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Running Head: BEHAVIORAL CONTRAST

Behavioral Contrast: A New Solution to an Old Problem.

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Abstract

The effects of component presentation and baseline rates of reinforcement on behavioral contrast were examined in rats. Each rat was exposed to a series of six multiple variable-interval schedules, divided into two three-schedule series. Each series consisted of a standard contrast design (baseline phase, contrast phase, and baseline recovery phase). The presentation of multiple schedule components within these three phases varied as a function of condition. In condition one, rats were presented with the traditional strict alternation of multiple schedule components. In condition two, rats were exposed to randomly alternating multiple schedule components. Each subject was exposed to both high (VI 15) and low (VI 30) baseline rates of reinforcement.

Neither component presentation nor baseline rate of reinforcement had a significant effect on behavioral contrast. Robust contrast was observed in both conditions, at both VI 15 and VI 30 baseline reinforcement rates. These results fail to support the predictions made by habituation theory. Furthermore, the presence of contrast at relatively low rates of reinforcement has implications for additivity theory. Further research is needed to determine the applicability of habituation theory to behavioral contrast.

Behavioral Contrast: A New Solution to an Old Problem.

Reynolds (1961) discovered that when the rate of reinforcement in one component of a multiple schedule changed, the response rate in the other, constant component changed in the opposite direction. He labeled this effect behavioral contrast. The initial discovery of behavioral contrast led to considerable research by numerous investigators (Gamzu & Schwartz, 1973; Hinson & Staddon, 1978; Ettinger & Staddon, 1982; Williams, 1983). Unfortunately, the operational definitions of behavioral contrast varied between investigators. The absence of consensus in defining contrast made comparison of results across studies difficult, and also made it difficult to develop theories of contrast.

McSweeney & Norman (1979) attempted to address this issue by providing a standard definition of contrast. The intraschedule definition assesses positive and negative contrast by comparing the rates of responding during component schedules which supply unequal rates of reinforcement to the rate of responding during a baseline schedule in which all components supply equal rates of reinforcement (McSweeney & Norman, 1979). For example, positive contrast occurs when the rate of responding during the constant component increases as a result of a decrease in rate of reinforcement in the variable component (McSweeney & Norman, 1979).

Positive contrast has traditionally been studied using a three schedule series. During the first, or *initial baseline* phase, both components of the multiple schedule provide the same rate of reinforcement. In the second, or *contrast* phase, one component (the *changed* component) provides an extinction schedule, while the other component (the *unchanged* component) continues to provide a rate of reinforcement equal to that of the initial baseline phase. During the final, or *baseline recovery* phase, both components provide a rate of reinforcement equal to that provided in the initial baseline phase. The multiple schedule components are typically signaled by some type of stimulus, such as a light above the response bar. A significant increase in rate of responding during the unchanged component in the contrast phase would be labeled positive contrast.

Identification of the variables that produce behavioral contrast is theoretically important. Numerous studies have investigated the parameters of this phenomenon . The observance of contrast has been experimentally and theoretically linked to both the baseline rate of reinforcement (Dougan, McSweeney, & Farmer, 1985; Hinson & Staddon, 1978; Beninger & Kendall, 1975; McSweeney & Weatherly, 1998; Williams 1983; Herrnstein 1970; Reynolds 1961), as well as component duration (McSweeney & Weatherly, 1998; Ettinger & Staddon, 1982). Hinson (1978) asserted that the level of operant behavior that a given rate of reinforcement will maintain in a given situation is affected by the amount of reinforcer obtained in other situations. Dougan et al. (1985) provided empirical evidence for this assertion, finding that the magnitude of contrast varied strongly as a function of baseline reinforcement rate. Component duration also has been implicated in the mechanics of behavioral contrast. Contrast has been found to be at its maximum with short-component multiple schedules (Ettinger & Staddon, 1982). The conclusion that contrast is multivariate has also been hypothesized (Dougan et al., 1985; Dougan, Farmer-Dougan, & McSweeney, 1989; Williams 1983). These suggestions include both relative reinforcement rate and component duration as variables as well as availability of alternative responses and deprivation for reinforcers produced by alternative responses (Dougan et al., 1985).

At least four major theories have been proposed to account for behavioral contrast: additivity theory (Gamzu & Schwartz, 1973), competition theory (Ettinger & Staddon, 1982; Hinson & Staddon, 1978), matching theory (Herrnstein, 1970; Williams, 1983), and habituation theory (McSweeney & Weatherly, 1998).

