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DIFFERENTIAL REINFORCEMENT OF CORRECT RESPONSES TO PROBES AND PROMPTS IN PICTURE-NAME TRAINING WITH SEVERELY RETARDED CHILDREN

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A systematic sequence of prompt and probe trials was used to teach picture names to three severely retarded children. On prompt trials the experimenter presented a picture and said the picture name for the child to imitate; on probe trials the experimenter did not name the picture. A procedure whereby correct responses to prompts and probes were nondifferentially reinforced was compared with procedures whereby correct responses to prompts and probes were differentially reinforced according to separate and independent schedules of primary reinforcement. In Phase 1, correct responses to prompts and probes were reinforced nondifferentially on a fixed ratio (FR) 6 or 8 schedule; in Phase 2, correct responses to prompts were reinforced on the FR schedule and correct responses to probes were reinforced on an FR schedule of the same value; in Phase 3, correct responses to prompts were reinforced on the FR schedule and correct responses to probes were reinforced on a continuous reinforcement (CRF; every correct response reinforced) schedule; in Phase 4, correct responses to prompts were reinforced on a CRF schedule and correct responses to probes were reinforced on the FR schedule; in Phase 5, a reversal to the conditions of Phase 3 was conducted. For all three children, the FR schedule for correct responses to prompts combined with the CRF schedule for correct responses to probes (Phases 3 and 5) generated the highest number of correct responses to probes, the highest accuracy (correct responses relative to correct responses plus errors) on probe trials, and the highest rate of learning to name pictures.

DESCRIPTORS: differential reinforcement, probes, prompts, picture-name training, retarded children

Much verbal training can be viewed as transferring behavioral control from one type of stimulus to another. For example, a retarded child who can imitate vocal sounds may be taught to name objects or pictures by changing the controlling stimuli from sounds to objects or pictures. Because an extensive object- and picture-naming repertoire seems important for further verbal development (e.g., see Harris, 1975), research concerned with improving methods for establishing such behavior is desirable.

Commonly used picture-name training procedures involve at least two types of trials: prompt trials on which the experimenter displays a picture and says its name, and probe trials on which the experimenter presents a picture but does not name it. On prompt trials, the child is reinforced for imitating the prompt; on probe trials, he or she is reinforced for naming the picture. Typically, the frequency of reinforcement is the same for correct responses on both prompt and probe trials (Biberdorf & Pear,

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1977; Bricker, 1972; Buddenhagen, 1971; Goldstein & Lanyon, 1971; Hartung, 1970; Hewett, 1965; Hingten & Churchill, 1970; Kircher, Pear, & Martin, 1971; Stephens, Pear, Wray, & Jackson, 1975; Wolf, Risley, & Mees, 1964).

Because such nondifferential reinforcement of prompted and unprompted naming responses permits the child to earn a relatively large amount of primary reinforcement by emitting only prompted responses, performance on probe trials may suffer. Lovaas, Freitas, Nelson, and Whalen (1967) suggested that perhaps only unprompted naming responses should be followed by primary reinforcement. A danger in this is that correct responding on prompt trials might extinguish. Therefore, it might be advisable to reinforce correct responses on prompt trials, but less frequently than on probe trials. The present research investigated the effects of such a differential reinforcement procedure on the performance of retarded children in a picture-naming task.

METHOD

Subjects

Two severely retarded boys and one severely retarded girl participated in this study. The children were residents of the St. Amant Centre in Winnipeg.

Gimmi was 4 yr old and had a diagnosis of Down's syndrome. At the beginning of the study, he imitated a number of vocal sounds but did not name any pictures. His spontaneous vocal behavior consisted of babbling and a few words (e.g., "hello," "hi," "come," "no," "bad boy," "bye").

Gilles was 4 yr old and also had a diagnosis of Down's syndrome. Like Gimmi, he imitated a wide variety of vocal sounds but did not name any pictures at the beginning of the study. His spontaneous vocal behavior consisted of babbling.

Marda was 4 yr old with microcephaly. Like the other two children, she had a broad imitative repertoire but no picture-name repertoire at the beginning of the study. Her spontaneous vocal behavior consisted exclusively of babbling.

All three children were initially unfamiliar with the procedures used in this study.

Setting, Apparatus, and Materials

Experimental sessions were conducted with each child individually in a small room. The child and the experimenter sat at a table facing each other. On the table, within easy reach of the child, were: (a) a small metal box whose functional parts were a button (operated by a force of 3.14 *N*) and a small green jewel light, and (b) an empty "M & M's" candy dispenser whose operation provided auditory feedback to the child and informed the experimenter when to deliver food reinforcement. (The candy dispenser was used only to give auditory feedback because M & M's were not suitable reinforcers for these children.) The operation of the candy dispenser was controlled by digital logic programming equipment located in an adjacent room.

Near the experimenter was another metal box which contained several switches and counters for controlling the green jewel light on the child's box and for recording data. It is important to note that this electronic equipment was used only to ensure precise control over the experimental conditions (e.g., by timing trial length) so that the effects of the relevant variables in this study would be compared accurately. In strictly applied settings, this equipment would not be necessary for carrying out the training procedures described in this article.

