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SOME EFFECTS OF REINFORCEMENT SCHEDULES IN TEACHING PICTURE NAMES TO RETARDED CHILDREN[1]

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The effects of several different schedules of primary reinforcement were compared in a picture-naming task with retarded children. In Experiment I, number of correct responses and learning rate were higher under fixed-ratio schedules than under continuous reinforcement. In Experiment II, number of correct responses and learning rate tended to be greater under intermediate than under low or high fixed-ratio schedules. In Experiment III, number of correct responses was higher under interlocking schedules, in which the response requirement increased with time following the previous reinforcement, than under comparable fixed-ratio schedules. Learning rates were generally low and, perhaps because of this, not very different under the two types of schedules in this experiment. Accuracy (*i.e.*, proportion of trials on which correct responses occurred) was typically high and insensitive to variations in schedule and schedule parameter throughout each experiment.

DESCRIPTORS: reinforcement schedules, continuous reinforcement, fixed-ratio schedule, interlocking schedule, retarded children, picture naming

One decision that must be made in devising procedures for training the mentally retarded concerns the schedule for reinforcer delivery, yet to date there is little applied research on which to base this decision.

Several studies have described the effects of various schedules of reinforcement on the lever-pressing behavior of normal children and retarded adults and children (*e.g.*, Ellis, Barnett, and Pryer, 1960; Long, Hammack, May, and Campbell, 1958; Orlando and Bijou, 1960), demonstrating that response rate is largely a function of the schedule of reinforcement maintaining the behavior. An immediate implication for areas such as the training of retarded children is that certain schedules might be preferable because of the high response rates they generate.

At present, training the mentally retarded often involves procedures in which primary and conditioned reinforcers follow each correct response (*e.g.*, Barton, 1970; McReynolds, 1969; Sailor and Taman, 1972; Whitman, Zakaras, and Chardos, 1971). That this is the most effective way to schedule primary reinforcers has not been established. Although some studies have employed intermittent schedules of primary reinforcement in training the mentally retarded (*e.g.*, Garcia, 1974; Garcia, Guess, and Byrnes, 1973; Guess and Baer, 1973; Twardosz and Baer, 1973), few have examined the effects of intermittent schedules in such procedures (but see Davidson and Osborne [1974] regarding the effects of several reinforcement schedules and

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schedule parameters on normal children's matching-to-sample behavior).

The purpose of the present study was to compare the effects of several schedules of primary reinforcement in a standardized procedure for teaching retarded children to name objects represented in pictures. Experiment I involved a comparison between a continuous reinforcement (CRF) schedule of primary reinforcement (*i.e.,* every correct response reinforced) and fixed-ratio (FR) schedules of primary reinforcement (every *n*th correct response reinforced, *n* fixed at some value greater than 1). Experiment II involved a comparison between different values of FR schedules of primary reinforcement. Experiment III involved a comparison between FR schedules and one type of interlocking schedule of primary reinforcement (every *n*th correct response reinforced, *n* increasing with time following the previous reinforcement).

GENERAL PROCEDURES

Each of the following three experiments involved comparisons between different schedules of primary reinforcement. Parts of the procedures common to all three experiments are outlined below.

Subjects

The children who served in the study were residents of the St. Amant Centre (in Winnipeg, Manitoba), were between the ages of 4 and 11 yr, had some verbal imitative ability, but could identify very few pictures. All were diagnosed either "severely retarded" or "autistic".

Experimental Setting

The research was conducted in small cubicles in a specially constructed operant-conditioning research area in the St. Amant Centre. Each child sat behind a table, in a corner of the cubicle, facing the experimeter. One child was worked with at a time.

Reinforcers

The verbal stimulus "good" was used for conditioned reinforcement and sugar-coated chocolate candies ("Smarties"), one per reinforcement, were used for primary reinforcement.

Preliminary Training

Before the research began, the children were taught to sit quietly, to imitate words, and to name pictures with reinforcement and shaping procedures similar to those described by Martin, England, Kaprowy, Kilgour, and Pilek (1968). The schedule of conditioned reinforcement was CRF, and the schedule of primary reinforcement was increased in steps of one from CRF to FR 5. These final reinforcement conditions were used throughout, except where otherwise indicated, for correct vocal responses.

Attending

Often in research of this type, trials are initiated only when the subject is attending. To avoid the possibility of experimenter bias when attending is defined subjectively, attending was here defined as pressing a lever or a translucent response key, depending on the type of apparatus used with a particular child, a sufficient distance to close a microswitch. Although types of apparatus differed, that used with each child was the same throughout each experiment.

