*RESISTANCE TO REINFORCEMENT CHANGE IN MULTIPLE AND
CONCURRENT SCHEDULES ASSESSED IN TRANSITION AND
AT STEADY STATE*

ANTHONY P. McLEAN AND NEVILLE M. BLAMPED

UNIVERSITY OF CANTERBURY, CHRISTCHURCH, NEW ZEALAND

Behavioral momentum theory relates resistance to change of responding in a multiple-schedule component to the total reinforcement obtained in that component, regardless of how the reinforcers are produced. Four pigeons responded in a series of multiple-schedule conditions in which a variable-interval 40-s schedule arranged reinforcers for pecking in one component and a variable-interval 360-s schedule arranged them in the other. In addition, responses on a second key were reinforced according to variable-interval schedules that were equal in the two components. In different parts of the experiment, responding was disrupted by changing the rate of reinforcement on the second key or by delivering response-independent food during a blackout separating the two components. Consistent with momentum theory, responding on the first key in Part 1 changed more in the component with the lower reinforcement total when it was disrupted by changes in the rate of reinforcement on the second key. However, responding on the second key changed more in the component with the higher reinforcement total. In Parts 2 and 3, responding was disrupted with free food presented during intercomponent blackouts, with extinction (Part 2) or variable-interval 80-s reinforcement (Part 3) arranged on the second key. Here, resistance to change was greater for the component with greater overall reinforcement. Failures of momentum theory to predict short-term differences in resistance to change occurred with disruptors that caused greater change between steady states for the richer component. Consistency of effects across disruptors may yet be found if short-term effects of disruptors are assessed relative to the extent of change observed after prolonged exposure.

Key words: behavioral momentum theory, resistance to change, multiple schedules, concurrent schedules, alternative reinforcement, key peck, pigeons

A property of behavior that has attracted increasing attention in recent years is the extent to which an operant resists disruption. A considerable body of research, using multiple schedules in which different rates of reinforcement are arranged in two components, has shown that responding in the component with the higher rate of reinforcement is more resistant to disruption by extinction, by prefeeding prior to experimental sessions, or by response-independent reinforcement delivered during intercomponent blackout periods (Nevin, 1974; Nevin, Mandell, & Atak, 1983). Specifically, changes in response rate during the first few sessions under changed conditions (relative to predisruption levels) are greater for the response maintained by relatively infrequent reinforcement. This dependence of resistance to change on reinforcement is sum-

marized in behavioral momentum theory (Nevin et al., 1983). According to the most recent statement of the theory (Nevin, 1992b), the resistance of responding in the presence of a stimulus depends on reinforcement obtained in the presence of that stimulus relative to reinforcement obtained in the entire experimental session.

Harper and McLean (1992) studied resistance to change as a function of relative reinforcer magnitude in two multiple-schedule components with equal rates and unequal magnitudes of reinforcement, and were particularly interested in whether resistance measured by manipulating reinforcer rates would conform to predictions of momentum theory. Reinforcer magnitude was varied using long presentations of the food hopper in one component and short presentations in the other. Consistent with behavioral momentum theory, resistance to disruption by food presented during intercomponent blackouts was greater in the component with the larger magnitude of reinforcement. However, different results were obtained in a second experiment in which they varied the rates of reinforcement in the two components, keeping the reinforcer-magnitude

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differential intact. This manipulation is on a continuum with extinction, a disruptor often used in resistance research, but Harper and McLean found no difference in the extent to which responding changed in the two components—neither during the first few sessions of disruption nor in steady-state responding achieved after extended training under the changed conditions. Thus, in Harper and McLean's study, results obtained using a disruptor presented outside the components of the multiple schedule (food during blackouts) were consistent with the theory, whereas those obtained when varying the schedules maintaining responding in the components were not.

The results obtained by Harper and McLean (1992) suggest that, at least with regard to changes in reinforcement rate as a means of changing rate of responding, the analysis of behavior in transition given in behavioral momentum theory will do little to advance our understanding of the steady-state relation between behavior and its consequences, often described in terms of a hyperbolic function (de Villiers & Herrnstein, 1976; Herrnstein, 1970). However, this implication is weakened by the alternative interpretation, acknowledged by Harper and McLean, that the conditions that were intended to establish differential resistance interacted with the operation used to disrupt responding in such a way that the disruptors used during their second experiment were not equal in the two components. Specifically, it might be that variation of reinforcer frequency in the large-reinforcer component represents a more powerful disruptor than the same variation in the small-reinforcer component. If this was the case, then their failure to find differential resistance would be expected, because the more powerful disruptor was applied to the component with the greater magnitude of reinforcement (the more resistant, according to behavioral momentum theory). This would reduce the measured differential in resistance between components. It was not possible to dismiss this alternative interpretation using Harper and McLean's procedure. Accordingly, the present work addresses the same question but eliminates the possible interaction by using concurrent reinforcement rather than unequal reinforcer magnitudes to produce differential resistance to change in two multiple-schedule components.

The present study makes use of a particularly interesting feature of behavioral momentum theory, the fact that resistance and rate of responding have separate determiners. A number of studies have suggested that resistance is determined by Pavlovian stimulus-reinforcer contingencies rather than by the response-reinforcer contingencies that govern rate of responding (Nevin, 1984; Nevin, Smith, & Roberts, 1987). This important result suggests that resistance to change is a property of the stimulus setting in which responses occur, not the responses themselves. Accordingly, all reinforcers obtained in a given stimulus context, such as a multiple-schedule component, increase the resistance of all responses that occur in that context. That is, resistance of any particular response in a multiple-schedule component is increased by any reinforcers obtained during that component, even if they are produced by some alternative response. Increases in resistance to change should therefore result when alternative reinforcement in a component is high. Response rate, on the other hand, is reliably decreased by alternative reinforcement (Catania, 1963; Rachlin & Baum, 1969, 1972).

Two studies have directly assessed the relation between resistance to change and total reinforcement in a component. Mace et al. (1990) studied resistance of a sorting response in humans in multiple schedules. They compared resistance of sorting to disruption by a concurrent distracting stimulus in a component in which no alternative reinforcement was scheduled with that in a second component in which additional, alternative reinforcement was contingent on omission of the sorting response. Consistent with the idea that resistance depends on Pavlovian contingencies, resistance of sorting was increased by concurrent reinforcement for omission of sorting. Similarly, Nevin, Tota, Torquato, and Shull (1990) studied resistance of key pecking to disruption by prefeeding or extinction in components of multiple schedules. They showed that resistance was higher in a component in which alternative, response-independent reinforcement was arranged concurrently with the multiple-schedule contingency (Experiment 1) or a second key-peck response was reinforced concurrently (Experiment 2). Thus, the functional stimulus context in each component was the color projected onto the keys, and its correla-

tion with reinforcement, summed over keys, determined resistance to change.

