*ACTION AT A TEMPORAL DISTANCE:
COMPONENT TRANSITION AS THE RELATIONAL
BASIS FOR SUCCESSIVE DISCRIMINATION*

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In a successive discrimination, red and green hues signaled component variable-interval schedules. The exponent of the power function relating ratios of responses in the red and green components to ratios of reinforcers provided a reinforcement-free measure of discrimination or stimulus control. Responses were recorded in successive 10-s subintervals of the 50-s components. The power-function exponent decreased systematically with increasing time since component transition in most conditions of five experiments. This reduction was not influenced by the absolute rate of reinforcement, consistent with the interpretation of the exponent as a measure of stimulus control. A reduction in the overall level of stimulus control by increasing the duration of response-produced keylight offset did not influence the decrease in discrimination with increasing time since component transition. The results support the conclusion that discriminative responding in successive discriminations is governed by several sources of stimulus control including delayed control by component transition.

Key words: successive discrimination, delayed stimulus control, sensitivity to reinforcement, multiple schedules, variable-interval schedules, key peck, pigeon

Successive discriminations raise the interesting question of action at a temporal distance in that behavior at one time is influenced by events occurring at another. Such events may include temporally distant reinforcers, as in schedule interactions or behavioral contrast (Williams, 1983), or stimulus events, as in procedures to study remembering (White, 1985a). In a simple successive discrimination, two discriminative stimuli such as red and green colors alternate in succession and independent reinforcement schedules are associated with each. The development of a response differential or discrimination is influenced by two sources of control: reinforcer and stimulus control. A response differential is unlikely in the absence of a reinforcer differential and is possible only under conditions of a stimulus difference. In general terms, the determinants of a discrimination are relational in that the effects of reinforcers and stimuli in one component are relative to those in the other (White, Pipe, &

McLean, 1984). When the stimulus or reinforcer differential is absent, the relativity is eliminated and the discrimination cannot be supported.

The relation between response and reinforcer differentials in successive discriminations or multiple schedules is best described as a power function (Lander & Irwin, 1968; McLean & White, 1983; McSweeney, Farmer, Dougan, & Whipple, 1986; Williams, 1983). In Equation 1, the ratio of responses in the two components, $B1/B2$, provides a measure of the response differential, and the ratio of reinforcers they produce, $R1/R2$, describes the reinforcer differential in the two components.¹ The exponent m of the power function quantifies the extent to which the response ratios vary with changes in the reinforcer ratios, and the constant q measures overall bias towards responding in one or the other component.

$$B1/B2 = q(R1/R2)^m. \quad (1)$$

The equivalent form of Equation 1 in terms

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¹ The power-function relation for multiple schedules (Lander & Irwin, 1968) should not be confused with the generalized matching law (Baum, 1974), which applies to concurrent schedules. In multiple schedules there is no choice between the two programmed reinforcement schedules; accordingly, it is not appropriate to speak of "matching," although the mathematical form of the power function is the same as for concurrent schedules (McLean & White, 1983).

of proportions shows that the traditional discrimination ratio, $B1/(B1 + B2)$, depends on the reinforcer differential. If the reinforcer differential is small, the discrimination ratio may also be small (depending on the value of m); if the reinforcer differential is large, the discrimination ratio is large, for the same value of m . In other words, if discrimination is measured by a response differential in a single condition with one reinforcer differential, the effect of stimulus disparity is confounded with the effect of the reinforcer differential.

We have previously argued that the value of the exponent m provides a measure of discrimination between the successively presented discriminative stimuli that is not confounded by the effect of the reinforcer differential (White et al., 1984). When $m = 0$, the response ratio remains constant over variations in the $R1/R2$ ratio, and there is no discrimination between the components. When $m = 1$, the response ratio follows the reinforcer ratio and discrimination is strong. The extent to which the reinforcer ratio determines the response ratio (or discrimination ratio) therefore depends on the value of m . White et al. (1984) showed that there was a hyperbolic relation between m and stimulus disparity. With small stimulus differences, values of m are small and increase with larger stimulus differences.

The value of m may be determined by a variety of factors in addition to stimulus disparity. Indeed, any measure of discrimination is relative and never takes an absolute value for a given difference on a stimulus dimension. The traditional measure of discriminability, d' , for example, is influenced by the disparity of the choice stimuli and whether the choice response is made in the presence of the discriminative stimuli (White, 1986). In successive discriminations, the availability of alternative reinforcers places a ceiling on the possible values of m (McLean & White, 1983). With low rates of alternative reinforcers, m remains low. Another possible candidate in successive discriminations is component duration, although there is little evidence that m is higher for shorter components (White, Pipe, McLean, & Redman, 1985; but see Williams, 1989). In the present study the variable of interest was time since component transition. Soon after component transition, m is

high (McLean & White, 1981) and stimulus disparity can influence m to a greater extent soon after component transition than later in the component (White et al., 1984).

The use of m as a measure of discrimination allows the separation of the effects of the various stimulus factors supporting a discrimination from the effects of the reinforcer differential. That is, m provides a measure of performance that describes the discrimination for a range of reinforcer differentials, analogous to the way that a measure of discriminability can be derived from the receiver operating characteristic in signal-detection theory for a range of false alarm rates. In the case of the receiver operating characteristic, a single measure, d' , describes discriminability independently of variation in false alarm rates (or response bias). In the case of performance in successive discrimination, the exponent m describes the discrimination independently of variation in the reinforcer ratio. That is, m does not depend on a specific reinforcer ratio but describes discriminative performance across a range of reinforcer ratios. Further, because the value of m is independent of the reinforcer differential, it could be appropriately described as stimulus discriminability.

White (1990) has argued that the temporally related decrement in discrimination reported for successive discriminations by McLean and White (1981) constitutes evidence for their relational basis. This effect is a reduction in the value of m for the function relating response ratios to reinforcer ratios (Equation 1) during the course of components. That is, at the beginning of components, response ratios vary considerably with changes in the ratio of reinforcers obtained by the responses in the two components as measured by the value of m in Equation 1. Towards the end of components, the response ratios vary to a lesser extent with change in the reinforcer ratio. The decrease in discriminability, m , with increasing time since the beginning of the component occurs reliably for different stimulus dimensions (McLean & White, 1981; White et al., 1984, 1985), although it seems less likely to occur with highly discriminable stimuli (Williams, 1988). Local behavioral contrast, in which absolute response rate in the richer component is initially high following the transition from

the leaner component (Williams, 1983), is a related effect in that the change in absolute response rate within one component reflects a change in discrimination. Local contrast is best described in terms of a change in the allocation between operant and extraneous behavior within each component (McLean, 1991). But in terms of discrimination, local contrast is a decrement in discrimination with increasing time since component transition, rather than an enhancement of the discrimination soon after component transition.

White (1990) showed that the high values of m at the beginning of components were the result of strong stimulus control by the transition between the component stimuli, and that the decrease in values of m with increasing time since component transition reflected the diminishing effect of delayed control by the component transition. When the transition was eliminated by replacing red or green discriminative stimuli at the end of the preceding component with the same white stimulus in both components, the discrimination was reduced. The present experiments further examine the possibility that the component (red or green) transition exerts delayed stimulus control over responding later in the component by incorporating blackouts between the components in order to separate them temporally. Because the interpretation of the changes in m over the course of the component in terms of delayed stimulus control relies on the validity of m as a reinforcement-free measure of discrimination, the first experiment asked whether m was a function of reinforcement effects.

EXPERIMENT 1

The interpretation that the exponent m of the power function in Equation 1 provides a measure of discrimination or perhaps stimulus discriminability relies on its independence from the reinforcer differentials that maintain discriminative responding. In relation to response ratios, this independence is a matter of definition in terms of Equation 1. The aim of Experiment 1 was to check the independence of m in relation to another major attribute of the reinforcement schedule, namely absolute reinforcement rate. Over 15 different conditions, reinforcer ratios were varied in such a way that overall totals provid-

ed lean, medium, or rich absolute reinforcement rates. In addition, response frequencies were recorded at different stages during the component in order to measure changes in m as a function of time since component transition. An interaction between changes in m since component transition and absolute reinforcement rate would require reconsideration of the notion that m provides a reinforcement-free measure of discrimination.

METHOD

Subjects

Subjects were 4 adult homing pigeons with extensive prior histories of multiple-schedule performance. Each bird was maintained at 85% of its free-feeding body weight. Grit and water were available in the stainless steel living cages, and supplementary feeding with mixed grain ensured maintenance of the prescribed weights. Daily sessions were conducted for each bird unless its weight was outside ± 10 g of the prescribed weight.

Apparatus

A black-painted sound-attenuating chamber, 32 cm wide, 35 cm deep, and 29 cm high, contained an interface panel with a single centrally mounted response key. The Plexiglas response key was 2.8 cm in diameter and 22 cm from the grid floor. An area in the center of the dark key (0.5-cm square) could be illuminated by red or green light. Each effective response required a force of approximately 0.15 N to close a reed relay mounted behind the key and produced a 50-ms offset of the keylight. A central hopper opening below the response key provided 3-s access to wheat. There was no houselight. When wheat was available the keylight was darkened and the hopper was illuminated by white light. Experimental events were controlled and recorded by an Intel® 486-based microcomputer with MED-PC® software and interfacing in an adjacent room.

Procedure

In the standard procedure, components that were 50 s in duration alternated in strict succession. In each session, 24 components signaled by red alternated with 24 components signaled by green. Components were separated by blackouts of 0.2-s duration, during which the keys were dark and responses

Table 1

Values (in seconds) for multiple VI VI schedules and number of sessions required by each bird to satisfy the stability criterion in Experiment 1. Condition numbers are in order of conduct across Experiments 1, 2, 4, and 5.