A trial began with the illumination of an attending light—either a light near the lever or visible through the translucent response key. To have a picture presented, the child turned off the attending light by emitting an attending response, *i.e.,* one lever or key press. The trial terminated, and a new one began, with the illumination of the attending light immediately after a correct vocal response or an error, defined as an incorrect vocal response or no vocal response within 5 sec after an attending response. Correct vocal responses were reinforced and errors were followed with the verbal stimulus "no". Lever or key presses when the attending light was off had no scheduled effect.

To establish the attending response, the experimenter held a picture, with its back facing the child, near the operandum (lever or key) during preliminary training sessions, and over trials faded verbal prompts to press the operandum. The picture was gradually relocated until it was face down in front of the experimenter at the beginning of each trial. After a number of sessions, the children usually pressed the operandum only when the attending light was illuminated and vocalized when a picture was presented.

Picture-Naming Baseline

A number of pictures of single objects, animals, and people were selected from a Peabody Picture Vocabularly Kit. To ensure that the learning of each picture name would be attributable to only one experimental procedure, pictures that each child could name (known pictures) and pictures that each child could not name but whose names he could imitate (unknown pictures) were determined according to a standardized procedure. The pictures categorized as known and unknown were divided randomly into two pools. The unknown pictures in one pool were taught according to the schedule in one experimental condition and those in the other pool according to the schedule in a second experimental condition.

Picture-Naming Procedure

The procedure used for teaching the children to name pictures was similar to that described by Kircher, Pear, and Martin (1971). In general, the procedure for teaching an unknown picture, randomly selected from the appropriate pool, involved a series of 24 steps in which the child was required to imitate the name of and name the unknown picture on 12 trials and to imitate the names of and name three known pictures, from the same pool as the unknown picture, on trials systematically interspersed four times each with trials on which the unknown picture was presented. Each correct vocal response advanced the procedure one step. Each error recycled the procedure a number of steps, determined by the step on which the error occurred. When the final step was successfully completed, the unknown picture was said to have reached criterion, and another unknown picture was randomly selected. If, upon subsequent testing, a picture that had reached criterion was correctly named at the beginning of the next three consecutive sessions in the experimental condition in which it had reached criterion, it was considered to be a learned picture. If it was incorrectly recalled on any of these test trials, it was immediately returned to Step 1 and the procedure was repeated with it. If a picture did not reach criterion within six sessions, or if it reached criterion six times without being learned, it was discarded. Learned pictures were added to the known pictures in the corresponding word pools.

Interobserver Reliability

About one-fifth of the experimental sessions were tape recorded and played to an independent observer after he had familiarized himself with the experimenter's criteria for correct and incorrect verbal responses. The observer scored each response before hearing the experimenter's decision. The interobserver reliability measures used were the ratio of agreements to agreements plus disagreements on responses the experimenter called correct and on responses the experimenter called incorrect. Instances in which the child failed to respond were excluded from the calculations.

EXPERIMENT I
A COMPARISON BETWEEN FIXED-RATIO AND CONTINUOUS-REINFORCEMENT SCHEDULES

Since CRF is so common in applied training procedures, it is a logical standard against which to compare the effects of other reinforcement schedules. In this experiment, CRF was compared with FR 5 and FR 12. Fixed-ratio schedules were chosen because they generate high response rates in basic research (*e.g.,* Ferster and

Skinner, 1957) and because they are relatively easy to program in applied settings.

Method

Subjects

Four males and one female served.

Sidney was 5 yr old. Having previously served in Experiment III, he was the only subject familiar with some aspects of the procedure.

Teddy, 11 yr old, was a paraplegic confined to a wheelchair. Despite a large intraverbal repertoire, he was unable to name many pictures.

Ricky, 7 yr old, was diagnosed "autistic".

James, 10 yr old with arrested hydrocephaly, had an extensive history of severe self-destructive behavior (head-banging). This behavior had been eliminated by means of electric-shock punishment before the experiment began.

Lucille, 7 yr old, had a diagnosis of Turner's Syndrome. Despite a sizeable intraverbal repertoire, she was unable to name many pictures.

Setting and Apparatus

Sessions with Sidney were conducted in a cubicle in which a Lehigh Valley Electronics Modular Human Intelligence System (Model #520-02) was situated on a counter to the left of the child. It contained six panels, two of which were operative: a candy dispenser panel and a stimulus-response panel containing two translucent response keys that could be illuminated by colored lights behind the keys. The panels were programmed by a solid-state logic system located in an adjacent cubicle. The experimenter held two silent switches, for recording correct and incorrect verbal responses, which were also connected to the programming equipment. The logic system contained a timing device that automatically recorded an omission and started a new trial if 5 sec elapsed without a verbal response after an attending response.

