THE UNIVERSITY OF MANITOBA

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

by

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ABSTRACT

Three retarded children were taught to name pictures using a systematic sequence of prompt and probe trials. On prompt trials the experimenter said the picture-name for the child to imitate; on probe trials the experimenter did not name the picture. Learning a picture-name was operationally defined by a specified number and distribution of correct responses by the child to prompts and probes. A procedure whereby correct responses to prompts and probes were non-differentially reinforced according to a single fixed-ratio (FR) schedule of primary reinforcement was compared with procedures whereby correct responses to prompts and probes were differentially reinforced according to separate and independent FR schedules of primary reinforcement. The study consisted of five phases. (One of the three children participated in only the first three phases.) In Phase 1, correct responses to prompts and probes were reinforced non-differentially on an FR n schedule (where n=8 for one child; n=6 for the other two children); in Phase 2, correct responses to prompts were reinforced on an FR n schedule and correct responses to probes were reinforced on an FR n schedule; in Phase 3 correct responses to prompts were reinforced on an FR n schedule and correct responses to probes were reinforced on an FR 1 schedule; in Phase 4 correct responses to prompts were reinforced on an FR 1 schedule and correct responses to probes were reinforced on an FR n

schedule; Phase 5 was a direct replication of Phase 3. For all three children, the FR n schedule for correct responses to prompts combined with the FR 1 schedule for correct responses to probes (Phases 3 and 5) generated a high number ot correct responses to prompts, a low number of errors to prompts, the highest number of correct responses to probes, the lowest number of errors to probes, and the greatest rate of learning to name pictures.

CHAPTER I

Introduction

Approximately three per cent of the population of North America has been classified as mentally retarded (Edgerton, 1967, p. 1). Within this segment of the population, it has been found that level of language development is the most reliable indicator of an individual's future social development (Eisenberg, 1956; Hartung, 1970). The most prominent characteristic of the mentally retarded is an absence of or deficiency in language production (Bricker, 1972; MacCubrey, 1971). For this reason, much research has been directed towards the development of effective verbal-training procedures for mentally retarded individuals. The majority of this research has focused on the verbal training of retarded children, who will therefore constitute the focus of the following discussion.

Two goals of the verbal training of retarded children are to generate behaviors which the child will emit in a variety of situations outside of the training setting and to produce generative verbal behavior (i.e., verbal behavior that was not specifically trained) (Barton, 1970; Bricker & Bricker, 1972; Gray & Fygetakis, 1968a; Schumaker & Sherman, 1970; Stevens-Long & Rasmussen, 1974). There is some controversy regarding the behavioral training sequence that achieves these goals most efficiently. While this

controversy remains to be resolved by empirical evidence, the majority of investigators have adopted the following general steps (e.g., Blake & Moss, 1967; Brawley, Harris, Allen, Fleming, & Peterson, 1969; Bricker, 1972; Bricker & Bricker, 1970; Buddenhagen, 1971; Hartung, 1970; Hewett, 1965; Lovaas, 1971; Marshall & Hegrenes, 1972; Schell, Stark & Giddan, 1967): first, the child is trained to sit quietly in a chair; second, he is trained to attend to the experimenter; third, he is trained to imitate gross and fine motor movements modelled by the experimenter; fourth, he is trained to imitate sounds and words modelled by the experimenter; fifth, he is trained to name objects and/or pictures of objects; sixth, he is trained to speak in grammatically accurate phrases and short sentences. Variations on this sequence include omission of attending training (e.g., Lovaas, Beberich, Schaeffer & Perloff, 1966; MacCubrey, 1971; Risley, Hart & Doke, 1972), omission of motor imitation training (e.g., Goldstein & Lanyon, 1971; Sulzbacher & Costello, 1970), and addition of a receptive language training stage between the vocal-imitation and object-naming stages (Kent, Klein, Falk & Guenther, 1972).

Several procedures for training at each stage of the sequence have been reported in the literature. Virtually all of these procedures are based on the principles of behavioral control established by the experimental analysis of behavior (Buddenhagen, 1971; Holland, 1967; MacCubrey, 1971; Matheny, 1968). Reinforcement is always used to

increase the probability of the occurrence of desired behaviors (e.g., Baer, Peterson, & Sherman, 1967; Buddenhagen, 1971; Frisch & Schumaker, 1974; Hingten & Churchill, 1969; Isaacs, Thomas, & Goldiamond, 1967; Kircher, Pear, & Martin, 1971; Lovaas et al., 1966; Risley & Reynolds, 1970; Salzinger, Feldman, Cowan & Salzinger, 1965; Steeves, Martin, & Pear, 1970; Weiss & Born, 1967). Punishment (e.g., time-out: Garcia, Guess & Byrnes, 1973; Lutzker & Sherman, 1974; Hartung, 1970; Barton, 1970; McReynolds, 1969; reprimand: Bricker & Bricker, 1972; Sulzbacher & Costello, 1970; token loss: McReynolds & Huston, 1971; shock: Kircher et al., 1971) or extinction (e.g., Schell et al., 1967; Twardosz & Baer, 1973; Risley & Wolf, 1967; Brawley et al., 1969) is often used to reduce the frequency of undesired behaviors. Shaping is used to develop new behaviors (e.g., MacCubrey, 1971; Garcia, Baer, & Firestone, 1971; Blake & Moss, 1967; McReynolds & Huston, 1971; Bricker & Bricker, 1970; 1972). Fading is used to bring existing behaviors under the control of new stimuli (e.g., Goldstein & Lanyon, 1971; Hingten & Churchill, 1969; Kent et al., 1972; Risley & Wolf, 1967; Sulzbacher & Costello, 1970). These techniques have been combined in a variety of ways to produce a variety of training procedures for each stage of the behavioral training sequence. The most widely accepted training procedures will be described for each stage.

Sitting

Investigators of verbal training agree that an important prerequisite for training is that the child sit quietly in a chair for the duration of the training period (e.g., Harris, 1975; Kent et al., 1972; Lovaas, Berberich, Perloff, & Schaeffer, 1966; Martin, England, Kaprowy, Kilgour, & Pilek, 1968). Shaping and reinforcement procedures are generally used to develop this behavior. For example, Kent et al. (1972) trained a child to sit quietly in the following way. The experimenter placed the child in a chair while saying "sit down", and reinforcement was immediately presented to the child. Gradually the child was required to remain seated for longer and longer intervals of time before a reinforcement was delivered. If the child left his chair before the time interval required for reinforcement had elapsed, the experimenter reseated him immediately and began timing the interval again. A similar procedure was used by Blake and Moss (1967) and by Martin et al. (1968).

Reinforcers that have been used in training of this type include primary reinforcers such as candy and ice cream (Kent et al., 1972), and conditioned reinforcers such as praise (Kent et al., 1972) or tokens which could be exchanged for edibles or toys (Martin et al., 1968). Another reinforcer was described by Blake and Moss (1967). These investigators placed the child by himself

in a small, dark booth. When the child remained seated for the required time interval, the booth was lighted and a shutter opened, allowing the child to see the experimenter seated outside the booth. Shaping and reinforcement procedures such as these have been very effective in training children to remain seated for the duration of training sessions.

Attending

While some investigators do not require the child to attend to the experimenter in training (e.g., MacCubrey, 1971; Sailor, Guess, Rutherford, & Baer, 1968), most investigators argue that the child's attention to the experimenter is a crucial requirement for effective training (e.g., Buddenhagen, 1971; Gray & Fygetakis, 1968; Harris, 1975; Hartung, 1970; Kent et al., 1972; Martin et al., 1968). A child is said to be attending when he emits some specified "attending" response. At least three attending responses have been described--eye contact with the experimenter (e.g., Bricker & Bricker, 1970; Buddenhagen, 1971; Risley & Wolf, 1967; Schell et al., 1967; Steeves, Martin, & Pear, 1970), pressing a lever (Biberdorf, 1975; Stephens, 1975; Stephens, Pear, Wray, & Jackson, 1975), and placing a marble into a box (Blake & Moss, 1967; Hewett, 1965). Once the desired attending response is established in the child's repertoire, the child is required to emit

this response to initiate a training trial (e.g., Frisch & Schumaker, 1974; Kircher et al., 1971; Risley & Wolf, 1967; Stephens et al., 1975).

