VI VI schedule sessions.

Obtained reinforcement rates (i.e., reinforcers per minute) were calculated for each session shown in Figure 1 for each pigeon. In the first condition, for Pigeons 2631, 2636, and 8127, respectively, these mean rates were 4.19, 3.27, and 3.41 for the VR schedule and 3.15, 2.93, and 2.19 for the DRL schedule. Reinforcement rate was similar under each VI schedule for each pigeon in each session after the first session of exposure to that schedule.

Figure 2 shows log proportion of baseline response rates in each prefeeding session for each pigeon, with probes separated by dotted vertical lines. Proportions were calculated by dividing the response rate in each prefeeding session by the mean response rate from the six sessions that preceded that probe. Thus, relative to baseline, any points below the solid horizontal line at zero represent a decrease in response rates, and any points above the line represent an increase in response rates. The range of values on the y-axis for Pigeon 2636 is different than the ranges on the other graphs. In Probe 1 for each pigeon, responding decreased more to the former VR-schedule key than to the former DRL-schedule key. In Probes 2 and 3,
the latter result occurred for Pigeons 2631 and 2636, whereas the reduction was not differential for Pigeon 8127.

Discussion

Following the training of differential response rates under a multiple VR DRL schedule, each of three pigeons continued to respond differentially under identical VI schedules for several sessions. In fact, one pigeon (i.e., Pigeon 2631) continued to respond at different rates under identical VI schedules for 126 sessions. There were nine prefeeding probes; response rates were unequal between components prior to seven of them and equal prior to the other two. Of the seven probes in which response rates were unequal, responding was more resistant to change in the lower-response-rate component during six of them (the exception was Probe 2 for Pigeon 8127). Of the two probes in which response rates were equal, there was one instance of differential resistance to change (Pigeon 2636, Probe 3), and that was greater resistance in the component formerly correlated with lower response rates.

All the pigeons initially responded at lower rates in the VI-schedule component previously correlated with lower response rates (as a result of the DRL schedule) than they did in the VI-schedule component previously correlated with higher response rates (as a result of the VR schedule). This latter finding replicates previous behavioral history effects, including the considerable variability in time until the response rates converged following the shift to the common VI schedule (e.g., Freeman & Lattal, 1992). As noted above, response rates still were differential for Pigeon 2631 after 126 sessions of the multiple VI VI schedule. This separation of response rates may represent a “permanent” behavioral history effect (cf. Cole, 2001; Tatham & Wanchisen, 1998). That is, although one cannot demonstrate conclusively that response rates
would have remained discrepant for an even longer period of time, it is tempting to suggest that they would given the results after 126 sessions.

That greater resistance to change occurred in the component with lower response rates during six of the probes replicates and extends previous findings involving resistance to change. Both Lattal (1989) and Nevin, Grace, Holland, and McLean (2001) found, with reinforcement rate equated, greater resistance to change for lower, as opposed to higher, response rates. A crucial difference between this experiment and the studies of Lattal and Nevin et al. is that the present resistance tests occurred while responding was maintained by identical schedules. Lattal generated high and low response rates under, respectively, tandem VI FR and tandem VI DRL schedules, and Nevin et al. did so under, respectively, random-ratio (RR) and random-interval (RI) schedules in one experiment and VR and VI schedules in another. Thus, it was not possible to separate entirely the effects of response rates and the contingencies supporting those rates as determining the differences in resistance (cf. Lattal). Because of the identical VI schedules in the present experiment, however, it is suggested that response rate and not the response-reinforcer contingency per se was responsible for the differential resistance observed in those studies, as well as in this one.

Another interpretation of the differential resistance observed in Experiment 1 is that responding in the former VR-schedule component was in greater transition than was responding in the former DRL-schedule component. Using a repeated-acquisition procedure, Thompson (1975) found that a drug dose disrupted responding when a different response sequence was reinforced each session but had no systematic effect when the same sequence was reinforced each session. In other words, responding in transition was less resistant to disruption (i.e., drug administration) than was stable responding. Two findings support the notion that in the present
experiment responding in the former VR-schedule component was in relatively greater transition than was responding in the former DRL-schedule component. First, variability in response rate in the former VR-schedule component was greater than the variability in response rate in the former DRL-schedule component before most of the probes. Second, the response-rate decrease from the VR schedule to the VI schedule was greater than the response-rate increase from the DRL schedule to the VI schedule.

Neither satiation in Experiment 1 or satiation or extinction in Cohen et al. (1994) yielded reliable latent behavioral history effects. In Experiment 1, differential resistance to change only occurred in one of the two cases in which response rates were equal between the components prior to a preceding probe. In the case of Cohen et al., as noted in the introduction, the use of a ratio schedule and a between-subject design might have interfered with the appearance of such history effects. In addition to within-subject comparisons, interval schedules were used in this experiment as the common schedule against which the latent history tests were made, but this too proved insensitive.