Sessions with the other four children were conducted in similar cubicles. A console, situated in front of the child, contained two levers with a stimulus light above each, and a smaller, attending light between the levers. A second console, situated in front of the experimenter, contained mechanical counters and switches for recording correct responses and errors and for controlling the operation of the child's levers and lights.

Procedure

The experiment compared two procedures, differing only in the schedule of primary reinforcement, for teaching children to name pictures. Two consecutive sessions were conducted at the same time each day with each child, five days a week except during illnesses. A 20-min session in which primary reinforcers were delivered according to a CRF schedule alternated with a 20-min session in which primary reinforcers were delivered according to an FR 5 schedule with Sidney, Teddy, and Ricky, and according to an FR 12 schedule with James and Lucille. Different colored lights, on the keys or above the levers, and different attending-response operanda were correlated with the two experimental conditions. The two daily sessions were separated by a 10-min break and the sequence of experimental conditions was alternated on successive days.

During the CRF condition, the experimenter immediately said "good" following each correct imitative or naming response and immediately delivered a candy.

During the FR reinforcement conditions, correct vocal responses were treated exactly as in the CRF condition, except that primary reinforcement occurred on an FR schedule. The experimenter said "good" following each correct response and every fifth or twelfth "good" was accompanied by the delivery of a candy.

Experiment I lasted 26 sessions with Sidney, 13 with Teddy, 13 with Ricky, 24 with James, and 18 with Lucille.

Interobserver Reliability

For Sidney, interobserver reliability was 0.93 for correct responses and 0.84 for incorrect responses. For Teddy, it was 0.95 for correct re-

sponses and not calculated for incorrect responses because he made so few of them (fewer than one in 400 trials). For James and Lucille, it was 0.85 and 0.89 respectively for correct responses, and 0.82 and 0.87 respectively for incorrect responses. Due to the loss of Ricky's audio tapes, a reliability measure could not be calculated for him.

Results

Table 1 (column 3) shows that all children emitted more correct imitative and naming responses per session in the FR conditions than in the CRF condition. Table 1 (column 4) shows also that for all children except James, accuracy, defined as the ratio of correct responses to total trials, was approximately the same in both experimental conditions. James, however, emitted more correct responses per trial in the FR condition than in the CRF condition.

Figure 1 shows that all children, except Ricky, learned pictures at a higher rate in the FR conditions than in the CRF condition. For Ricky, the small number of pictures learned may have rendered this variable relatively insensitive to schedule effects.

Discussion

Picture-naming behavior in the FR conditions was superior to that in the CRF condition for all subjects. For all children except James, the FR schedule produced more trials per session than did the CRF schedule, while leaving accuracy relatively unaffected. As a result of this

Table 1

Mean number of correct responses per session and accuracy (ratio of correct responses to total trials) for each child in each condition during Experiment I. The first three sessions in each condition were omitted from these calculations.

Child	*Experimental Condition*	*Correct Responses*	*Accuracy*
Sidney	CRF	27	0.84
	FR 5	54	0.85
Teddy	CRF	37	0.97
	FR 5	62	0.98
Ricky	CRF	23	0.68
	FR 5	40	0.66
James	CRF	31	0.54
	FR 12	45	0.79
Lucille	CRF	41	0.85
	FR 12	55	0.83