Eye contact is the most commonly reported attending response in the literature on verbal training. The child is typically trained to make eye contact with the experimenter using techniques of fading and reinforcement. For example, in one type of eye-contact training, the experimenter holds the reinforcer (typically, a spoonful of food) at his eye level. Since a child will look at the reinforcer, this procedure tends to ensure that the child looks towards the experimenter's face. The experimenter waits until the child's glance shifts from the reinforcer to his face and then presents the reinforcer to the child. As the child begins to focus on the experimenter's face more and upon the reinforcer less, the experimenter gradually lowers the reinforcer. The effectiveness of this procedure has been reported by Goldstein and Lanyon (1971) and by Risley and Wolf (1967). A second procedure to develop eye contact is similar to this except that, rather than waiting for the child to establish eye contact with the experimenter spontaneously, the child is told "look at me", or "look over here". The child is reinforced for obeying the command within a preset time limit. If the child fails to obey the instruction, the experimenter may provide a physical prompt by moving the child's head in

the appropriate direction. The success of this procedure has been reported by Bricker and Bricker (1972), Kent et al. (1972), Marshall and Hegrenes (1970), and Sulzbacher and Costello (1970).

The lever-press and marble-drop attending responses have been used by only a small number of investigators. While the procedures for training these responses have not been described in detail (e.g., see Blake & Moss, 1967; Hewett, 1965), some effective procedures have involved physical and verbal prompts which are gradually faded, and praise and primary reinforcement (usually candy) which are delivered to the child each time he emits the desired response (e.g., Biberdorf, 1975; Stephens, 1975; Stephens et al., 1975).

Motor Imitation

Any behavior can be considered imitative if it occurs shortly after behavior demonstrated by someone else, called a model, and if its topography is similar to and functionally controlled by the topography of the model's behavior (Baer, Peterson, & Sherman, 1967, p. 405).

Virtually all investigators emphasize the importance of a verbal imitative repertoire to the development of speech (e.g., Lovaas et al., 1966; Lovaas, Freitas, Nelson, & Whalen, 1967; Metz, 1965; Risley et al., 1972; Schell et al., 1967; Sherman, 1965; Wolf & Risley, 1967). While there are few data documenting the extend to which

motor-imitation training facilitates later verbal-imitation training (Harris, 1975) and while some investigators recommend omission of the motor imitation stage of training (e.g., Garcia et al., 1971; Lovaas et al., 1966), most investigators assume that motor-imitation training facilitates the later acquisition of verbal imitation (e.g., Buddenhagen, 1971; Hartung, 1970; Hingten & Churchill, 1970; Marshall & Hegrenes, 1970; Stark, Giddan, & Meisel, 1968). For this reason, the majority of investigators include a motor imitation phase in their verbal training program.

Motor-imitation training typically involves techniques of fading and reinforcement. Training usually proceeds in the following way (e.g., Baer et al., 1967; Blake & Moss, 1967; Brawley et al., 1969; Bricker & Bricker, 1970; Garcia et al., 1971; Kent et al., 1972; Lovaas et al., 1967; MacCubrey, 1971; Stark et al., 1968). The experimenter models a motor response (e.g., hand-clapping) to a non-imitative child while saying "do this". The child is then physically prompted to imitate the experimenter's behavior--that is, the experimenter "puts the child through" the behavior (e.g., by clapping the child's hands together). The child is immediately reinforced (usually with praise and edibles) for performing the response. This procedure is repeated many times while the experimenter gradually uses fewer prompts. If the child responds incorrectly, most investigators

ignore the behavior and provide the necessary prompts to produce a correct response (e.g., Lovaas et al., 1967; Metz, 1965; Stark et al., 1968). However, some experimenters say "no" following an incorrect response and then prompt the behavior if necessary (e.g., Bricker & Bricker, 1970), while others institute a time-out period for incorrect responses and provide the necessary prompt on the next trial (e.g., Hewett, 1965). As the frequency of incorrect responses declines, and it becomes apparent that the child will imitate the response without a prompt, the experimenter gradually fades out the prompts. Eventually, the child comes to imitate the experimenter's behavior without prompts. Thus, the child's behavior, initially controlled by prompting, comes under the control of the experimenter's modeling behavior. After one imitative response is established in the child's repertoire, a second response is taught using the same procedure. After the second imitative response is established in the child's repertoire, the experimenter requires the child to imitate both responses in a single session, thereby teaching the child to discriminate one from the other. Additional imitation responses are then trained in a similar manner.

Early in training, praise and a primary reinforcer (usually an edible) are provided following each correct response, prompted or unprompted, on a continuous reinforcement schedule (CRF). However, as training

progresses, the primary reinforcer is usually delivered less frequently according to some intermittent schedule (Brawley et al., 1969).

In addition to developing those motor-imitative behaviors that have been specifically trained, intensive training appears to produce motor-imitative behaviors that have not been directly trained. This behavioral phenomenon has been referred to as generalized motor imitation (Baer et al., 1967; Baer & Sherman, 1964; Garcia et al., 1971).

Vocal Imitation

When an extensive motor imitation repertoire has been established such that virtually any new motor performance by the experimenter is almost certain to be imitated, vocal-imitation training typically begins (Baer et al., 1967). Vocal imitation training involves techniques of shaping, fading and reinforcement.

The most commonly reported procedure for developing verbal imitation involves four stages (Hartung, 1970; Hingten & Churchill, 1970; Lovaas, 1971; Lovaas et al., 1966; Lovaas, Koegel, Simmons, & Long, 1973; Risley et al., 1972). Initially all vocalizations emitted by the child are reinforced. When the child is vocalizing at a high rate, reinforcement is delivered contingent on only those vocalizations which are emitted by the child within a prescribed time limit after an experimenter's vocalization. The third stage requires that

the child be reinforced only if the sound he emits within the prescribed time interval resembles the experimenter's sound. The fourth stage involves the introduction of a new sound randomly interspersed with the sound trained at the third stage. Beyond this point, the process is one of increasing the number of discriminated sounds (Harris, 1975). Variations of this procedure include by-passing the first two stages of the sequence (e.g., Bricker, 1972; Hewett, 1965), training the new sound at the fourth stage without interspersing the previously trained sounds (e.g., Blake & Moss, 1967), and adding a fifth stage to train discrimination between two (or more) previously established verbal imitation responses (e.g., Blake & Moss, 1967).

Another, less frequently used, procedure to develop vocal imitation involves incorporating a vocal response to be imitated in a chain of motor responses. That is, the experimenter models a chain of motor responses which terminates with a vocal response. The child is required to imitate the complete motor-verbal chain to earn reinforcement. As the child begins to imitate the chain (including its verbal component) the motor components are gradually eliminated. Eventually, the child imitates the vocal model presented alone. Then, further training is conducted to develop imitation of other sounds. This procedure has been successfully used by Baer et al., (1967) and by Borus, Greenfield, Spiegel, and Daniels (1973).

The child's first vocal imitations must be developed by careful shaping procedures. That is, successively closer and closer approximations to the desired behavior must be reinforced, until finally the child emits the desired imitation. To facilitate this shaping training, many investigators favor sounds with visual components (e.g., /oh/, /m/, /ah/, /ee/) for early vocal imitation training (e.g., Buddenhagen, 1971; Schell et al., 1967; Stark et al., 1968). Shaping procedures to develop the imitation of such sounds may be augmented by the use of prompts which position the child's mouth and lips appropriately. These prompts are faded until the child imitates the sound on his own. After the child learns to imitate sounds with visual components in this way, he may be more easily taught to imitate other, less visually distinctive, sounds and words by means of shaping (Harris, 1975; Lovaas et al., 1966).

A variety of reinforcers have been used in developing vocal imitation. Conditioned reinforcement typically consists of praise (e.g., Bricker & Bricker, 1972; Garcia et al., 1971; MacCubrey, 1971; Steeves et al., 1970). Conditioned reinforcement is usually delivered according to a CRF schedule of reinforcement (Harris, 1975). Primary reinforcement may consist of edibles (e.g., Baer et al., 1967; Blake & Moss, 1965; Bricker & Bricker, 1972; Garcia et al., 1971; Steeves et al., 1970), coloured lights (e.g., Blake & Moss, 1967),

music (e.g., Buddenhagen, 1971), physical contact (e.g., Kerr, Meyerson, & Michael, 1965; Lovaas et al., 1966), games (e.g., Hewett, 1965), and the opportunity to play with a tape recorder (e.g., Buddenhagen, 1971). At the beginning of training primary reinforcement is delivered according to a CRF reinforcement schedule, but as training proceeds, primary reinforcement is shifted to an intermittent schedule (MacCubrey, 1971; Salzinger et al., 1965; Steeves et al., 1970).