In sum, then, the present results show that, under certain conditions, a behavioral history can influence resistance to change differentially. Specifically, there was differential resistance when the behavioral history still was directly influencing responding, as gauged through response rate. There was no reliable differential resistance, however, when the history was no longer directly influencing responding, again, as gauged through response rate.

Experiment 2

Both Cohen et al. (1994) and the present Experiment 1 explored the effects on resistance to change of a behavioral history consisting of different reinforcement schedules. Though reliable resistance-to-change differences occurred during the early probes in Experiment 1, latent
effects were unreliable, just as reported by Cohen et al. The second experiment, therefore, relied on the construction of a behavioral history that differed from the ones created in Experiment 1 and by Cohen et al. In Experiment 2, three pigeons first received 90 sessions of a multiple VI extinction schedule before being exposed to a multiple VI VI schedule. As in Experiment 1, each of three resistance-to-change probes occurred at different stages of the multiple VI VI schedule training. Thus, there were three questions addressed in Experiment 2. First, would this novel training history (i.e., the presence versus absence of reinforcement) generate a typical behavioral history effect? Second, would this training history also generate differential resistance to change? Third, if observed, would such resistance-to-change differences occur both before and after responding has converged across the two VI schedules?

Method

Subjects

Three experimentally naïve White Carneau pigeons were maintained as in Experiment 1.

Apparatus

A chamber similar to the one described for Experiment 1 was used. The primary difference between the two chambers was that the one used in this experiment had one response key and it was centered on the front wall.

Procedure

For each pigeon, autoshaping followed magazine training. Next, each pigeon was exposed to a two-component multiple schedule, in which each component was 2 min in duration and was preceded by a 30-s period in which only the houselight was on. The key was green in one component and blue in the other. The first component of each session was chosen randomly
and the remainder of the components strictly alternated thereafter until each occurred 15 times.

Sessions occurred, once per day, seven days per week.

In the first condition, a multiple VI 90-s extinction schedule was in effect with the VI schedule operating when the key was green and extinction when it was blue. This first condition lasted 90 sessions for each pigeon, during which time responding stabilized as assessed visually. Extinction then was replaced by a VI 90-s schedule. As in Experiment 1, each VI schedule was comprised of 20 intervals arranged according to the distribution described by Fleshler and Hoffman (1962). To hasten the transition from extinction to the VI schedule during the first session, an FR 1 schedule was in effect for the first 3 key pecks in the blue-key component for each pigeon. For Pigeon 422, three response-independent food deliveries preceded the three FR-food deliveries because that pigeon did not peck during the first several blue components.

Three 1-session probes occurred during the multiple VI VI schedule condition. In each probe session, a VT 15-s schedule was in effect during the 30-s intercomponent intervals. The first probe occurred after five multiple VI VI schedule sessions, the second after another five sessions, and the third after another five sessions (excluding prior probes).

Results

The left graphs of Figure 3 show response rates in the last 6 sessions of the multiple VI extinction schedule and each session of the multiple VI VI schedule for each pigeon. The single data points between the solid vertical lines show response rates during the probes. The range of values on the y-axis for Pigeon 825 is different than the ranges on the other graphs. In the first condition for each pigeon, relatively high response rates occurred under the VI schedule and little to no responding occurred in extinction. Under the multiple VI VI schedule, response rates to the former extinction-schedule key increased rapidly to a level at or near that obtained under
the other VI schedule. For Pigeons 422 and 825, rates did not converge completely until later in training.

The right graphs of Figure 3 show log proportion of baseline response rates during each probe for each pigeon. The graphs were constructed as described for Figure 2 except that the proportions were calculated by dividing the response rate from each probe by the mean response rate from the three sessions preceding that probe. Data from three sessions were used to calculate proportions to represent average baseline response rates more accurately, particularly for Probe 1. In Probe 1 for each pigeon, response rates to the former extinction-schedule key decreased more than did response rates to the key that always had been correlated with the VI schedule. In Probes 2 and 3, response-rate reduction either was similar across components (Pigeons 152 and 825) or reversed from Probe 1 (Pigeon 422).

Obtained reinforcement rates (i.e., reinforcers per minute) were calculated for the final 6 sessions of the first condition and each session of the multiple VI VI schedule. In the first condition, for Pigeons 152, 422, and 825, respectively, these mean rates were 0.64, 0.60, and 0.63 for the VI schedule. For each pigeon, reinforcement rate was similar in each component of the multiple VI VI schedule in each session after the first session of exposure to that schedule.