A large stop clock on a nearby shelf timed the length of each session. A tape recorder beside the stop clock recorded the verbal responses emitted during each session. Picture cards from a Peabody Articulation Kit were used as the stimuli for picture-name training. Each of these pictures vividly depicted an item that could be described with a single word. Diet chocolate (.125 square per reinforcement) was used as

the food reinforcer for Gimmi, and ice cream (1 tsp or 4.9 ml per reinforcement) was used for Gilles and Marda. Halfway through Phase 3 the amount of ice cream per reinforcement was reduced from 1 tsp to .5 tsp (2.4 ml) for Marda because the ward staff felt she was receiving too much; however, this reduction in reinforcement magnitude did not have any observable effect on the data.

Preliminary Procedures

Preliminary procedures similar to those reported previously (Martin, England, Kaprowy, Kilgour, & Pilek, 1968) were used to train each child to sit quietly and to make eye contact with the experimenter. Following this training, the child's picture-name repertoire was tested. Between 50 and 80 pictures were presented in a fixed order to the child three times each. When a picture was presented, the child was asked, "What's this?" and given 5 sec to answer. If a correct response had occurred on all three trials, the picture would have been called a criterion picture. There were no criterion pictures for any of the three children. If no response or an incorrect response occurred within the 5-sec time limit, the experimenter prompted the child by saying the correct word. If the child correctly imitated the experimenter's prompt within 5 sec on all three trials, the picture was called a subcriterion picture. All pictures (approximately 10 to 15) not classified as either criterion or subcriterion were discarded.

Following this testing, each child was trained individually to respond on a picture-naming task. (Picture stimuli used during this preliminary picture-name training were not used during the actual study.) During this training, the schedule of food reinforcement was gradually increased from continuous reinforcement (CRF), where each correct response was followed by a food reinforcer, to a fixed ratio (FR) schedule, where food reinforcement followed a specified number of correct responses. Gimmi's picture-naming was maintained with an FR schedule whereby food reinforcement followed every eighth correct response (FR 8). For Gilles and Marda, picture-naming was maintained with an FR 6 schedule. Throughout the experiment, each food reinforcement, although delivered by hand, was accompanied by the sound produced by the operation of the empty candy dispenser. Praise ("good boy" or "good girl") was presented after each correct response.

When the food reinforcement schedule had been adjusted to its maintenance value, each child was trained to press the button on his or her console to begin a trial. To help ensure that the child would be disposed to respond to a picture when it was presented, a picture was presented only when the child had pressed the button on his or her console. At first the experimenter instructed and, when necessary, physically prompted the child to press the button. As the child's button pressing frequency increased, the experimenter faded out the prompts until the child was emitting unprompted button presses. Following button-press training, the experimental sessions began.

General Procedures

Two 20-min picture-name training sessions, separated by a 10-min break, were conducted each weekday with each child individually. The procedure for teaching the child to name pictures was similar to that used by Stephens et al. (1975). In general, the naming of each picture to be taught went through a systematic sequence. When the sequence was completed, the behavior of naming that picture reached criterion and the picture was called a "criterion picture." During the sequence, pictures with which criterion had previously been reached (i.e., criterion pictrues) were alternated with the subcriterion picture in the manner outlined below.

The sequence by which naming of subcriterion pictures was taught is diagramed in Figure 1. Although it appears to be quite complex, we have found that an inexperienced research trainee can be taught to implement the procedure within a period of 30 to 60 min. On each trial, the experimenter presented either a sub-