The present study also used alternative reinforcement to manipulate resistance to change in components of multiple schedules. For one response key, reinforcers were frequent in one component and infrequent in the other. On a second key, rates of reinforcement were equal in the two components. In different parts of the experiment, responding was disrupted either by varying reinforcement on the second key (analogous to Harper and McLean's, 1992, Experiment 2) or by varying the rate of response-independent food presented in an intercomponent blackout. The procedure thus allowed us to reassess the effects of varying the schedule maintaining the response under study and also to replicate the effects reported by Mace et al. (1990) and Nevin et al. (1990) that relate resistance to change to total reinforcement obtained in a component.

METHOD

Subjects

Four homing pigeons, with previous experience in multiple schedules of reinforcement, were maintained at 80% to 85% of their ad lib weights. Supplementary feed was given at the end of sessions when needed. Home cages had continuous supplies of water and grit.

Apparatus

Four similar experimental chambers (33 cm by 31 cm by 35 cm) each contained an interface panel. Two response keys were mounted 20 cm from the grid floor and 10 cm from the center (left key) and at the center (right key) of the panel. Pecks exceeding about 0.15 N operated the keys, produced a feedback relay click, and turned off for 50 ms the green (Component 1) or red (Component 2) lights illuminating the keys from behind. Centered in the interface panel and mounted 8 cm above the floor was a hopper containing wheat. This was operated and lit with white light for 3 s during reinforcement, which was arranged using Fleshler and Hoffman's (1962) variable-interval (VI) schedules. A third response key and the chamber houselight were inoperative throughout the experiment. Scheduling and recording of all experimental events were man-

aged by an IBM® compatible 286 computer running MED-PC® software and interfaced to the chambers using MED Associates® hardware.

Procedure

There were three parts to the experiment. In all three, a multiple VI 40-s VI 360-s schedule was arranged on the left key. Presentations of components lasted 60 s, and between components a blackout period of 30 s occurred, during which response-independent food was sometimes delivered on variable-time (VT) schedules. Sessions lasted for 40 min. The right key always displayed the same color stimulus as the left key, and the arranged rates of reinforcement for pecking it were always the same in the two components. Any response that directly followed a response on the other key constituted a changeover. Changeovers were never reinforced and always started a changeover delay that prevented reinforcement altogether for a period of 3 s.

The schedules used in the various conditions are given in Table 1. In Part 1, the right-key schedules were varied over conditions, with a baseline schedule (VI 120 s) run between each experimental value. No food was given during blackouts. Training in all conditions was continued for at least 30 sessions. In Part 2, extinction was scheduled for the right key in both components, and training continued for 30 sessions. Responding was then disrupted for periods of at least 25 consecutive sessions by response-independent food presented during intercomponent blackouts. Three different rates of VT food were used, each separated by a redetermination of baseline lasting at least 25 sessions. In Part 3, the right-key schedules were VI 80 s in both components and were constant over conditions. After 30 sessions of baseline training, responding was disrupted by different rates of response-independent food presented during intercomponent blackouts, as in Part 2. Disruption conditions were maintained for 11 consecutive sessions and were preceded and followed by baseline determinations lasting for at least 30 sessions. No formal stability criterion was used during baseline conditions because, in our experience, the numbers of sessions given are more than sufficient for response rate to stop changing following changes in conditions.

Table 1

Reinforcement schedules on left and right keys in Components 1 and 2 and the intercomponent blackout for each condition in the experiment. Schedule values are in seconds and are listed in the order they were used. The number of sessions of training in each condition is given in the last column.

Con- di- tion	Component 1		Component 2		Black- out	Ses- sions
	Left	Right	Left	Right		
Part 1						
1	VI 40	VI 120	VI 360	VI 120	—	32
2	VI 40	VI 40	VI 360	VI 40	—	34
3	VI 40	VI 120	VI 360	VI 120	—	32
4	VI 40	VI 400	VI 360	VI 400	—	37
5	VI 40	VI 120	VI 360	VI 120	—	33
6	VI 40	VI 60	VI 360	VI 60	—	33
7	VI 40	VI 120	VI 360	VI 120	—	32
8	VI 40	VI 240	VI 360	VI 240	—	36
9	VI 40	VI 120	VI 360	VI 120	—	31
10	VI 40	ext	VI 360	ext	—	30
Part 2						
11	VI 40	ext	VI 360	ext	VT 300	25
12	VI 40	ext	VI 360	ext	—	25
13	VI 40	ext	VI 360	ext	VT 120	26
14	VI 40	ext	VI 360	ext	—	28
15	VI 40	ext	VI 360	ext	VT 80	25
16	VI 40	ext	VI 360	ext	—	30
Part 3						
17	VI 40	VI 80	VI 360	VI 80	—	30
18	VI 40	VI 80	VI 360	VI 80	VT 300	11
19	VI 40	VI 80	VI 360	VI 80	—	31
20	VI 40	VI 80	VI 360	VI 80	VT 120	11
21	VI 40	VI 80	VI 360	VI 80	—	31

RESULTS

Data used were generally those from the last 10 sessions of training in each baseline condition and the first 10 sessions in each disruption condition. For Part 1 we also used performance in the final 10 sessions in each disruption condition for analysis of behavior at steady state. Response and reinforcer rates were calculated for each session and were then averaged over the 10 sessions. Perhaps because of the changeover delay, obtained reinforcer rates were often lower than scheduled rates. Standard deviations of daily response rates were computed and may be used as an index of variability within the 10 sessions. Means and standard deviations are given in the Appendix.