Condi- tion			Bird			
			J1	J2	J4	J5
Rich reinforcer rate						
32	VI 100	VI 20	34	37	39	39
33	VI 20	VI 100	28	33	35	33
34	VI 60	VI 30	40	32	28	26
35	VI 30	VI 60	34	39	36	35
36	VI 40	VI 40	43	30	26	26
Medium reinforcer rate						
37	VI 200	VI 40	37	53	30	45
38	VI 40	VI 200	38	29	32	38
39	VI 120	VI 60	32	36	31	28
40	VI 60	VI 120	25	28	25	26
41	VI 80	VI 80	33	54	25	37
Lean reinforcer rate						
42	VI 300	VI 60	27	33	25	35
43	VI 60	VI 300	37	38	27	25
44	VI 180	VI 90	36	30	25	29
45	VI 90	VI 180	30	46	34	28
46	VI 120	VI 120	34	27	34	26

were ineffective. When the key was red, responses were followed by reinforcers according to one variable-interval (VI) schedule; when the key was green, responses were followed by reinforcers according to another independent VI schedule. The VI schedules were constructed from a constant-probability progression with 12 intervals. Reinforcers arranged in a component but not obtained by the end of the component were canceled. (As shown by the tables of response and reinforcer frequencies in Appendix A, the consistently high response rates throughout the present experiments resulted in very few instances in which reinforcers were not collected as soon as they were available.)

Three sets of five conditions were arranged, with a range of reinforcer ratios in each. Table 1 shows the nominal values of the VI schedules for each condition. In the first set of five conditions, the VI schedules arranged reinforcers frequently (rich rate). For these particular conditions, the session duration was halved and 24 rather than the usual 48 components were completed per session to avoid excessive weight gain. In the second set of five conditions, the absolute reinforcement rate was medium, and for the third set

it was lean. For these last 10 conditions, each session comprised 48 components. The pairs of VI schedules in each set of conditions were chosen to keep reinforcer totals per session approximately constant. Averaged over the five conditions in a set, mean obtained reinforcer rates closely approximated arranged rates and were 92 reinforcers per hour for the rich schedules, 46 reinforcers per hour for the medium schedules, and 32 reinforcers per hour for the lean schedules.

Table 1 gives the order in which each of the conditions was conducted and the number of sessions completed by each bird. All of the conditions in Experiment 1 were conducted (in the order indicated in Table 1) following the last condition reported in Experiment 4. For each bird, a condition continued on a daily basis until a stability criterion was satisfied. The criterion was that each condition should be conducted for at least 25 sessions and until the stage at which, in each of five consecutive sessions, responses in the richer component as a proportion of total responses did not exceed $\pm 5\%$ of the mean response proportion for the five sessions. The response totals for these last five sessions provided the basis for data analysis and, because of the application of the stability criterion, showed very little variance from day to day over the last 5 days per condition.

RESULTS AND DISCUSSION

Analyses for individual birds were based on total response frequencies in each of the 10-s subintervals in each component and on total reinforcer frequencies obtained in each component (Appendix A). These frequencies were summed over the last five sessions per condition, separately for each component (red and green), and represent stable performance. With consistently high response rates over components in the different conditions, reinforcers obtained in the consecutive 10-s subintervals closely approximated the frequencies arranged by the constant-probability VI schedules. However, total reinforcers over the whole component were used in the analyses because reinforcers within component subintervals tended to vary unsystematically when summed just over the last 5 days, especially for the lean schedules. When analyses were conducted using reinforcer frequencies obtained in component subintervals, the

standard errors of the estimate of best fitting straight lines increased (owing to an increase in x -axis error variance), but the slopes of the lines were not systematically different from the slopes of lines based on the more stable estimates of reinforcer totals over whole components. The following analyses therefore used reinforcer totals for whole components rather than frequencies partitioned by component subinterval.

The data for a set of five reinforcement conditions were used to assess discriminability as measured by the exponent m in Equation 1. The logarithmic form of Equation 1 is a straight line with slope m and intercept $\log q$. That is,

$$\log(B1/B2) = m \log(R1/R2) + \log q. \quad (2)$$

Logarithms (base 10) of the ratios of responses, $B1/B2$, in each of the 10-s component subintervals were plotted as a function of the logarithms (base 10) of the ratios of reinforcers in the two components, $R1/R2$. Straight lines were fitted to these functions using the method of least squares. The fits of Equation 2 to the data were in all cases excellent, as indicated by the small values of the standard error of the estimate. The excellent fits of Equation 2 verify the power function as a satisfactory description of the relation between response ratios and reinforcer ratios in successive discriminations.

Figure 1 shows that for each of the three sets of reinforcement conditions the change in log response ratios as a function of the change in log reinforcer ratios was greatest in the first 10-s subinterval of the components and decreased systematically across the subintervals. These changes are most clearly summarized by the slopes of the best fitting straight lines, m . Values of m are given as the first of the three numbers adjacent to each function in Figure 1. The value for $\log q$ is the second, and the standard error of the estimate is the third. For each bird and for all three sets of conditions, the value of m was the highest for the first 10-s subinterval. There were no systematic changes in $\log q$, which approximated zero in all cases.

Figure 2 summarizes the changes in the values of m for each bird and shows that there were no systematic differences in the function relating m to component subinterval for the rich, medium, and lean reinforcement-rate

conditions. In all three cases, however, it is clear that discrimination was strongest in the first 10 s since component transition and decreased systematically with increasing time since component transition.

The result summarized in Figure 2 confirms the time-related decrement in discriminability over the course of the component reported in previous studies (McLean & White, 1981; White, 1990; White et al., 1984, 1985). For all three sets of reinforcement-rate conditions, discrimination, as measured by the exponent m of the power function relating response ratios to reinforcer ratios, was highest in the first 10 s of components and decreased systematically with increasing time since component transition. The bottom panel in Figure 2 shows values of m averaged over the 4 birds and clearly indicates that means for both the overall levels of discrimination and the change in m within the components were the same for the rich, medium, and lean absolute reinforcement-rate conditions. The result of Experiment 1 therefore confirms the assumption that m is independent of both relative and absolute reinforcement rate. Because m is a single number describing performance as represented by the functional relation between response and reinforcer ratios, it is used here as a useful higher order measure of discriminative performance. Data from the five reinforcer-ratio conditions per fitted function were collected from at least 125 sessions for each bird, and the very close fit of data points to the straight lines in Figure 1 shows high replicability of the functional relation. The single measure m that summarizes discriminative performance over all five conditions is therefore very reliable.

EXPERIMENT 2

White (1990) reported a reduction in m for the first subinterval of components in a successive discrimination when the stimulus in the last subinterval of the preceding component was the same for both components. That is, in the last quarter of the component the discriminative stimulus changed from green to white and from red to white. The red-to-green or green-to-red component transition was thus eliminated, although the VI schedules remained in effect throughout the whole components and component transitions were

Fig. 1. Logarithms (base 10) of response ratios in successive subintervals of components plotted as a function of logarithms of ratios of reinforcers obtained in the components for (a) rich, (b) medium, and (c) lean conditions in which absolute reinforcer rates averaged 92, 46, and 32 reinforcers per hour, respectively. Values for the slope (m), intercept ($\log q$), and standard error of the estimate are given for each best fitting straight line.

signaled by changes from white to red or white to green. The results of this and similar procedures in which the component transition was altered were interpreted as showing delayed control by the component transition over responding within the successive components. In terms of relational theories of discrimination, the opportunity for "stimulus comparison" is said to be an important factor (Lashley & Wade, 1946; Lawrence, 1963; Mackintosh, 1974). White (1990) concluded that the stimulus relation in question is the transition between the component stimuli.

Because the component transition requires temporal proximity of the discriminative stim-

uli, disruption of the relation by interpolating a blackout between components should attenuate delayed control by the component transition. A previous study in which local contrast was eliminated by the introduction of longer blackouts between VI and extinction components (Mackintosh, Little, & Lord, 1972) offers support for this possibility, but it has yet to be directly tested. In Experiment 2, the effect of interpolating 10-s blackouts between components was compared to a condition nominally with no blackout (a 0.2-s blackout), using the procedure for the medium reinforcement-rate conditions of Experiment 1.

Fig. 1. Continued.

METHOD

The subjects, apparatus, and procedure were the same as in Experiment 1, with the exception that each effective response did not produce a 50-ms offset of the keylight. Experimental events were controlled and recorded by a PDP® 11/23 computer running SKED® software. Two sets of conditions were arranged. Both sets included the four pairs of differential VI schedules with the medium absolute reinforcement rate used in Experiment 1, and the first set included a nondifferential condition (Table 2). The procedure for the first set of five conditions included 0.2-s blackouts between the 50-s components, and for the second set the procedure included 10-s blackouts between consecutive com-

ponents. During blackouts the chamber was dark and responses were not effective. The same stability criterion was used as in Experiment 1. Table 2 gives the order of conditions and the number of sessions conducted for each bird in each condition.

RESULTS AND DISCUSSION

Data were analyzed in the same way as in Experiment 1, separately for the 0.2-s and 10-s blackout conditions (Appendix A). Logarithms of ratios of responses in 10-s subintervals of the two components were plotted as a function of logarithms of ratios of reinforcers obtained in the two components. Equation 2 was fitted to these functions using least squares regression. The data and fitted func-

Fig. 1. Continued.

tions for the different subintervals in the two sets of conditions are not shown here but were very similar to the functions in Figure 1. Standard errors of the estimate were small, and values of $\log q$ approximated zero. The only differences between the functions relating response and reinforcer ratios in Experiment 2 and those in Experiment 1 were in the slopes of the functions, as summarized in Figure 3. Figure 3 shows that for Birds J2, J4, and J5, values of m for the 0.2-s blackout condition decreased with increasing time since component transition in exactly the same way as in Experiment 1. For Bird J1, m increased across the component. The functions for the 10-s blackout condition decreased across the component for Birds J1, J4, and J5, but in-

creased markedly for Bird J2. For all birds, the value of m in the first 10-s subinterval of the component was higher for the 0.2-s blackout condition than for the 10-s blackout condition. This result was due to a greater response differential at the beginning of components for the 0.2-s condition than for the 10-s blackout condition. Otherwise, overall absolute response rates for the different blackout duration conditions were very similar, as illustrated in Figure 4 by response rates for VI 40 and VI 200 components of Condition 13 (0.2-s blackout) and Condition 18 (10-s blackout).