Discussion

Following a history of exposure to a multiple VI extinction schedule, for two of the three pigeons, response rates converged under identical VI schedules after approximately 15 sessions of exposure to the multiple VI VI schedule (Pigeon 152 was the exception). A resistance-to-change probe during the sixth session of the multiple VI VI schedule, with reinforcement rate equated, consistently yielded more resistance in the component formerly correlated with reinforcement versus the component formerly correlated with extinction. In the final two probes,
there was no systematic difference across pigeons in resistance to change between the two components.

The persistence of differential response rates for two of the pigeons under the identical VI schedules extends previous behavioral history findings to a novel training condition consisting of a multiple VI extinction schedule. This history effect, though, was relatively smaller (i.e., it was less persistent) than the results often observed in studies involving behavioral history (e.g., following the multiple VR DRL schedule training of Experiment 1). Such a discrepancy is noteworthy because it is consistent with the claim that the training history arranged in the first condition of a behavioral history investigation influences the occurrence of behavioral history effects, just as the reinforcement schedules arranged in the second condition do. Relative to previous behavioral history investigations, the transition from the extinction schedule to the VI schedule in Experiment 2 may have been relatively rapid because there was no prior response (pattern) to be modified (e.g., DRL-schedule responding).

An interpretation based on reinforcement history describes the differential resistance found in the first probe of Experiment 2. Because reinforcement is such a potent determinant of resistance to change, it seems reasonable to conclude that the differential reinforcement history of the initial condition generated the differential resistance in the first probe. This reinforcement-history interpretation, however, seems inconsistent with the results of the final 2 probes. Considering the conclusion from Experiment 1, that lower response rates tend to be more resistant than higher response rates, may aid in the description of the results from the final probes. That is, because response rates were lower, prior to most of the probes, in the VI-schedule component formerly correlated with extinction, this factor may have competed, in some
sense, with the differences in reinforcement history, particularly as that history became further removed (i.e., the later probes).

In addition to the aforementioned reinforcement-history interpretation, the differential resistance found in the first probe of Experiment 2 also may be described in terms of the responding in transition interpretation offered in the discussion of Experiment 1. That is, perhaps responding was less resistant during the VI-schedule component formerly correlated with extinction because that responding was in the midst of transition from a relatively low to a relatively higher rate, whereas there was little change in response rate in the other component.

General Discussion

Two experiments were conducted to determine if differential resistance to change would occur under identical schedules in individual organisms as a function of prior exposure to different reinforcement contingencies. In Experiment 1, response resistance to prefeeding was compared across identical VI schedules following a multiple VR DRL schedule. Early in training under the VI schedules, when response rates still were discrepant between components, greater resistance occurred in the component formerly correlated with the DRL schedule. Later in training, however, when response rates converged between the components, there was no reliable difference in resistance. In Experiment 2, response resistance to alternative reinforcement (arranged during the intercomponent intervals) was compared across identical VI schedules following a multiple VI extinction schedule. In the first probe for each pigeon, greater resistance occurred under the VI schedule that had been in effect longer, and this result was absent during the later two probes. Discussed next are the implications of these results for predicting the conditions under which a behavioral history will influence resistance to change under identical schedules differentially, as well as for interpreting the variables operating in those conditions.
Considering the results of Cohen et al. (1994) and the present two experiments, two conclusions can be offered regarding the conditions under which a behavioral history will influence resistance to change differentially under identical schedules. The first conclusion is that differences in resistance are more likely to occur during tests that shortly follow the training history, rather than during tests that occur after extended exposure to the identical reinforcement schedules. Stated differently, the training history is more likely to influence resistance differentially if that history still is impacting responding, as indexed through response rate. This conclusion is based on three findings. First, Cohen et al. found a similar amount of resistance to change under identical PR schedules, across groups, when such tests occurred after responding had converged following the construction of the different behavioral histories. Second, in the present experiments, there also was a similar amount of resistance during tests that occurred after responding had converged across the VI schedules. Third, there were reliable resistance differences in the present experiments during the tests that occurred early in training under the identical VI schedules. A second conclusion that follows from both the present research and the work of Cohen et al. is that it remains unknown whether there are conditions under which latent behavioral history effects can be found during resistance-to-change tests. On the one hand, subsequent research may uncover a test sensitive enough to unmask such effects. On the other, when the effects of a behavioral history no longer appear in responding, resistance to change may be solely a function of current reinforcer and response dimensions.