In Part 1, Components 1 and 2 differed in terms of total reinforcement by an arranged ratio of 3:1 in baseline conditions. Responding was disrupted on both keys by changing the value of the schedules used on the right key

from the baseline value of 120 s to some other value, keeping them equal in the two components. At issue in Part 1 were the following: (a) At steady state, were there differences between components in the relation between response rate on either key and reinforcer rates on the right key? (b) In the short term, did responding on both keys change more, relative to baseline levels, in Component 2 when the schedules maintaining right-key responding were varied? To address these questions, change in response rate during disruption was measured proportionally. Specifically, response rate in each disruptor condition (i.e., when the right-key schedules were changed) was divided by response rate averaged over the preceding and following baseline conditions (i.e., VI 120 s). The only exception to this was Condition 10 (extinction) in Part 1, which was not followed by a baseline determination; here, change was expressed relative to the rate in the preceding baseline condition. *P.F.B.*

Figure 1 shows response rate on the left key and the right key at steady state, plotted as a function of reinforcer rate on the right key averaged over the two components. Response rates are shown for all disruption conditions, and are expressed as proportions of baseline rates obtained when the right schedules were VI 120 s. For the right key, the disruptor was a change in the schedules maintaining responding, a manipulation that is on a continuum with the more commonly used extinction test. For all subjects, response-rate change on the right key was proportionally greater for Component 1 than for the leaner Component 2—the opposite of the relation expected from other resistance-to-change findings. For the left key, the disruptor was manipulation of alternative reinforcement, obtained by making a second response (cf. Nevin, Mandell, & Yarowsky, 1981). In this case, response-rate change was proportionally greater for the leaner Component 2, consistent with the existing data on resistance to change.

The diverse relations between components in terms of resistance to change for left and right keys raise the question of whether steady-state responding might reveal different relations from behavior in transition. That is, Figure 1 displays change in response rate with respect to change in reinforcement rate using steady-state behavior, but responding observed in the first few sessions after conditions are

changed might reveal more rapid change in Component 2 for both the left and right keys. Accordingly, transition data were studied by displaying change in response rate with respect to time (rather than reinforcement, as in Figure 1). Figure 2 shows the resistance to change functions for the right key in Component 1 and Component 2 obtained over the first 10 sessions in each of three extreme conditions (right-key schedules of VI 40 s, VI 400 s, and extinction). On the VI 40-s schedule, responding generally increased relative to baseline in both components, and clearly increased more in the component with the larger reinforcer total (Component 1). On the VI 400-s schedule, responding generally decreased relative to baseline and, overall, decreased more in Component 1. In extinction, responding again decreased more in Component 1, but the difference was small and not consistent until Sessions 7 to 10. Thus, data from the first 10 sessions in each disruption condition were consistent with the changes observed in steady-state responding—right-key responding was less resistant to change in the component with the larger reinforcer total. Data for the left key are treated the same way in Figure 3. Overall, these data were more variable, but in the extreme conditions (VI 40 s and extinction) they were clearly consistent with the steady-state data in that, with one exception (Bird D1), responding changed more in the short term for the leaner component.

Parts 2 and 3 were conducted to see whether the subjects and procedure used in the present study would produce the expected resistance-to-change findings when more commonly used resistance determiners and resistance tests were used. In Part 2, responding on the right key was never reinforced, and resistance to change for Components 1 and 2 was studied using response-independent food presented during intercomponent blackouts (e.g., Nevin, 1974; Nevin et al., 1983). The expected finding is that responding on the left key in Component 1 (maintained by VI 40-s reinforcement) would resist change more than that in Component 2 (VI 360 s). The left panels in Figure 4 show response rates averaged over the first 10 sessions of each disruptor condition, expressed as proportions of baseline rates, for Components 1 and 2. Response rates are plotted as a function of the rate of response-independent reinforcement presented during blackouts. Fig-

Fig. 1. Response rate at steady state in all conditions of Part 1, in which responding was disrupted by changing the right-key schedules from VI 120. Response rates are expressed as proportions of rates in adjacent baseline determinations, and are plotted as a function of average reinforcers per hour obtained on the right key in the two components. The first column gives data for the left key, the second gives data from the right, and unfilled circles represent data from the component with the lower overall rate of reinforcement.

Fig. 2. Response rate in Components 1 (filled circles) and 2 (unfilled circles) during each of the first 10 sessions after conditions changed from baseline in Part 1. Response rates are given for the right key only, expressed as proportions of rates in adjacent baseline conditions, for three changes in rate of right-key reinforcement.

ure 4 shows that, for all subjects, resistance was greater for Component 1 than for Component 2. That is, response rate decreased less, relative to baseline, in Component 1. The results of Part 2 thus confirm that when re-

sponding is disrupted by food during inter-component blackouts, the subjects in this procedure showed the expected effect of greater resistance in the component with the greater reinforcer total.

The results of Part 2 confirmed the previous finding of differential resistance to change when responding was disrupted by intercomponent food presentations in multiple-schedule components that differed in terms of the rates of reinforcement maintaining the target response. However, right-key data from Part 1 showed the opposite result when components differed in terms of alternative (left-key) reinforcement and the disruptor was a change in the schedule maintaining the target response. These results suggest that either (a) variation of the schedule maintaining the target response does not function in the same way as other disruptors used in resistance-to-change research, as Harper and McLean (1992) concluded, or (b) the control of resistance to change by alternative reinforcement, reported by others, has limited generality. Accordingly, Part 3 attempted to replicate the finding of Mace et al. (1990) and Nevin et al. (1990) that resistance to change is indeed affected by reinforcers obtained in a component, even if they are not contingent on the response under study. Instead of using concurrent distracting stimuli, prefeeding and extinction (as in the previous studies), or variation of the schedules in the two components (as in Part 1 above), we used food presentation during blackouts as the disruptor.

In Part 3, reinforcers were arranged for both keys, and the schedules on the right key were equal over components. Left-key schedules differed so as to yield a ratio of reinforcer totals over the two components of about 2.5:1. Resistance was measured using responding on both keys. The right panels in Figure 4 show responding in the two components, summed over the two keys and plotted as a function of rate of food presentation during blackout. With the exception of 1 subject in one condition, the result was similar to that in Part 2: Responding showed greater resistance to disruption in the component with the larger reinforcer total. The smaller differentials found in Part 3 were expected because the reinforcer totals for components were more similar in Part 3.