Interpolation of a blackout between components resulted in a reduction in discrimination between the components, as measured

Fig. 2. Values of discrimination, m , estimated by the slopes of straight lines that best described the relation between logarithms of response ratios and logarithms of reinforcer ratios (Equation 2) for successive subintervals of the components in rich, medium, and lean reinforcer-rate conditions of Experiment 1.

Table 2

Values (in seconds) for multiple VI VI schedules and number of sessions required by each bird to satisfy the stability criterion in Experiment 2. Condition numbers are in order of conduct across Experiments 1, 2, 4, and 5.

Condi- tion	Bird			
	J1	J2	J4	J5
0.2-s blackout				
13 VI 40 VI 200	29	26	29	23
14 VI 200 VI 40	36	33	25	30
15 VI 60 VI 120	28	24	26	23
16 VI 120 VI 60	47	27	29	28
17 VI 80 VI 80	33	37	22	31
10-s blackout				
18 VI 40 VI 200	29	28	27	48
19 VI 200 VI 40	35	28	26	36
20 VI 60 VI 120	31	30	40	40
21 VI 120 VI 60	25	25	26	24

by the exponent m of the power function relating response ratios to reinforcer ratios. This result provides further evidence that increasing the temporal separation of the discriminative stimuli signaling the components of a successive discrimination attenuates the effect of the component transition on discriminative behavior. That is, delayed stimulus control by the component transition is attenuated by separating the components by a blackout.

There were two instances in Experiment 2 in which m increased with time since component transition, instead of decreasing as it did in Experiment 1 and in prior studies (McLean & White, 1981; White et al., 1984). Such an increase has been reported by Williams (1988), who suggested that with highly discriminable stimuli the response differential may increase in anticipation of the next component. The increase in m over the component in the 10-s blackout condition for Bird J2 was consistent with absolute response-rate changes over the component. In the VI 40 VI 200 condition (Condition 18), Bird J2's absolute response rate in the VI 40-s component increased from 71 responses per minute in the first 10-s subinterval to 81 responses per minute in the last 10-s subinterval. At the same time, response rate decreased in the VI 200-s component from 27 responses per minute in the first 10-s subinterval to 13 responses per minute in the last subinterval. The decrease in m over the course of the

Fig. 3. Values of discrimination, m , for successive subintervals of components in 0.2-s blackout and 10-s blackout conditions of Experiment 2.

Fig. 4. Absolute response rates in VI 40-s (open symbols) and VI 200-s (filled symbols) components of Condition 13 (0.2-s blackouts; circles) and Condition 18 (10-s blackouts; triangles) of Experiment 2.

component has been interpreted by White (1990) in terms of delayed control by component transition and is inconsistent with the possibility of stimulus control by the transition into the impending component. The value of m for the last 10-s subinterval in the 10-s blackout condition for Bird J2 represents a large response differential, however, and given the implausibility that the preceding component transition was influential, raises the question of the source of the discriminative stimulus control.

EXPERIMENT 3

Local contrast refers to a higher response rate at the beginning of the richer component and, assuming constant or increasing response rates across the leaner component, contributes to the high values of m at the beginning of components. Williams suggested that "local contrast might . . . persist when the two discriminative stimuli share many features in common" (1988, p. 207). In Experiment 1, each response was followed by a 50-s offset of the keylight, a procedural feature introduced to minimize proprioceptive stimulus control (White, 1985b). With such feedback, the topography of a single response is clearly differentiated and the brief and rapid responses purportedly under proprioceptive control are eliminated. The result, however, is that a large proportion of the time in a component is spent in the presence of the dark key in both components. That is, the 50-ms periods of dark key are common to both the discriminative stimuli, and exteroceptive stimulus control may be reduced. In Experiment 2, each response was not followed by offset of the keylight. The stimuli in Experiment 2 may therefore have been more discriminable overall than those in Experiment 1. Indeed, the values of m in Experiment 2 were higher overall than those in Experiment 1. Experiment 3 was therefore designed to ask the procedural question of whether response-produced periods of keylight offset attenuate stimulus control. In order to examine such an effect, a standard response-produced keylight offset of 40 ms was compared to a much longer offset duration of 1 s.

METHOD

Subjects

Subjects were 4 adult homing pigeons (2 female) with prior histories of delayed matching-to-sample and multiple-schedule performance. They were between 8 and 11 years of age at the beginning of the experiment. They had not participated in Experiments 1 or 2. A 5th bird (15 years old) died following the first set of conditions. The birds were maintained at 85% of their free-feeding weights. Daily sessions were conducted for each bird unless its weight was outside ± 10 g of the prescribed weight. Grit and water were available in the living cages, and supplementary feeding with mixed grain ensured maintenance of the prescribed weights.

Apparatus

A matte black experimental chamber (32 cm wide, 35 cm deep, and 29 cm high) contained an interface panel with a centrally mounted response key. The normally closed switch of the key could be operated with a minimum force of 0.15 N. The key could be illuminated with light having peak wavelengths of 506 nm (blue-green) and 576 nm (yellow), produced by Kodak Wratten filters mounted in an in-line display behind the key. The key was 1.8 cm in diameter. A central hopper opening below the response key allowed 3-s access to wheat, at which time the hopper opening was illuminated and the keylight was dark. There was no houselight. Experimental events were controlled and recorded by a PDP® 11/23 computer running SKED® software, located in an adjacent room.

Procedure

The procedure and stimulus conditions for the first set of conditions were similar to those reported by White (1990). Daily experimental sessions consisted of 48 60-s components separated by 0.1-s blackout periods. Components during which the key was illuminated yellow directly alternated with components in which it was illuminated blue. Responses intermittently produced 3-s access to wheat according to independent constant-probability VI schedules in each component. Responses and reinforcers were recorded in consecutive 15-s quarters of each component. A reinforcement condition was conducted for

Table 3

Values (in seconds) for multiple VI VI schedules and number of sessions required by each bird to satisfy the stability criterion in Experiment 3. Condition numbers are in order of conduct.

Condi- tion	Bird					
	F1	F2	F3	F4	F5	
40-ms keylight offset						
1	VI 40	VI 200	30	33	31	28
2	VI 200	VI 40	26	24	22	26
3	VI 60	VI 120	29	32	23	32
4	VI 120	VI 60	22	29	34	34
5	VI 80	VI 80	25	21	30	29
1-s keylight offset						
6	VI 80	VI 80	25	25	27	30
7	VI 200	VI 40	40	37	33	28
8	VI 40	VI 200	35	26	27	31
9	VI 120	VI 60	32	28	33	25
10	VI 60	VI 120	25	25	25	25

at least 20 sessions and until the stability criterion used in Experiment 1 was satisfied. Table 3 shows the numbers of sessions conducted for each bird and the order of conditions. There were two sets of reinforcement conditions, with the same pairs of VI schedules as those used for the medium rate VI schedules in Experiment 1 (Table 3). In the first set of five conditions, each response in both components was followed by a 40-ms offset of the keylight. In the second set of five conditions, each response was followed by a 1-s offset of the keylight.

RESULTS AND DISCUSSION

Response frequencies in successive quarters of each component and reinforcer frequencies in whole components were summed over the last five (stable) sessions of each condition (Appendix B). Performance in the conditions with response-produced 40-ms keylight offset was generally similar to performance of the different birds in Experiment 1. Absolute response rates in the conditions with the 1-s keylight offset were reduced by a factor of at least 2 compared to the 40-ms conditions. This change is illustrated in the response frequencies summed over whole components for Bird F1 in Table 4. The highest response rate for Bird F1 in the 1-s conditions was about 45 responses per minute in a VI 60-s component (taking reinforcer duration into account), about half of that in the

Table 4

Response and reinforcer frequencies in Components S1 and S2 for Bird F1 summed over the last five sessions of each condition in Experiment 3.

Condition		Reinforcer totals		Response totals	
S1	S2	S1	S2	S1	S2
40-ms keylight offset					
VI 80	VI 80	85	81	12,427	12,463
VI 40	VI 200	173	36	17,813	10,858
VI 200	VI 40	33	177	8,956	11,868
VI 60	VI 120	111	55	14,121	9,284
VI 120	VI 60	56	111	11,104	12,106
1-s keylight offset					
VI 80	VI 80	91	93	4,718	4,684
VI 40	VI 200	165	26	5,061	4,793
VI 200	VI 40	36	174	4,824	5,058
VI 60	VI 120	115	53	5,196	5,100
VI 120	VI 60	58	109	5,140	5,068

equivalent component in the 40-ms condition. Table 4 indicates that the marked reduction in response rate did not influence the rate of obtained reinforcers. The rate of obtained reinforcers was close to the arranged rate and was approximately the same for equivalent reinforcement conditions in the 40-ms and 1-s keylight-offset conditions.

Logarithms of the ratios of responses in successive quarters of the two components are plotted in Figure 5 as a function of logarithms of obtained reinforcer ratios. Least squares fits of Equation 2 to these data, shown as straight lines in Figure 5, were generally excellent with small standard errors of the estimate. Values of log *q* for the best fitting functions approximated zero. The result of major interest is the change in the slopes of the functions (*m*) across consecutive quarters of the components and the difference in slopes between the 40-ms and 1-s keylight-off-set conditions. Figure 5 shows that for each bird the steepest function was in the first quarter of the component. Values of *m* (the first of the three numbers next to each fitted line in Figure 5) were highest in the first quarter. The reduction in slopes across successive quarters is very clear for Bird F5 who did not complete the second set of conditions. Slopes of functions for the 1-s conditions were very flat, indicative of minimal stimulus control. For each bird, however, values of *m* were highest in the first quarter.

Fig. 5. Logarithms of response ratios as a function of logarithms of reinforcer ratios in successive quarters of components in conditions with (a) 40-ms response-produced keylight offset and (b) 1-s response-produced keylight offset in Experiment 3. Values of the slope (m), intercept ($\log g$), and the standard error of the estimate are given for each best fitting straight line (Equation 2).

Fig. 6. Values of discrimination, m , for successive subintervals (quarters) of components in conditions with 40-ms response-produced keylight offset and 1-s response-produced keylight offset in Experiment 3.

