THE UNIVERSITY OF MANITOBA

A Comparison of Several Errorless and Traditional Methods of Teaching Discriminations, and Their Effects on Generalization and Retention with Severely and Moderately Retarded Girls.

by

STEWART McDONALD

A Thesis
Submitted to the Faculty of Graduate Studies
In Partial Fulfillment of the Requirements for the Degree
of Master of Arts

Department of Psychology
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ABSTRACT

The present study had three main purposes: first, to compare the effectiveness of several procedures in teaching discriminations to retarded subjects; second, to compare the effectiveness of these methods in producing generalization and retention during training, post training, and on a five month follow-up test; and third, to examine some critical variables of fading procedures and evaluate their relative importance.

Two experiments, each with two experimental phases, were conducted. The second experimental phase in each experiment was a direct replication of the first and Experiment II was a systematic replication of Experiment I. The discriminations taught were identifying or reading color words in Experiment I and identifying or reading number words in Experiment II.

Subjects were two low moderately retarded and two severely retarded teenage girls. Each subject was taught four words in each experimental phase, i.e. one word by each of the methods being compared. Words and teaching methods were counterbalanced across procedures. Two teaching methods were based on "trial and error" procedures and two were based on fading or errorless procedures.

The two "trial and error methods" were as follows: Traditional 1, a procedure in which stimulus words varied along only one stimulus dimension, spelling; Traditional 2, a procedure in which an additional stimulus associated with the correct stimulus word (S^D) was provided to

facilitate discrimination.

The fading methods were as follows: Fading 1 in Experiment I, a procedure in which an additional cue associated with the S^D was faded out and the S^D was faded in; Fading 1 in Experiment II, a procedure in which the S^D was held constant and incorrect stimuli (S^Δs) were faded in; and Fading 2, a procedure in which additional stimuli associated with S^D were faded out.

Results indicated that all teaching methods were effective for teaching discriminations as determined by a learning criterion of 90% correct responses for two consecutive sessions.

Results of tests conducted during training, post training, and five months after termination of the experiment showed that the Traditional 1 teaching method and the Fading 1b method of Experiment II produced the highest degree of generalization and retention.

In addition, the moderately retarded subjects performed at higher levels than the severely retarded subjects on generalization tests.

Plausible reasons for the results obtained were discussed and their implications for future research in the area of generalization following discrimination training was also suggested.

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CHAPTER I

INTRODUCTION

This research is concerned with the evaluation and identification of some of the important variables that influence discrimination learning in severely and moderately retarded subjects. In designing programs geared towards normalization of the retardate it is important to teach discriminations in such a way that a repertoire can be acquired quickly and be durable over time. Another aspect of the general problem in discrimination learning is that occurrence of behaviors acquired in the training situation must occur appropriately outside of the learning environment. Generalization, then, should be programmed at the learning stage as part of the discrimination training procedures.

This thesis has attempted to address the above problem by evaluating several methods of teaching discriminations and their consequent effect on retention and generalization. It has particular implications for the design of academic training procedures needed to teach the retardate the minimal skills necessary to function in non-institutional settings.

CHAPTER II

REVIEW OF THE LITERATURE

A. Theoretical Analysis of Discrimination Learning

One of the fundamental processes that the study of behavior is concerned with is discrimination learning. Experimental psychologists, no matter what their theoretical orientations, are all interested in explaining the ability of organisms to form discriminations. Being able to discriminate between difficult stimuli in a variety of situations is crucial if an organism is to survive. In a natural setting the living organism must learn not only to make a certain response, but when and under what conditions to make it. This is the problem of relating the behavior to the environmental situation or in scientific terms, of placing the response under the control of discriminative stimuli. A young child learns the word "daddy" and often will initially call all men he comes in contact with, "daddy". In such a case a discrimination has not taken place but rather it is an instance of stimulus generalization. The same response is emitted to a variety of similar stimuli, in this case, men. The child soon learns to make the response only in the presence of his father and a finer discrimination is said to be learned. What then is the process by which the discrimination has been learned? What variables account for the differential rates of responding? In this example the child will emit the response "daddy" at a high rate in the presence of his father and at low rates, probably zero, in the presence of other men.

Several theoretical formulations have been postulated to explain the discrimination learning process. Important in most theories, however, are the concepts of reinforcement, extinction, and discriminative stimuli. These types of theories view discrimination learning as a combination of reinforcement and extinction.

In the Hull and Spence theory of drive reduction, discrimination learning was explained as a result of a particular response being emitted in the presence of a stimulus complex and being reinforced (Hull, 1943; Spence, 1936). The reinforcement reduced a particular need of the organism and response strength (s^Hr) increased with the number of reinforcements. Response strength also increased with respect to the stimuli associated with reinforcement. Conversely responses that are non-reinforced decrease in strength, via inhibition (s^Ir), and stimuli associated with these responses tend not to produce the response in the future. That is, there is an inhibiting function for non-reinforced responses. Typical experiments in the Hull-Spence framework studied discrimination learning as a function of motivation and in relation to stimulus generalization.