Figure 5 shows Part 3 data from the two keys separately. Response rates for the left key and right key are plotted as a function of the rate of response-independent food presented in intercomponent blackouts. If the relation reported by Mace et al. (1990) and Nevin et al. (1990) is obtained here, the following would be expected for the left and right keys. For the

Fig. 3. Response rate in Components 1 (filled circles) and 2 (unfilled circles) during each of the first 10 sessions after conditions changed from baseline in Part 1. Response rates are given for the left key only, expressed as proportions of rates in adjacent baseline conditions, for two extreme changes in rate of right-key reinforcement.

left key, responding was reinforced at the same rates as in Part 2 (VI 40 s in Component 1 and VI 360 s in Component 2), so resistance should be greater in Component 1. However, smaller differentials between components in resistance to free food were expected, relative to those in Part 2, because the ratio of reinforcer totals was made less extreme by adding equal concurrent reinforcement in each component. For the right key, reinforcer rates were equal in the two components, but alternative reinforcement was high in Component 1 and

Fig. 4. Response rate for two components in Parts 2 and 3, expressed as proportions of baseline, plotted as a function of food rate during blackout. For Part 2, response rates on the left key are shown in the left panels. For Part 3, response totals summed over both keys are shown in the right panels. Filled circles are data from the component with the larger total of reinforcement, and unfilled circles are data from the other component.

low in Component 2. This concurrent reinforcement was expected to produce greater resistance to change in Component 1. Data in the left column of Figure 5, like the total responding shown in Figure 4, confirm that the large differentials in resistance found in Part 2 were reduced in Part 3 when the only change was the addition of concurrent reinforcement. Comparing left-key responding in Part 3 with that in Part 2, the resistance differential was reduced for 2 birds (D1 and D2), was reversed for Bird D4, and was unsystematic for Bird D3. The reduction in differential resistance is consistent with expectations from earlier work, although overall, it would still be expected that responding would be more resistant in Component 1 than in Component 2. For the right key, data shown in the second column of Figure 5 confirm the relation reported by other studies of concurrent reinforcement and resistance to change. Despite equal schedules on the right key in Components 1 and 2, all subjects showed greater reductions in response rate as a function of food presentation during blackout for Component 2, the component with less concurrent reinforcement.

DISCUSSION

The present study considered both transition data obtained soon after conditions were

disrupted and steady-state data obtained after 30 to 37 sessions of exposure to disruptors. Our steady-state data were in ordinal agreement with predictions from Herrnstein's (1970) equation for concurrent schedules:

$$B_i = \frac{kR_i}{R_i + R_a + R_e} \quad (1)$$

According to this formulation, the rate of a target response (B_i) is directly related to reinforcement for that response (R_i) and is inversely related to the total reinforcement in the situation. R_a and R_e are reinforcers for an alternative response and for behavior other than the measured responses, respectively, and both are measured in the same units as R_i . The constant k represents the total of all behavior in the situation, measured in the same units as the target response. Figure 6 shows predictions from Equation 1 for the conditions arranged in Part 1 of the experiment, with $k = 200$ and $R_e = 5$. The upper left panel shows predictions for the left key in Components 1 and 2, and the upper right panel shows predictions for the right key in both components. The lower panels show response rate for the same keys, only now it is expressed as a proportion of predicted rates in the baseline condition (VI 120 s on the right key in both components), as our data were presented in Figure

Fig. 5. Response rates in Components 1 (filled circles) and 2 (unfilled circles) plotted as a function of the rate of VT food presented in the intercomponent blackouts (Part 3). Response rates are expressed as proportions of the rates in adjacent baseline conditions. The first column gives data for the left key and the second gives data from the right key.

1. For the left key, Equation 1 predicts greater change relative to baseline in Component 2, as we found. For the right key, greater change is predicted for Component 1, again, as we found. For Parts 2 and 3, which used food during blackout as the disruptor, predictions are the same as for the left key in Figure 6, because food during blackout belongs in the denominator of Equation 1 and therefore has the same effect as R_a . Thus, Equation 1 accurately predicts the greater change found in Component 2 for transition data from Parts 2 and 3 of the experiment.

However, the data were not consistent with

Fig. 6. Predictions from Herrnstein's equation for concurrent schedules for the conditions arranged in Part 1. In the upper row, predicted response rates are shown for the richer Component 1 (filled circles) and the leaner Component 2 (unfilled circles). Predictions for the left and right keys are shown in different panels. In the lower row, the same predictions are expressed as proportions of the rates predicted for the baseline condition.

Herrnstein's (1970) analysis at a quantitative level when nonlinear least squares fits were conducted. The results of fitting Equation 1 to absolute response rates in Part 1 are given in Table 2, and estimates for the free parameters reveal several problems. First, best fitting hyperbolas had unreasonably high k and R_e values in several cases (right-key data for Bird D1 in Component 1, left-key data in Component 1 for Bird D3, and possibly left-key data for Bird D2). Second, negative values for R_e produced the best fits in several cases. Finally, and related to the negative values for R_e , there were several cases in which estimates for k (by definition, $k = B_i + B_a + B_e$) were clearly too small. Unless it is allowed that extraneous behavior (B_e) may be negative, fitted values should always exceed the sum of response rates on the left and right keys ($B_i + B_a$) when the physical requirements of the two

Table 2

Estimates of the free parameters in Equation 1, with proportion of variance accounted for (VAC). Fits were obtained for Component 1 (upper row) and Component 2 (lower row) and for each key, using a nonlinear least squares procedure and data from all conditions in Part 1. Very extreme estimates are replaced by dashes.

Bird	Left key			Right key		
	k	R_e	VAC	k	R_e	VAC
D1	172	151.3	.54	—	—	—
	72.3	22.1	.81	78.9	23.4	.9
D2	494	226.3	.27	117.21	—9	.98
	490.8	82.6	.81	124	4.2	.95
D3	3190	2756	—	127.4	—3.2	.98
	23.5	—6.5	.95	71.5	—9.7	.82
D4	251.8	67.4	.24	85.2	30.4	.87
	55.7	5.3	.91	85.6	5.3	.73

keys are similar. Comparing estimates for k with these sums (see Appendix for response rates on the two keys) revealed underestimates for k in several cases. Similar problems were noted with fits of Herrnstein's equation by White, McLean, and Aldiss (1986). Thus, the steady-state data were in agreement with Herrnstein's analysis only in that Equation 1 correctly predicts which component will show greater change in response rate.

Our transition data were consistent with expectations from behavioral momentum theory, but only when disruptors did not involve changing the contingencies maintaining the target response. Parts 1 (left key) and 3 (both keys) replicated the finding that resistance of responding to disruption is increased by the total reinforcement obtained in the component, even when some of the reinforcement was not contingent on the target response. Previous studies reporting this finding have used extinction and prefeeding or satiation as disruptors. The present study extended these by replicating the result using disruption by food during intercomponent blackouts (Part 3) or by changes in concurrent reinforcement (Part 1, left-key data). Similarly, in Part 2 of the present work, resistance was a function of reinforcer rate in components, again using food during blackouts as the disruptor. Thus, studies using alternative reinforcement and prefeeding as disruptors seem to be in agreement that total reinforcement in a component determines resistance to change.