Figure 6 summarizes the changes in m for the birds that completed both sets of conditions. The reduction in m across the component is evident for both 40-ms and 1-s keylight-offset conditions and is consistent with

the result of Experiment 1. The clearest difference in Figure 6 is in the overall levels of m for the two sets of conditions, with markedly lower values of m when responses were followed by 1-s keylight offset.

This result is not an artifact of calculating response rates without taking into account the time in a component occupied by the response-produced periods of keylight offset. Typically, the whole component is used as the time base because it is the time available for a response to occur. Even if a response takes some time to execute (e.g., a treadle press), response duration is not usually subtracted from the time base. Subtracting the 40-ms or 1-s keylight-offset periods from the time base for the present data, however, did not alter the result. For example, the values of m for Bird F1 (Figure 6) for consecutive subintervals were .48, .23, .19, and .16 for the 40-ms offset condition and .03, .03, .02, and .01 for the 1-s offset condition. With offset periods subtracted from the time base, the corresponding values of m were .46, .23, .21, and .14 for the 40-ms offset condition and .10, .10, .07, and .04 for the 1-s offset condition. The different time base is not expected to alter the conclusion, of course, because with generally similar response rates in each component, about the same amount of time is subtracted from the time base for each component.

The result of Experiment 3 confirms Williams's (1988) suggestion that component stimuli become less discriminable when they share more features in common. In the present case, when both stimuli included relatively long dark-key periods, stimulus control was considerably weakened. It is nonetheless of interest that even with reduced stimulus control, discrimination in the first quarter of components was proportionally higher than later in the component, consistent with the notion that component transition exerts delayed control over discriminative responding in the first part of the component.

In Experiment 1, reduction in overall reinforcement rate did not change the decrease in m with increasing time since component transition. In Experiment 3, overall reinforcement rate remained unchanged between the two sets of keylight-offset conditions, but there was a marked reduction in overall response rate. The reduced response rate did

not affect the decrease in m over the course of the component, although the overall effect was attenuated and stimulus control was markedly reduced.

EXPERIMENT 4

Instances in Experiment 2 in which m increased with increasing time since component transition were consistent with similar instances reported by Williams (1988) for highly discriminable stimuli. The result of Experiment 3 confirms the supposition that the stimuli in Experiment 2, in which responses were not followed by keylight offset, were more discriminable than in Experiment 1, in which a 50-ms keylight offset followed each response. The reduction in discriminability that results from inclusion of response-produced keylight offset may interact with the discriminability changes (m) that occur across the course of the component. The question asked in Experiment 2—namely, does interpolation of a blackout between components decrease delayed control by component transition—was asked again in Experiment 4, but with the inclusion of the same 50-ms keylight offset after each response that was used in Experiment 1.

METHOD

The subjects, apparatus, and procedure were identical to those in Experiment 2. Table 5 summarizes the order of conditions and the number of sessions completed in each condition by each bird. Each condition was conducted for at least 24 sessions and until the stability criterion used in Experiment 1 was satisfied. The pairs of VI schedules were those used for the medium reinforcement-rate conditions in Experiment 1. Five pairs of VI schedules with 0.1-s blackouts separating components included an additional VI 200 VI 40 condition but omitted the nondifferential VI 80 VI 80 condition. Five pairs of VI schedules with 10-s blackouts separating components included the nondifferential reinforcement-rate condition (Table 5). As in the preceding experiments, data analyses were based on response and reinforcer frequencies summed over the last five sessions of each condition (Appendix A).

Table 5

Values (in seconds) of multiple VI VI schedules and number of sessions required by each bird to satisfy the stability criterion in Experiment 4. Condition numbers are in order of conduct across Experiments 1, 2, 4, and 5.

Condi- tion	Bird			
	J1	J2	J4	J5
0.1-s blackout				
22 VI 200 VI 40	29	27	26	27
23 VI 40 VI 200	24	24	24	24
24 VI 200 VI 40	24	26	28	28
25 VI 60 VI 120	28	27	26	25
26 VI 120 VI 60	31	28	25	27
10-s blackout				
27 VI 40 VI 200	25	25	25	25
28 VI 120 VI 60	30	38	25	27
29 VI 60 VI 120	31	32	32	28
30 VI 200 VI 40	31	25	29	31
31 VI 80 VI 80	37	34	25	37

RESULTS AND DISCUSSION

Logarithms of ratios of responses in consecutive 10-s subintervals of components were plotted as a function of logarithms of ratios of reinforcers obtained in components, in the same manner as in Experiment 1. (The replicated data points in the first set of conditions corresponded very closely.) Equation 2 was fitted to these data points using least squares regression. These data and the fitted functions are not shown here but were very similar to those in Figure 1 in that standard errors of the estimates for the fits were small and values of $\log q$ approximated zero. The functions systematically differed only in the slopes (m) of the best fitting straight lines. These slopes are summarized in Figure 7, which shows that for Birds J1, J2, and J5 introduction of the 10-s blackout between components resulted in both an overall reduction in m and a reduction in m in the first 10-s subinterval. Comparison of the mean values of m in the bottom panel of Figure 7 to those for Experiment 2 in the bottom panel of Figure 3 shows that the overall pattern of change in m across the component with and without blackouts was the same in both experiments. Values of m in Experiment 4, in which keylight offset followed responses, were smaller than in Experiment 2 for each bird. This comparison is consistent with the result of Experiment 3 in that discriminability was lowered as a result of response-produced keylight

Fig. 7. Values of discrimination, m , for successive subintervals of components in conditions with 0.01-s and 10-s blackouts in Experiment 4.

offset. Otherwise, the general similarity between the results of Experiment 2 and 4 suggests that the nature of the change in m with increasing time since component transition does not interact with the overall level of discrimination.

EXPERIMENT 5

The main conclusion from the results of Experiments 2 and 4 is that interpolating a blackout between components decreases discrimination in the first part of the compo-

nent. That is, delayed control by the component transition is attenuated by the temporal separation of the components. Further, the reduction in m over the course of the component does not interact with the overall discrimination. Williams (1988), however, reported instances in which m increased with increasing time since component transition, consistent with control by the impending component transition rather than delayed control by the preceding transition. In Experiments 2 and 4 there were also instances of such "anticipatory" effects for Birds J1 and J2 that may have obscured the effect of blackout duration. In Experiment 5, therefore, blackout duration was varied over a wider range of values.

METHOD

The subjects and apparatus were the same as those in Experiment 2 except for the discriminative stimuli. In the preceding experiments, these were small squares of red and green light in the center of the response key (2.8 cm diameter) dimmed by the addition of a 0.8 neutral density filter. For Experiment 5, the light was brightened by removing the neutral density filter and allowing the light to occupy the entire surface of the key. Responses were not followed by brief periods of keylight offset. Three sets of four reinforcement conditions were conducted, using the medium reinforcement-rate conditions of Experiment 1 (Table 6). For the first set, the between-component blackout duration was 10 s, for the second set it was 0.2 s, and for the third set it was 50 s. In the conditions with the 50-s blackout, each session consisted of 28 components instead of the usual 48 components. Each condition was conducted for at least 20 sessions and until the stability criterion used in Experiment 1 was satisfied. Bird J5 did not complete the 50-s blackout condition with the VI 60-s VI 120-s schedules because of a chipped beak. Table 6 gives the order of conditions and the numbers of sessions completed by each bird. Data analyses were based on response and reinforcer frequencies summed over the last five sessions per condition (Appendix A).

RESULTS AND DISCUSSION

Equation 2 was fitted to logarithms of ratios of responses in successive 10-s subintervals of

Table 6

Values (in seconds) of multiple VI VI schedules and number of sessions required by each bird to satisfy the stability criterion in Experiment 5. Condition numbers are in order of conduct across Experiments 1, 2, 4, and 5.

Condi- tion			Bird			
			J1	J2	J4	J5
0.2-s blackout						
1	VI 60	VI 120	33	32	28	33
2	VI 120	VI 60	36	24	32	29
3	VI 40	VI 200	27	25	28	26
4	VI 200	VI 40	27	27	23	22
10-s blackout						
5	VI 60	VI 120	25	32	21	25
6	VI 120	VI 60	26	30	32	24
7	VI 40	VI 200	32	24	27	31
8	VI 200	VI 40	34	35	27	41
50-s blackout						
9	VI 40	VI 200	33	30	31	31
10	VI 200	VI 40	35	22	34	20
11	VI 60	VI 120	25	27	22	—
12	VI 120	VI 60	20	25	22	24

components plotted as a function of logarithms of ratios of reinforcers obtained during components, as in Experiment 1. Again, both the data and the fitted functions (not shown here) were very similar to those in Figure 1, with very small standard errors and values of $\log q$ approximating zero. Figure 8 summarizes the slopes of the best fitting straight lines (m) for the different conditions. Compared to the data reported above, several features are apparent. First, m in the first 10-s subinterval was higher for the 0.2-s than for the 10-s blackout conditions for Birds J1 and J4 but did not differ for Birds J2 and J5. The effect of blackout on m was therefore attenuated under the stimulus conditions of Experiment 5. For each bird, the values of m for the 10-s blackout condition were very similar to those in Experiment 2, but the values of m for the 0.2-s condition were lower than in Experiment 2. Second, in the first subinterval m was clearly reduced in the 50-s blackout condition, consistent with the effect of temporally separating components on control by component transition. Third, the 0.2-s and 10-s blackout functions for Birds J1 and J2 increased in the manner described by Williams (1988). For these functions, the largest difference in m occurred at the end of the component, consistent with the notion advanced

Fig. 8. Values of discrimination, m , for successive subintervals of components in conditions with 0.2-s, 10-s, and 50-s blackouts in Experiment 5.

by Williams of control by the following component. However, the difference is not large and may not be reliable.

With a 50-s blackout, there was a clear reduction in m soon after component transition, thus supporting the results of Experiments 2 and 4. Further, in the 50-s condition m decreased with increasing time since component transition, consistent with the general result of Experiment 1. Williams (1988) has suggested that such a decrement might require generally low levels of discriminability. At the beginning of the components, the values of m for the 0.2-s blackout condition were generally lower than the values of m for the corresponding condition in Experiment 2. The stimulus conditions of Experiment 5 may therefore have resulted in attenuated discriminability.