Operant psychologists study discrimination learning as a functional relationship between antecedent stimuli and the probability of occurrence of a response. At a theoretical level the term "stimulus control" replaces the terms generalization and discrimination because "the terms generalization and discrimination describe processes rather than empirical functions" (Terrace, 1966, p. 271). The basic operation for establishing stimulus control is to reinforce a specified operant in the presence of one stimulus (S^D); and to withhold reinforcement for that same operant in the presence of another stimulus (S^{Δ}). In the operant framework the establishment of stimulus control or discrimination training can be represented as follows:

$$S^D \longrightarrow R \longrightarrow S^{r+}$$
$$S^{\Delta} \longrightarrow R \longrightarrow 0$$

Thus, reinforcement always follows a response when it is emitted in the presence of the S^D, but never follows the response when it is emitted in the presence of the S^{Δ}. The procedure then is actually based on two sub-procedures, reinforcement and extinction.

An attempt to explain the process by which the organism learns a discrimination has been postulated by the cognitive theory of learning (Guthrie, 1952). This theory is a relational one which holds that discriminations are learned by comparison of stimuli. In a simultaneous discrimination problem the organism is able to make a direct comparison between stimuli, and responses are made in relation to these stimuli. In the successive discrimination paradigm the organism relies on memory traces of preceding stimuli in order to relate them to present stimuli, and then makes a decision to respond or not respond. The major prediction of this theory is that discriminations will be learned more rapidly using a simultaneous rather than a successive paradigm since the former allows a direct comparison while the latter necessitates the organism comparing by memory. Experimental results have supported (Spence, 1952), shown opposite results (Teas & Bitterman, 1952), and shown no difference (Grice, 1949) in this prediction.

Another theory of discrimination learning was proposed by Harlow (1949). This theory is based on the fact that organisms improve in their ability to solve discrimination problems with practise. Harlow assumes that the correct response is available at the beginning of discrimination training but is suppressed by error tendencies. Learning takes place as error tendencies are extinguished and these extinguished tendencies are transferred to new discrimination problems. Thus, such a learning set theory is able to account for faster discrimination learning with practise in terms of extinction of errors.

Researchers have developed a variety of apparatus to test the discriminative capacities of organisms. Some of the most popular of these apparatus were the Lashley jumping stand (Lashley, 1938), the pull-in apparatus for monkeys (Harlow, 1948), and the Wisconsin General Test Apparatus (Harlow, 1949). A common feature of these early apparatus is that they readily lent themselves to the manipulative responses of the organisms under study including rats, monkeys, chimpanzees, and children. Technology has developed since these early days and today researchers use much more sophisticated equipment in presenting discrimination problems to subjects. Today trials are programmed automatically and responses and reinforcers recorded and delivered immediately by relay equipment in some experiments (e.g. Lipsitt, 1963 and Weisberg & Simmons, 1966). These advances have allowed researchers to study discrimination learning more efficiently under many of the above theoretical orientations.

One model or procedure used to investigate discrimination learning which is particularly facilitated by the advanced technology or programming equipment, and offers a more optimistic view for teaching complex discriminations to many populations, is the errorless method developed by Terrace (1963, a,b). This model and its implications are discussed extensively in the next section.

B. Errorless Discrimination Research

The past decade of research in the area of discrimination learning has yielded a variety of studies demonstrating errorless or nearly errorless learning of discrimination problems (Corey & Shamow, 1972; Gollin & Savoy, 1968; McDonald, Martin, Williams, & Hardy, 1973; Moore & Goldiamond, 1964; Powers, Cheney, & Agostino, 1970; Sidman & Stoddard, 1967; Terrace, 1963, a,b; Touchette, 1968). Discrimination problems examined in these studies have ranged from form and color to letter and word discriminations. Experimental populations of these studies have included retardates (McDonald et al., 1973; Sidman et al., 1967; Touchette, 1968), nursery school children (Corey et al., 1972; Gollin et al., 1968; Moore et al., 1964; Powers et al., 1970), and pigeons (Terrace, 1963, a,b). In addition this method has been successful with both successive and simultaneous discrimination tasks.

Terrace (1963,a) trained pigeons to discriminate between the colors red and green with very few errors. More specifically, Terrace conditioned the pigeons to peck a key on the wall of an experimental chamber when it was illuminated red, but not peck the same disc when it was illuminated green. When the key was red (S^D) the pigeons were reinforced with grain on a VI 1 min. for key pecks. However, when the key was green (S^Δ) the birds were never reinforced for key pecks. The usual method of training this type of successive discrimination is to present the S^D and S^Δ stimuli in an alternating random sequence for equal durations of time. Responses to S^D are reinforced and responses to S^Δ are extinguished until eventually the probability of responding to S^D is very high and the probability of responding to S^Δ is very low. When the latter occurs the organism is said to have learned the discrimination. If the discrimination is quite difficult learning may not occur and if it does it usually takes a great deal of time and many error trials. The training method that Terrace employed differed from the above procedure in several respects. Terrace's strategy was to present the S^D stimulus in its criterion conditions for the entire procedure but to vary certain aspects of S^Δ stimulus such that initially the discrimination was simple, but in the final phase it was difficult. In the first phase of the experiment the red stimulus (S^D) was presented for 3 min. and pecking this stimulus was reinforced on a VI 1 min. The S^D presentation remained constant throughout the experiment. Presentation of the green stimulus (S^Δ) varied along two dimensions; duration of presentation, and wave length of the color. In the first phase the S^Δ key was dark and duration of its presentation was 5 sec. Throughout this phase the key remained dark, but the presentation time was increased gradually to 30 sec. In the second phase the presentation time was set back to 5 sec. but the intensity of the S^{Δ} key was increased gradually until the red (S^{D}) and green (S^{Δ}) keys were equally bright. In the third phase the green (S^{Δ}) key was at full intensity and the duration of presentation was increased from 5 sec. to 3 min., at which point both the S^{D} and S^{Δ} conditions were equal in terms of presentation times and intensity of illumination. The birds trained using this method made virtually no errors in acquisition.