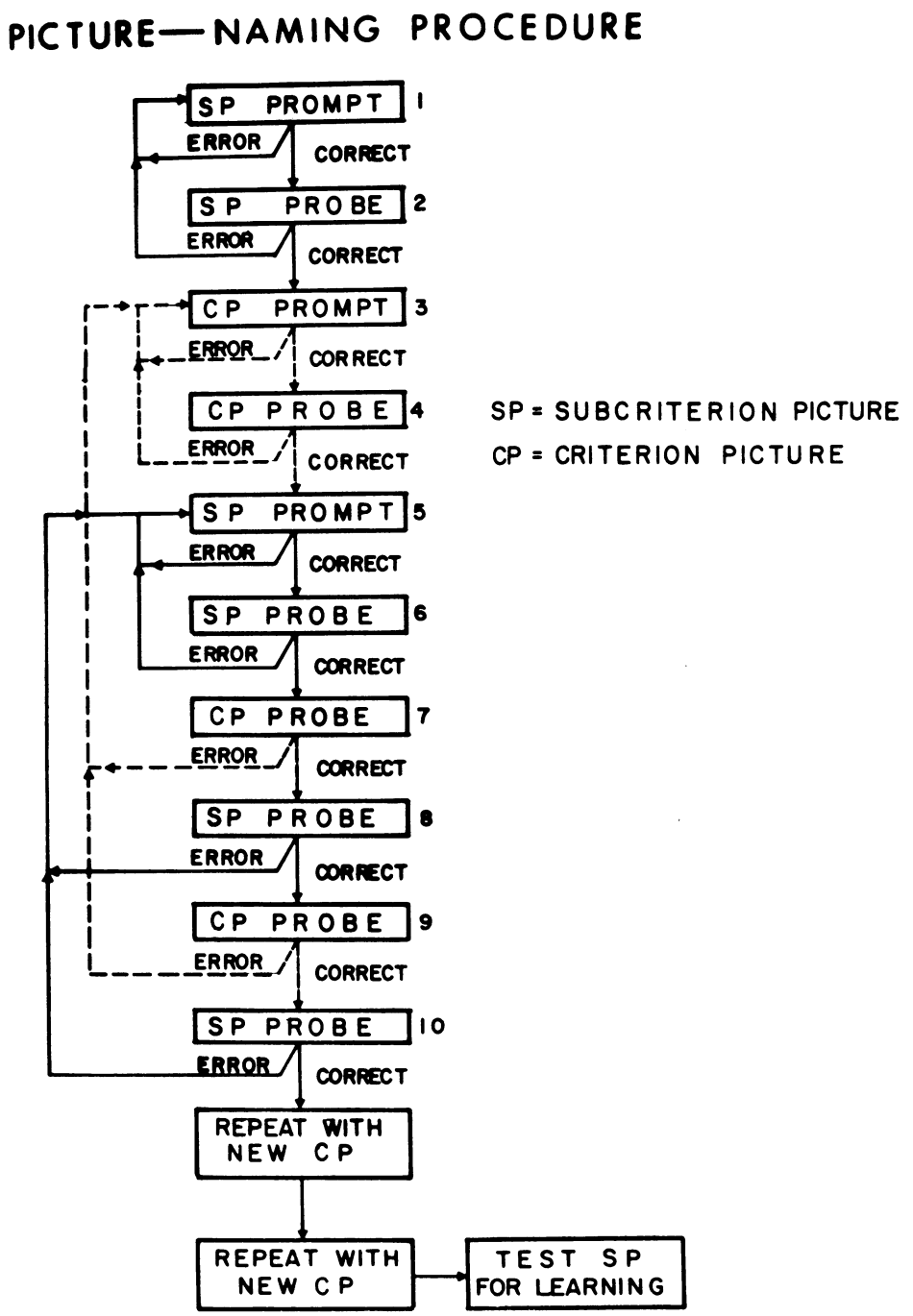

Fig. 1. Diagram of the picture-name training procedure.

criterion picture or a criterion picture. Two types of trials were used: prompt trials, on which the experimenter named the picture (e.g., said "What's this? Apple."), and probe trials, on which the experimenter simply asked the name of the picture ("What's this?"). No fading was used in the transition from prompt to probe trials. On Step 1 of the sequence, a randomly selected subcriterion picture was presented on a prompt trial. Step 1 was repeated on the next

trial with the same subcriterion picture if the child made an error, i.e., an incorrect response or a response omission. A response omission was scored if the child did not respond within 8 sec after picture presentation. If the child responded correctly on Step 1, Step 2 occurred on the next trial. On Step 3, a randomly selected criterion picture was presented, if available, and was alternated with the subcriterion picture in the manner diagramed in Figure 1. The first 10 steps of the sequence were repeated three times with, if possible, a different criterion picture each time. In the early part of the study when there were no criterion pictures, the subcriterion picture was presented on every step.

When the 10 steps were completed three times in a single session with a subcriterion picture, that picture was tested with a probe trial on each succeeding day until an error was made on one of these trials or the picture was correctly named on three consecutive days. If the former occurred, the picture-naming procedure was started anew for that subcriterion picture; if the latter occurred, the picture was considered to have reached criterion and was eligible to be used as a criterion picture in subsequent applications of the picture-naming procedure. (Note that on the days when a particular picture was tested, no training was conducted with that picture.) If a child did not complete the picture-name training sequence with a particular subcriterion picture within 6 sessions, the picture was discarded from the experiment. Approximately 15 to 20 pictures were discarded in this manner for each child.

To evaluate the reliability of the experimenter's decisions regarding correct and incorrect verbal responses, tape recordings of approximately one-sixth of the experimental sessions were played to an independent observer after she had familiarized herself with the experimenter's criteria for correct and incorrect verbal responses. This familiarization was necessary because perfect pronunciation was not required; rather, specified close approximations were acceptable. 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. Omissions were excluded from the calculations because their inclusion would have inflated the reliability measure. Percentage agreement on correct and incorrect responses, respectively, were 98% and 96% for Gimmi, 93% and 97% for Gilles, and 98% and 97% for Marda.

Trial Presentation Procedure

To begin a training session, the experimenter pressed a button on her console, thereby illuminating the green light on the child's console. The green light signaled to the child that pressing the button on his or her console would initiate a picture-naming trial. The child's button press turned off the green light and activated a trial timer in the experimenter's console. The trial terminated when a correct picture-naming response, an incorrect naming response, or a response omission occurred. A 5-sec period then elapsed prior to the next illumination of the green light, thereby giving the experimenter time to record data and prepare for the next trial. Trials were presented in this manner throughout the session.

Experimental Procedures

Table 1 summarizes the experimental conditions used in this study. A five-phase "reversal design" (e.g., Kadzin, 1979, pp. 87-90; Martin & Pear, 1978, pp. 307-310) was used. During each phase, praise followed all correct responses on both prompt and probe trials.

Phase 1—FR. Food reinforcement was delivered nondifferentially for correct prompt and probe responses according to an FR 8 schedule for Gimmi and an FR 6 schedule for Gilles and Marda. That is, correct responses on either prompt or probe trials were subsumed within the same FR primary reinforcement schedule.

Phase 2—DIFF(FR, FR). Primary reinforcement was delivered differentially for correct

Table 1

Summary of experimental conditions. Bracketed numbers represent the average obtained ratios of overall correct responses (i.e., correct responses to prompts and probes) to reinforcers for the indicated children throughout the indicated phases.