GENERAL DISCUSSION

The present experiments sought confirmation that discriminative behavior in successive discriminations is under delayed control by the stimulus transition between components. In Experiments 2, 4, and 5 the transition was weakened by interpolating a blackout between components. The main result was a reduction in discrimination soon after component transition, as measured by smaller values of the exponent m of the power function relating response ratios to reinforcer ratios. In general, the longer the blackout, the greater the reduction in m , relative to m for the discrimination later in the component. The result confirms the earlier conclusion that the time-related decrement in discrimination is under delayed control by the stimulus transition (White, 1990).

The present data indicate that several factors may influence stimulus control in successive discriminations. In a previous study (White, 1990) the discrimination was influenced by both the prevailing stimulus and delayed control by the component transition. The role of the latter was confirmed in the present study. However, there were a few instances of reversal of the time-related discrimination decrement, as reported by Williams (1988). Although Williams suggested that the reversed effect is related to local anticipatory contrast effects, the exact mechanism has yet to be specified. Under conditions of high dis-

criminability, control by the prevailing discriminative stimulus may be much stronger than control by the component transition. A strong response differential at the end of components could therefore result from a combination of strong exteroceptive stimulus control and increasingly strong proprioceptive control by low or high response rates. Such "mediating" behavior enhances the stimulus control of remembering in delayed matching to sample (Blough, 1959) and could also play a role in successive discrimination. There was no evidence from the present data, however, to suggest that occurrence of the anticipatory effect was related to the overall level of discriminability.

Delayed control of discriminative responding by component transition provides a mechanism for the relational basis of successive discrimination. The stimulus relation is defined by the transition between temporally proximal component stimuli. It is therefore not necessary to assume that relational control involves delayed control of behavior in one component by the stimulus in a temporally distant component. The mechanism for action at a temporal distance in successive discriminations is control by stimulus *transition*. By the same token, the conclusion from studies of behavioral contrast that behavior in one component is directly determined by reinforcers in the temporally distant component has been questioned by McLean and White (1983), who argued that successive discriminations involve *successive independence*. That is, behavior allocation in one component is independent of the reinforcer distribution in a temporally distant component. McLean and White assumed that behavior in a component is determined solely by the reinforcer distribution in that component. Using multiple concurrent schedules of reinforcement, McLean (1983, 1988, 1991) and White, Alsop, and McLean (1992) have reported compelling empirical evidence for successive independence in terms of the relation between response ratios in one component and reinforcer ratios in the other. If stimulus transition provides the basis for stimulus relativity and if successive independence characterizes reinforcer effects, local contrast effects may be best described as resulting from changes in control by the stimulus transition rather than changes in the reinforcer interaction.

McLean (1991) described a local interaction in multiple-concurrent schedules in which left-to-right response ratios ($B11/B21$) in a component (Component 1) in which the concurrent left-to-right reinforcer ratio ($R11/R21$) was constant were inversely related to the left-to-right reinforcer ratio ($R12/R22$) in the alternating component (Component 2). This interaction was observed for the first quarter of the component, but there was successive independence for the remainder of the component. McLean showed that Equation 3 described his result:

$$\log(B11/B21) = (a - n)\log(R11/R21) + n \log(R12/R22). \quad (3)$$

Averaged values of $(a - n)$ reported by McLean for the response ratios in the alternating component ($B12/B22$) in which left-to-right reinforcer ratios were varied were 0.82, 0.54, 0.50, and 0.45 for consecutive quarters of components. Averaged values of n for consecutive quarters were -0.24, 0.02, 0.04, and 0.01. McLean interpreted the exponent a as sensitivity of left-to-right response ratios to ratios of concurrently available reinforcers obtained by the left and right responses. He interpreted the exponent n as a measure of the successive interaction, with $n = 0$ for successive independence. His data fit well with his interpretation of Equation 3.

A slightly different interpretation of Equation 3 is more consistent with the main conclusion from the present experiments. Equation 3 can be rewritten as follows, with a change of sign for n :

$$\begin{aligned} \log(B11/B21) \\ = a \log(R11/R21) \\ + n \log[(R11/R21) \cdot (R22/R12)]. \end{aligned} \quad (4)$$

Consistent with the conclusion offered by White (1990) and the present data, a is sensitivity to the concurrent reinforcer ratio and is determined by prevailing stimulus control. That is, when control by the discriminative stimulus in the current component is strong, a is high. The exponent n measures stimulus control by the component transition. When the left-to-right reinforcer ratios in both successive components are the same, the term $n \log[(R11/R21) \cdot (R22/R12)]$ becomes zero. When the concurrent reinforcer ratios in the

two components are large and equal and opposite, the latter term will take values greater than zero, depending on the value of n . The opposition of the reinforcer ratios in this term describes the effects of the stimulus transition in terms of the reinforcer effect. Towards the end of components, delayed control by the stimulus transition may be near zero, in which case the left-to-right response ratio is under stimulus control of the current discriminative stimulus. At the beginning of the component, control by the stimulus transition may be strong and n will be greater than zero. Hence, the left-to-right response ratio in each component is influenced by two factors—the concurrent reinforcer ratio modified by the strength of prevailing stimulus control (a) and the opposition of concurrent reinforcer ratios in the two components, modified by the strength of stimulus control by the component transition (n).

This account can be applied to successive discriminations by assuming that in each component the choice between responding and engaging in other behavior is determined by reinforcers obtained by responding relative to reinforcers obtained by other behavior (McLean, 1995; McLean & White, 1983). This application is consistent with extant data on the conditions favoring the occurrence of the time-related decrement in discrimination and is supported by a result recently reported by Todorov, Souza, and Bori (1993). Todorov et al. showed that when an increase in the minimum interchangeover time in a changeover-key concurrent schedule rendered the procedure more similar to a multiple schedule, sensitivity to concurrent reinforcer ratios was high for short times and low for long times, analogous to the reduction in m with increasing time since stimulus transition, as illustrated by the present Experiment 1. Because multiple concurrent schedules make explicit the control by concurrently available reinforcers in successive discriminations, they will provide a fruitful avenue for the future exploration of control by stimulus transition.

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APPENDIX A

Response and reinforcer totals summed over the last five sessions of each condition separately for the five component subintervals in Components 1 and 2 of Experiments 1, 2, 4, and 5.

Bird	Condi- tion	Component 1 subintervals					Component 2 subintervals				
		1	2	3	4	5	1	2	3	4	5
Response totals											
J1	1	970	1,047	1,129	1,317	1,411	509	796	879	910	956
	2	500	606	670	714	784	668	666	747	790	757
	3	1,043	1,118	1,332	1,387	1,556	540	629	627	590	563
	4	621	581	591	591	608	849	808	876	886	871
	5	731	910	1,105	1,233	1,290	520	638	651	602	679
	6	412	537	542	498	455	700	736	822	920	932
	7	920	909	963	1,139	1,166	292	394	422	436	453
	8	442	395	326	276	240	728	838	893	1,015	1,016
	9	450	622	679	650	560	344	484	607	653	591
	10	185	309	456	572	605	282	208	234	243	186
	11	548	643	700	702	593	486	560	542	520	493
	12	492	644	641	657	595	424	345	317	310	324
	13	1,533	1,844	1,904	1,857	1,836	419	442	520	542	560
	14	479	343	381	368	275	1,176	1,432	1,575	1,757	1,664
	15	799	1,249	1,459	1,493	1,497	695	760	748	626	591
	16	809	1,003	829	778	775	1,279	1,500	1,589	1,647	1,745
	17	1,193	1,378	1,386	1,283	1,302	988	1,637	1,623	1,504	1,548
	18	1,429	1,461	1,495	1,404	1,405	775	911	910	803	872
	19	843	989	858	775	703	1,059	1,195	1,206	1,274	1,345
	20	1,162	1,288	1,401	1,414	1,395	687	1,139	1,197	1,277	1,246
	21	735	1,160	1,247	1,311	1,309	1,183	1,263	1,323	1,395	1,426
	22	344	521	573	594	691	1,099	1,099	1,139	1,223	1,306
	23	580	807	1,145	1,495	1,642	321	468	414	446	416
	24	756	709	591	599	603	1,231	1,188	1,142	1,160	1,165
	25	903	1,150	1,214	1,344	1,485	683	802	807	785	794
	26	855	1,088	1,178	1,113	1,089	1,086	1,144	1,230	1,293	1,357
	27	1,161	1,118	1,268	1,372	1,359	640	960	868	790	673
	28	788	993	987	947	934	1,278	1,329	1,370	1,334	1,289
	29	1,213	1,363	1,450	1,528	1,649	967	1,303	1,252	1,119	1,040
	30	611	677	596	522	474	1,022	1,337	1,356	1,556	1,464
	31	673	958	1,063	1,193	1,148	1,008	1,396	1,368	1,257	1,324
	32	111	140	150	157	118	379	321	335	432	432
	33	355	482	415	421	473	98	175	173	186	161
	34	194	327	315	317	322	504	565	539	501	612
	35	460	509	498	524	607	218	422	429	399	377
	36	351	450	476	446	452	437	498	466	439	394
	37	199	372	433	412	447	948	941	1,176	1,245	1,342
	38	884	1,040	1,027	1,139	1,116	345	544	560	544	502
	39	259	567	574	558	498	787	997	1,109	1,077	1,109
	40	774	877	953	969	1,030	386	600	638	550	559
	41	496	809	881	951	911	657	1,016	1,016	997	1,033
	42	233	439	451	504	490	1,210	1,232	1,214	1,200	1,268
	43	815	1,149	1,169	1,218	1,229	299	691	722	674	614
	44	303	548	604	574	588	925	1,056	1,050	1,075	1,113
	45	758	1,002	1,095	1,097	1,044	544	894	841	860	791
	46	556	858	958	1,007	907	543	917	930	959	972
J2	1	651	1,076	1,500	1,606	1,662	394	292	265	248	218
	2	299	304	289	304	302	878	1,267	1,349	1,367	1,445
	3	724	804	842	899	1,016	352	432	402	415	378
	4	357	271	187	225	216	1,432	1,363	1,478	1,558	1,597
	5	874	864	939	974	1,052	442	426	394	383	366
	6	526	488	472	433	438	1,159	1,079	1,047	1,132	1,104
	7	973	933	1,059	1,093	1,061	421	273	228	151	123
	8	377	193	184	145	123	916	917	1,006	1,094	1,170
	9	494	497	516	569	598	279	437	544	647	709
	10	239	199	172	144	203	670	842	834	802	841