Although there is substantial agreement

when disruptors are events that occur remote from the response under study, there is less agreement when the disruptor is a change in the contingency of reinforcement which maintains a target response. In Parts 1 and 3, reinforcement was equal in the two components for one key, but reinforcement totals for components were made unequal by the addition of concurrent reinforcement. The two parts differed in that for Part 1 the right-key response was disrupted by changing the rate of reinforcers maintaining it, whereas in Part 3 a remote disruptor was used (food during blackout). In Part 1, change in responding was clearly greater for the component with the larger reinforcement total—the opposite of what was found in Part 3, where rate of food delivery during blackout was varied, and in Nevin et al. (1990) and Mace et al. (1990), where prefeeding, extinction, or concurrent distraction was used as the disruptor.

Our result when extinction was arranged for the right key in Part 1 was, if anything, consistent with the lesser variations used in other conditions; responding on the right key in the richer component showed greater change, although not until at least six sessions of extinction had been completed. This result contrasts with that reported by Nevin et al. (1990, Experiment 2), who also used extinction and manipulated resistance to change using alternative reinforcement and found greater change in the leaner component. One clear difference between the two procedures was that Nevin et al. withheld all reinforcers, not just those maintaining the target response, whereas we kept intact the conditions instituted to produce the differential in resistance to change and extinguished only the target response. Nevin et al. considered whether their results might have been different if only the target response had been extinguished, but concluded that they probably would not have been. This was based on Catania's (1969) group-average data on extinction in concurrent schedules that were arranged singly rather than in a multiple schedule, as was the case here. Our data suggest that this conclusion may have been premature.

The right-key result from Part 1 is in part consistent with that reported by Harper and McLean (1992), and is not subject to the interpretation that the disruptors used in the two components might have been different. In that

study, changes in response rate with changes in reinforcement rate were compared for two components that differed only in terms of the magnitudes of the reinforcers. When they considered transition and steady-state data, the extent of change relative to baseline was similar regardless of the magnitude of reinforcement, contrary to the difference predicted by momentum theory and contrary to their results when food during blackout was the disruptor. In the present study, however, the failure of momentum theory seems even clearer. Greater change is predicted for the component with low overall reinforcement, and the results showed the exact reverse pattern.

Overall, the data indicate that the relation between components in terms of resistance to change depends on the disruptor used. The predictions of momentum theory were borne out when the disruptor was remote from the contingency maintaining the target response, but the predictions failed when the schedule maintaining the target response was varied to disrupt responding. Two approaches to resolving this inconsistency across disruptors are apparent. One requires that the domain for behavioral momentum theory be restricted to exclude some disruptors, and the other requires that a new scale be used for the study of transition data. We consider each of these approaches next.

The results of Harper and McLean (1992) and the present results might seem to suggest that "internal" disruptors (i.e., disruption of responding caused by changes in its consequences) are boundary conditions for behavioral momentum theory and that the theory applies only to disruptors that are remote from the contingency maintaining a target response. However, the results obtained using extinction complicate this considerably. Extinction is a case in which responding is disrupted in the same way as was right-key responding in Part 1 of the present work (by changing the schedules maintaining the target response) and should therefore be viewed as an internal disruptor. Overall, the results obtained with extinction are ambiguous. On the one hand, there are several conditions in which extinction has produced problematic results for momentum theory, such as discrete-trials procedures, extinction following limited training in baseline (see Nevin, 1988), and extinction in Part 1 here. On the other hand, there is a great deal

of free-operant data obtained with components that differed in terms of reinforcer magnitude (Shettleworth & Nevin, 1965), reinforcer rate (e.g., Nevin et al., 1983), or conditioned reinforcement (Nevin et al., 1987), for which extinction produced greater change in the learner component. Thus, distinguishing between internal and external disruptors might achieve greater consistency but has the unfortunate effect of excluding a great deal of orderly data on resistance to change from the domain of momentum theory.

An alternative approach, which might yield greater consistency of results across disruptors, is to revise the scale on which transition data are studied. Resistance is usually studied using short periods of exposure to the disruptor (often about five or six sessions). Asymptotic levels of responding are not normally determined under disruption, so eventual change in response rate (i.e., the difference between response rates observed in baseline and at steady state under disruption) is not known. In the absence of information about eventual change, Harper and McLean (1992) distinguished two interpretations of the short-term effects observed when responding is disrupted, which are illustrated in Figure 7. Figure 7 shows hypothetical reactions to a disruptor for two responses, including short-term and asymptotic effects. In each panel, two component responses decrease over sessions by a constant proportion of the remaining distance to a new steady state, and in the short-term analysis show greater change (lower resistance) in one component than the other. Two interpretations are illustrated in the upper two panels. First, the less resistant response may approach its new asymptote more rapidly than the other response, but eventual change relative to baseline is the same (i.e., components are distinguishable in terms of rate of change). This pattern is illustrated in the upper panel. Alternatively, differential resistance might reflect eventually different reductions relative to baseline for the two components, with the rate of change equal (i.e., components differ in terms of the eventual extent of change). This pattern is illustrated in the middle panel. In the short term, over the five- to six-session period normally used for analysis of resistance to change, either pattern produces a differential in response rate, and therefore behavioral momentum theory does not, at present, distinguish

Fig. 7. Hypothetical reactions to a disruptor for responding in two components. In all cases, change in response rate from session to session is a constant proportion of the remaining distance to the new steady state shown at the extreme right in each panel. In the upper panel, response rates in the two components ultimately decrease to the same proportion of baseline, but do so at unequal rates. In the middle panel, the two responses approach different asymptotes at the same rate. In the lower panel, the response that undergoes less change, relative to baseline, has the greater rate of change.

between them. The two patterns may be distinguished empirically only if eventual change is quantified by allowing responding to stabilize under the influence of the disruptor. Rates of change could then be compared by expressing short-term change as a proportion of eventual change.

The pattern shown in the middle panel of Figure 7 (response rate in the two components approaches different asymptotes at equal rates) might obviate a separate theory for behavior in transition altogether. This is because the ordinal relation between components in the short term is a simple reflection of the relation

observed at steady state, and an adequate theory for the latter (perhaps Herrnstein's analysis) would then also suffice for behavior in transition. It seems unlikely, however, because although this pattern might be observed with some disruptors, it can have only limited generality. One clear counterexample comes from extinction. Here, the long-term effect of the disruptor is to reduce responding in both components by the same proportion of baseline (i.e., 1.0), and yet short-term differences between components are often observed. Clearly these short-term differences indicate different rates of change, because the eventual extent of change is the same.