Additivity Theory

According to additivity theory, behavioral contrast is the result of the interaction of two processes: Pavlovian and operant conditioning . Pavlovian conditioning occurs whenever a stimulus predicts a reinforcer, while operant conditioning occurs whenever reinforcement is contingent upon a specific response. During the baseline phase, operant conditioning should be prevalent because both schedules are providing the same rate of reinforcement. During the contrast phase, Pavlovian conditioning will also occur because the signal that indicates a change in schedule also predicts reinforcement rates. Additivity theory hypothesizes that contrast occurs when a differential stimulus-reinforcer dependency (Pavlovian conditioning) is imposed upon an already existing response-reinforcer dependency (operant conditioning) resulting in an increase in response rate (Gamzu & Schwartz, 1973).

Additivity theory does not make definitive predictions concerning the effects of reinforcement rate on responding. The strong version of additivity theory (McSweeney, Ettinger,

& Norman, 1981) predicts species differences; suggesting that Pavlovian and operant responses are distinguishable via their physical form. Positive contrast occurs when Pavlovian responding facilitates operant responding (McSweeney et al., 1981). For example, pigeons peck keys for food reinforcement, and also peck keys as a result of Pavlovian conditioning (Brown & Jenkins, 1968). Therefore, the strong version of additivity theory asserts that positive contrast is likely in situations that involve pigeons pecking keys. In contrast, rats are less likely to press bars during Pavlovian conditioning and therefore may not display consistent behavioral contrast. The intermediate version of additivity theory (McSweeney et al., 1981) distinguishes Pavlovian and operant responses by the theoretical ideas that govern them. Contrast occurs when both classical and operant conditioning are present and interacting. According to the weak version of the additivity theory (McSweeney et al., 1981), Pavlovian and operant responses can be distinguished by the environmental relations that govern them. Therefore, operant responses are driven by a response-reinforcer relation, whereas Pavlovian responses are governed by the relationship between a stimulus and a reinforcer (McSweeney et al., 1981).

As mentioned earlier, rats pressing bars as a result of Pavlovian conditioning is unlikely. Consequently, researchers have used pigeons as subjects to test the predictions of additivity theory. Keller (1974) executed an experiment with pigeons in which he spatially separated response-reinforcer and stimulus-reinforcer relations. The original response key was always illuminated by the same stimulus and operant response on this key resulted in reinforcement (Keller, 1974). Stimuli on the second key were used to signal the different components of a three component schedule. During *mult* VI EXT, pigeons began pecking at the VI stimulus on the second signal key (Keller, 1974). These responses in combination with responses on the operant key surpassed the amount of responding during the baseline phases, indicating behavioral contrast (Keller, 1974).

Competition Theory

According to the competition theory, behavioral contrast involves the interaction between two types of activity: interim and terminal behavior. Interim activities are not directly related to reinforcement in the operant sense (Ettinger & Staddon, 1982). Instead, their reinforcement is intrinsic, or contained within the behavior itself. For example, when rats are required to press a bar for reinforcement, they may also engage in interim behaviors such as grooming, drinking, or exploratory behavior. Terminal behavior is that response which is under the control of scheduled reinforcement, such as bar pressing (Dougan, McSweeney, & Farmer-Dougan, 1986). During the baseline phase of the experimental session, these two behaviors are competing for available time (Hinson et al., 1978). When the rate of reinforcement for terminal responses is placed on extinction in the changed component, interim activity is reallocated to the changed component, reducing its inhibitory effect on the terminal responding in the other, unchanged component (Hinson et al., 1978). The magnitude of behavioral contrast is dictated by the magnitude of reallocation available. The amount of reallocation is determined by the relationship between the amount of reinforcement for the terminal response and reinforcement for interim activities. This function is described by Equations 1 and 2 (from Staddon, 1982)

$$Co = \frac{r_1 + .5r_0}{r_1} \qquad r_0 < r_1 \tag{1}$$

$$Co = \frac{2r_1 + r_0}{r_1 + r_0} \qquad r_0 > r_1 \tag{2}$$

where *Co* represents magnitude of behavioral contrast, rate of reinforcement in the constant component is represented by r_1, and r_0 represents reinforcement for interim responses.