In a second experiment, Terrace (1963, b) demonstrated that pigeons were able to make an errorless transfer from a known discrimination to a novel discrimination. The birds were first trained on the red - green key light discrimination (Terrace, 1963, a) as described above. A vertical and a horizontal line were superimposed on the red and green key lights respectively. By gradually decreasing the intensity of the key lights to zero, such that only the vertical or horizontal lines remained to distinguish the keys, the pigeons were able to make the transfer with no responses to (S^{Δ}), the horizontal line. If, however, the fading of the intensity from full through zero was not used, and instead, the change was abrupt, then the pigeons made many errors before learning the discrimination.

It seems that two deviations from the normal method of teaching discriminations are necessary to obtain errorless performance. First, the initial discrimination must be relatively simple. For example, a discrimination in which the S^{D} and S^{Δ} vary along two or more dimensions. Second, the transition from the simple discrimination to the difficult discrimination must be gradual. A difficult discrimination might be defined as a discrimination in which S^D and S^Δ vary only slightly along one stimulus dimension. An example would be "brightness" in a color discrimination.

Moore & Goldiamond (1964) applied Terrace's findings to human subjects. The task was a delayed match-to-sample discrimination in which nursery school children had to locate a triangle differing in angle of rotation from two other triangles presented simultaneously. The (S^D) triangle, the one to be matched, was presented alone briefly, just prior to each trial. This discrimination was accomplished by initially illuminating only the correct triangle. Gradually the incorrect triangles were illuminated from zero to full intensity. The discrimination obtained by differences in brightness between the S^D and S^Δ was maintained in its absence, i.e. stimulus control was transferred from brightness to form with almost no errors.

A similar study was reported by Sidman & Stoddard (1967) using retarded children as subjects. The task was a simultaneous form discrimination. Subjects chose the correct stimulus circle from a nine-key matrix containing one circle (S^D), and seven elipses (S^Δ), with the center key being dark. The position of the circle varied from trial to trial. This experiment employed both a control group and a program group. For the control group all keys on the matrix were equally illuminated such that the discrimination could only be based on differences in form between the circle and the elipses. The criterion task for the program group and the control group was identical. However, the initial steps of the program group were much different and approached the criterion task in successively programmed steps over two stages. In stage 1 the S^D was presented fully illuminated on 1 key while the background was gradually faded in from black to white in seven consecutive slides. In stage two, the elipses (S^{Δ}'s) were faded in on the white background in 10 consecutive slides.

All nineteen subjects were exposed to the control procedure first, but only one was able to learn the circle-elipse discrimination. Of the ten subjects exposed to the program procedure, seven were able to make the circle vs. elipse discrimination.

This data, then, supports the inference that stimulus fading techniques can be more effective in teaching discriminations than a technology which generates errors and depends only on reinforcement and extinction.

McDowell (1968, 1969) capitalized on fading techniques, developed from Heilman (1961), to teach nursery school children to read words. By pairing the textual stimuli of words with supplementary echoic, tactual, and intraverbal stimuli, and then subsequently fading out the additional stimuli so that only the textual stimuli remained, low error percentages were obtained compared to a group taught the same words using a more traditional look-and-say method. McDowell cited two advantages to using a fading technique to teach reading in this type of situation. Since the fading group had a very low error percentage they had less opportunity to practice errors. Conversely, the high percentage of errors in the look-and-say group resulted in less motivation for the task. This was evidenced in statements of frustration, complaints, and a desire to terminate when error percentages were high in the look-and-say group. Therefore, the fading group should have a high level of motivation relative to the look-and-say group.

Touchette (1968) conducted an experiment similar to Moore, et al., (1964). Retardates faced a three key matrix and were reinforced for responding to the key on either the right or the left which was physically closer to a .75 in. black square presented on the middle key. Only one of seven subjects was able to learn the discrimination using a trial and error method but when the discrimination was programmed for these same six subjects, all but one was able to learn the discrimination. Six subjects who were given only the programmed procedure were all able to learn the criterion discrimination and performed at a higher level on a thirty-five day retention test. Touchette noted that poorer performance on the retention tests by subjects in group I may have been a result of their previous history of trial and error learning before programmed training.