Procedures to minimize incorrect responding and other unwanted behaviors during vocal imitation training include time out (e.g., Borus et al., 1973; Hewett, 1965; McReynolds, 1969; Steeves et al., 1970), extinction (e.g., Clarke & Sherman, 1975; Cook & Adams, 1966; Schell et al., 1967), response cost (e.g., McReynolds & Huston, 1971), increased task complexity (Sailor, Guess, Rutherford, & Baer, 1968), and shouts and slaps (e.g., Lovaas et al., 1966).

Thus, a wide variety of investigators have studied procedures to develop vocal imitation in children. Procedures of shaping, fading physical prompts, reinforcement of desired behavior and extinction and punishment of undesired behavior have been shown to be very effective in training children to imitate vocal behavior. Like the case of motor-imitation training, intensive vocal-imitation training appears to develop imitation not only of those vocal responses directly trained, but

also of vocal responses not trained. That is, vocal imitation training seems to establish a generalized vocal-imitative response class (Bricker, 1972; Brigham & Sherman, 1968; Garcia et al., 1971; Steinman, 1970).

Object-Naming

Imitative speech per se has no communicative value. Thus, after a child has been trained to imitate vocal stimuli, further training is necessary to transform this behavior into a "useful skill" (Harris, 1975). The first step towards this end is to teach the child to name objects and/or pictures of objects (Lovaas, 1971; Harris, 1975; Hartung, 1970). Several procedures to develop object-naming in children have been described.

The most commonly used object or picture-name training procedure proceeds in the following way. The experimenter holds up an object or picture, says "What is this?" and then immediately prompts with the appropriate name. Reinforcement is contingent on the child's imitating the prompt. After several such trials, the time between the question ("What is this?") and the prompt is gradually lengthened. If, after several trials, the child continues to wait for the presentation of the verbal prompt, a partial prompt is given ("ba" for ball, for example). If the correct response does not occur within about five additional seconds, the complete prompt is presented. When the

child begins to say the name when only a partial prompt is presented, the experimenter continues the above procedure but begins to say the partial prompt more softly. If the child fails to respond correctly on any trial, the partial prompt is presented more loudly on the following trial. When the child responds correctly to the partial prompt, the next partial prompt is given more softly. Eventually, the child comes to respond to the object and the question, "What is this?", with the name of the object without any prompts. After the child has been taught in this way to name one object, he is taught in the same way to name a second object. The two objects are then presented in a random order and the child is taught to name each appropriately. The child thus learns to discriminate between the two objects. Training then continues with additional objects. This procedure has been used by many investigators to develop extensive naming repertoires in children (e.g., Goldstein & Lanyon, 1971; Hartung, 1970; Hingten & Churchill, 1969; Risley et al., 1972; Risley & Wolf, 1967; Stark et al., 1968; Sulzbacher & Costello, 1970; Wolf, Risley, & Mees, 1964).

A second object-name training procedure is similar to that just described, except that it does not involve a lengthening of the time between the question ("What is this?") and the prompt. Instead, whenever the experimenter holds up the object and asks "What is this?"

he immediately prompts with the object's name on every trial. The child is reinforced for imitating the prompt. As the training proceeds, the experimenter fades the intensity (i.e., the volume) of the prompt until, eventually, the child comes to name the object without a prompt from the experimenter. The effectiveness of this procedure has been reported by several investigators (e.g., Bricker & Bricker, 1972; Buddenhagen, 1971; Hewett, 1965; Kent et al., 1972; Lovaas, 1971; MacCubrey, 1971; Marshall & Hegrenes, 1970; Martin et al., 1968).

A third object-name training procedure has also been reported. Training according to this procedure involves two types of trials: prompt trials, whereby the experimenter holds up an object, asks "What is this?", and then prompts with the object's name; and probe trials, whereby the experimenter holds up an object and asks the child to name it without a prompt. Prompt and probe trials are presented in a precisely specified sequence. A correct response moves the child to the next step in the sequence. An incorrect response on a prompt trial results in a repetition of that trial. An incorrect response on a probe trial results in a prompt on the next trial. While there are exceptions (e.g., Guess et al., 1968), the sequence of prompt and probe trials typically involves trials of each kind for objects the child is learning to name and for objects

the child has previously learned to name. This procedure has been shown by a variety of investigators to develop extensive naming repertoires in children (e.g., Biberdorf, 1975; Kircher et al., 1971; Lutzker & Sherman, 1974; Stephens, 1975; Stephens et al., 1975).

While different investigators favor different name training procedures, all agree that it is not reasonable to consider an object- or picture-name as part of a child's repertoire until the child has named the object or picture after the passage of time and after other names have been trained. A variety of methods have been devised to test whether the procedure has been effective in adding the name of an item to a child's repertoire (e.g., Bricker & Bricker, 1972; Hartung, 1970; Kent et al., 1972; Risley et al., 1972). One common method is to conduct a probe trial, where the child is asked to name the item,on each of several consecutive days after training. The name is considered to be in the child's repertoire if he responds correctly each day (e.g., Biberdorf, 1975; Goldstein & Lanyon, 1971; Kircher et al., 1971; Risley & Wolf, 1967; Stephens, 1975; Stephens et al., 1975).

Presenting conditioned and primary reinforcement contingent upon correct responses is a crucial part of the training. Conditioned reinforcement typically consists of praise (e.g., Biberdorf, 1975; Isaacs,

Thomas, & Goldiamond, 1965; Kircher et al., 1971; MacCubrey, 1971; Martin et al., 1968; Risley & Wolf, 1967), and/or tokens (e.g., Lutzker & Sherman, 1974; MacCubrey, 1971; Martin et al., 1968). It is generally delivered according to a CRF schedule. Primary reinforcement typically consists of edibles (e.g., Hewett, 1965; Kircher et al., 1971; Martin et al., 1968; Stark et al., 1968; Stephens et al., 1975).

While many investigators report delivering primary reinforcement according to a CRF schedule (e.g., Hingten & Churchill, 1970; Risley & Wolf, 1967; Sulzbacher & Costello, 1970; Wolf et al., 1964), the majority of investigators favor an intermittent schedule of primary reinforcement (e.g., Kircher et al., 1971; MacCubrey, 1971; Martin et al., 1968; Salzinger et al., 1965; Stephens et al., 1975).

Thus, a variety of procedures have been developed to train children to name objects and/or pictures of objects. All of these procedures begin with the experimenter providing a prompt for the child to imitate and all aim to eliminate prompting so that the child comes to name objects without a prompt.

Phrase and Sentence Usage

After a child has been taught to name a variety of items, the next stage is to train him to use these words in phrases or short sentences. The procedure for

developing phrase and sentence usage in children is very similar to those for teaching object- or picture-names. The experimenter holds up a picture, asks the child a question about it, and prompts with the answer. The prompted answer usually consists of a four or five word sentence and the child is reinforced for imitating the sentence. As training proceeds, the experimenter gradually fades the prompt until the child responds to the experimenter's question with an unprompted sentence. Prompts are generally faded according to the principle of backward chaining--that is, first the last word of the sentence is omitted from the prompt, then the last two words are omitted, and so on (Brawley et al., 1969; Clarke & Sherman, 1975; MacCubrey, 1971; Martin et al., 1968). This procedure has been used to train children to respond in phrases or short sentences to questions concerning the colour of objects portrayed in a picture (Hart & Risley, 1968), the activity depicted in a picture (Clarke & Sherman, 1975; MacCubrey, 1971; Stevens-Long & Rasmussen, 1974), the function of objects presented to the child (Marshall & Hegrenes, 1970), and the child's own desires or activities (Bricker & Bricker, 1970; Hartung, 1970; Risley et al., 1972; Risley & Wolf, 1967). Reinforcement procedures and consequences of incorrect responses during sentence training are similar to those discussed in the two preceding sections.

Thus, like object-name training procedures, phrase- and sentence-usage training procedures begin with the experimenter providing a prompt for the child to imitate and aim to fade these prompts until the child comes to speak in unprompted sentences.

From the foregoing discussion it is clear that a variety of procedures have been devised to develop the target behavior at each stage of the behavioral training sequence. All of these procedures, except for those designed to develop verbal imitation, have one important factor in common--a transfer of control over the child's behavior from one stimulus to another stimulus. The experimenter facilitates this transfer by prompting the target behavior with the first stimulus (which controls the child's behavior) in the presence of the second stimulus (which does not control the child's behavior). (For example, in picture-name training, the experimenter prompts the target behavior by naming a picture while showing the picture to the child.) The prompt is gradually faded or eliminated until the child responds to the second stimulus (e.g., the picture, in picture-name training) in the absence of the first (e.g., the experimenter's prompt). In this way, the second stimulus comes to control the child's emission of the target behavior.