APPENDIX A

(Continued)

Bird	Condi- tion	Component 1 subintervals					Component 2 subintervals				
		1	2	3	4	5	1	2	3	4	5
	11	570	620	644	662	686	406	636	691	704	797
	12	502	645	617	650	493	519	630	679	717	685
	13	1,303	1,366	1,397	1,447	1,519	293	358	428	445	472
	14	317	367	400	424	459	2,322	2,290	2,387	2,295	2,221
	15	1,506	1,505	1,546	1,503	1,551	584	696	822	845	925
	16	499	588	664	611	653	1,664	1,489	1,491	1,418	1,344
	17	580	647	586	649	644	1,023	905	816	749	753
	18	1,332	1,360	1,508	1,444	1,530	534	367	296	282	263
	19	537	444	412	392	385	1,955	2,174	2,315	2,478	2,467
	20	1,477	1,689	1,854	1,891	2,017	550	659	603	575	499
	21	814	963	831	739	688	1,708	1,812	1,853	1,804	1,805
	22	514	538	562	586	577	2,275	2,414	2,529	2,680	2,628
	23	2,305	2,287	2,390	2,297	2,443	470	535	598	674	718
	24	390	448	476	552	753	2,063	1,978	2,043	2,073	2,105
	25	1,331	1,391	1,430	1,452	1,429	566	735	741	662	727
	26	745	813	777	757	803	1,491	1,628	1,633	1,596	1,553
	27	1,693	1,760	1,771	1,850	1,944	1,077	1,063	1,048	1,047	984
	28	1,017	1,053	979	837	862	1,780	1,762	1,876	1,864	1,986
	29	2,572	2,643	2,608	2,619	2,531	2,022	2,155	1,823	1,644	1,495
	30	812	868	772	746	736	1,537	1,374	1,363	1,381	1,309
	31	1,746	1,927	1,969	1,968	2,020	1,898	2,167	2,094	2,114	1,984
	32	190	203	211	241	253	713	762	766	818	775
	33	698	716	750	825	781	171	224	279	299	317
	34	375	401	420	455	413	893	905	877	903	801
	35	753	801	760	704	706	476	614	600	594	564
	36	485	613	744	676	671	819	808	714	679	611
	37	495	550	556	571	666	1,601	1,755	1,673	1,683	1,823
	38	1,658	1,752	1,765	1,791	1,909	502	602	636	632	750
	39	682	854	967	1,006	1,014	1,649	1,648	1,523	1,458	1,424
	40	1,309	1,561	1,632	1,682	1,790	700	803	811	755	720
	41	964	1,303	1,256	1,216	1,142	979	1,356	1,335	1,296	1,331
	42	457	694	760	851	896	1,618	1,695	1,638	1,678	1,779
	43	1,727	1,761	1,864	1,897	2,068	603	660	678	759	816
	44	806	894	879	898	917	1,355	1,520	1,541	1,498	1,526
	45	1,856	1,945	1,813	1,734	1,665	721	899	879	911	918
	46	946	1,227	1,133	1,067	970	747	1,097	1,176	1,1521	1,205
J4	1	2,122	2,413	2,447	2,312	2,379	1,564	1,752	1,779	1,720	1,678
	2	1,838	1,878	1,911	1,957	1,819	1,976	1,869	1,979	2,098	2,103
	3	2,327	2,499	2,566	2,572	2,315	1,405	1,800	1,885	1,852	1,904
	4	1,529	1,913	1,965	2,010	1,770	2,488	2,461	2,418	2,507	2,559
	5	2,361	2,212	2,135	2,010	1,910	1,586	1,897	1,915	1,948	1,829
	6	2,060	2,091	2,116	2,142	2,372	2,232	2,216	2,201	2,152	
	7	2,250	2,535	2,495	2,431	2,363	1,236	1,354	1,518	1,671	1,845
	8	1,246	1,633	1,946	2,288	2,332	2,735	2,729	2,995	2,907	2,916
	9	1,218	1,403	1,506	1,579	1,671	1,267	1,570	1,679	1,793	1,742
	10	1,206	1,568	1,782	1,861	1,979	1,298	1,559	1,936	1,881	1,779
	11	1,334	1,286	1,402	1,580	1,676	1,226	1,336	1,414	1,576	1,695
	12	1,133	1,340	1,433	1,529	1,757	1,221	1,462	1,671	2,011	2,166
	13	2,802	2,786	2,954	2,773	2,870	1,122	1,776	1,820	1,946	1,834
	14	1,263	1,979	2,071	2,254	2,183	2,525	2,283	2,277	2,338	2,215
	15	2,284	2,212	2,285	2,202	2,107	1,617	1,943	1,860	1,789	1,907
	16	1,436	2,164	2,418	2,299	2,299	2,828	1,676	2,536	2,375	2,355
	17	1,973	2,157	2,144	2,157	2,275	2,164	2,218	2,210	2,163	2,175
	18	2,616	2,874	2,903	2,873	2,942	1,843	1,989	1,890	1,908	1,813
	19	1,814	1,933	1,886	1,933	1,858	2,538	2,512	2,507	2,611	2,623
	20	2,348	2,254	2,393	2,360	2,274	1,785	1,946	1,925	1,948	1,760
	21	1,857	1,988	1,945	1,803	1,800	2,146	2,442	2,321	2,180	2,167

APPENDIX A

(Continued)

Bird	Condi- tion	Component 1 subintervals					Component 2 subintervals				
		1	2	3	4	5	1	2	3	4	5
	22	1,403	2,097	2,211	2,304	2,286	2,475	2,326	2,478	2,522	2,590
	23	2,740	2,721	2,874	2,688	2,704	1,914	2,150	2,172	2,193	2,136
	24	1,724	2,241	2,309	2,464	2,402	2,739	2,556	2,603	2,666	2,759
	25	2,555	2,405	2,426	2,387	2,385	1,968	2,177	2,232	2,200	2,117
	26	2,134	2,541	2,396	2,476	2,351	2,566	2,481	2,353	2,486	2,500
	27	2,788	2,715	2,729	2,715	2,802	1,776	2,100	2,082	2,114	2,135
	28	2,095	2,443	2,651	2,624	2,546	2,947	2,912	2,951	2,916	2,850
	29	2,475	2,708	2,723	2,573	2,602	2,290	2,554	2,592	2,546	2,534
	30	1,750	1,847	1,812	1,927	1,927	2,528	2,671	2,607	2,691	2,700
	31	1,874	2,433	2,438	2,446	2,320	2,347	2,716	2,657	2,604	2,495
	32	544	774	1,022	1,112	1,001	1,096	994	1,010	1,084	1,117
	33	1,107	1,130	1,095	1,070	1,082	764	1,110	1,158	1,100	1,231
	34	1,021	1,108	1,148	1,105	1,115	1,211	1,113	1,141	1,280	1,211
	35	1,005	1,005	962	1,042	1,072	893	1,030	1,005	1,071	1,037
	36	988	1,008	1,063	1,022	968	933	1,044	1,016	976	911
	37	1,392	1,885	2,209	2,341	2,271	2,470	2,468	2,385	2,245	2,430
	38	2,289	2,440	2,514	2,371	2,420	1,505	2,032	2,268	2,242	2,273
	39	1,895	2,160	2,202	2,195	2,309	2,422	2,476	2,363	2,442	2,411
	40	2,128	2,204	2,067	2,162	2,180	1,576	1,898	1,962	1,985	2,024
	41	2,040	2,085	2,042	2,052	2,086	2,001	2,021	2,072	2,087	1,992
	42	1,460	1,935	2,251	2,331	2,399	3,010	2,815	2,741	2,907	2,853
	43	2,735	2,585	2,597	2,746	2,581	1,731	2,098	2,210	2,187	2,213
	44	2,044	2,178	2,322	2,222	2,290	2,572	2,484	2,556	2,560	2,555
	45	2,809	2,834	2,727	2,704	2,712	2,135	2,494	2,412	2,562	2,555
	46	2,222	2,161	2,169	2,132	2,247	2,042	2,272	2,167	2,096	2,119
J5	1	1,965	2,200	2,098	1,930	1,886	1,000	1,059	984	1,015	1,057
	2	1,004	1,250	1,203	1,166	1,181	1,692	1,696	1,566	1,539	1,541
	3	1,844	2,105	1,976	1,983	2,042	410	666	739	908	890
	4	1,010	1,052	1,102	1,170	1,167	1,895	1,744	1,760	1,720	1,837
	5	2,373	2,545	2,193	1,986	1,807	1,183	1,568	1,594	1,747	1,617
	6	1,102	1,289	1,466	1,601	1,744	2,226	2,149	2,153	2,159	2,211
	7	2,240	2,261	2,296	2,323	2,265	816	842	1,017	1,226	1,338
	8	986	883	1,122	1,118	1,145	1,903	1,947	2,055	2,166	2,201
	9	1,040	1,122	1,154	1,091	1,039	538	710	837	900	920
	10	996	1,045	1,068	1,080	1,140	1,043	929	1,047	1,125	1,235
	11	not run									
	12	875	927	946	850	916	1,120	908	1,114	1,136	1,095
	13	3,129	3,295	3,079	3,195	3,032	873	1,239	1,778	2,064	2,185
	14	596	559	713	806	986	3,303	3,326	3,104	3,244	3,280
	15	2,179	3,115	3,391	3,137	3,044	1,192	1,222	1,309	1,405	1,482
	16	1,048	1,662	1,762	1,701	1,706	3,390	3,170	3,009	2,838	2,747
	17	1,868	2,755	2,842	2,691	2,671	2,697	3,037	2,904	2,816	2,885
	18	3,454	3,678	3,602	3,441	3,412	985	910	894	891	847
	19	1,713	2,201	2,097	5,285	1,725	3,616	3,529	3,309	3,408	3,236
	20	2,341	2,813	2,935	2,814	2,837	1,815	2,420	2,405	2,366	2,285
	21	1,963	2,558	2,551	2,296	2,289	2,719	2,975	2,973	2,869	2,849
	22	1,623	1,936	2,082	2,155	2,242	3,367	3,477	3,421	3,433	3,322
	23	3,420	3,406	3,255	3,105	3,136	1,189	1,773	2,222	2,481	2,494
	24	1,488	2,254	2,556	2,596	2,638	3,421	3,358	3,406	3,361	3,379
	25	3,224	3,098	3,050	2,960	2,938	1,598	2,471	2,637	2,711	2,743
	26	1,794	2,440	2,510	2,624	2,573	2,653	3,018	2,907	2,886	2,943
	27	3,497	3,522	3,525	3,591	3,585	1,697	2,039	2,032	2,168	2,000
	28	2,982	3,381	3,157	2,944	2,926	3,388	3,457	3,291	3,210	3,110
	29	3,197	3,374	3,247	3,163	3,245	2,308	2,749	2,643	2,554	2,521
	30	2,281	2,577	2,396	2,373	2,201	3,395	3,368	3,273	3,281	3,202
	31	2,575	2,893	2,602	2,278	2,105	2,608	2,953	2,777	2,607	2,459
	32	463	828	858	933	908	1,400	1,273	1,122	1,240	1,109