Phases	*Gimmi*	*Gilles*	*Marda*
1. FR	FR 8 (prompts or probes) [8]	FR 6 (prompts or probes) [6]	FR 6 (prompts or probes) [6]
2. DIFF (FR, FR)	FR 8 (prompts); FR 8 (probes) [8]	FR 6 (prompts); FR 6 (probes) [6]	FR 6 (prompts); FR 6 (probes) [6]
3. DIFF (FR, CRF)	FR 8 (prompts); CRF (probes) [1.5]	FR 6 (prompts); CRF (probes) [1.5]	FR 6 (prompts); CRF (probes) [1.5]
4. DIFF (CRF, FR)	CRF (prompts); FR 8 (probes) [1.4]	CRF (prompts); FR 6 (probes) [1.3]	CRF (prompts); FR 6 (probes) [1.5]
5. DIFF (FR, CRF)	FR 8 (prompts); CRF (probes) [1.8]	FR 6 (prompts); CRF (probes) [1.6]	FR 6 (prompts): CRF (probes) [1.6]

prompt and probe responses according to *separate* FR 8 (for Gimmi) or FR 6 (for Gilles and Marda) schedules. That is, every eighth or sixth correct response on a prompt trial and every eighth or sixth correct response on a probe trial were reinforced.

Phase 3—DIFF(FR, CFR). Differential reinforcement was instituted whereby correct responses to prompts were reinforced on FR, as above, and correct responses to probes were reinforced on a CRF schedule.

Phase 4—DIFF(CRF, FR). This phase was identical to Phase 3 except that the schedules of reinforcement were reversed: Correct responses to prompts were reinforced on the CRF schedule and correct responses to probes were reinforced on the FR schedule.

Phase 5—DIFF(FR, CRF). This phase was a direct replication of Phase 3.

Note that no DIFF(CRF, CRF) comparison condition was used in this study. This was because Stephens et al. (1975) found that CRF generated less efficient picture-naming performance than moderate FR schedules did.

Dependent Variables

Seven dependent variables were studied in this research. They were:

1. Daily number of correct responses to probes.
2. Daily number of errors (i.e., incorrect responses and response omissions) to probes.
3. Daily number of correct responses to prompts.
4. Daily number of errors to prompts.
5. Daily probe accuracy (i.e., the proportion of probe trials responded to correctly).
6. Daily prompt accuracy.
7. Daily number of picture-names reaching criterion.

RESULTS

Figure 2 presents the daily number of correct responses and errors (defined as incorrect responses plus response omissions) to probes for each child. There was no appreciable change in either of these variables from Phase 1, when the nondifferential FR condition was in effect, to Phase 2, when the DIFF(FR, FR) condition was in effect. However, when correct responses to probes were reinforced on the CRF schedule in the DIFF(FR, CRF) condition of Phase 3, there was a marked increase in the number of correct responses to probes for each child. At the same time, Gimmi and Gilles emitted slightly