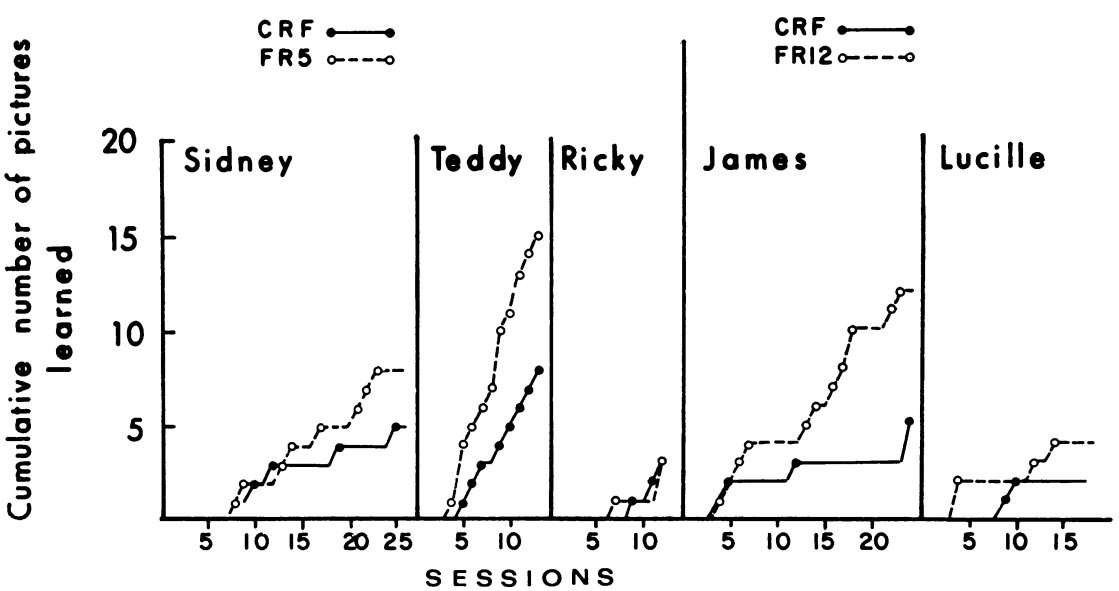

Fig. 1. Cumulative number of picture names learned by each subject under each condition during Experiment I.

higher response rate, these children emitted more correct responses, and (except Ricky) learned more pictures in the FR conditions than in the CRF condition. James, on the other hand, initiated about the same number of trials per session in both conditions. His correct responding and learning rate were greater in the FR condition than in the CRF condition because his accuracy was greater in the FR condition.

The present results contrast with those of Ferster (1958), who found that a chimpanzee emitted a greater number of correct responses in a complex response sequence under FR schedules than under a CRF schedule, but emitted approximately the same number of errors under the two types of schedules. In the present experiment, both correct responses and errors increased proportionately about the same in the FR conditions for all children except James; for all children except James, accuracy under CRF was quite high and therefore may not have been very sensitive to schedule effects (see Table 1).

The results of Experiment I are discussed more extensively in conjunction with those of Experiment II.

EXPERIMENT II
A COMPARISON BETWEEN DIFFERENT FIXED-RATIO SCHEDULES

Experiment I indicated that picture-name training can be more effective, in terms of absolute number of correct responses and learning rate, with FR than with CRF schedules of primary reinforcement. Continuous reinforcement is equivalent to FR 1, and thus these results suggested probing the range of this advantage of high FR values over low ones. This was done in Experiment II by comparing FR 5 with higher FR schedules on picture-name training.

METHOD

Subjects

Serving in this experiment were two children, Teddy and Sidney, who had previously served in Experiment I. Teddy's experimenter was unavailable after the second phase of Experiment II and, consequently, Teddy did not experience as many phases as Sidney.

Setting and Apparatus

Sessions with each child were conducted in the same cubicle and with the equipment used for that child in Experiment I.

Procedure

As in Experiment I, each child received two daily 20-min sessions conducted under different experimental conditions. The order of the conditions alternated from day to day. A different discriminative stimulus was associated with each condition, and an attending response was required on the operandum corresponding to the prevailing stimulus in order for a picture to be presented. The experimenter said "good" after each correct imitative or naming response and one candy was delivered contingent upon correct verbal responding according to the schedule in effect in each experimental condition.

Experiment II consisted of two phases for Teddy and five phases for Sidney. In one condition, the schedule of primary reinforcement was FR 5 across successive phases. In the second condition, it was FR 10, FR 15, FR 20, FR 25, and FR 15 respectively in Phases 1 through 5. Thus, the effects of the FR 5 schedule in one experimental condition served as a standard against which the effects of higher FR schedules in the other experimental condition could be compared. Teddy received 17 and 20 sessions respectively in Phases 1 and 2, and Sidney received 22, 23, 20, 6, and 8 sessions respectively in Phases 1 through 5.

Interobserver Reliability

For Teddy, interobserver reliability was 0.95 for correct responses and was not calculated for incorrect responses because he made so few of them. For Sidney, interobserver reliability was 0.91 for correct responses and 0.86 for incorrect responses.

RESULTS

Table 2 shows mean correct responding per session and accuracy in each condition of Experiment II for each child. Figure 2 indicates individual learning rates, in terms of cumulative pictures learned across sessions, in each condition.

During Phase 1, both children emitted more correct responses in the FR 10 condition than in the FR 5 condition. For Teddy, accuracy was the same—approximately 1.00—in both conditions, whereas for Sidney, it was slightly higher under FR 10 than under FR 5 (Table 2). Teddy learned six more pictures in the FR 10 condition, whereas Sidney learned at about the same rate in both conditions (Figure 2).

During Phase 2, both children again emitted more correct responses in the condition associ-

Table 2

Mean number of correct responses per session and accuracy (ratio of correct responses to total trials) for each child in each condition during Experiment II. The first three sessions in each condition of each phase were omitted from these calculations.