If behavioral momentum theory is to accommodate the results of varying the schedule maintaining the target response, it seems clear that it must predict the rate at which different responses approach new asymptotes under disruption, independently of how different the new asymptotes are from baseline. This is because some of the data on extent of change during transition do not support it. In particular, the failures of momentum theory occurred when disruptors were used that, consistent with Herrnstein's (1970) equation, were found to change response rate more relative to baseline for the richer component (right-key data in Figures 1 and 2). The lower panel in Figure 7 illustrates a third possible pattern, which might be consistent with the theory at this level and yet still might produce a counterexample when data are analyzed as proportions of baseline, either in the short term or at steady state. In this panel, the less resistant response approaches its new asymptote at a higher rate than a second, more resistant one, but the response with lower resistance in terms of *rate* of change is the one that undergoes greater change in the long term. That is, the extent of change and rate of change may be independent. Such a pattern produces a reversal of the usual relation reported in resistance-to-change research, and yet is consistent with momentum theory when change is viewed in relation to eventual change. It might be that measuring resistance in terms of rate of change will yield greater consistency in results across disruptors, although much of the existing support for behavioral momentum theory would need to be reevaluated. Alternative reinforcement, whether arranged concurrently or successively with the target re-

sponses, has been shown to produce proportionally larger changes in the leaner of two components when stability is reached or prolonged training is given (Harper & McLean, 1992; McLean & White, 1983; Nevin et al., 1981; Pliskoff, Shull, & Gollub, 1968; and Figure 1 above), as have satiation (Herrnstein & Loveland, 1974) and superimposed shock (Bouzas, 1978). It would need to be shown that in these cases greater change relative to baseline was also achieved at a higher rate for the component with less reinforcement.

Because analysis of resistance in terms of rate of change might reconcile the results from different disruptors, we asked whether our data are consistent with momentum theory when change is expressed relative to eventual change, so as to remove the effect of extent of change. Figure 8 gives a plot of group-average data from Parts 1 and 2 of the present experiment, in which training continued under disruptors for at least 25 sessions and thus allowed time for response rate to stop changing. For Part 1, asymptotic performances in each condition were the rates plotted in Figure 1. For Part 2, asymptotic data were calculated over the last five of 25 sessions conducted with each rate of food during blackout. (Data from Part 3 could not be analyzed because only 11 sessions of training were given with each disruptor and no estimates of asymptotic response rate were available.) In Figure 8, the change from baseline for the target response in each of the first 10 sessions was expressed as a proportion of eventual change using the following formula:

$$\text{Proportion} = \frac{B_{bs} - B_{dt}}{B_{bs} - B_{ds}},$$

where B is response rate and the subscripts identify baseline (b) and responding under the disruptors (d), either in transition (t) or at steady state (s).

It is clear that this treatment did not result in consistency in the data from the two keys in Part 1. For the right key, responding was overall a little more variable in the leaner Component 2 than in Component 1, but responding in neither component changed more rapidly than in the other. For the left key, change was consistently more rapid in the richer Component 1. In Part 2, response rate changed more for the richer component, relative to eventual change, in the first session or two.

This was clear, but transient, when VT 30-s or VT 120-s food was scheduled for blackouts. Accordingly, the present data offer little support for the conjecture that the variables that increase resistance to change in momentum theory have their effect by making responding change more slowly when disrupted.

However, it should be noted that the present conditions were not entirely suited to this analysis. Inspection of Figure 1 shows that eventual change for the richer component between the baseline condition (VI 120 s) and VI 400 s or VI 40 s was sometimes so small that the measure of short-term change relative to eventual change may have been uninterpretable. Larger changes in the schedule maintaining right-key responding may present a different picture. Alternatively, other measures of behavior (such as concurrent response allocation) may be better suited to analysis in these terms. Mazur (1992) recently studied the rate at which choice responding approached new asymptotic levels when reinforcement conditions were changed. The value of this analysis in the present context will have to await further experimentation, because neither the present conditions nor those of Mazur were appropriate to assess it in relation to behavioral momentum theory.

Because Herrnstein's (1970) steady-state analysis deals with our steady-state data (albeit only at an ordinal level), and our transition data generally showed the same differences between components as were found at steady state, it might appear that Equation 1 deals with behavior in transition as well. However, there are several results that are contradictory to Herrnstein's theory, which indicates that it does not suffice after all. First, Nevin et al. (1990) found that extinction and satiation in multiple concurrent schedules not only produced greater changes for a component with no alternative reinforcement, but also altered the ordinal relations among components in terms of response rates (their Figure 8). This is not consistent with Herrnstein's equation, because ordinal relations between components in terms of relative reinforcer rate should be unaffected. Second, Nevin (1992a) presented data showing that responding in a component was more sensitive to disruption when the alternating component was rich than when it was lean. Again, Herrnstein's equation predicts the opposite. These results suggest that

Fig. 8. Changes in response rate over the first 10 sessions of training in the presence of disruptors in Part 1 (upper and middle rows) and Part 2 (lower row). Changes for each disruptor are averages for the group, and are expressed as proportions of the change in rate that occurred between steady state in baseline and that obtained with the disruptor present. Thus, zero on the ordinate corresponds to the asymptotic rate in baseline, and 1.0 corresponds to the asymptotic rate reached under the disruptor.

existing steady-state models do not suffice and that it is likely to be useful to develop a separate analysis for behavior in transition.

To conclude, no generalization that is apparent to us is consistent with all of the data. Our main finding was that response rate was more, not less, resistant in the leaner component when the schedule maintaining respond-

ing was varied. This result in particular, and the general question of consistency across disruptors of ordinal relations in resistance to change, clearly represent a considerable challenge to the generality of behavioral momentum theory. It may be that the scale on which transitional data are studied should be revised. According to our reasoning, the appropriate

scale is the distance from baseline to a new steady state that is reached with the disruptor present. The steady-state results reported here indicate (a) that these distances differ between components as an orderly function of reinforcement and (b) that the ordinal relation between them will depend on the disruptor used. The role for a theory of behavior in transition is to characterize the rate at which responding in two components undergoes these changes, independently of the eventual magnitudes of change. The focus of future work on resistance to change should therefore be on short-term effects *relative to* eventual change, as was attempted with the present data. Although the analysis of our data in these terms was not encouraging, there are indications that such an approach might be fruitful. Responding disrupted by extinction generally shows that rate of change is not equal for richer and leaner components, and that responding in the leaner component changes more quickly. Thus, it seems clear that there are some conditions in which responses may vary in terms of the time taken for them to reach a new asymptotic level under changed conditions. Identifying the conditions that determine this feature of behavior may result in a more comprehensive generalization about behavioral resistance to change.