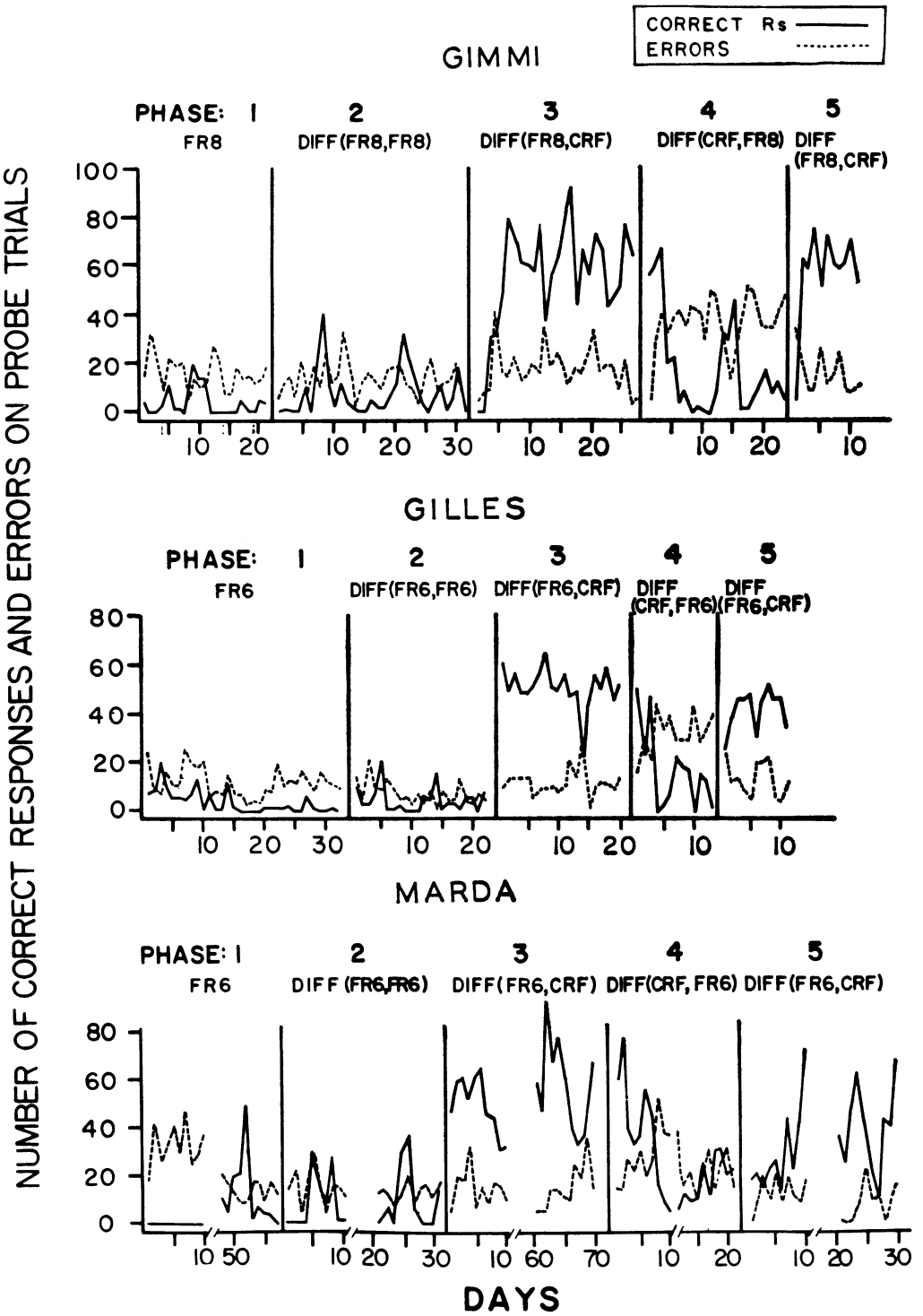

Fig. 2. Daily number of correct responses and errors on probe trials for each child. To conserve space, only the first 10 days and the last 10 days of each phase are shown for Marda. Schedule abbreviations are explained under Experimental Procedures and in Table 1.

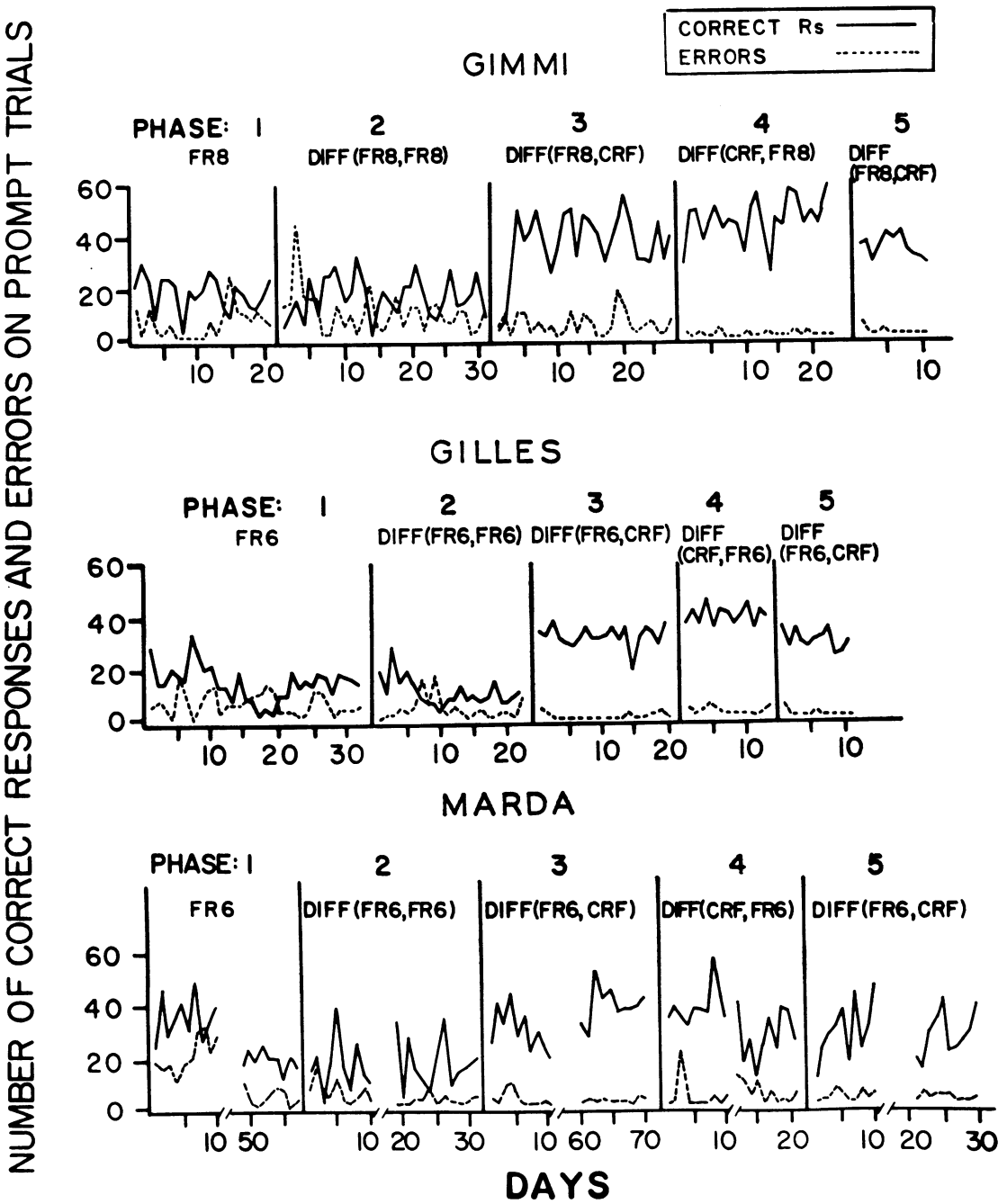

Fig. 3. Daily numbers of correct responses and errors on prompt trials for each child. To conserve space, only the first 10 days and the last 10 days of each phase are shown for Marda. Schedule abbreviations are explained under Experimental Procedures and in Table 1.

more errors to probes and Marda showed a slightly increased variability in the number of errors to probes. Because the number of trials presented was determined by the child, the increase in both correct responses and errors indicates an increase in overall rate of responding. The increase in errors reflects changes in the number of incorrect responses and not in the number of omissions.