Phase	Experimental Condition	Mean Correct Responses		Accuracy	
		Teddy	Sidney	Teddy	Sidney
1	FR 5	60	39	1.00	0.85
	FR 10	80	50	1.00	0.90
2	FR 5	67	57	0.99	0.87
	FR 15	93	70	1.00	0.84
3	FR 5	—	61	—	0.85
	FR 20	—	66	—	0.86
4	FR 5	—	51	—	0.87
	FR 25	—	32	—	0.84
5	FR 5	—	46	—	0.77
	FR 15	—	69	—	0.86

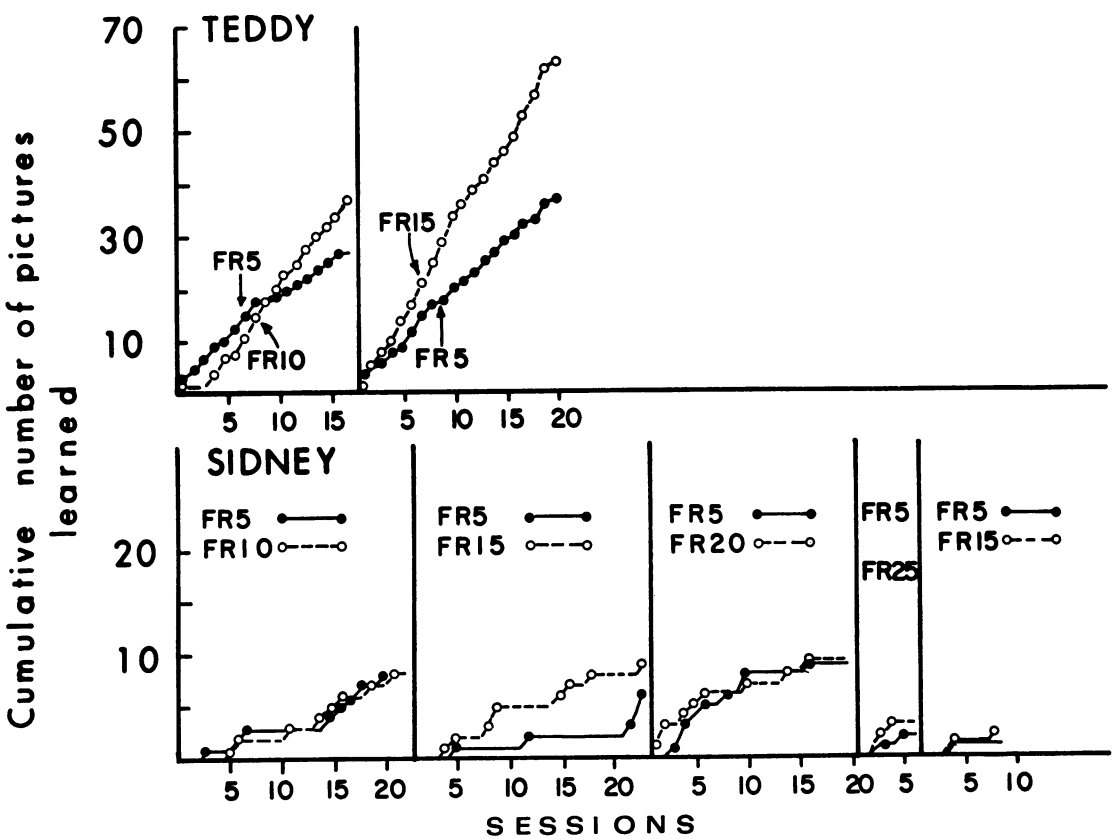

Fig. 2. Cumulative number of picture names learned by each subject under each condition during Experiment II.

ated with the higher FR value, and showed little difference in accuracy between the two conditions (Table 2). Both children learned at higher rates in the FR 15 condition than in the FR 5 condition (Figure 2).

During Phase 3, when the higher schedule was increased to FR 20 for Sidney, the two conditions yielded about the same number of correct responses (Table 2) and about the same rate of learning (Figure 2). As in previous comparisons, accuracy was about the same in both conditions (Table 2).

During Phase 4, when the higher schedule was increased to FR 25, correct responding deteriorated in the FR 25 condition such that considerably more correct responses were emitted in the FR 5 condition (Table 2). Very few pictures were learned in either condition in this phase (Figure 2). Even so, the conditions were not appreciably different from each other or from the conditions in the previous phases with respect to accuracy (Table 2).

During Phase 5, when the higher schedule was decreased to FR 15 (its value in Phase 2), Sidney again emitted more correct responses in the higher FR condition and, atypically, showed greater accuracy in the higher FR condition (Table 2). As in the preceding phase, Sidney learned very few pictures, although he did learn one more in the FR 15 condition than in the FR 5 condition (Figure 2).