APPENDIX A

(Continued)

Bird	Condi- tion	Component 1 subintervals					Component 2 subintervals				
		1	2	3	4	5	1	2	3	4	5
	33	1,634	1,338	1,348	1,375	1,274	624	843	822	898	872
	34	782	1,065	1,097	1,069	1,022	1,628	1,504	1,342	1,304	1,331
	35	1,628	1,342	1,295	1,267	1,216	686	1,043	1,034	1,107	1,046
	36	1,306	1,334	1,228	1,192	1,163	1,120	1,200	1,268	1,181	1,250
	37	1,192	1,626	1,748	1,684	1,668	3,091	3,070	2,883	2,794	2,768
	38	3,247	3,220	3,009	2,984	2,925	1,401	1,950	1,878	1,905	1,835
	39	1,641	2,172	2,171	2,143	2,195	2,617	2,471	2,404	2,221	2,247
	40	2,534	2,709	2,653	2,696	2,655	1,508	1,920	2,013	1,941	1,945
	41	2,686	2,836	2,807	2,599	2,596	2,462	2,809	2,792	2,716	2,636
	42	1,063	1,297	1,508	1,536	1,476	3,397	3,389	3,255	3,171	3,156
	43	3,205	3,196	3,086	3,052	2,912	1,409	1,902	1,952	1,905	1,795
	44	2,081	2,569	2,554	2,450	2,446	2,869	2,810	2,660	2,478	2,432
	45	2,944	3,196	3,096	3,028	2,888	1,998	2,330	2,409	2,295	2,337
	46	1,812	2,222	2,265	2,200	2,164	1,485	2,030	1,883	1,835	1,900
Reinforcer totals											
J1	1	22	18	20	22	21	6	8	7	9	5
	2	11	6	11	8	10	18	19	14	17	19
	3	35	22	19	21	28	5	8	4	5	7
	4	7	5	7	3	5	35	33	20	31	30
	5	23	19	15	20	19	15	13	8	7	11
	6	11	13	6	11	9	15	21	22	14	21
	7	27	20	29	37	37	6	3	4	2	8
	8	9	2	5	4	2	27	31	34	31	23
	9	13	16	12	16	21	3	1	6	1	3
	10	1	3	2	1	3	24	23	17	8	10
	11	7	16	17	8	10	5	6	6	9	2
	12	5	7	8	7	4	10	8	11	9	15
	13	35	25	33	28	31	2	10	6	2	8
	14	7	3	7	10	2	30	32	27	30	28
	15	19	25	12	20	22	7	10	8	14	9
	16	9	12	10	5	7	22	18	22	19	23
	17	14	19	13	17	15	17	14	17	11	12
	18	31	23	27	34	30	7	4	4	4	6
	19	4	6	8	6	5	23	29	31	35	23
	20	21	20	14	17	17	7	10	8	11	10
	21	8	10	16	8	6	21	14	17	23	21
	22	7	5	8	2	2	28	26	39	25	20
	23	25	38	23	32	31	4	1	12	5	10
	24	9	3	7	1	4	21	30	34	31	34
	25	19	14	24	17	23	13	5	11	12	6
	26	10	7	6	12	14	15	23	20	19	22
	27	33	30	18	23	41	4	2	11	1	7
	28	6	12	14	5	3	18	18	16	22	20
	29	18	19	15	18	22	9	11	12	9	7
	30	7	5	4	2	5	26	36	28	23	27
	31	12	22	20	15	10	15	13	14	21	12
	32	3	7	2	3	4	19	37	24	33	24
	33	16	28	29	29	17	3	4	7	2	10
	34	8	10	6	10	8	22	13	19	32	11
	35	17	16	23	18	18	6	8	8	7	12
	36	11	19	18	16	9	9	14	12	16	22
	37	1	5	7	3	9	22	31	31	30	31
	38	22	26	31	28	34	2	9	6	6	5
	39	2	11	10	12	12	13	16	23	20	20
	40	17	17	22	15	15	5	9	14	10	9
	41	13	14	15	14	17	6	19	15	15	23

APPENDIX A

(Continued)

Bird	Condi- tion	Component 1 subintervals					Component 2 subintervals				
		1	2	3	4	5	1	2	3	4	5
J2	42	3	5	6	4	5	16	16	28	17	15
	43	25	14	20	24	19	2	11	4	6	6
	44	4	5	3	5	8	13	14	13	18	12
	45	9	14	6	21	16	3	5	6	5	3
	46	8	10	11	7	14	6	11	13	12	6
	1	16	14	16	28	21	13	5	13	3	10
	2	10	5	9	11	8	17	19	17	14	20
	3	21	18	32	35	32	1	10	2	3	9
	4	6	3	11	1	7	31	28	28	27	30
	5	19	15	18	22	22	11	15	8	9	8
	6	6	13	6	12	9	27	14	16	14	22
	7	32	22	26	25	46	10	8	5	3	1
	8	12	1	8	2	5	31	33	26	29	30
	9	14	16	17	17	20	2	2	5	5	4
	10	8	1	8	1	1	15	10	18	19	19
	11	14	14	7	13	5	1	3	8	5	6
	12	7	7	9	3	1	8	12	10	7	11
	13	32	27	30	32	26	6	5	7	5	9
	14	6	4	10	2	4	21	41	27	25	27
	15	20	18	28	23	15	11	11	10	6	6
	16	4	13	10	11	6	19	16	17	22	23
	17	11	16	15	12	14	12	12	20	20	7
	18	25	37	22	33	22	9	4	10	7	1
	19	3	6	5	6	6	29	29	31	25	34
	20	20	16	21	20	16	10	8	8	8	11
	21	12	9	9	5	7	18	16	15	24	18
	22	10	9	4	3	5	29	27	25	32	37
	23	35	24	30	26	34	9	6	11	7	4
	24	4	6	2	1	6	35	32	20	27	38
	25	20	16	19	19	21	14	6	6	7	11
	26	10	12	6	5	12	26	13	19	20	20
	27	33	18	33	32	26	5	5	9	4	9
	28	3	8	16	9	5	21	20	16	22	23
	29	26	19	20	15	12	11	10	14	6	11
	30	8	5	5	4	2	26	38	32	27	28
	31	6	18	17	15	14	10	17	16	7	18
	32	3	6	7	5	7	31	22	26	23	35
	33	26	33	29	19	37	3	10	8	9	5
	34	10	10	10	8	10	16	26	20	10	25
	35	15	14	14	24	22	8	6	11	9	13
	36	14	20	8	19	14	8	14	13	18	20
	37	5	6	6	5	10	20	36	38	31	23
	38	32	24	30	34	24	3	8	4	3	11
	39	9	8	8	4	12	20	17	21	20	16
	40	13	19	23	27	13	4	13	9	10	7
	41	11	17	18	13	13	8	17	19	15	15
	42	1	5	4	7	5	21	15	26	14	14
	43	15	26	24	19	10	3	3	3	4	5
	44	3	6	5	7	5	8	15	12	20	14
	45	12	12	11	12	12	7	7	7	7	2
	46	9	10	6	7	10	7	6	13	9	14
J4	1	21	18	15	21	21	5	9	11	5	7
	2	13	10	11	5	11	15	19	23	21	18
	3	30	27	28	35	22	2	4	5	5	4
	4	4	8	2	2	5	32	24	34	32	26
	5	21	25	16	23	15	12	10	10	9	11
	6	9	8	14	10	6	27	22	17	20	21

APPENDIX A

(Continued)