When correct responses were reinforced un-

der the DIFF(CRF, FR) condition of Phase 4, each child's number of correct responses to probes declined to the level observed in the first two phases when correct responses to probes were also reinforced on an FR schedule. Concomitant with this decline, all three children showed an increase in the number of errors to probes. Indeed, Gimmi and Gilles maintained higher rates of errors to probes during this phase than during any other phase of the study. For Marda, this particular effect was less pronounced and was transitory.

When the DIFF(FR, CRF) condition of Phase 3 was reinstated in Phase 5, the number of correct responses to probes increased for all three children. It increased to the level observed in Phase 3 for Gimmi, and to slightly below that level for Gilles and Marda. The number of errors to probes decreased to their Phase 3 levels for all three children.

Figure 3 presents the daily number of correct responses and errors to prompts for the three children. As in the case of probes, there was no appreciable change in either of these variables from Phase 1, when the FR condition was in effect, to Phase 2, when the DIFF(FR, FR) condition was in effect. However, when the DIFF(FR, CRF) condition was introduced in Phase 3, there was a sizable increase in the number of correct responses to prompts for each child relative to the first two phases, despite the fact that during all three phases correct responses to prompts were reinforced on the same FR schedule. There was no appreciable change in the number of errors to prompts. When correct responses were reinforced under the DIFF(CRF, FR) condition of Phase 4, Gimmi and Gilles emitted slightly more correct responses to prompts than in Phase 3, while errors to prompts were near zero. Marda, on the other hand, emitted slightly fewer correct responses and slightly more errors to prompts in Phase 4 than in Phase 3. However, she still emitted more correct responses to prompts in Phase 4 than in Phases 1 and 2.

When the DIFF(FR, CRF) condition of Phase 3 was reinstated in Phase 5, the number of correct responses to prompts for each child remained at a level above that observed in Phases 1 and 2. For Gimmi and Gilles, the number of correct responses to prompts returned to the level observed in Phase 3. For Marda, the number of correct responses to prompts did not change systematically. Number of errors remained low for all three children.

Figure 4 presents the daily probe and prompt accuracies. Probe accuracy was defined as the proportion of probe trials responded to correctly; prompt accuracy was defined as the proportion of prompt trials responded to correctly. In Phases 1 and 2, when correct responses were reinforced on FR and DIFF(FR, FR), respectively, there was a large amount of unsystematic variability in both probe and prompt accuracy for all children. In Phase 3, when correct responses were reinforced under the DIFF(FR, CRF) condition, all three children showed a substantial reduction in the variability of both types of accuracy and a marked increase in their magnitudes. When correct responses were reinforced under the DIFF(CRF, FR) condition of Phase 4, probe accuracy declined to the levels recorded in Phases 1 and 2 for all children. Prompt accuracy in Phase 4 remained at the high levels recorded in Phase 3 for Gimmi and Gilles. Although Marda's prompt accuracy initially decreased, it returned to the high level previously observed in Phase 3. When the DIFF(FR, CRF) condition of Phase 3 was reinstated in Phase 5, probe and prompt accuracies returned to or remained at the high levels observed in Phase 3 for all children.

Figure 5 presents the cumulative records across days of the pictures on which naming reached criterion for each child. The rate at which picture-naming reached criterion was near zero for all children under the FR condition of Phase 1 and the DIFF(FR, FR) condition of Phase 2. However, under the DIFF(FR, CRF) condition of Phase 3, all three children showed a dramatic increase in the rate at which their naming of the pictures reached criterion. Under