Each investigator advocates the virtues of his training procedure. Indeed, it appears that sufficient training in a variety of settings often produces an extensive verbal repertoire (Baer et al., 1967; Barton, 1970; Brawley

et al., 1969; Bricker & Bricker, 1970; Buddenhagen, 1971; Clarke & Sherman, 1975; Frisch & Schumaker, 1974; Fygetakis & Gray, 1970; Gray & Fygetakis, 1968a; 1968b; Guess et al., 1968; Hart & Risley, 1968; Hartung, 1970; Hewett, 1965; Issacs et al., 1960; Jensen & Womack, 1967; Lutzker & Sherman, 1974; MacCubrey, 1971; Risley et al., 1972; Risley & Wolf, 1967; Schumaker & Sherman, 1970; Stevens-Long & Rasmussen, 1974; Sulzbacher & Costello, 1970; Weiss & Born, 1967; Wheeler & Sulzer, 1970). Nevertheless, a close scrutiny of the literature reveals that the transfer of stimulus control is occasionally laden with difficulties (Harris, 1975). The nature of these difficulties, when they are encountered, has received little attention.

CHAPTER II

Statement of the Problem

An integral part of most procedures for developing verbal behaviors is the transfer of control over the child's behavior from one stimulus to another. Procedures designed to execute this transfer generally involve prompts to generate the target behavior, gradual elimination of the prompts, and equal probability of reinforcement for both prompted and unprompted behaviors (i.e., non-differential reinforcement for prompted and unprompted responses). Much has been made of the success of these procedures. However, close scrutiny of the literature reveals several instances where their efficacy is questionable. For example, Risley and Wolf (1967) report difficulty in transferring control of an autistic child's verbal behavior from an auditory stimulus (i.e., the experimenter naming an object) to a visual stimulus (i.e., the object itself). Similar problems have been reported by Buddenhagen (1971), Lovaas et al. (1966), Lovaas et al. (1967), Lovaas et al. (1973), Lovaas, Schreibman, and Koegel (1974), and Risley et al. (1972).

One possible solution to the problem is to eliminate prompts completely from training. As pointed out by Harris (1975), "there are no data indicating the long-term desirability of providing prompts in language training (p. 571)." However, Bricker (1972) and Risley and Wolf (1967) emphasize

that without prompt procedures, verbal training would involve long, arduous shaping procedures. Also, it is difficult to develop procedures independent of prompts for training some verbal behavior (e.g., picture naming, sentence usage). Thus elimination of prompts from training may render verbal training impractical or even impossible.

A second possible solution to the problem concerns reinforcement procedures. Most investigators non-differentially reinforce both prompted and unprompted occurrences of the target behavior (e.g., Buddenhagen, 1971; Kent et al, 1972; Kircher et al., 1971; MacCubrey, 1971; Steeves et al., 1970; Stephens et al., 1975). However, such a procedure allows the child to earn a considerable amount of primary reinforcement without emitting an unprompted response. Thus, the child may consistently receive the primary reinforcer, while failing to expand his verbal repertoire (Olenick, unpublished data). A possible solution to this apparent procedural inadequacy has been suggested, although not tested, by Risley et al. (1972) and by Lovaas et al. (1967). They propose that while praise should follow prompted and unprompted behavior, primary reinforcement should follow only unprompted behavior. These investigators thus suggest that the frequency of correct unprompted behavior may be increased by providing more reinforcement for it relative to the amount of reinforcement provided for correct prompted behavior.

Findings from basic research lend support to this notion. A variety of basic researchers have demonstrated that when given a choice between stimulus conditions,

experimental animals prefer to respond in the presence of stimuli correlated with the maximal available reinforcement frequency. For example, Autor (1960) trained pigeons on two concurrently programmed chained schedules. The experimental space contained two response keys, and a two-component chained schedule could be completed on either key. The first components of these chained schedules were identical, but independent, variable-interval 1-min schedules (VI 1 min; reinforcement becomes available on the average of once per minute). Different stimuli were correlated with each of these VI schedules. Whenever the stimulus correlated with the second component of the chain was produced on one key, the stimulus correlated with the second component of the chain on the other key could not appear, and responses on the other key were ineffective. When the chained schedules were the same on each key, response rates in the first components on the two keys were equal. As the frequency of reinforcement in the second component on one key was increased, the relative frequency of responding in the first component on that key increased monotonically. Similar findings have been reported by Baum and Rachlin (1969), by Herrnstein (1958), by Mechner (1958) and by others. Thus, evidence from the basic laboratory suggests that when two schedules of reinforcement, each associated with different stimulus conditions, are available, animals tend to respond to the stimuli associated with the maximal reinforcement frequency.

In the verbal training situation described previously, the child is, at different times, required to emit prompted and unprompted behavior to receive reinforcement. The paradigm clearly differs from the situations studied in the above-mentioned basic research. Nevertheless, a cautious extension of those findings suggests that the frequency of unprompted behavior may be increased by increasing the relative frequency of reinforcement for unprompted behavior. The present experiment was designed to investigate the effects of such a differential reinforcement procedure on the performance of retarded children in a picture-naming task.

CHAPTER III

Method

Subjects

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

Gimmi was four years old with a diagnosis of Down's syndrome. At the beginning of the study he imitated a number of vocal sounds but was unable to name any pictures. Gimmi's spontaneous vocal behavior consisted of babbling and a few phrases (e.g., "Hello", "Hi", "Come", "No", "Bad boy", "Bye").

Gilles was four years old with a diagnosis of Down's syndrome. Like Gimmi, at the beginning of the study he imitated a wide variety of vocal sounds but was unable to name any pictures. Gilles' spontaneous vocal behavior consisted of babbling.

Marda was four years 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 babbles.

All three children were naive to the procedures used in this study.

Setting and Apparatus

Experimental sessions were conducted with each child individually in a small cubicle. The child and the experimenter sat at a table facing each other. On the table within easy reach of the child was an empty candy dispenser and a stimulus-response console. The candy dispenser was used only to provide a solenoid "click" to inform the experimenter when to deliver primary reinforcement. The functional parts of the child's console were a button, operated by a force of 3.14 N., and a small green light. Also on the table, near the experimenter and operated by her, was another console which contained several switches and counters for controlling the child's console, for recording data, and for operating the candy dispenser. A large stop-clock on a nearby shelf was used to time the length of each session. A tape recorder placed beside the stop-clock was used to record each session. Picture cards from a Peabody Picture Vocabulary Kit were used for verbal training. Diet chocolate--one-eighth of a square per reinforcement--was used as the primary reinforcer for Gimmi; ice cream--one teaspoonful per reinforcement--was used as the primary reinforcer for Gilles and Marda.

Preliminary Procedures

These preliminary training procedures were similar to those used by Stephens et al. (1975).

Prior to conducting this research, the children were trained to sit quietly and to make eye contact with the

experimenter. To develop eye contact, each brief glance at the eyes of the experimenter was reinforced with praise and a primary reinforcer. As the frequency of these glances increased, the duration of eye contact required for reinforcement was gradually lengthened to three seconds.

Following this training, a determination of each child's picture-naming repertoire was made. A number of pictures of single objects, animals, and people were selected from a kit of Peabody Articulation Cards. Each of these pictures was presented to the child three times. Each time, the child was asked, "What's this?" and given five seconds to answer. If a correct response occurred within five seconds on all three trials, the picture was called a known picture. If no response or an incorrect response occurred within this time limit, the experimenter prompted the child by saying the correct response. If this occurred on all three trials, and the child correctly imitated the experimenter's prompt each time, the picture was called an unknown picture. All other pictures were discarded.

Following this, each child was trained individually to respond in a picture-naming task. During this training, the schedule of primary reinforcement was gradually increased from continuous reinforcement (CRF), where each correct response was followed by a primary reinforcer, to a fixed ratio schedule where reinforcement followed a specified number of correct responses. For Gimmi, picture-naming was maintained with a fixed ratio schedule whereby reinforcement

followed every eighth correct response (FR 8); for Gilles and Marda, picture-naming was maintained by an FR 6 schedule. Throughout the experiment, each delivery of a primary reinforcer was accompanied by the sound produced by the operation of the candy dispenser. Praise ("Good boy", or "Good girl") occurred after every correct response.