Hinson and colleagues (1978) tested the predictions of competition theory empirically. The experimental design included a running wheel as an available, measurable interim behavior. When no wheel was present, modest positive behavioral contrast was observed with terminal responding continuing in the changed component (Hinson et al., 1978). However, when the wheel was present, considerable positive contrast in combination with significant decreases in terminal behavior in the changed component was observed (Hinson et al., 1978). This suggests that the animals were reallocating their interim behavior in the predicted manner. More recent studies (Dougan et al, 1986; Dougan, McSweeney, & Farmer, 1985) have provided mixed support for competition theory, finding reallocation of interim behavior (drinking) only when subjects were deprived of the interim behavior.

Matching Theory

According to matching theory, behavioral contrast is a result of the matching law (Herrnstein, 1970). Responding in one component varies inversely with reinforcement frequency in the other component (Honig & Staddon 1977). The amount of behavioral contrast on a three-schedule series is described by Equation 3 (derived from Herrnstein 1970):

$$Co = \frac{r_1 + mr_2 + r_o}{r_1 + r_o} \tag{3}$$

where Co represents magnitude of behavioral contrast and the rates of reinforcement provided in the constant and changed components are represented by r_1 and r_2 respectively. The degree of interaction between components is represented by m, while r_o represents the rate of reinforcement from unscheduled sources. When both components of a multiple schedule are providing reinforcement, changes in the reinforcement rate of one component will subsequently cause the response rate in the other component to change in the opposite direction, producing observable behavioral contrast. Dougan and colleagues (1985, 1986) found experimental support for the matching theory of behavioral contrast, asserting that the magnitude of contrast varied as a function of baseline reinforcement rate.

Habituation Theory

Habituation theory is the newest attempt to describe contrast. Habituation can be defined as a decrease in the responsiveness to a stimulus as a function of repeated presentation. Because reinforcers are stimuli, their effectiveness can be explained by habituation. Any change in the rate of habituation will affect all ongoing behavior related to that stimulus. When the rates of reinforcement are changed in the contrast phase, the rate of habituation changes. This change in habituation affects responding in the unchanged component. According to habituation theory, it is this change in value, not conditions of reinforcement in the changed component that are directly responsible for contrast. Subsequently, contrast should be attributed to the change in reinforcer value that is present at the time of measured contrast (McSweeney & Weatherly, 1998). The argument behind this theory is that the change in reinforcers disrupts the habituation to produce the characteristic increase in response rate that has been labeled positive contrast. If the rate of reinforcement is decreased in one component, the overall amount of habituation to that reinforcer is decreased. The remaining reinforcers would be more effective and thus support a higher rate of responding (positive contrast). The ability of a reinforcer to support instrumental responding decreases as subjects habituate to that reinforcer (McSweeney & Weatherly, 1998).

Species Differences

Behavioral contrast, though a robust phenomenon in pigeons, has been difficult to demonstrate consistently with rats. The investigators that have been successful in demonstrating positive contrast in rats have employed relatively high baseline rates of reinforcements (Dougan et al., 1985; Dougan et al., 1986; Dougan et al., 1989; Beninger et al., 1975). Dougan and colleagues (1985) were unable to produce contrast in rats at a low rate of reinforcement (*mult* VI 60 VI 60). A comparative study of pigeons and rats by Dougan et al. (1989) found that pigeons maintained significant contrast at *mult* VI 15 VI 15, *mult* VI 30 VI 30, and *mult* VI 60 VI 60 schedules, while rats demonstrated significant contrast exclusively on the schedule providing the highest rate of reinforcement (*mult* VI 15 VI 15). Recently, there has been some suggestion that the difficulty in finding contrast in rats may be related to the way in which multiple schedule components alternate within the three phases. Traditionally, the components are presented in strict alternation. That is, the right bar and associated schedule are presented for a certain interval, followed by the presentation of the left bar and associated schedule, and so on in strict alternation. Recently, McSweeney and colleagues at Washington State University (personal communication) have used randomly alternating components and have initially reported robust contrast in rats. In the randomly alternating design, the right and left bar and their associated schedules are not presented in any predictable order. The presentation of phases is identical: baseline, contrast, baseline recovery. However, the alternation of multiple schedule components within the phases is generated at random.