Gollin and Savoy (1968) investigated the effect of using fading procedures to teach an initial discrimination, and then a reversal of the initial discrimination followed by a conditional discrimination. The conditional discrimination was one in which, at random, either the initial S^D was the correct stimulus or the reversal S^D was the correct stimulus. Gollin and Savoy found that more subjects trained using a fading method in the original and reversal discrimination performed without errors, but more subjects trained using a traditional method were able to solve the conditional discrimination problem. The authors state that perhaps the poor performance on the conditional discrimination problem by the fading group was a result of the gradual introduction of the S^{Δ} stimuli in training which left this group with inefficient comparative experience for transfer to the conditional discrimination situation.

Powers, Cheney, and Agostino (1970) utilized a fading procedure to teach a very difficult color discrimination to nursery school children. Using a successive discrimination paradigm they found that using a fading technique subjects were able to acquire a fine discrimination, rapidly and with very few errors. On the other hand, subjects in a traditional group were not able to learn the discrimination at all. In addition, Powers et al. reported that much emotional behavior in terms of leaving the apparatus, banging the lever, and walking around the room, occurred in the traditional group. There was no evidence of these behaviors in the fading group subjects.

Another interesting feature of the data presented by Powers et al. was the fact that errors emitted by subjects in the fading group decreased over experimental sessions. Conversely the error rate of the traditional group generally increased as the experiment progressed. Eighty-five percent of the errors of the fading group (errorless procedure) occurred in the final five training sessions before any color was introduced. The authors offer the rationale that perhaps the initial S^{Δ} condition, which was five seconds, was too long and did not represent a sufficiently great contrast from the S^{D} condition.

An interesting study was reported by Corey & Shamow (1972) which extended the investigation of the effectiveness of fading procedures on teaching reading, initially conducted by McDowell (1968), and McDowell et al. (1969). In a series of two experiments, non-reading nursery school children were taught to read simple words in either one of two groups, fading or superimposition. In the fading group a slide appeared with a word printed on it and a picture representing the word shown above it. The picture was faded out over a series of five steps. In the superimposition group the picture appeared above the word and remained there throughout the training procedure. The results of Experiment I significantly favored the fading group.

Experiment II was a replication of Experiment I and in addition two new groups were added. The two new groups were instructed to point to the stimulus before naming it, thus forcing those groups to emit an overt observing response. One observing group was given superimposition training while the other group was given fading training. The results of Experiment I were replicated in this experiment. The groups that made the observational responses were less successful than the original groups they were paired with.

A study by McDonald, Martin, Williams, & Hardy (1973) examined additional aspects of the effects of teaching retardates using either a fading program or a more traditional technique. Their results supported those of other researchers in that more subjects on a fading program were able to learn the discrimination, in this case learning to read their names. The subjects of the fading group were also more proficient in retention tests after five months than were the subjects of the traditional group. Perhaps the most important aspect of the McDonald et al. study, and the variable with the most important implications for applied researchers, were the generalization tests administered to subjects of both groups directly after discrimination training and again five months after the completion of the study. Three progressively more difficult discriminations were involved in the generalization tests. The subjects in the fading or errorless group were superior to the subjects in the traditional group on all tests of generalization.

The studies described above demonstrate a new approach to teaching difficult discriminations to a wide variety of subject populations. This approach seems to work effectively where none of the more traditional methods of teaching the same discriminations seem to have had a great deal of success. This method capitalizes on techniques developed by researchers in the field of operant psychology. By using the principle of stimulus fading, control of a response is transferred gradually from one set of stimuli to another, such that the original controlling stimuli are no longer available, but a new set of stimuli now control the original response. More specifically, errorless procedures teach initial discriminations such that they can be acquired by the organism with minimal difficulty. Once the simple discrimination is learned, or under the control of the stimuli presented to the organism in that situation, then the stimuli are changed over a series of graduated steps, each making the discrimination progressively more difficult. The final step usually involves a discrimination that differs only in terms of one stimulus dimension, e.g. color, form, spelling of a word, whereas in the initial steps the discrimination may involve two or three inequalities in stimulus dimensions between the correct and incorrect stimulus making the initial discrimination quite easy.

In addition to the fact that a fading program is usually an effective method of teaching difficult discriminations, researchers have also pointed out several other important aspects of this approach which seem to be inherent to the technique itself. Because of the extremely low error rate and the inversely high correct response rate produced by this method, the subjects usually receive a high density of positive reinforcement. Unlike the trial and error method which generates many errors and often leads to emotional and frustrative behavior as well as termination of sessions and/or tasks, and loss of training time, the fading technique produces none of the above behaviors as noted by several researchers (McDowell, 1968, 1969; Powers et al., 1970).

A fading technique is also most advantageous in breaking up deviant response patterns, such as always responding to one position, often exhibited by subjects in traditional studies (McDonald et al., 1973; Powers et al., 1970). With the fading method the initial stimulus dimensions of the correct and incorrect stimuli are usually so dramatically different that the subject has no trouble attending to at least some of the differences and is thus making correct choices consistently in early training. In traditional training, on the other hand, when the stimuli differ only along one dimension and the differences are slight, subjects are apt to be misled by reinforcement contingencies which generate positional responding. That is, a position response which is correct perhaps one-third or one-half the time on the average is maintained by the reinforcement contingencies, and the subject then fails to attend to the correct cues. In fact in this type of situation the subject is actually being conditioned to respond to the wrong stimuli.