When the schedule of primary reinforcement had been increased as described, each child was trained to press the button on his console to initiate a trial. Initially, 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 frequently emitting unprompted button presses. Following button-press training, the experimental sessions began.

General Procedures

Two twenty-minute picture-name training sessions, separated by a ten-minute break, were conducted each week day with each child individually. The procedure for teaching the children to name pictures was similar to that used by Stephens et al. (1975). On each trial the experimenter presented either an unknown or a known picture. Two types of trials were used: prompt trials, on which the experimenter named the picture (e.g., said "What is this? Apple."); and probe (unprompted) trials, on which the experimenter did not name the picture (e.g., said "What is this?").

A correct response was recorded on a prompt trial if the child imitated the name (prompted behavior), and a correct response was recorded on a probe trial if the child named the picture (unprompted behavior).

Unknown pictures were taught to each child according to the steps illustrated in Figure 1, with only one step per trial. In Step 1, a randomly selected unknown picture was presented on a prompt trial. Step 1 was repeated on the next trial with the same unknown picture if the child made an error; i.e., an incorrect response or a response omission. A response omission occurred if the child did not respond within eight seconds of picture presentation. If the child responded correctly on Step 1, Step 2 occurred on the next trial. In Step 3, a randomly selected known picture was presented and, on successive steps, was alternated with the unknown picture as is diagrammed in Figure 1. When Steps 1 to 10 were completed with the known picture, they were repeated twice with two other randomly selected known pictures. A new randomly selected unknown picture was then taught with the same procedure. If the ten-step sequence was not completed with an unknown picture and three known pictures during one session, the sequence started from the beginning with that unknown picture and the first of the three known pictures during the next session. Following its completion of the ten-step sequence with three known pictures, an unknown picture was tested with a probe trial on each succeeding day until either an error was made (i.e., an incorrect

PICTURE—NAMING PROCEDURE

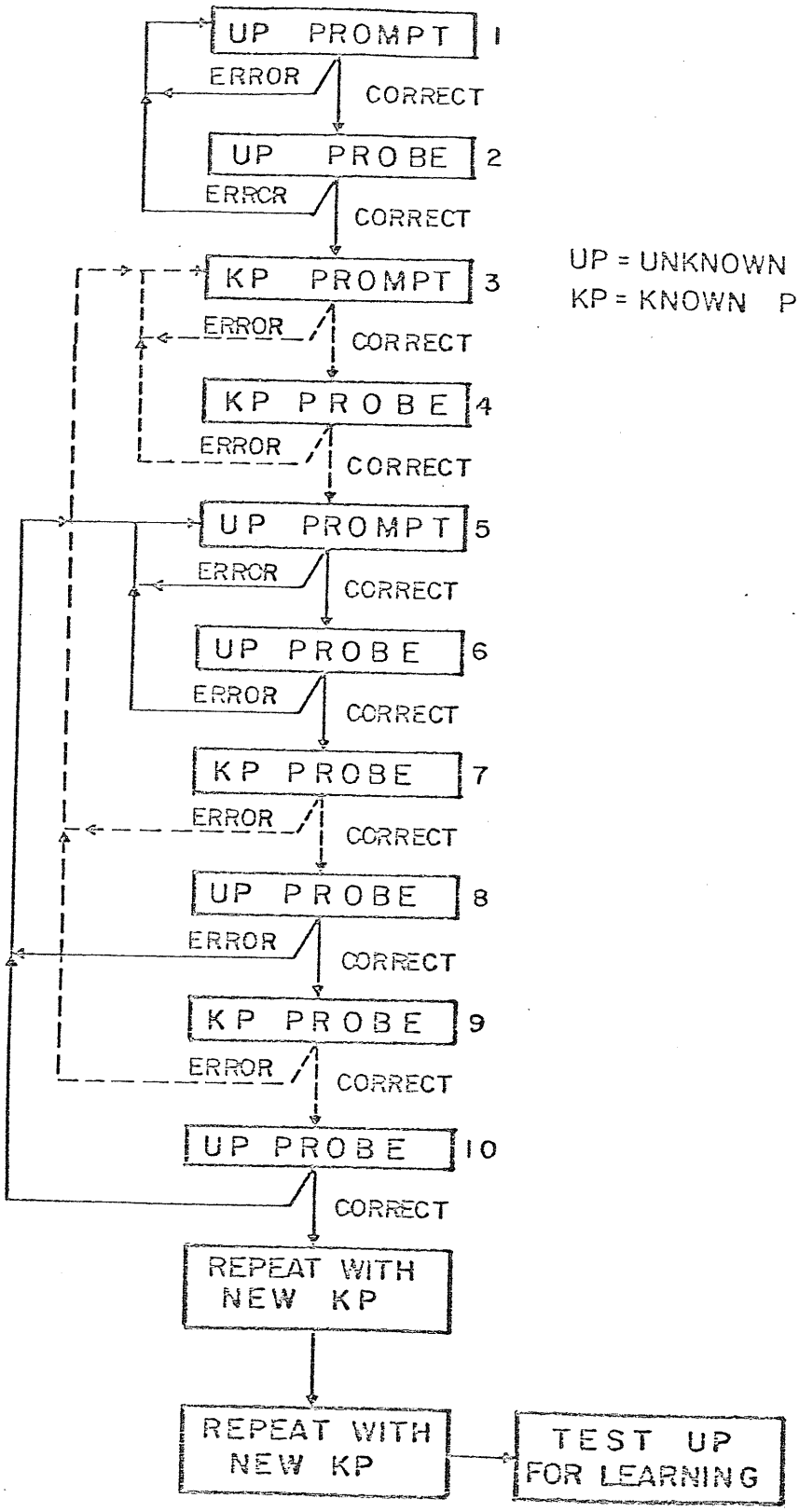

Figure 1.

response or a response omission occurred) on one of these trials or the picture was correctly named on three trials. If the former occurred, the picture-naming procedure was started anew for that unknown picture; if the latter occurred, the picture was considered to be learned and was eligible to be used as a known picture in subsequent applications of the picture-naming procedure.

An unknown picture was discarded from the experiment if it did not become eligible to be tested for learning within six sessions after beginning the picture-naming procedure, or if it was not correctly named on six tests for learning.

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. 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. Interobserver reliability coefficients for correct and incorrect responses respectively were 0.98 and 0.96 for Gimmi, 0.93 and 0.97 for Gilles, and 0.98 and 0.97 for Marda.

Trial-Presentation Procedures

To begin a verbal-training session, the experimenter pressed a button on her console thereby illuminating the green light on the child's console. When this light was illuminated, a button-press by the child initiated a picture-naming trial and turned off the green light. Upon the initiation of a trial, the experimenter presented a picture card to the child. The trial terminated when a correct response or an error (i.e., an incorrect response or a response omission occurred). At the conclusion of a trial, a five-second period (inter-trial interval) elapsed prior to the next illumination of the green light.

Experimental Procedures

This experiment consisted of five phases, although only the first three phases were carried out with Marda. During each phase, praise followed all correct responses to both prompt and probe trials. The schedule of primary reinforcement varied from phase to phase in a similar manner for all children. The primary reinforcement procedures in each phase will first be described for Gimmi.

Phase 1. Primary reinforcement was delivered according to a fixed-ratio schedule where every eighth correct response was reinforced (FR 8). That is, correct responses on prompt and probe trials were reinforced non-differentially--correct responses on prompt trials and correct responses on probe trials advanced the same FR 8 primary

reinforcement schedule. This will be called "FR".

Phase 2. Primary reinforcement was delivered following every eighth correct response on a prompt trial and following every eighth correct response on a probe trial. That is, correct responses on prompt trials and probe trials were reinforced differentially--correct responses on prompt trials and probe trials were reinforced on independent FR 8 schedules. This will be called "DIFF (FR, FR)".

Phase 3. Differential reinforcement continued with correct prompted responses being reinforced on an FR 8 schedule and correct unprompted responses (i.e., correct responses on probe trials) on a CRF schedule. This will be called "DIFF (FR, CRF)".

Phase 4. This phase was identical to Phase 3, except that the schedules of reinforcement were reversed; correct responses on prompt trials were reinforced according to a CRF schedule, and correct responses on probe trials were reinforced according to an FR 8 schedule. This will be called "DIFF (CRF, FR)".

Phase 5. This phase was a direct replication of Phase 3. This will be called "DIFF (FR, CRF)".

Because Gilles' and Marda's performances on the picture-naming task could not be maintained with FR primary reinforcement schedules above FR 6, the five phases for Gilles and the three phases for Marda involved an FR 6 schedule rather than an FR 8 schedule. That is, where an FR 8 schedule was used for Gimmi, an FR 6 schedule was used for

Gilles and Marda.