Discussion

With the exception of James, the children in Experiments I and II showed better performance at the higher FR values in most comparisons, due to greater overall responding rather than greater accuracy at those values (Tables 1 and 2). For James, better performance at the higher FR value seemed to result from the effect of the schedule parameter on accuracy, rather than on overall responding. It is interesting to compare these results with those of studies on matching-to-sample accuracy. Ferster (1960) found that pigeons' matching-to-sample accuracy increased as the FR value increased. Nevin, Cumming, and Berryman (1963), on the other hand, found that pigeons' matching-to-sample accuracy first decreased and then showed no consistent trend across subjects as the FR value increased. Similarly, Davidson and Osborne (1974) found no consistent trend in normal children's matching-to-sample accuracy as the FR value increased. It may be relevant to note that in the present study, accuracy at low FR values was quite high for all children except James. High accuracy at low FR values was typical also in the studies by Nevin *et al.* and Davidson and Osborne, but not in Ferster's study. Thus, the effects on accuracy of increasing the FR value may depend on the accuracy at low FR values.

The results of Experiments I and II suggest a function in which correct responding first increases and then decreases as the FR value increases (Tables 1 and 2). Such a non-monotonic relationship between rates of simpler responses and FR size is inferred by Nevin (1973; pp. 206-207) in discussing several basic research studies on responding maintained by ratio schedules (Boren, 1953; Brandauer, 1958; Felton and Lyon, 1966). Due largely or entirely to the pattern of correct responding that defined learned pictures in the present research (see General Procedures section), learning rate tended to show the same relation to FR size as did number of correct responses (see Figures 1 and 2), However, the effect was clearer for correct responding than for learning rate, probably because there were necessarily many more correct responses than learned pictures.

Possible contributions of within-session satiation, consumption time, *etc.*, to higher response rates under the higher FR values in Experiments I and II are unclear. No obvious within-session performance decrements attributable to satiation were noted, but numerical data on this were not recorded. Consummatory behavior did not hinder performance because the children frequently emitted attending and verbal responses while eating. Moreover, they frequently accumulated several candies before eating them. Conclusively isolating the influence of such factors requires,

however, a more precise experimental analysis than was attempted here.

EXPERIMENT III
A COMPARISON BETWEEN INTERLOCKING AND FIXED-RATIO SCHEDULES

The results of Experiments I and II indicate that different simple FR schedules of reinforcement differentially affect a fairly complex operant such as picture-naming behavior. There are a number of more complex schedules whose effects might also be of interest to applied workers. In particular, schedules imposing time restrictions on responding would seem likely to enhance overall performance.

Contingencies of this sort are programmed in, for example, interlocking schedules, in which, as defined by Reynolds (1968, p. 84), the number of responses required for reinforcement changes as a function of time following the previous reinforcement. Since the results of Experiments I and II suggested that picture-naming performance is enhanced by schedules that generate high response rates in basic research, it seemed potentially useful to investigate interlocking schedules with increasing response requirements. While no data have been reported for such schedules, Zeiler (1970) reinforced pigeons' key pecking when a specified number of responses was completed in less than or more than a specified time since the previous reinforcement. He found that the former time requirement speeded completion and the latter time requirement slowed completion of the required responses. Thus, it seems that the rates of responding typically generated by FR schedules of reinforcement can be altered greatly by adding temporal contingencies.

METHOD

Subjects

Two severely retarded boys served. Bobby was 8 yr old and had been hospitalized for almost 4 yr. He had previously been a subject in an experiment investigating the effects of electric shock as a punisher in a picture-naming task (Kircher *et al.,* 1971), and was thus familiar with some aspects of the procedures used in the present experiment. Sidney was 4 yr old and had been hospitalized for 2 yr. He served in Experiment III before serving in Experiments I and II, and was completely naive with respect to the present procedures.

Setting and Apparatus

Sessions with each child were conducted in the same cubicle and with the same equipment used during sessions with Sidney in Experiments I and II, except that a lever panel, rather than a key panel, was used for the attending response. In addition, a panel containing a column of six red lights was used.

Procedure

As in the previous two experiments, a different discriminative stimulus was associated with each experimental condition. In one condition, a column of six red lights was illuminated; in the other, the lights were dark. Primary reinforcers ("Smarties" and either orange or apple juice) were delivered according to the schedule of reinforcement in effect in each experimental condition. The first candy received in each session, and subsequently every fifth candy, were accompanied by about one ounce of juice. Unlike the previous experiments, a 15-sec period in which the attending stimulus was not presented occurred after each primary reinforcement. In addition, the same operandum was used for the attending response in both conditions. In all other respects, the procedures were closely similar to those used in the first two experiments.