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APPENDIX

Responses per minute (B) and reinforcers per hour (R) on left and right keys in Components 1 and 2 and reinforcers per hour during intercomponent blackouts (BO). Data from all three parts of the research are given for all 4 birds, and are listed in the order subjects were exposed to conditions (see Table 1). For baseline conditions, data are averages over the last 10 sessions. For intervention conditions, data are averages over the last 10 sessions for Part 1 and the first 10 sessions for Parts 2 and 3. Standard deviations of response rates are given in parentheses.

Bird	BL1	BR1	BL2	BR2	RL1	RR1	RL2	RR2	BO
Part 1									
D1	64.1 (5.3)	11.5 (1.6)	23.3 (5.4)	32.6 (4.2)	80.1	21.4	15	27	0
	36.8 (4.1)	31.4 (3.1)	5.6 (2.0)	62.9 (6.3)	69.4	66.4	7.7	85.7	0
	59.7 (3.9)	7.9 (2.7)	14.0 (3.3)	34.5 (4.3)	85.7	19.3	12	27	0
	66.9 (3.4)	2.6 (0.7)	20.8 (4.0)	17.2 (3.7)	85.3	6.4	13.3	9.4	0
	60.7 (3.4)	6.7 (2.3)	15.6 (5.8)	25.5 (6.9)	82.7	19.7	14.6	23.1	0
	52.9 (2.6)	11.7 (2.6)	13.5 (3.7)	39.8 (5.5)	81.4	39.4	12.9	54.9	0
	51.8 (4.2)	7.9 (2.4)	9.1 (1.3)	36.4 (6.7)	83.1	20.1	11.1	24.4	0
	50.5 (4.7)	5.4 (1.5)	12.8 (5.1)	27.9 (6.4)	83.1	9.4	11.1	16.7	0
	51.7 (4.2)	6.8 (2.3)	15.2 (3.3)	30.2 (3.0)	83.1	18	14.6	24	0
	57.1 (2.2)	1.4 (0.6)	32.3 (5.7)	8.3 (2.8)	81.4	0	15.9	0	0
D2	136.4 (5.0)	29.8 (4.0)	59.5 (13.6)	81.7 (7.4)	84.9	22.7	13.7	27.4	0
	105.3 (5.9)	58.2 (4.7)	37.9 (7.5)	102.2 (8.7)	83.1	72.9	15.4	78.4	0
	123.9 (9.7)	36.2 (2.8)	47.2 (6.9)	82.7 (10.9)	85.7	28.3	12.9	25.7	0
	145.1 (4.7)	11.3 (3.0)	74.1 (14.1)	38.3 (6.6)	79.7	6.4	13.7	6.4	0
	125.1 (4.2)	27.1 (4.8)	65.1 (8.0)	64.9 (8.0)	83.6	25.3	15.4	23.1	0
	102.0 (7.3)	48.3 (4.5)	38.8 (6.1)	91.9 (5.8)	76.7	48.4	11.6	56.6	0
	125.4 (6.5)	25.6 (4.4)	54.7 (10.4)	71.4 (10.7)	84.4	25.3	12	23.1	0
	129.7 (4.7)	14.8 (3.5)	54.2 (11.5)	51.6 (7.8)	82.7	10.7	12	14.6	0
	120.8 (6.1)	26.8 (4.8)	41.0 (4.8)	77.2 (6.1)	80.1	21.9	11.1	30.9	0
	111.1 (7.1)	0.2 (0.4)	66.3 (13.2)	9.8 (5.0)	86.6	0	15	0	0
D3	92.7 (7.5)	30.4 (8.5)	11.6 (1.5)	70.1 (3.6)	84.4	21	10.3	24	0
	84.0 (5.5)	59.7 (6.6)	5.4 (2.6)	64.7 (4.7)	78.4	66.4	15.4	84	0
	92.6 (9.3)	30.2 (8.6)	14.2 (7.2)	53.7 (6.7)	82.7	21	10.3	28.3	0
	97.2 (4.5)	6.3 (4.3)	15.6 (3.4)	57.1 (8.5)	79.3	3.9	11.6	7.7	0
	85.2 (7.0)	20.6 (4.6)	7.6 (2.4)	64.1 (5.0)	82.7	16.3	9.4	30	0
	94.8 (6.5)	43.8 (5.1)	3.0 (0.8)	76.3 (3.8)	81.4	40.7	12.4	59.1	0
	102.5 (3.3)	28.1 (3.8)	10.0 (2.7)	74.9 (3.0)	83.1	23.6	10.7	29.6	0
	95.9 (5.9)	2.0 (4.1)	16.9 (3.7)	64.0 (6.5)	84.9	1.3	16.7	13.7	0
	86.8 (3.4)	21.4 (4.1)	7.4 (1.0)	64.3 (5.8)	83.1	21.9	15	30.4	0
	88.1 (6.0)	0.7 (1.2)	57.2 (11.0)	1.9 (2.3)	84	0	11.1	0	0
D4	90.4 (7.1)	14.4 (2.4)	15.8 (7.5)	45.7 (7.1)	82.7	19.7	14.6	27.4	0
	98.2 (9.4)	33.1 (6.9)	10.9 (3.6)	76.2 (7.2)	84.9	64.7	12.4	80.6	0
	114.9 (17.2)	14.3 (4.6)	18.1 (5.7)	49.3 (9.8)	83.6	17.6	14.1	26.6	0
	109.6 (4.0)	8.1 (3.0)	22.2 (2.8)	31.2 (4.9)	84.9	6	14.1	11.1	0
	87.3 (10.9)	14.6 (3.6)	10.1 (2.0)	31.6 (11.2)	81.9	23.6	12.0	28.7	0
	129.8 (7.5)	15.7 (4.8)	12.1 (3.3)	65.8 (7.9)	85.7	38.6	12.9	57.9	0
	139.2 (14.0)	15.8 (2.9)	19.4 (3.8)	62.8 (10.5)	85.3	27	16.3	28.7	0
	155.9 (8.1)	9.1 (2.8)	21.5 (6.3)	44.4 (7.5)	85.3	10.7	9.9	9.9	0
	134.2 (11.0)	10.5 (2.3)	19.4 (7.7)	45.8 (8.7)	82.3	20.6	13.7	25.3	0
	164.2 (6.2)	1.9 (1.1)	41.5 (11.5)	9.1 (6.1)	84	0	13.7	0	0
Part 2									
D1	57.1 (2.1)	1.3 (0.6)	32.8 (5.9)	7.3 (2.2)	83.1	0	15.4	0	0
	59.8 (2.7)	0.7 (0.7)	20.0 (6.2)	5.7 (2.1)	81	0	12	0	115.7
	62.7 (4.0)	0.4 (0.4)	44.9 (5.9)	2.1 (1.6)	86.1	0	16.7	0	0
	67.3 (4.3)	0.1 (0.1)	40.6 (6.7)	3.7 (1.7)	84.4	0	16.7	0	25.4
	70.3 (4.2)	0.1 (0.1)	56.5 (5.5)	0.4 (0.3)	87	0	13.3	0	0
	69.7 (4.2)	0.1 (0.1)	43.0 (5.4)	1.9 (1.4)	84.9	0	15.4	0	43.1
D2	75.2 (4.2)	0.1 (0.2)	56.2 (8.4)	0.1 (0.1)	83.6	0	10.3	0	0
	110.2 (6.6)	0.1 (0.1)	63.8 (9.6)	9.1 (4.6)	86.6	0	14.1	0	0
	111.3 (10.4)	0.3 (0.4)	29.2 (9.5)	1.8 (.18)	84	0	14.1	0	120.3
	109.8 (6.0)	0.1 (0.2)	56.2 (14.7)	1.5 (1.1)	84.4	0	13.7	0	0
	105.8 (7.2)	0	35.4 (7.3)	0.4 (0.8)	85.3	0	17.1	0	25.9