Bird	Condi- tion	Component 1 subintervals					Component 2 subintervals				
		1	2	3	4	5	1	2	3	4	5
	7	28	20	32	38	31	1	5	6	5	7
	8	3	2	1	1	14	31	34	25	25	33
	9	11	22	24	13	19	1	4	4	2	6
	10	2	2	3	1	5	25	15	13	20	16
	11	7	10	12	9	16	2	6	6	6	1
	12	2	7	5	9	2	9	11	13	13	12
	13	34	25	29	29	35	3	4	3	4	11
	14	5	6	8	1	7	35	35	23	28	28
	15	18	15	15	22	26	6	9	6	14	8
	16	5	7	11	7	11	19	18	19	18	23
	17	13	21	12	17	12	12	13	19	16	17
	18	26	25	38	28	28	2	7	4	3	11
	19	7	4	7	1	3	29	19	33	27	36
	20	22	22	20	14	15	11	9	13	5	8
	21	3	8	10	6	11	26	16	17	23	16
	22	4	7	7	6	4	35	24	18	37	40
	23	27	31	25	28	33	5	2	5	4	12
	24	2	5	8	7	6	21	39	34	35	30
	25	19	25	14	21	15	8	12	9	9	13
	26	6	11	8	8	12	15	16	25	23	17
	27	28	28	31	32	30	6	6	7	3	6
	28	9	12	10	9	9	22	20	15	13	23
	29	15	26	21	23	16	6	14	10	9	5
	30	8	4	5	5	5	25	20	34	32	32
	31	16	19	15	6	13	9	19	18	15	15
	32	9	9	4	4	10	21	30	32	27	27
	33	29	20	29	33	34	7	5	5	10	3
	34	6	11	9	9	10	13	23	28	11	19
	35	18	22	23	19	17	6	8	9	11	7
	36	10	15	14	14	19	14	9	16	17	25
	37	1	9	5	3	6	25	20	28	39	29
	38	26	20	29	41	33	5	7	6	6	10
	39	9	7	10	9	8	17	9	25	17	19
	40	13	20	25	17	20	9	6	9	5	14
	41	14	17	19	14	13	8	15	14	14	20
	42	2	2	4	5	1	12	20	25	15	15
	43	22	19	19	15	15	4	4	2	5	5
	44	6	6	3	5	10	16	11	11	15	11
	45	16	8	12	16	14	7	7	7	6	6
	46	10	9	8	9	7	9	8	10	7	8
J5	1	15	22	21	17	22	13	8	8	7	6
	2	11	8	10	5	10	20	16	18	19	12
	3	25	28	39	34	23	5	2	3	1	6
	4	6	4	6	3	8	25	33	29	36	25
	5	17	19	23	16	17	13	6	11	9	10
	6	8	15	12	12	5	27	22	14	17	16
	7	32	29	27	24	37	7	4	6	5	2
	8	6	7	9	3	6	27	37	34	23	28
	9	9	16	16	22	21	2	3	6	3	5
	10	2	1	5	1	5	21	14	17	22	14
	11	not run									
	12	6	11	6	11	3	16	9	8	8	17
	13	28	23	29	26	36	5	5	9	8	7
	14	4	8	8	2	6	29	21	36	38	30
	15	14	18	16	24	18	13	10	5	7	11
	16	3	10	10	11	7	27	16	16	17	22
	17	15	21	14	16	15	19	11	14	15	16

APPENDIX A

(Continued)

Bird	Condi- tion	Component 1 subintervals					Component 2 subintervals				
		1	2	3	4	5	1	2	3	4	5
	18	30	26	31	39	28	6	5	8	4	8
	19	3	10	29	3	7	29	26	38	19	32
	20	19	16	15	29	21	6	11	11	11	13
	21	8	13	9	9	7	17	17	20	21	19
	22	7	5	6	7	4	38	27	28	26	33
	23	28	21	36	38	27	6	3	7	2	16
	24	4	6	7	7	7	34	29	31	34	22
	25	11	24	18	22	16	12	14	8	7	6
	26	6	12	11	3	17	21	17	22	25	14
	27	38	27	29	25	25	5	2	9	1	7
	28	12	8	9	10	6	22	20	15	18	16
	29	12	19	21	22	15	10	7	11	9	9
	30	4	4	10	2	5	24	22	32	36	32
	31	19	14	12	17	15	9	19	9	14	20
	32	5	7	13	4	4	18	27	35	22	40
	33	17	38	25	25	35	3	7	5	4	5
	34	8	11	10	5	9	16	19	17	19	18
	35	13	27	16	19	21	7	5	13	7	12
	36	13	14	12	17	14	11	20	18	20	10
	37	1	2	10	1	7	24	32	28	34	28
	38	29	22	31	33	26	4	2	5	4	8
	39	11	4	8	15	10	12	14	24	21	19
	40	15	24	26	23	14	10	14	7	7	9
	41	12	21	14	14	13	21	17	12	14	13
	42	3	5	3	2	5	15	14	22	20	14
	43	20	17	24	17	18	2	3	4	2	7
	44	3	3	4	11	7	14	9	6	21	15
	45	13	9	13	14	18	2	7	4	5	5
	46	9	8	11	7	13	3	5	14	9	12

APPENDIX B

Response and reinforcer totals summed over the last five sessions of each condition separately for the four component subintervals in Components 1 and 2 of Experiment 3.

Bird	Condition	Component 1 subintervals				Component 2 subintervals			
		1	2	3	4	1	2	3	4
Response totals									
F1	1	4,658	4,456	4,520	4,179	1,997	2,842	2,972	3,047
	2	1,579	2,289	2,468	2,620	2,984	2,902	2,920	3,062
	3	3,676	3,514	3,451	3,480	1,846	2,392	2,557	2,489
	4	2,645	2,754	2,819	2,886	2,961	3,099	3,070	2,976
	5	3,326	2,710	3,237	3,154	2,954	3,149	3,179	3,181
	6	1,158	1,180	1,192	1,188	1,146	1,182	1,165	1,191
	7	1,185	1,174	1,227	1,238	1,252	1,280	1,265	1,261
	8	1,254	1,259	1,265	1,283	1,161	1,195	1,197	1,240
	9	1,265	1,298	1,286	1,291	1,260	1,265	1,260	1,283
	10	1,292	1,292	1,327	1,285	1,285	1,274	1,261	1,280
F2	1	3,760	3,461	3,485	3,597	1,726	2,389	2,636	2,716
	2	1,505	1,814	1,927	2,028	3,117	2,985	3,113	3,266
	3	3,780	3,507	3,361	3,285	2,407	2,516	2,466	2,416
	4	1,812	1,858	1,875	1,721	2,413	2,072	1,890	2,059
	5	1,963	1,864	1,988	1,878	2,022	1,948	1,958	1,983
	6	931	916	910	944	865	896	912	901
	7	641	760	813	827	1,039	1,065	1,097	1,107
	8	1,051	1,084	1,030	1,053	878	951	960	962
	9	857	864	860	859	898	878	877	888
	10	957	888	877	891	834	871	862	882
F3	1	3,285	3,924	4,398	4,523	1,137	1,491	1,649	1,697
	2	1,054	1,936	1,980	2,088	3,164	2,832	2,908	2,839
	3	2,223	2,383	2,351	2,436	1,535	1,661	1,845	1,936
	4	1,350	1,681	1,859	1,847	2,943	3,160	3,139	3,105
	5	3,153	3,498	3,399	3,420	3,274	3,559	3,374	3,292
	6	1,158	1,138	1,131	1,117	1,082	1,101	1,086	1,076
	7	982	1,194	1,255	1,260	1,134	1,099	1,123	1,074
	8	1,169	1,150	1,166	1,160	944	1,124	1,211	1,225
	9	1,150	1,217	1,256	1,257	1,202	1,225	1,189	1,184
	10	1,203	1,237	1,237	1,234	1,154	1,184	1,216	1,205
F4	1	4,116	4,348	4,255	4,440	1,025	966	1,194	1,285
	2	2,779	3,490	3,750	4,295	4,044	4,066	4,123	4,361
	3	3,344	3,733	4,003	3,999	2,281	2,979	3,042	3,101
	4	3,821	5,471	5,516	5,950	5,735	5,604	5,868	6,336
	5	5,880	6,326	6,388	6,193	6,134	6,455	6,878	6,539
	6	1,238	1,222	1,238	1,246	1,179	1,200	1,188	1,220
	7	940	964	1,144	1,201	1,195	1,227	1,236	1,292
	8	1,355	1,330	1,295	1,329	1,015	1,111	1,192	1,235
	9	1,329	1,398	1,408	1,375	1,325	1,320	1,302	1,366
	10	1,377	1,404	1,409	1,394	1,340	1,354	1,378	1,403
F5	1	2,511	2,481	2,517	2,674	377	786	955	1,013
	2	946	2,133	2,402	2,404	3,257	3,396	3,457	3,523
	3	3,210	3,186	3,210	3,201	1,547	2,293	2,227	2,158
	4	715	1,572	1,665	1,841	2,024	2,282	2,287	2,288
	5	2,107	2,951	2,920	2,891	2,314	2,749	2,775	2,704
Reinforcer totals									
F1	1	45	32	38	58	14	10	6	6
	2	7	9	10	7	38	44	48	47
	3	21	28	32	30	12	12	10	21
	4	15	12	14	15	28	23	31	29
	5	23	14	20	28	23	26	18	14
	6	25	28	20	21	25	18	32	18
	7	8	12	7	9	46	37	47	44

APPENDIX B

(Continued)

Bird	Condition	Component 1 subintervals				Component 2 subintervals			
		1	2	3	4	1	2	3	4
F2	8	41	44	47	33	5	6	8	7
	9	17	13	11	17	31	27	33	18
	10	29	32	22	32	10	11	18	14
	1	41	38	46	48	6	9	14	7
	2	7	8	6	10	40	43	43	45
	3	31	30	26	26	19	13	9	9
	4	14	16	14	13	29	21	35	26
	5	27	21	13	21	20	19	24	21
	6	18	31	20	17	24	21	19	25
	7	12	8	4	6	49	43	38	45
F3	8	48	39	54	37	8	10	12	11
	9	14	14	12	16	23	28	32	26
	10	29	28	28	27	19	11	8	12
	1	40	45	44	43	10	12	7	6
	2	2	13	11	5	51	42	37	45
	3	28	26	29	25	18	11	14	12
	4	16	17	10	13	32	26	38	19
	5	19	21	21	23	23	13	21	23
	6	22	24	23	25	18	27	29	16
	7	10	8	5	11	51	52	33	49
F4	8	43	49	42	35	4	8	8	4
	9	14	16	14	12	22	24	34	35
	10	34	29	28	25	13	16	13	16
	1	40	44	49	38	6	12	9	4
	2	7	12	11	6	50	45	41	38
	3	30	31	22	28	14	11	15	13
	4	15	14	16	12	29	37	30	22
	5	25	24	15	25	26	23	17	17
	6	27	19	18	21	18	25	28	19
	7	10	10	10	4	56	37	43	33
F5	8	31	53	48	40	3	11	8	9
	9	8	13	15	19	34	35	26	20
	10	33	22	31	27	10	18	12	20
	1	39	45	46	40	2	12	10	3
	2	5	8	11	7	47	52	38	36
	3	23	35	23	35	14	12	20	10
	4	12	12	17	14	29	27	33	29
	5	16	15	17	18	23	18	20	14