The behavioral histories constructed in the first conditions of the present experiments could have produced the unequal resistance in the initial probes by generating differences in response rate (Experiment 1), reinforcement history (Experiment 2), and/or transitional responding (Experiments 1 and 2). As noted above, with reinforcement rate equated, it has been
shown several times that lower response rates are more resistant than higher response rates (see also Blackman, 1968; Lattal, Reilly, & Kohn, 1998; but see Fath, Fields, Malott, & Grossett, 1983). Accounts offered for this greater resistance of lower response rates have included, among others, the aversiveness of high response rates (Lattal et al.), response elasticity (Nevin et al., 2001), and operant response class size (Doughty & Lattal, 2001; Reed & Doughty, 2003).

Though the present results do not allow one to distinguish between these different accounts, they provide further evidence that the differential resistance that follows the training of unequal response rates can be predicted by the response-rate differences per se, rather than the contingencies supporting those rates. This conclusion is supported in two ways. First, as discussed above, the differential resistance in the initial probes of Experiment 1 occurred under nominally identical schedules, such that a confound present in earlier studies was removed. That there were unequal rates under the nominally identical schedules, however, suggests that there may have been functionally different contingencies in place (cf. Lattal, 1989). Second, in the various studies that have yielded greater resistance of lower response rates (with reinforcement rate equated), the lower rates have been generated in different ways. Lattal used tandem schedules, Nevin et al. used simple schedules, and simple schedules different than those employed by Nevin et al. were utilized in this study. In addition, Reed and Doughty (Experiment 1) created their unequal response rates by manipulating the presence or absence of a signal that accompanied reinforcement (see also Roberts, Tarpy, & Lea, 1984). Thus, the greater resistance of lower response rates across these various studies, despite the operation of different contingencies, provides converging evidence that the crucial predictor is the difference in response rate per se.
The success of a reinforcement-history interpretation for the unequal resistance in the first probe of Experiment 2, but not in the final two probes of that experiment, seems consistent with some findings on resistance to extinction. Several studies have demonstrated a positive relation between resistance to extinction and the number of reinforcers delivered during training (e.g., Hearst, 1961). In other words, the greater the reinforcement history, the greater the amount of resistance to change (i.e., to extinction). In addition, as noted by some investigators (e.g., Zarcone, Branch, Hughes, & Pennypacker, 1997), there also may be an asymptote at which additional reinforcers have no further impact on subsequent resistance. This latter assertion might explain why there was differential resistance between the reinforcement histories prior to the first probe (i.e., a comparison of reinforcement histories of 95 and five sessions), but not prior to the second probe (i.e., a comparison between 101 and 11 sessions). That is, during the transition from extinction to the VI schedule, the amount of exposure to the VI schedule necessary to equate subsequent resistance across components may have reached its asymptotic level sometime during the first and second probe.

A final interpretation discussed briefly already about how the behavioral histories could have produced the differential resistance in the initial probes of the present experiments emphasized the susceptibility of responding that is in transition. Such an interpretation has both strengths and limitations. One strength is that it described the results from each experiment. One limitation is that it is a molar description in that it does not delineate the variables that are responsible for the transition itself. Another limitation is that it may be difficult, in some cases, to specify the point at which the transition has terminated and present performance has been reached. Subsequent research might provide clarity regarding the adequacy of this proposed responding-in-transition interpretation.
References


Authors’ Note

Currently, Adam H. Doughty is at the University of Kansas, Sergio Cirino is at Faculdade de Educação/Universidade Federal de Minas Gerais, Kristin H. Mayfield is at the University of Florida, and Hiroto Okouchi is at Osaka Kyoiku University. The first author received support while completing portions of this manuscript from NICHD Grant No. T32-18852. Address correspondence, and reprint requests, to Adam H. Doughty, University of Kansas, Parsons Research Center, PO Box 738, 2601 Gabriel, Parsons, KS 67357 (Email: adoughty@ku.edu).
Table 1. Number of baseline sessions for each pigeon during Experiment 1 under the multiple VR DRL schedule (i.e., baseline) and the number of multiple VI VI schedule sessions that preceded each probe. The number of sessions prior to each probe excludes previous prefeeding sessions.

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<th>Pigeon 2631</th>
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Figure Captions

*Figure 1.* Mean response rate (and standard deviation) from the last 6 sessions of the multiple VR DRL schedule and response rate from the six sessions of the multiple VI VI schedule that preceded each probe in Experiment 1 for each pigeon.

*Figure 2.* Log proportion of baseline response rates in each prefeeding session for each pigeon in Experiment 1.

*Figure 3.* The left graphs show response rates in the last 6 sessions of the multiple VI extinction schedule and each session of the multiple VI VI schedule for each pigeon in Experiment 2. The right graphs show log proportion of baseline response rates during each probe for each pigeon in Experiment 2.