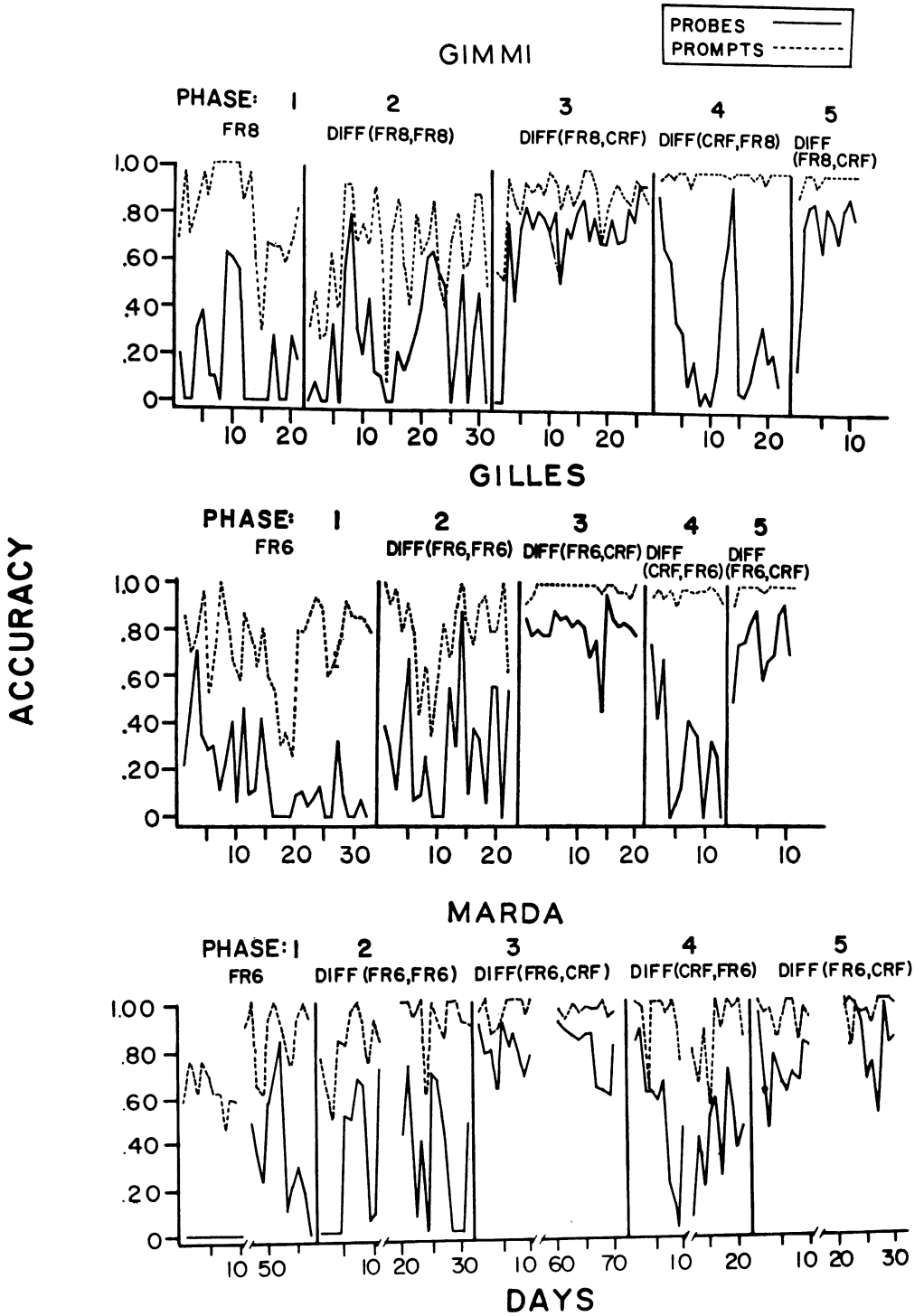

Fig. 4. Daily accuracies on probe and prompt trials for each child. To conserve space, only the first 10 days and the last 10 days of each phase are shown for Marda. Schedule abbreviations are explained under Experimental Procedures and in Table 1.

the DIFF(CRF, FR) condition of Phase 4, the rates were initially high but quickly dropped to the near-zero levels observed in Phases 1 and 2. It should be noted that the pictures for which naming reached criterion at the beginning of Phase 4 were trained at the end of Phase 3; the test probes for these pictures were conducted over the first three days of Phase 4 (see General Procedures section) and therefore naming of these pictures was recorded as reaching criterion in Phase 4. Thus, the high rates observed at the beginning of Phase 4 reflect the effects of the DIFF(FR, CRF) condition of Phase 3. (This is indicated in the cumulative record by not resetting the line to zero at the beginning of a phase until testing had been completed on the picture-names that were completely trained in the previous phase.) When the DIFF(FR, CRF) condition was reinstated in Phase 5, the rates at which picture-naming reached criterion returned to the high levels observed under the same condition in Phase 3 for all three children.

DISCUSSION

The results of this study indicate that reinforcement schedules involving equal densities of primary reinforcement for correct responses on both probe and prompt trials may not be the most effective in the verbal training of retarded children. It appears that a more effective reinforcement schedule for such verbal training is one in which the density of primary reinforcement is greater for correct responses to probes than for correct responses to prompts. All three children in this study made many more correct probe responses, had markedly higher probe accuracies, and learned picture-names at higher rates under this type of differential reinforcement schedule.

Because the schedule manipulations in this study were associated with changes in the overall number of correct responses per reinforcement (see the bracketed numbers in Table 1), it is necessary to consider the possibility that the observed effects resulted from these changes rather than from the differential reinforcement procedures per se. Two lines of evidence indicate the remoteness of this possibility. First, Stephens et al. (1975), using a procedure similar to the nondifferential procedure used in Phase 1 of the present study, found that accuracy was little affected by changes in the overall ratio of correct responses to reinforcement. Although in that study the behavior of one child tended to show a functional relationship between accuracy and this ratio, that relationship was a direct one, whereas it was inverse in Phases 2 and 3 of the present study (see Table 1 and Figure 4). Moreover, whereas the children in the Stephens et al. study made more correct responses and learned more picture names when the ratio was increased (within the range of the overall ratios in the present study), the increases in correct responses and learning in Phase 3 of the present study were associated with decreases in the ratio (see Table 1 and Figures 2, 3, and 5). The second, and probably more important, line of evidence can be seen by examining the data from Phases 3, 4, and 5 of the present study. The ratios of correct responses to reinforcement showed very little change from one phase to the next (see Table 1). Yet the children emitted many more correct responses to probes and had higher learning rates in Phases 3 and 5 than in Phase 4 (see Figures 2 and 5). From the evidence in the study of Stephens et al., it seems unlikely that such slight changes in reinforcement frequency alone could have resulted in such large effects.