The experimental manipulations are summarized in Table 1.

Each phase continued until the data became stable, as determined by visual inspection.

TABLE 1

SUMMARY OF EXPERIMENTAL PROCEDURES

	Gimmi	Gilles	Marda
Phase 1:			
Non-differential	FR 8 (prompts or probes)	FR 6 (prompts or probes)	FR 6 (prompts or probes)
Phase 2:			
Differential	FR 8 (prompts); FR 8 (probes)	FR 6 (prompts); FR 6 (probes)	FR 6 (prompts); FR 6 (probes)
Phase 3:			
Differential	FR 8 (prompts); CRF (probes)	FR 6 (prompts); CRF (probes)	FR 6 (prompts); CRF (probes)
Phase 4:			
Differential	CRF (prompts); FR 8 (probes)	CRF (prompts); FR 6 (probes)	
Phase 5:			
Differential	FR 8 (prompts); CRF (probes)	FR 6 (prompts); CRF (probes)	

CHAPTER IV

Results

Figure 2 presents the daily number of correct responses to prompts, and the daily number of errors to prompts for the three children. There was no appreciable change in any 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 significant increase in the number of correct responses to prompts for all three children relative to the first two phases, despite the fact that during all three phases correct responses to prompts were reinforced on an FR schedule. The simultaneous decrease in the number of errors to prompts for all three children is attributable to the fact that the number of omissions to prompts decreased almost to zero under the DIFF (FR, CRF) condition of Phase 3. When correct responses to prompts were reinforced on a CRF schedule under the DIFF (CRF, FR) condition of Phase 4 with Gimmi and Gilles, (Marda did not continue past Phase 3) both children emitted a slightly greater number of correct responses to prompts relative to Phase 3, while emitting almost no errors to prompts. When the DIFF (FR, CRF) condition of Phase 3 was re-instated in Phase 5, both children showed a drop in the number of correct responses to prompts to a level slightly below that observed

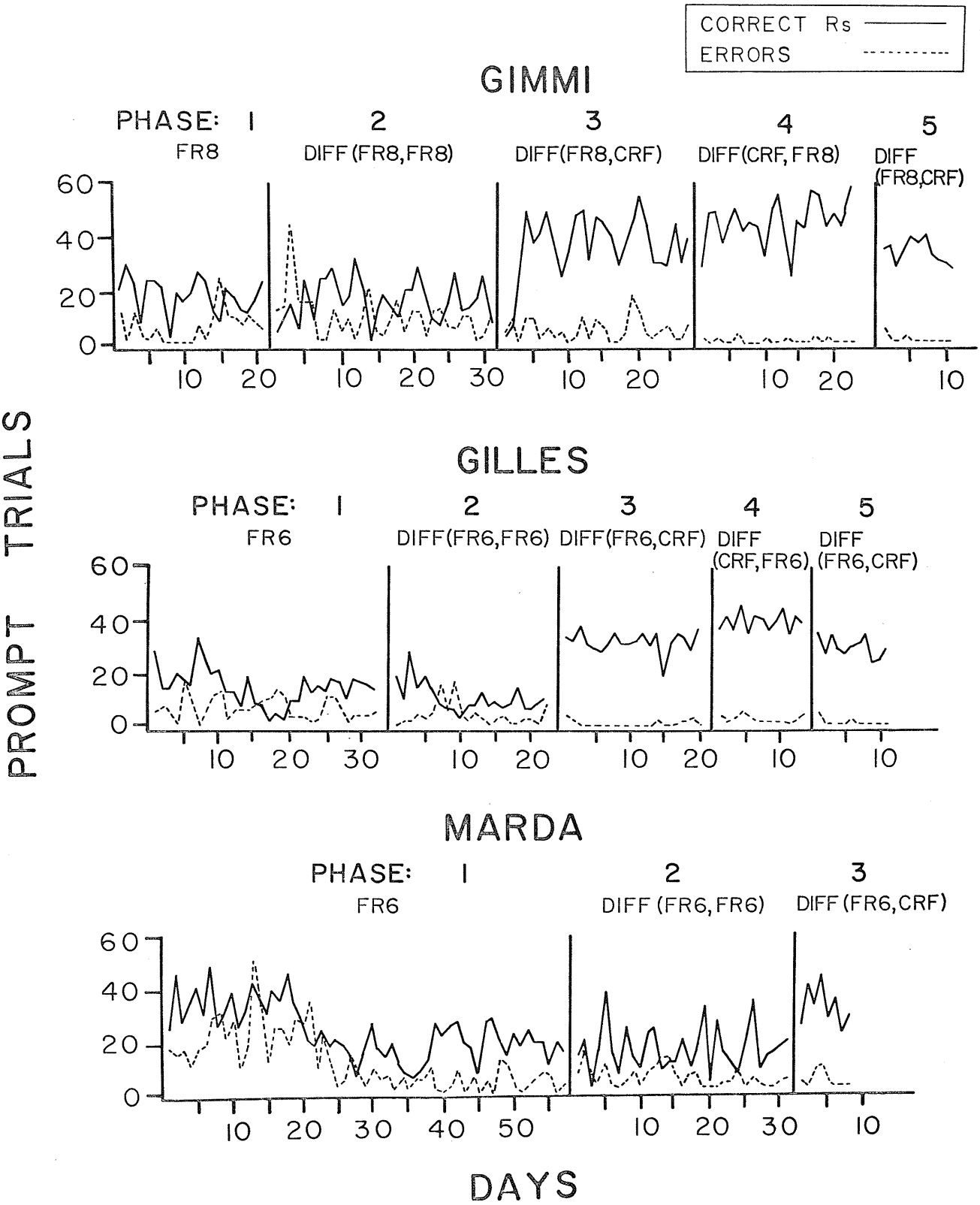

Figure 2. Daily number of correct responses and errors on prompt trials for each child. Abbreviations are explained under Experimental Procedures.

in Phase 3. The number of errors to prompts remained near zero, as during the previous phase.

Figure 3 presents the daily prompt accuracies defined as the ratios of the daily number of correct responses to prompts to the daily number of prompts, for the three children. Thus, variations in the numbers of correct responses and errors to prompts are reflected in variations of prompt accuracy. In the first two phases of the study there was a considerable amount of unsystematic variation in this variable. However, the DIFF (FR, CRF) condition of Phase 3 markedly reduced this variability and significanty increased prompt accuracy for all three children. This is consistent with the increase in correct responses to prompts and the decrease in errors to prompts observed for all three children in Phase 3. When prompts were reinforced on a CRF schedule in Phase 4 with Gimmi and Gilles, accuracy increased almost to 1.00 for Gimmi and remained at the near-one level observed in Phase 3 for Gilles. When the DIFF (FR, CRF) condition of Phase 3 was re-instated in Phase 5, prompt accuracy remained at or near 1.00 for both children.

Figure 4 presents the daily number of correct responses to probes and the daily number of errors to probes for all three children. As in the case of prompts, there was no appreciable change in any of these variables from Phase 1 to Phase 2. However, when correct responses to probes were reinforced on a CRF schedule in the DIFF (FR, CRF) condition of Phase 3, there was a marked increase in the