The present study will compare the instances of positive behavioral contrast obtained via the new, random-presentation design with the instances of positive behavioral contrast obtained through utilization of the strict component alternation design. If it is found that contrast is indeed more reliable and robust as a result of the random-presentation design, it will have implications for all four theories of contrast. Additivity theory, competition theory, and matching theory do not predict an effect of component presentation on behavioral contrast. The results of the present study will have the most profound impact on the assertions of the habituation theory. Because the presentation of multiple schedule components is random, there are instances where the animal is exposed to two or three extinction schedules in a row. Habituation is a relatively short-term phenomenon, therefore, this extended period of time without exposure to the reinforcer stimuli lessens the degree of habituation to that reinforcer. Thus, when the VI schedule is finally reintroduced, the reinforcers are able to support a higher rate of responding. It is the decrease in habituation to the reinforcer that is responsible for the higher rates of responding during the unchanged component of the randomly alternating design.

Methods

Subjects

The subjects were twelve naive Sprague-Dawley rats (numbered B1-B12) obtained from the animal colony at Illinois Wesleyan University. Subjects were housed individually and were maintained at approximately 80% of their ad libitum body weights throughout the experiment. The 80% free feeding weights were readjusted weekly to account for normal weight gain associated with maturation. Water was freely available in the home cages at all times.

Apparatus

The apparatus was a standard operant conditioning unit for rats (BRS/LVE model RTC-028), 24cm in width, 30cm in length, and 26.5cm in height. The two side walls and the ceiling were made of plexiglass while the front and rear walls were composed of stainless steel. Two retractable response bars (BRS/LVE model RRL-005) were located on the front wall, both 5cm from the wire grid floor and 3cm in from the nearest side wall. The bars extended 2.5cm into the chamber when extended and were flush with the front wall when retracted. The response bars were 3cm wide and required a force of approximately .35N to operate. Three 5W cue lights (red, green, and white) were mounted 5cm above both response bars with 2cm separating the lights from each other. Food pellets were delivered through a food cup positioned 2cm from floor level and 11cm from the right side wall. The cup extended 1.5cm into the chamber. A 5W house light was mounted in the center of the front wall, 1cm from the ceiling. The entire apparatus was housed in a sound-attenuating chamber. Computerized control equipment including an IBM PC compatible computer running MED-PC software and a MED Associates interface were used for programming and data collection. The computer and interface were located in an adjacent room.

Procedure

The subjects were hand shaped to press the response bar for a 45mg Noyes Improved Formula A food pellet. Testing sessions began when all rats were reliably pressing the bar. The twelve rats were divided into two condition groups: strict alternation and random alternation. Within these condition groups, each rat was exposed to two series of three schedules each (See Table 1).

As seen in Table 1, each series consisted of a baseline, contrast, and baseline recovery phase. Each phase (baseline, contrast, and baseline recovery) within a series was in effect for ten consecutive days, with the order of baseline reinforcement rates (VI15, VI30) counterbalanced across animals to avoid systematic order effects. Scheduled interreinforcer intervals were determined using the arithmetic method suggested by Catania and Reynolds (1968).

At the beginning of each session, the rat was placed in a dark chamber with both response bars retracted. Approximately thirty seconds later, commencement of the session was signaled by illumination of the houselight, insertion of the appropriate bar into the chamber, and illumination of the corresponding cue light. Each multiple schedule component within a phase was associated with a different response lever. For example, in the contrast phase, the VI schedule was associated with the left lever and the extinction schedule with the right response lever. Multiple schedule components were in effect for sixty seconds at a time and were cued by the presentation of the response bar and illumination of the correct cue light. When not in use, response bars were retracted and cue lights were off. The houselight remained illuminated throughout the 30 minute session.

In both the strict alternation and random alternation series, the three phases (baseline, contrast, and baseline recovery) were presented in the same order. The alternation of components within the phases varied. In the strict alternation condition, the right bar (and associated schedule) was presented for sixty seconds, immediately followed by the presentation of the left bar (and associated schedule) for sixty seconds, and so on. In the random alternation condition, the presentation of components was generated randomly by the programming equipment with the single restriction that no component would be presented more than three times consecutively. As in the strict alternation condition, multiple schedules were presented for sixty second intervals. Sessions were conducted once a day, 7 days per week. Supplementary feedings were administered approximately one hour after the session to maintain 80% body weight.

Results

Response rates were calculated by dividing the number of bar presses made in each component by the number of minutes spent in that component. Response rates were calculated for all subjects during the last five days of all three conditions (baseline, contrast, and baseline recovery) for each rate of reinforcement (VI 15 and VI 30). The data from the initial baseline and baseline recovery phases were combined to yield a single mean baseline score. Table 2 presents the response rates for all twelve subjects during both rates of reinforcement (VI 15, VI 30). Behavioral contrast (denoted by an asterisk) occurred when the rate of responding in the unchanged component during the contrast phase was higher than the rate of responding in the unchanged component during both the initial baseline and baseline recovery phases. As seen in Table 2, behavioral contrast occurred in all subjects at both scheduled rates of reinforcement regardless of component alternation condition, with the exception of subject 12 at VI 30 rate of reinforcement.