APPENDIX

(Continued)

Bird	BL1	BR1	BL2	BR2	RL1	RR1	RL2	RR2	BO
D3	107.0 (9.6)	0.1 (0.1)	63.6 (4.5)	2.2 (1.5)	85.3	0	16.3	0	0
	113.6 (6.3)	0	40.7 (8.7)	0.3 (0.4)	90	0	14.6	0	39
	103.2 (4.3)	0	51.4 (9.5)	0.3 (0.7)	89.6	0	12.4	0	0
	87.2 (4.4)	1.4 (2.2)	57.7 (10.7)	1.5 (2.3)	83.1	0	10.7	0	0
	85.3 (5.6)	1.5 (2.7)	29.7 (3.2)	0.4 (0.4)	81.4	0	14.6	0	113.1
	82.3 (4.4)	0	62.4 (6.8)	0.5 (0.8)	84.4	0	15.9	0	0
	81.3 (6.4)	0	57.0 (5.1)	0	81.0	0	15	0	27.7
	84.1 (5.3)	0	56.8 (5.0)	4.6 (5.3)	85.7	0	14.6	0	0
	73.0 (5.3)	0	51.0 (7.7)	0.4 (0.4)	82.3	0	16.3	0	39.9
	78.7 (4.4)	0	67.8 (7.8)	0.2 (0.4)	86.6	0	14.6	0	0
D4	163.7 (6.7)	1.8 (0.9)	42.0 (11.6)	7.9 (3.9)	84.4	0	14.1	0	0
	107.9 (16.3)	1.2 (1.3)	15.6 (6.4)	7.6 (4.7)	81.4	0	12.9	0	119.3
	152.2 (7.5)	0.3 (0.2)	29.4 (11.3)	4.5 (2.4)	87.4	0	14.1	0	0
	126.3 (11.0)	0.1 (0.2)	17.6 (6.6)	4.0 (3.1)	83.1	0	12	0	25.5
	140.6 (9.7)	0.2 (0.2)	55.8 (11.3)	3.0 (1.4)	84.9	0	15.9	0	0
	88.9 (12.9)	0.3 (0.2)	26.7 (5.5)	2.4 (1.0)	84	0	13.3	0	41.2
	129.6 (10.9)	0.3 (0.2)	42.2 (11.9)	1.4 (1.4)	84.4	0	17.6	0	0
Part 3									
D1	65.5 (3.7)	4.7 (1.2)	26.6 (4.1)	32.2 (4.6)	83.1	21	17.6	37.3	0
	62.1 (3.2)	8.1 (2.8)	20.3 (3.7)	25.4 (3.0)	86.6	24	12.9	36	116.7
	62.6 (3.7)	6.3 (1.8)	23.9 (2.6)	34.7 (3.9)	81.9	24.4	14.6	39	0
	59.2 (3.1)	6.1 (1.6)	17.6 (4.1)	34.5 (6.8)	81.4	24.9	12.0	36.9	27.6
	64.5 (2.8)	5.3 (0.7)	21.4 (3.4)	29.5 (1.6)	80.1	26.1	13.7	36.4	0
D2	97.6 (4.7)	35.9 (5.2)	42.8 (4.7)	72.8 (10.5)	85.7	38.1	14.6	35.6	0
	92.9 (6.7)	35.9 (3.8)	27.1 (4.5)	40.7 (8.0)	83.6	34.7	14.1	29.1	120.8
	104.2 (5.4)	31.4 (4.1)	46.9 (8.1)	72.7 (7.3)	85.7	38.6	14.6	38.1	0
	100.9 (3.3)	32.8 (6.1)	29.9 (3.3)	56.3 (9.4)	81.9	33	16.7	33.9	28.6
	94.1 (6.2)	31.7 (5.6)	40.2 (6.7)	69.9 (4.8)	84.9	32.6	12.9	37.7	0
D3	85.2 (4.6)	24.6 (8.6)	6.9 (2.2)	71.9 (5.2)	83.6	24.9	12	37.3	0
	69.6 (4.8)	29.0 (5.3)	10.6 (2.9)	47.9 (12.2)	81.4	32.1	13.3	39.4	117.2
	98.5 (4.3)	36.7 (3.3)	9.7 (1.9)	73.4 (5.8)	80.1	33.9	16.7	43.3	0
	99.6 (6.9)	41.2 (4.8)	6.3 (2.2)	72.3 (2.9)	82.7	34.7	9	41.1	25.4
	93.4 (5.0)	37.5 (3.7)	10.5 (1.9)	71.6 (5.8)	83.6	30.9	12.9	42.9	0
D4	122.7 (10.6)	17.3 (5.0)	17.8 (4.7)	35.8 (6.6)	81.9	31.3	10.7	38.1	0
	96.1 (7.1)	17.4 (5.9)	15.5 (3.0)	30.0 (7.5)	79.7	26.1	11.6	35.1	117.2
	126.9 (10.3)	16.5 (4.4)	13.5 (2.5)	37.8 (10.9)	84.9	28.3	9	38.6	0
	109.2 (11.4)	20.0 (4.5)	14.5 (4.4)	31.0 (3.6)	79.3	30	14.1	37.3	27.7
	123.1 (4.3)	18.1 (4.3)	20.5 (6.3)	52.2 (10.6)	81.4	33.4	15.9	36	0