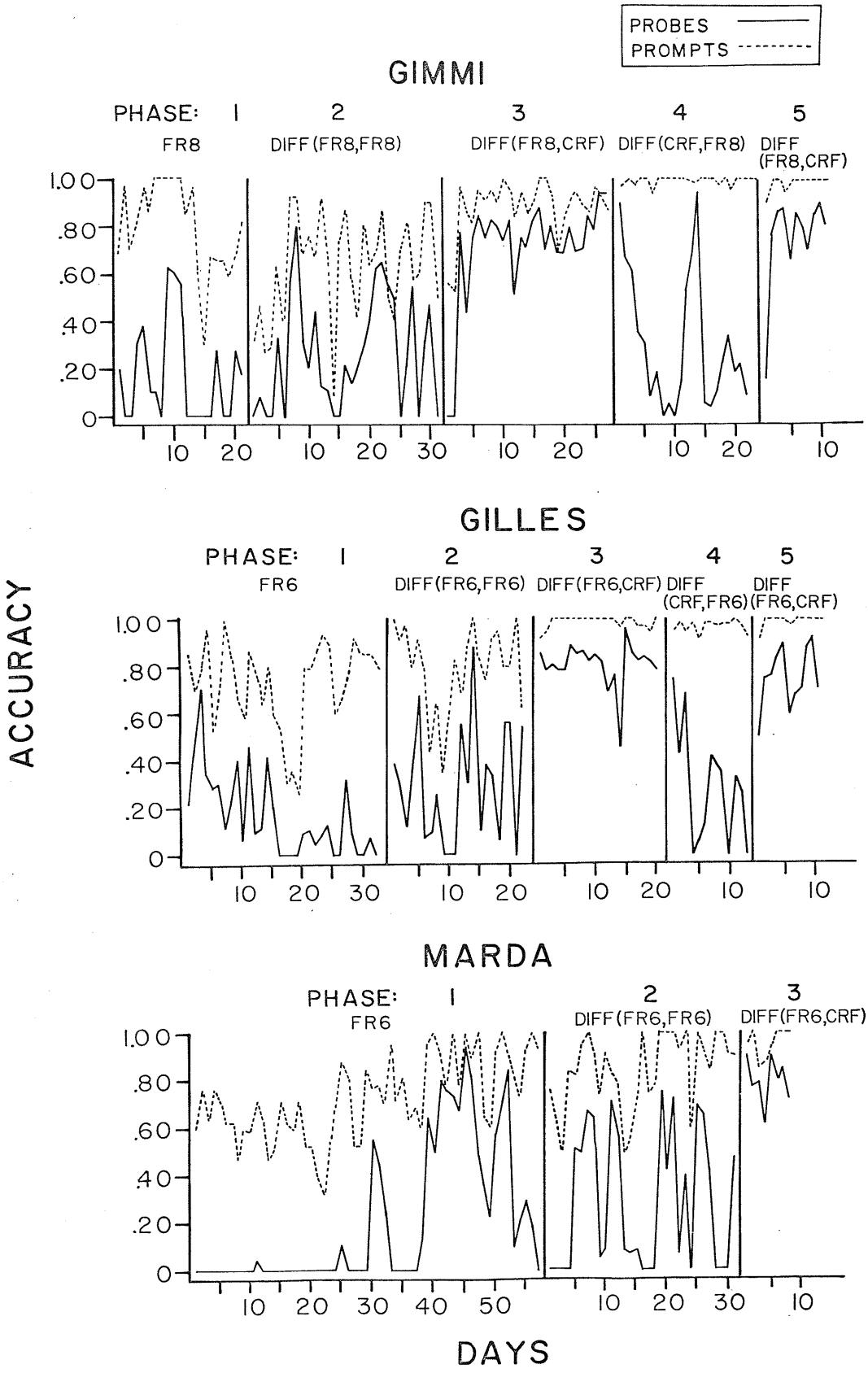

Figure 3. Daily prompt and probe accuracies for each child. Abbreviations are explained under Experimental Procedures.

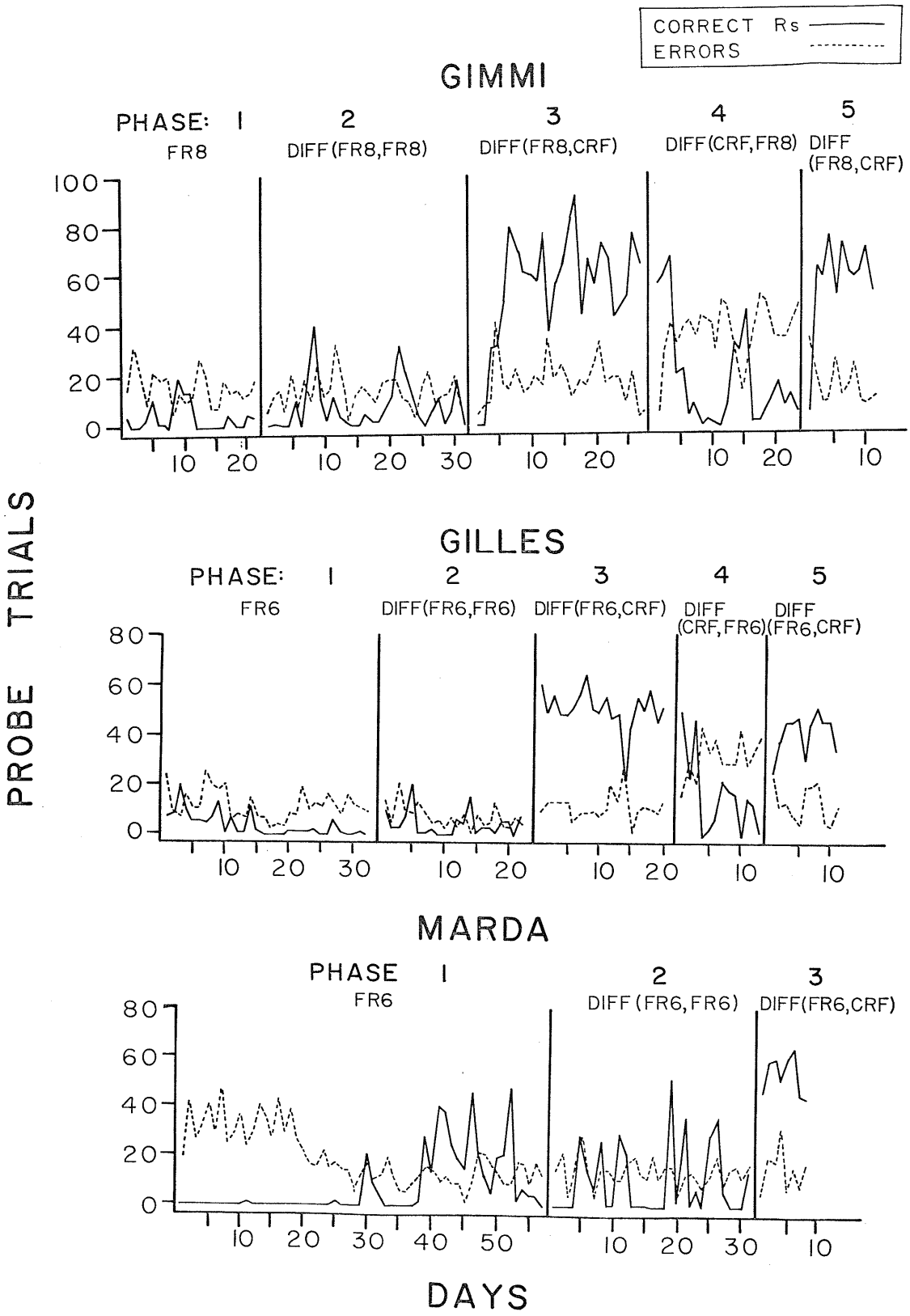

Figure 4. Daily number of correct responses and errors on probe trials for each child. Abbreviations are explained under Experimental Procedures.

number of correct responses to probes for all three children as compared to the two previous phases when correct responses to probes were reinforced on an FR schedule. At the same time, there was a slight increase in the number of errors to probes for Gimmi and Gilles that is attributable to a slight increase in the number of incorrect responses to probes. There was no appreciable change in the number of errors to probes for Marda. When correct responses to probes were reinforced on an FR schedule under the DIFF (CRF, FR) condition of Phase 4 with Gimmi and Gilles, the number of correct responses to probes declined for both children, to the levels observed in the first two phases of the study when correct responses to probes were also reinforced on an FR schedule. Concomitant with this decline, both children showed a significant increase in the number of errors. This increase reached levels above those observed during any other phase of the study. When the DIFF (FR, CRF) condition of Phase 3 was re-instated in Phase 5, the number of correct responses to probes increased to the level observed in Phase 3 in the case of Gimmi and to slightly below the level observed in Phase 3 in the case of Gilles. For both children, the number of errors to probes decreased to the level observed in Phase 3.

Figure 3 presents the daily probe accuracies defined as the ratios of the daily number of correct responses to probes to the daily number of probes, for all three children. Thus, variation in probe accuracy reflects variation in the numbers of correct responses and errors to probes. In

Phases 1 and 2, when correct responses to probes were reinforced on an FR schedule, there was a large degree of unsystematic variability in probe accuracy for all children. In Phase 3, when correct responses to probes were reinforced on a CRF schedule under the DIFF (FR, CRF) condition, all three children showed a significant reduction in the variability of and a marked increase in the magnitude of probe accuracy. When correct responses to probes were again reinforced on an FR schedule under the DIFF (CRF, FR) condition of Phase 4 with Gimmi and Gilles, probe accuracy for both children declined to the levels recorded in Phases 1 and 2. When the DIFF (FR, CRF) condition of Phase 3 was re-instated in Phase 5, probe accuracy returned to the high levels observed in Phase 3.