The rate measurements in Table 2 were transformed into deviation from baseline scores by dividing the rate of responding in the unchanged component during contrast phase by the average baseline rate of responding in the unchanged component, multiplying by one hundred, and subtracting one hundred from the result (Equation 4).

$$\left[\left(\frac{\text{response rate contrast}}{\text{response rate baseline}}\right) \times 100\right] - 100 \tag{4}$$

Equation 4 yields a percent deviation from baseline responding, in which a positive score indicates positive behavioral contrast and a value of zero indicated no change in response rate relative to baseline (Table 3). Table 3 presents the percent deviation from baseline responding for each subject at each rate of reinforcement.

A two factor (condition x schedule) mixed design analysis of variance was performed to determine if the degree of contrast varied as a function of reinforcement rate or presentation mode. There was no main effect of either component presentation, $[F(1,10) = .11, p > .05]$, or reinforcement rate $[F(1,10) = 2.26, p > .05]$. The test for an interaction between the two aforementioned variables was also not statistically significant $[F(1,10) = .834, p > .05]$.

A one tailed *t* test was used to analyze the deviation from baseline during the contrast phase of testing. The mean percentage of deviation for each subject on each schedule series (sample mean) was compared to a population mean (the null hypothesis of zero) yielding a significant *t* score which indicated positive behavioral contrast $[t = 6.71, p < .001]$. It is important to note that this high degree of significant deviation from baseline responding was obtained using data from all subjects at both schedules of reinforcement despite failure of one subject to demonstrate contrast at VI 30.

Discussion

The present experiment compared contrast using strictly alternating multiple schedule components to contrast obtained using randomly alternating components at both high and low baseline rates of reinforcement. Analysis of responding during the contrast phase of testing indicated that contrast did not vary as a function of component presentation or rate of reinforcement. Instead, robust behavioral contrast was observed in both strict and random component conditions regardless of baseline rate of reinforcement.

The results of the present study do not support predictions made by the habituation theory of contrast. Habituation theory predicts higher rates of behavioral contrast in the random presentation condition. Because presentation of components is random, there are instances where the animal is exposed to two or three extinction schedules consecutively. This extended period of time without exposure to the reinforcing stimuli lessens the degree of habituation to that reinforcer, producing higher rates of responding during the unchanged component of the randomly alternating design.

This is one of the earliest attempts at addressing habituation theory empirically, thus it is premature to dismiss habituation theory in its entirety. It is possible that the current experiment attempted to address habituation theory through ineffective parameters. One of the most salient differences between the current methodology and that of earlier research are the discriminatory stimuli used to signal the commencement of multiple schedule components. Previous researchers (Dougan et al., 1985; Dougan et al., 1986; Dougan et al., 1989) have used the illumination of the cue light as the sole discriminatory stimulus, whereas the current experiment utilized both cue light illumination and response bar presentation as discriminatory stimuli. Consequently, the behavioral contrast observed in the present study may be a function of the relatively salient discriminatory stimuli.

The duration of testing sessions is another parameter in which the methodology of the current experiment differed from the research in other laboratories. In particular, the current experiment set out to replicate preliminary reports regarding greater contrast with randomly alternating components from McSweeney and colleagues at Washington State University (personal communication). The preliminary reports were based on methodology that utilized sixty minute session durations. The present experiment employed a session duration of thirty minutes, half of what McSweeney and colleagues were using in their studies. It is possible that the effects of habituation may be stronger later into the session. Consequently, the thirty minute sessions used in the current experiment may not have been sufficient for the full development of habituation. Further research is needed to determine the necessary parameters for effectively studying habituation theory and its predictions regarding behavioral contrast.

In addition to providing important implications for habituation theory, the current study produced significant behavioral contrast at relatively low rates of reinforcement (VI 30). Unlike their pigeon counterparts which display contrast at a VI 60 or lower, rats have, until this point, only reliably produced contrast at high rates of reinforcement (Dougan et al., 1985; Dougan et al., 1986; Dougan et al., 1989; Beninger et al., 1975). It seems likely that discrimination played a role in contributing to the presence of robust contrast at a VI 30 reinforcement rate. As mentioned earlier, the use of response bar presentation as a discriminatory stimulus in addition to cue light illumination is unique to this study. Further research is currently being conducted to explore the relative strength of contrast when the salience of the discriminatory stimulus is varied.