Though the fading method has established its usefulness as a teaching technique experimentally, it cannot, as yet, be considered a technology in and of itself. Many important questions with respect to both the method and the implications of the method remain to be answered before the approach can be widely accepted and used as means of teaching in applied situations.

Most studies in this area to date have focused on purely experimental questions in an effort to compare and judge the effectiveness of the fading method with more traditional methods of teaching a variety of discrimination problems. Unfortunately, this has not led to a wide usage of the method in applied situations such as classrooms and special teaching situations. Probably the major reason for this has been the emphasis to date on the programmed fading steps which seem to necessitate expensive equipment such as slide projectors, light filters, etc. Secondary to this would be reluctance of administrators to invest in this type of equipment to aid in the teaching of problems that are of dubious use in everyday application. For example, it seems doubtful if an institution would be willing to spend several hundred dollars on equipment that would help retarded children discriminate a rectangle from a square when the practical significance of such learning is at best limited.

It seems that the focus of the research in this area, at this point, should shift towards problems that would be beneficial in a practical sense to the population to whom they are directed.

Little is known about many of the variables important to the fading procedure. Some of the variables that warrant investigation have been hidden by the method itself. The strategy of the fading method is to make the steps involved in the stimuli change as gradual as possible. One question is, how gradual is gradual? With the exception of Sidman & Stoddard (1967), no research has examined the problem of systematically decreasing or increasing the number of fading steps required to teach a particular discrimination. Another important but seemingly ignored variable is the number of trials a subject receives on each of the graduated steps of the fading procedure. No effort has been made in any of the studies reported to hold the number of fading steps constant while systematically varying the number of trials per step. If the assumption is true that errors in learning spawn more errors, and consequently interfere with and hinder learning, then research should strive to isolate the variables that might be responsible for errors. The fading method with its unique teaching framework has been able to drastically reduce over-all error rates and cumulative number of errors in discrimination training. However, if more research is directed at the parameters of the method itself as outlined above, then the method itself will be stronger, the results even more dramatic, and the vision of a technology in this area even closer.

Other effects of the fading approach that are of major importance to the applied researcher are the areas of retention and generalization. Although more recent studies in the area (Corey & Shamow, 1972; McDonald et al., 1973; Touchette, 1968) have examined these two variables, further systematic investigations appear warranted. The behaviors taught using this method must be persistent over time and they must be available to the subject in a wide variety of situations in response to a variety of appropriate cues. These aspects are crucial and must be inherent to the procedure if it is to be maximally useful.

The stimuli used in the fading procedure constitute an interesting and critical variable. These stimuli are critical in the sense that their systematic change over steps must be sensitive enough to ensure maximum stimulus control throughout the procedure. It is interesting to note how researchers have programmed the fading stimuli to date. In nearly all studies reviewed, the stimuli have been programmed such that the correct stimuli (S^Ds) are presented in their criterion form throughout the entire fading sequence. That is, the stimulus to be learned is always held constant and some aspect(s) of the incorrect stimuli (S^Δs) are faded. The question posed is: would a fading method, in which the incorrect stimuli are held constant and dimensions of the correct stimuli are faded, result in errorless discrimination learning? A variation to the above format is the research of McDowell (1968, 1969). McDowell successfully taught reading words by fading out pictures superimposed over the words which represented the words. The question, however, could better be answered by actually fading in the correct words.

In summary, the evidence provided thus far demonstrates that fading techniques have a wide range of application in terms of teaching a variety of different discriminations to many types of subjects. Much more research is needed, however, to determine exactly what the essential components of the fading technique are. Once its limitations are more thoroughly examined we may look for more widespread application to settings such as the classroom in the future.

CHAPTER III

STATEMENT OF THE PROBLEM

The major purpose of the present study was to make additional comparisons between traditional (trial and error) and fading (errorless) methods for teaching discriminations. In essence, the comparisons made were systematic applications of experimental procedures.

A second purpose was to examine the relative effectiveness of each of the teaching procedures on generalization and retention during training, directly following training, and after five months.

In addition, the study was designed to evaluate the importance of certain aspects of the fading procedures: fading in the S^D compared to fading in S^{Δ} components and fading out additional cues associated with the S^D.

CHAPTER IV

METHOD

Subjects

Two severely and two low-moderately retarded teenage girls served as subjects. All were residents of Kin Kare, an experimental residence in downtown Portage la Prairie, Manitoba, for graduates of an institutional behavior modification program for severe and profound retardates (Martin, 1973; Martin & Lowther, 1972). The subjects had previously been residents of Cedar Cottage, a ward of the Manitoba School, Portage la Prairie, for about three years and all had very extensive histories in behavior modification programs (Martin, England, & England, 1971; Martin, Kehoe, Bird, Jensen, & Darbyshire, 1971; Martin, McDonald, & Omichinski, 1971; Treffry, Martin, Samels, & Watson, 1970). During the five years the subjects had been involved in behavior modification programs they had learned to dress and groom themselves, to serve tables, eat properly, and do a variety of household tasks, such as wash dishes, make beds, vacuum and dust (see Martin, 1973; Martin & Lowther, 1972).