Figure 5 presents the cumulative records across days of the pictures each child learned to name. Note that the learning rates for all three children were near zero in every phase of the study except Phase 3 and Phase 5. That is, the children learned to name pictures at the greatest rate when the DIFF (FR, CRF) condition was in effect.

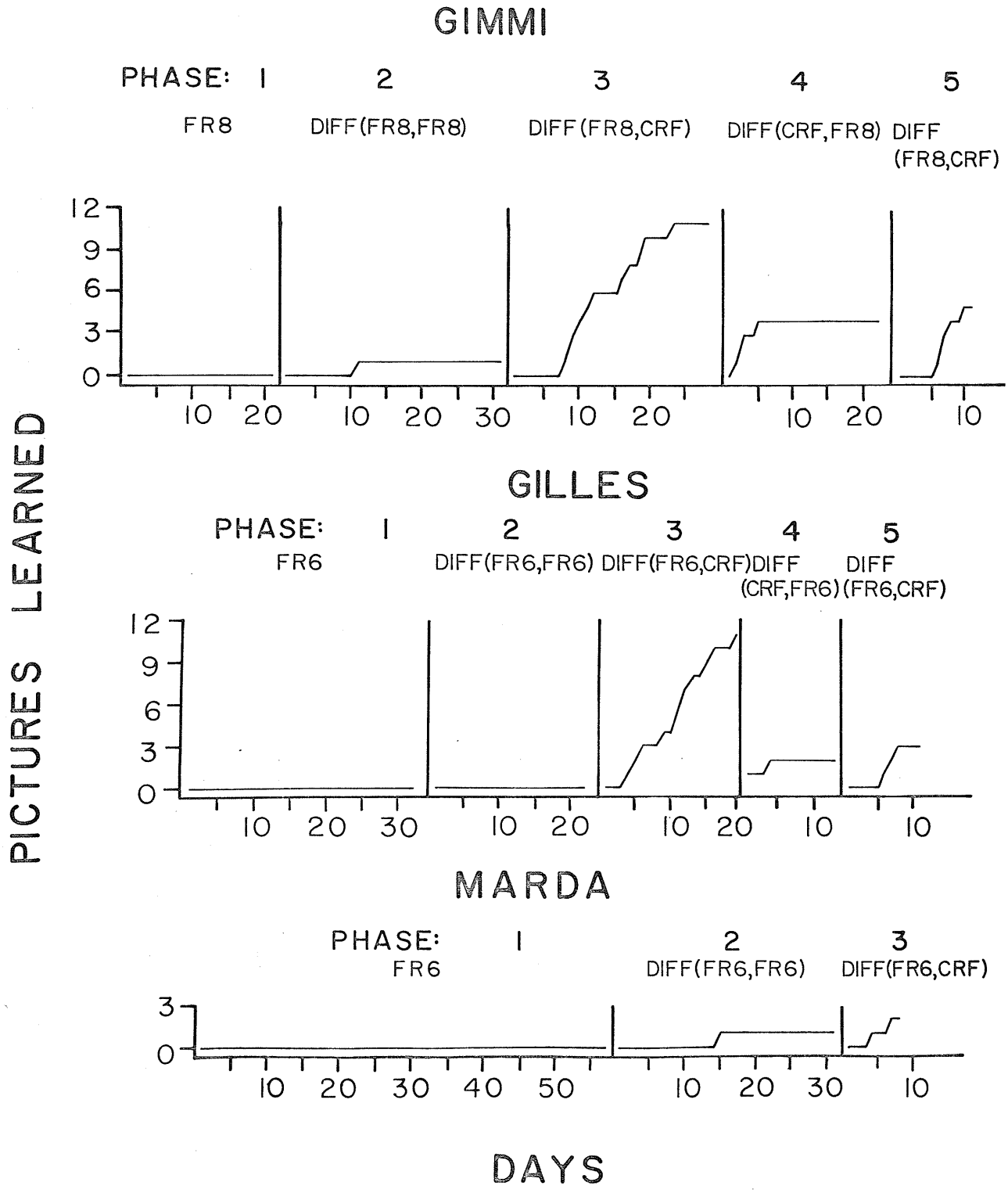

Figure 5. Cumulative records over days of the number of pictures each child learned to name. Abbreviations are explained under Experimental Procedures.

CHAPTER V

Discussion

The results of this study suggest that a reinforcement procedure involving more frequent reinforcement for correct responses to probes relative to that for correct responses to prompts produces better performance in a verbal task than does a reinforcement procedure involving equal or less frequent reinforcement for correct responses to probes relative to correct responses to prompts. All three children made more correct responses, made fewer errors, and learned picture-names at a greater rate when correct responses to probes were reinforced more frequently than correct responses to prompts. Thus, the data indicate that the optimal reinforcement procedure in verbal training with retarded children is a differential reinforcement schedule whereby correct responses to probes are reinforced more frequently than correct responses to prompts.

Since the schedule manipulations in this research were associated with changes in the overall reinforcement frequency, it is necessary to consider the possibility that the observed effects were the result of these changes rather than the result of the differential reinforcement procedures per se. For example, the introduction in Phase 3 of the CRF schedule for correct responses to probes was associated with an increase in the average frequency of reinforcement

as compared to the previous two phases. We must consider the possibility that this increase in reinforcement frequency may have generated the observed improvement in performance on prompt and probe trials and the increased rate of learning picture-names.

Two factors indicate the remoteness of this possibly. Firstly, in this study, both prompt and probe accuracies varied systematically with the changes in the differential reinforcement schedule. Other research (Stephens et al., 1975) has indicated that accuracy is not significantly affected by changes in reinforcement frequency. This suggests that the findings of this study were not merely the results of changes in reinforcement frequency. Secondly, a comparison of the data from Phases 3 and 4 for Gimmi and Gilles indicates that changes in reinforcement frequency cannot account for the observed effects. Each of these phases involved a differential reinforcement schedule with an FR and a CRF component. (In Phase 3 correct responses to prompts were reinforced on an FR schedule and correct responses to probes on a CRF schedule; in Phase 4 the schedules were reversed.) Thus, the reinforcement frequencies of these two phases were nearly equal. Yet both children emitted more correct responses to prompts and fewer correct responses to probes in Phase 4 relative to Phase 3. That is, the changes in the differential reinforcement procedure from Phase 3 to Phase 4 had a differential effect on performance that could not be attributed to changes in reinforcement frequency. Thus, it seems that

the differential reinforcement procedures per se were responsible for the effects observed in this study.

Two effects of the schedule manipulations on the number of correct responses to prompts are particularly worthy of note since they were somewhat unexpected. Firstly, when correct responses to probes were reinforced on a CRF schedule in Phase 3, there was an increase in correct responses to prompts relative to Phases 1 and 2, although in all three phases correct responses to prompts were consistently reinforced on the same FR schedule. Secondly, when correct responses to prompts were reinforced on a CRF schedule in Phase 4 with Gimmi and Gilles as opposed to the FR schedule of the previous phases, both children emitted only slightly more correct responses to prompts as compared to Phase 3. The first finding may be related to the fact that, according to the picture-name training procedure, a probe trial followed every correct response to a prompt trial. Since correct responses to probes were continuously reinforced in Phase 3, the presentation of a probe trial may have become a conditioned reinforcer. Thus, in this phase, correct responses to prompts may have been reinforced on a CRF schedule of conditioned reinforcement that was not in effect in the two previous phases. This conditioned reinforcement contingency may have produced the increase in correct responses to prompts observed in Phase 3. If this interpretation is valid, the surprisingly minimal increase in correct responses to prompts in Phase 4 would indicate that the combined CRF schedule of

conditioned reinforcement and FR schedule of primary reinforcement for correct responses to prompts in Phase 3 was almost as effective as the CRF schedule of primary reinforcement for correct responses to prompts in Phase 4.

In conclusion, of all the reinforcement procedures studied, the differential schedule involving delivery of reinforcement for correct responses to prompts according to an FR schedule and delivery of reinforcement for correct responses to probes according to a CRF schedule generated the best performance in the verbal task. All three children emitted more correct responses, made fewer errors, and learned picture-names at a greater rate when the DIFF (FR, CRF) schedule was in effect. Thus, it may be that the optimal reinforcement procedure in picture-name training with retarded children is one whereby correct responses to probes are reinforced more often than are correct responses to prompts. It remains now to determine the optimal combination of schedules of primary reinforcement for correct responses to prompts and to probes.

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