If discrimination did in fact contribute to the results of the current study, there are implications for additivity theory. Additivity theory hypothesizes that contrast occurs when a differential stimulus-reinforcer dependency is imposed upon a response-reinforcer dependency (Gamzu & Schwartz, 1973). Pigeons peck keys as a result of both Pavlovian conditioning and operant conditioning. Therefore, the same stimulus is involved in both the stimulus-reinforcer and response-reinforcer dependencies. Conversely, rats do not press bars as a result of Pavlovian conditioning. Subsequently, additivity theory does not predict robust contrast in rats because the combination of Pavlovian and operant conditioning on a single stimulus is unlikely. The robust contrast observed in the present study thus undermines additivity theory because the absence of contrast in rats has always been taken as support for additivity theory. Because the response bar is involved in both the stimulus-reinforcer and response-reinforcer dependencies in the current study, it is possible that there was an interaction between Pavlovian and operant responding.

Alternatively, the results of the current study are in support of a portion of additivity theory. In general, additivity theory predicts a positive correlation between the level of discrimination and behavioral contrast. As mentioned earlier, it is possible that rats were better able to discriminate between multiple schedule components in this experiment because the components were cued by response bar presentation. Further research is needed to determine if discrimination is indeed the cause of the robust contrast observed here. Findings would have implications for the application of additivity theory to behavioral contrast in rats.

The current study examined the effects of multiple schedule component presentation and baseline rate of reinforcement on behavioral contrast in rats. The predictions of habituation theory were not supported by the results: random component presentation did not produce greater contrast than strict component presentation. Also, robust contrast was observed in conditions providing relatively high rates of reinforcement as well as conditions providing low rates of reinforcement. In general, future research is needed to address the effects of discrimination on behavioral contrast. The effects of discrimination on contrast would have implications for both additivity and habituation theories. In regard to habituation theory, future research will also be necessary to determine the parameters for examining the contributions of habituation theory to the phenomenon of behavioral contrast.

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Table 1

Organization of Twelve Subjects into Two Series of Three Schedule Each

Subject	Condition	Series 1	Series 2	
1,5,9	strict alt.	VI15, VI15	VI30, VI30	baseline
		VI15, ext	VI30, ext	contrast
		VI15, VI15	VI30, VI30	baseline recovery
2,6,10	random alt.	VI15, VI15	VI30, VI30	baseline
		VI15, ext	VI30, ext	contrast
		VI15, VI15	VI30, VI30	baseline recovery
3,7,11	strict alt.	VI30, VI30	VI15, VI15	baseline
		VI30, ext	VI15, ext	contrast
		VI30, VI30	VI15, VI15	baseline recovery
4,8,12	random alt.	VI30, VI30	VI15, VI15	baseline
		VI30, ext	VI15, ext	contrast
		VI30, VI30	VI15, VI15	baseline recovery

Table 2

Mean Rate of Response in the Unchanged Component During Baseline (B) and Contrast (C) Schedules at Each Rate of Reinforcement for Each Subject.

	Scheduled Interreinforcer Interval			
	VI 15 seconds		VI 30 seconds	
subject	B	C	B	C
		strict alternation		
1	21.6	50.6*	45.7	59.6*
3	32.7	50.6*	16.4	32.2*
5	50.3	67.5*	66.7	82.8*
7	75.1	99.2*	29.2	44.9*
9	33.2	57.2*	29.2	40.4*
11	21.2	23.8*	14.9	22.4*
		random alternation		
2	46.1	57.8*	66.6	69.4*
4	28.4	62.6*	11.9	19.6*
6	23.3	33.8*	33.4	42.5*
8	26.5	32.3*	11.9	17.2*
10	23.0	51.0*	45.4	67.5*
12	27.3	39.1*	16.0	15.6

Table 3

Percent Deviation From Baseline Scores at Each Rate of Reinforcement for Each Subject.

	Scheduled Reinforcement Interval	
	VI 15 seconds	VI 30 seconds
subject	Strict Alternation	
1	134%	30%
3	55%	96%
5	34%	24%
7	32%	54%
9	72%	38%
11	12%	50%
	Random Alternation	
2	25%	4%
4	121%	65%
6	45%	27%
8	22%	44%
10	122%	49%
12	43%	-3%