The subjects had been taught a variety of academic skills in the classroom. All could name and identify many objects and pictures, print a few simple words, and speak in clear but short phrases. In addition, they were all trained to sit quietly and attend to the teacher in a classroom and all were familiar with tokens and a variety of token systems. Table 1 summarizes the medical and psychological characteristics of the subjects. It is interesting to note the increase in I.Q. scores of the subjects since entering the behavior modification programs at Cedar Cottage.

Apparatus

All experimental sessions were conducted in the living room of the resident's home. This room ordinarily served as a classroom for all six of the Kin Kare residents. Dimensions of the room were 10 ft. by 12 ft. and windows were located on two sides. During sessions, curtains were pulled across the windows to prevent any outside distractions. Two tables, each measuring 2.5 ft. by 2.5 ft. were placed side by side in approximately the center of the room. Chairs were arranged so that one subject and the experimenter sat facing each other across one of the tables. A bowl containing pegs (conditioned reinforcers) and a peg board were located to the right of the subject on this table. On the experimenter's right were the data sheets and other materials needed for a particular session. In the center of this working table stimulus cards for a specific training method were arranged. The second table was used to store stimulus cards and data sheets not in use, and back-up reinforcers (chocolate coated candies; M & M's). Located on one wall of the room was a 3 ft. by 4 ft. bulletin board used to hold stimulus cards during generalization tests.

Stimulus cards for the various conditions of both experiments were designed and constructed in such a way that the only differences in them were designated by the particular conditions under investigation.

TABLE 1

Medical and Psychological Characteristics of the Subjects

SUBJECTS	DIAGNOSIS	CURRENT AGE YRS.	MO.	ENTERED CEDAR	I.Q. AT LAST TESTING AT KIN KARE
S_1	Encephalopathy associated with primary cranial anomaly. microephaly	13	2	I.Q. 33 (Peabody Picture Vocabulary Test) (PPVT). Mental age - 2 yrs. 7 mo.	I.Q. 46 (May 16,1972. S-B. Mental age - 5 yrs. 0 mo.)
S_2	Cerebral Palsy	13	9	I.Q. 24 (PPVT.) Mental age - 2 yrs. 5 mo.	I.Q. 41 (May 16,1972. S-B. Mental age - 4 yrs. 8 mo.)
S_3	Down's Syndrome (Mongolism)	15	7	I.Q. 19 (PPVT.) Mental age - 2 yrs. 3 mo.	I.Q. 31 (February 3, 1972. S-B. Mental age - 3 yrs. 10 mo.)
S_4	Encephalopathy due to unknown or uncertain cause, with the structural reaction alone manifest. Epilepsy	15	8	I.Q. 25 (PPVT). Mental age - 2 yrs. 8 mo.	I.Q. 22 (May 16,1972. S-B. Mental age - 3 yrs. 6 mo.

These cards will be described in detail in the procedural sections of Experiments I and II.

Procedure

Pre-Experimental Baselines

Prior to the actual experiments, baselines were conducted for all subjects to determine their repertoires for identifying colors and numbers and reading or identifying words describing colors and numbers. Two methods were used to gather baseline data on each subject. In the first method when the subject was attending to the experimenter across the working table (attention was defined as eye-to-eye contact) the experimenter would hold up a stimulus card and ask the subject, "What color is this," or if it was a word stimulus card, "What color does this word say?" Similar instructions were given to subjects with respect to stimulus cards for numbers and number words. If the subject made a correct response within five seconds a check mark was recorded beside that item on the data sheet for that subject. If the subject made a wrong response or did not respond within five seconds an X was marked beside that item on the data sheet. The stimulus items in this method were presented randomly one at a time. Only one set of stimulus cards was tested at a time for each subject. That is, baselines were conducted for each subject for color identification before testing any of the other stimulus card sets. After the set of stimulus cards for colors had been presented to the subject once, they were re-shuffled and presented another four times with re-shuffling following each complete presentation of the list. Each subject was therefore tested five successive times on each stimulus item.

The second baseline method employed a simultaneous testing technique. All of the cards for a particular stimulus set (e.g. twelve number cards) were placed on the working table in front of the subject at the same time. When the subject was attending to the experimenter she was instructed to "Point to number ----", if it was a number card, or "Point to the word that says RED," if it was a color word stimulus card. Scoring in this method was the same as that used in the first method. When the subject had been asked to point to all stimulus cards in that set they were re-shuffled by the experimenter and replaced on the working table. The subject was given five trials on each item as in the first method.

Reinforcement during baselines was not contingent upon correct responses. The subjects, however, earned pegs (conditioned reinforcers) for sitting quietly, attending, and naming various parts of their anatomy in between trials. When a subject had earned ten pegs she was allowed to cash them in for a back-up reinforcer.