One effect of the schedule manipulations on number of correct responses to prompts is particularly noteworthy, because it was somewhat unexpected. Reinforcing correct responses to probes on CRF in Phase 3 led to an increase in correct responses to prompts, even though the FR reinforcement schedule for correct responses to prompts was the same as in Phase 2. This finding can probably be explained by the sequencing of prompt and probe trials (see Figure 1). A correct response on a prompt trial led to a probe trial, whereas an error on a prompt

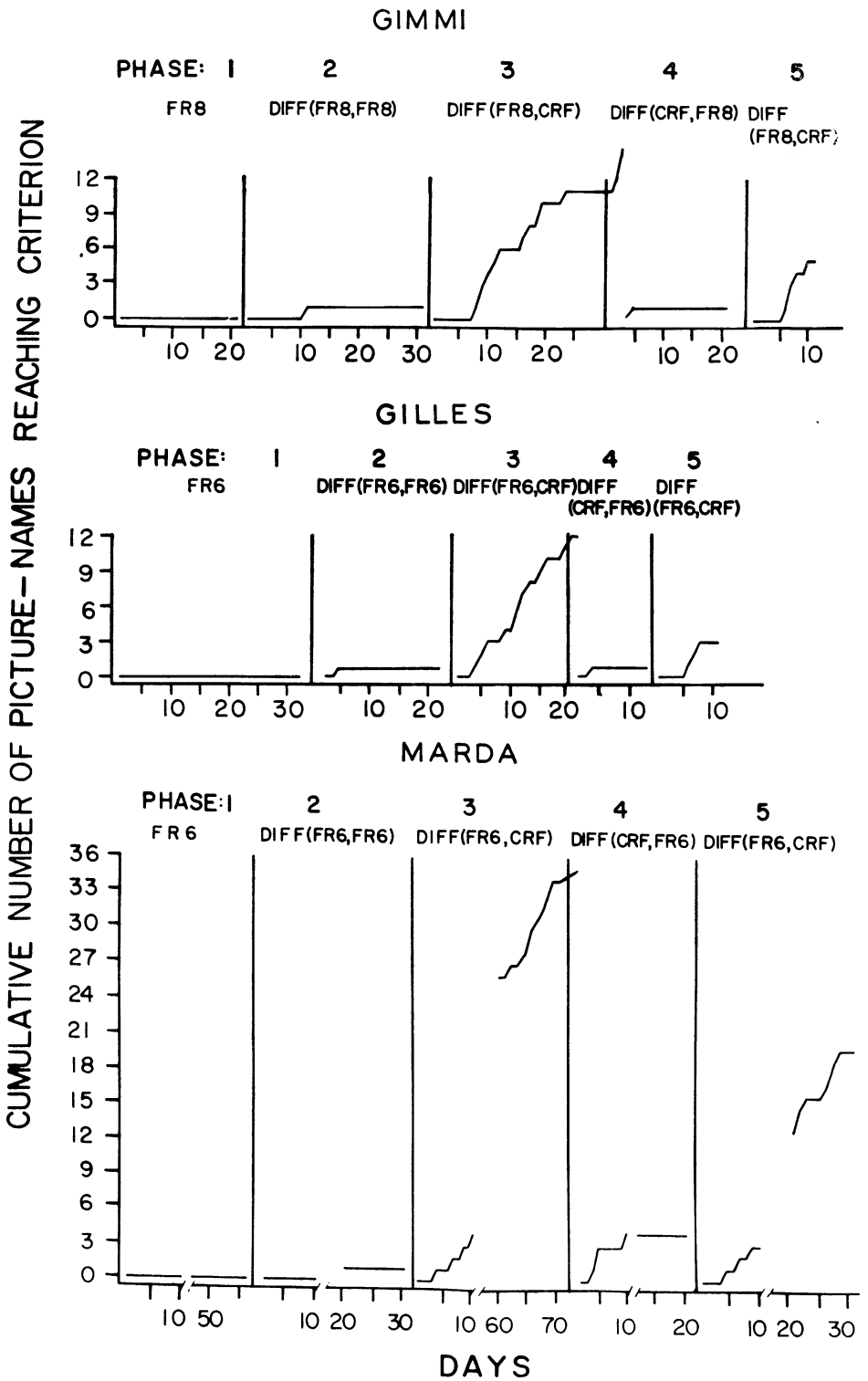

Fig. 5. Daily cumulative number of picture-names reaching criterion for each child. The line does not reset after the end of a phase until that point at which all the pictures trained during that phase had been tested. To conserve space, only the first 10 days and the last 10 days of each phase are shown for Marda. Schedule abbreviations are explained under Experimental Procedures and in Table 1.

trial was followed by another prompt trial. Hence, increasing the density of reinforcement for correct responses on probe trials in Phase 3 may have enhanced the effectiveness of probe trials as conditioned reinforcers for correct responses on prompt trials. When the schedule of food reinforcement for correct probe responses was changed from FR to CRF in Phase 3, the increased conditioned reinforcement value of probe trials produced a corresponding increase in correct prompt trial responding.

The increase in errors on probe trials in Phase 4 may be explained in a similar manner. Whereas correct responses to prompts were always followed by probe trials, errors on probe trials always led to prompt trials. Hence, when the reinforcement density for correct responses to prompt trials increased, there was a corresponding increase in errors on probe trials. This observation underlines the major conclusion to be drawn from this study: The relative amount of reinforcement available for correct responses on prompt and probe trials may exert a strong influence on the progress of verbal training.

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