Sessions were conducted five days a week except during illnesses. One condition consisted of a 20-min session under an FR schedule of reinforcement, the other of a 20-min session under an interlocking schedule of reinforcement. Sessions were separated by a 10-min break and the sequence of the conditions was alternated from

one experimental day to the next. Correct responses and errors were treated as in Experiments I and II. The experiment consisted of the following four phases.

Phase 1. During Phase 1, the effects of an FR 5 schedule of primary reinforcement were compared to the effects of an interlocking schedule. In the FR 5 condition, primary reinforcement occurred after every fifth correct imitative or naming response. In the interlocking-schedule condition, primary reinforcement occurred after every fifth correct response, provided that these five responses occurred within a time period, t, following the previous reinforcement. If five correct responses did not occur within t, the response requirement increased by two responses; *i.e.,* five to seven. If this new requirement was not met within an additional time period, t, the response requirement increased by two additional responses. Until the response requirement was met, it continued to increase by two responses each time period, t, to a maximum of 15 responses. Each delivery of a primary reinforcer reset this schedule to its initial value.

Initially, t was set at a high value (2 min) and then was gradually reduced until reinforcement occurred on an average of once every eight to 10 correct responses. The final value of t = 60 sec was reached in Session 6 with Bobby and in Session 19 with Sidney. Phase 1 lasted 21 sessions for Bobby and 24 sessions for Sidney.

Phase 2. In Phase 2, the value of the FR schedule was increased to FR 8 to equal the average number of responses per reinforcement occurring in the interlocking schedule. The interlocking schedule of reinforcement remained at the same value as in Phase 1. Phase 2 lasted seven sessions for Bobby and nine for Sidney.

Phase 3. This phase reversed the conditions of Phase 2 back to the conditions of Phase 1. It lasted seven sessions for Bobby and nine for Sidney.

Phase 4. In Phase 4, the time requirement of the interlocking schedule was changed from t = 60 sec to t = 30 sec to determine if any differences between the effects of the FR schedule and the interlocking schedule in the previous phase could be accentuated. The FR schedule remained the same as in Phase 3. Phase 4 lasted five sessions for Bobby and eight for Sidney.

Interobserver Reliability

For Bobby, interobserver reliability was 0.97 for correct responses and 0.88 for incorrect responses. For Sidney it was 0.94 for correct responses and 0.79 for incorrect responses.

RESULTS

Table 3 shows mean correct responding per session and accuracy in each condition of Experiment III for each child. Figure 3 indicates individual learning rates, in terms of cumulative pictures learned across sessions, in each condition.

During Phase 1, both children emitted more correct responses in the interlocking condition and accuracy was about the same in both experimental conditions (Table 3). During Phase 1, Bobby learned six more pictures in the interlocking condition than in the FR 5 condition; Sidney learned an equal number in both conditions (Figure 3).

During Phase 2, little change resulted from increasing the FR schedule of reinforcement from FR 5 to FR 8, even though each child was now emitting about the same number of correct

Table 3

Mean number of correct responses per session and accuracy (ratio of correct responses to total trials) per session for each child in each condition during Experiment III. The first three sessions in each condition of each phase were omitted from these calculations.

		Mean Correct Responses		*Accuracy*	
Phase	*Experimental Condition*	*Bobby*	*Sidney*	*Bobby*	*Sidney*
1	Fixed-Ratio	55	40	0.89	0.88
	Interlocking	62	51	0.92	0.88
2	Fixed-Ratio	47	33	0.80	0.91
	Interlocking	61	47	0.86	0.90
3	Fixed-Ratio	51	33	0.79	0.92
	Interlocking	64	48	0.82	0.92
4	Fixed-Ratio	67	25	0.80	0.82
	Interlocking	87	29	0.90	0.84