Experimental Design

Each of the two phases of each experiment followed the same basic design. A multiple baseline technique was used to compare four methods of teaching a discrimination. The same four words were taught to each subject in a particular phase of the experiment. However, each word was taught to each subject using a different method. This counter-balanced the words in such a manner that expected ease in learning words could not be due to any intrinsic variables if there were sizeable differences between methods. In addition, daily baselines were taken on words being taught and words not being taught as a test of both learning, retention, and generalization.

Experiment I

General Procedures

Experiment I was designed to compare four methods of teaching subjects to discriminate or read color names. Following pre-experimental baselines eight colors that all of the subjects knew, but could not read or identify the names of, were selected. These colors were randomly divided into the following four pairs: Brown, Green; Purple, Yellow; Pink, Red; Blue, Orange. The first word in each word pair was taught during the first phase of Experiment I while the second word in each word pair was taught in the second phase. The methods used to teach the words were counter-balanced across subjects such that no subject was taught the same word using the same method. The design of Experiment I is presented in Table 2.

Sixteen training sessions, four for each subject, were conducted during each session day. This allowed each subject to come in contact with each of the teaching methods on a given session day. Sessions were randomized such that no subject had consecutive training sessions. A word and subject were randomly chosen at the beginning of a session day to determine the order of sessions for that day. For example, (see Table 2) if the subject 2 and the word PINK were chosen, PINK would be taught to subjects 2, 3, 4, and 1 consecutively, then ORANGE, BROWN, AND PURPLE, using the appropriate method designated for

TABLE 2

Experimental Design Used to Teach Color Words to Subjects in Experiment I.

Subject	Color Word Phase 1	Color Word Phase 2	Teaching Method	
S_1	BROWN	GREEN	Traditional	2
	PURPLE	YELLOW	Traditional	1
	PINK	RED	Fading	2
	ORANGE	BLUE	Fading	1
S_2	BROWN	GREY	Fading	1
	PURPLE	BLACK	Traditional	2
	PINK	PURPLE	Traditional	1
	ORANGE	WHITE	Fading	2
S_3	BROWN	GREEN	Fading	2
	PURPLE	YELLOW	Fading	1
	PINK	RED	Traditional	2
	ORANGE	BLUE	Traditional	1
S_4	BROWN	GREEN	Traditional	1
	PURPLE	YELLOW	Fading	2
	PINK	RED	Fading	1
	ORANGE	BLUE	Traditional	2

each subject.

The task in both phases of Experiment I was a simultaneous discrimination problem in which the subject had to choose from three stimulus cards, one relevant S^D and two irrelevant S^{Δ}s. For each S^D word there were two corresponding S^{Δ} words that were associated with only that particular stimulus word. For example, the S^D word BROWN was always presented in training sessions with the S^{Δ} words HORSE and UNCLE. Refer to Table 3 for a complete list of all S^D and S^{Δ} words used in Experiment I.

Stimulus cards for the various conditions of Experiment I were held constant in terms of card, letter, and word size. All stimulus cards were made of heavily bonded white paper measuring 8.5 in. by 11 in. Letter size was 2 in., and print type was solid Gothic. All S^{Δ} words were chosen such that they contained the same number of letters as the S^D words they were associated with (see Table 3). Each of the four training conditions of Experiment I had a set of stimulus cards relevant to and determined by the method being investigated in that particular condition. Differences in these cards are described in the next section.

The order of presentation of stimuli is presented in Table 4. The position of at least two of the stimulus cards changed each trial and one stimulus was never in the same position on more than two consecutive trials. This mixed presentation order of stimuli repeated itself every six trials.

Trials were identical for all four teaching methods. A trial began when the subject was sitting quietly and attending to the

TABLE 3

S^D and S^{Δ} Word Pools Used in Experiment I.

Word Pool	S^D_1	S_2	S_3
1. Phase I	BROWN	HORSE	UNCLE
Phase II	GREEN	TODAY	MARCH
	*GREY	DRED	SAID
2. Phase I	PURPLE	HOSTEL	TRAVEL
Phase II	YELLOW	RECORD	LISTEN
	*BLACK	SEVEN	EIGHT
3. Phase I	PINK	FARM	MAID
Phase II	RED	BUN	CAR
	*PURPLE	HOSTEL	TRAVEL
4. Phase I	BLUE	TIME	SURE
Phase II	ORANGE	WINDOW	PENCIL
	*WHITE	MONEY	FENCE

* S^D and S^{Δ} words for Phase II of Experiment I for subject 2 only.

TABLE 4

Presentation Order of S^D and S^Δ Stimulus Cards in Experiment I.

Trial	Left	Position Middle	Right
1.	1	2	3
2.	2	1	3
3.	3	1	2
4.	2	3	1
5.	1	3	2
6.	3	2	1

Note - Number 1 refers to the position of the S^D stimulus card, while numbers 2 and 3 refer to the position of the S^Δ stimulus cards, relevant to the subject.

experimenter. Attending was defined as eye-to-eye contact. When the subject attended, the experimenter gave the command, "Point to the word that says (e.g.) BROWN." If the subject pointed to the correct word, the experimenter gave her social praise, e.g. "Good girl, that's right." The experimenter then pointed to the S^D card and asked the subject, "What color does this word say?" If the subject said the correct word the experimenter again gave her social praise and she was allowed to take a peg. A wrong response, that is, pointing to either of the two S^Δ cards, or no response within five seconds of the initial command "Point to the word that says ----?", was followed by a loud "No" from the experimenter and a ten second extinction period. If the subject responded correctly to the initial command, but gave no response or an incorrect response to the second command, "What color does this word say?", she was again told "No" and given a ten second extinction period. Wrong responses were never followed by social praise or conditioned reinforcers.