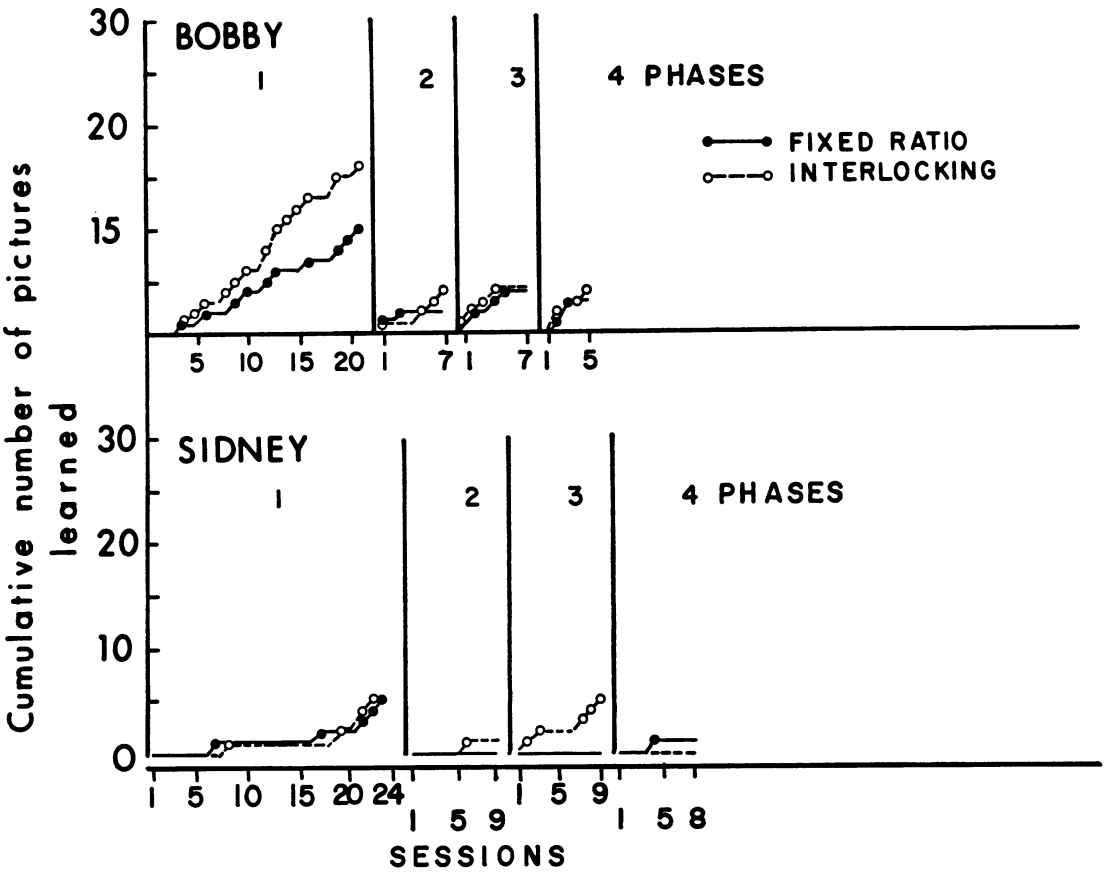

Fig. 3. Cumulative number of picture names learned by each subject under each condition during Experiment III.

responses per reinforcement in both conditions. Both children emitted more correct responses (Table 3) and learned more pictures (Figure 3) in the interlocking condition. Both children showed little difference in accuracy between conditions (Table 3).

During Phase 3, the value of the FR schedule was changed back to that in effect in Phase 1. Both children continued to emit more correct responses in the interlocking condition and, as before, accuracy was about the same in both conditions (Table 3). Sidney learned five more pictures in the interlocking condition, whereas Bobby learned an equal number in both conditions (Figure 3).

Reducing the time requirement (t) of the interlocking schedule in Phase 4 improved Bobby's performance slightly and decreased Sidney's performance in both experimental conditions. Bobby's performance was superior across all measures in the interlocking condition. Sidney emitted slightly more correct responses in the interlocking condition and his accuracy was about the same in both conditions (Table 3). He learned one more picture in the FR condition (Figure 3).

Discussion

In general, correct responding on the picture-naming task was better in the interlocking condition than with FR (Table 3). As in Experiments I and II, schedule differences had no appreciable effect on accuracy (Table 3), indicating that the schedule primarily affected overall response rate. Also as in Experiments I and II,

learning rates (Figure 3) were less sensitive to the experimental manipulations than were number of correct responses (Table 3), again, probably because there were fewer learned pictures than correct responses.

As was found in Experiment II, the improvement to be gained by increasing the response requirement appears to reach a maximum and then decrease. In Experiment II, Sidney's performance deteriorated when the FR value was increased above a certain point (Table 2 and Figure 2). In Experiment III, his performance deteriorated when the value of t in the interlocking schedule was abruptly decreased (Table 3 and Figure 3). Regarding this, note that in both experiments these decreases appeared to generalize to the comparison conditions. This apparent lack of independence should be considered in extrapolating to cases in which the conditions compared in this study are used in isolation.

In general, the data from Experiment III suggest that the type of interlocking schedule used here can effectively increase response rates. This corresponds to Zeiler's (1970) finding that the response rates of pigeons on FR schedules can be altered greatly by adding temporal restrictions. While the somewhat complex electronic programming used for the interlocking schedule might seem to limit its utility, sophisticated equipment is not essential. Such a schedule could be established with a stopwatch in any training procedure in which each target response is observed and recorded.

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