Following each trial all stimulus cards were turned over and rearranged out of sight of the subject for presentation on the next trial following the order described in Table 4.

The experimenter kept data for each trial. Correct and wrong responses were recorded for each part of the trial. Thus, there were three possibilities for the data on a given trial. The subject could be correct for both pointing and naming (instructions 1 and 2), correct for pointing but incorrect for naming, and incorrect for pointing at which point the trial terminated. In addition, the experimenter kept records of the position of pointing errors, in terms of the position of the S^{Δ} card(s), with respect to the subject; i.e. right, left, and middle errors. Each session in Experiment I consisted of eighteen trials as described above. Session duration was approximately ten minutes.

Training Methods

Experiment I compared four methods of teaching the subjects to read color names: two methods utilized what could be described as traditional procedures while the other two methods employed fading or errorless procedures.

a) Traditional 1. The S^D and two S^{Δ} cards in this procedure could only be distinguished on the basis of spelling differences. All words were printed in black letters on cards as described above.

b) Traditional 2. An extra cue was given to subjects in this condition in the form of a 2 in. by 2 in. square located above the S^D word on the white background. The color of this square was determined by the S^D word. If the S^D word was BROWN, then the colored square was brown. This square was removed in the final training session.

c) Fading 1. Additional cues were provided to subjects in this condition by the S^D word which was printed in the same color that the word described. If the S^D word was BROWN then the lettering was brown. The brown lettering was systematically faded from brown to black in seven steps. On the seventh step there were no differences in this procedure and the Traditional 1 procedure, i.e. both S^D and S^{Δ} words were printed in black.

Fading of the S^D word in this condition from the relevant color to black was programmed in the following manner. On the first of the seven steps the S^D word was printed in 2 in. letters of the relevant color (e.g. brown lettering). On the second step the top and bottom ¼ in. of all letters of S^D were printed in black while the remaining 1½ in. of the S^D word was printed in the relevant color. On the third step, another ¼ in. of black was added to the top and bottom of the S^D word, while the remaining 1 in. was still printed in the color of the relevant stimuli. This process of adding black print to the top and bottom of each letter in the S^D on each successive step took seven steps to completely change the S^D word from the relevant color to black.

d) Fading 2. The additional cue provided by the Traditional 2 procedure (2 in. by 2 in. colored square located above the S^D word) was systematically faded out, by reducing its size, over seven steps. On the seventh step there was no difference between this procedure and the previous three procedures in terms of the appearance of the stimulus cards.

Generalization and Retention Tests

Generality and retention of words learned in training sessions was tested twice each day for each subject. One test was conducted in the early morning before training sessions and the second test was administered late in the afternoon following training sessions. Tests were in the form of a baseline session in which the subject was presented with the eight S^D color words (four words from each of the two phases) taught in Experiment I. The S^D words used in these tests were always in their criterion forms; i.e. black 2 in. solid Gothic lettering on 8½ in. by 11 in. white backgrounds. Two methods, similar in design to the pre-experimental baselines, were utilized to test generalization and retention.

During the first six session days the testing method used was a method in which each S^D card was presented successively in a random manner. On each trial the subject was asked "What color does this word say?" This was identical to the second instruction for each trial in all training methods. Each test consisted of four presentations of each S^D card. Because of problems encountered with two of the subjects in using this method, the test procedure was reassessed following the sixth experimental day and an alternative method for conducting generalization and retention was selected. The problems created by subjects 3 and 4 were two: they either did not respond to the experimenter's question or if they did they pronounced the name of a single letter in the S^D word. Each of these was counted as an incorrect response.

The second test procedure required the subject to point to the relevant S^D card from among all eight S^D cards arranged simultaneously in two rows of four on the bulletin board on the classroom wall. The instructions for this method were for example, "Point to the word that says BROWN," which was the initial instruction of each trial for all training procedures. After all words had been randomly tested from this display once, the S^D cards were repositioned and the procedure repeated three more times so that each word was tested four times during each test session. This procedure was used as a probe during the final generalization and retention tests of phase 1 and was used for all tests in phase 2.

During these test sessions reinforcement was never associated with correct responding. Contingencies of reinforcement were similar to those employed in the pre-experimental baselines.

Experiment II

Experiment II compared four methods of teaching subjects to read or discriminate number words. Pre-experimental baselines showed that all of the subjects could identify the numeric symbols for the numbers one to twelve, but could not read the words which represented these numbers. Following baselines eight number words were randomly chosen from the above twelve. These eight words were then randomly divided into four pools of two words each.

General Procedures

Since Experiment II was designed as a systematic replication of Experiment I, many of the variables of this experiment were identical to those in Experiment I. These included the same design for counter-balancing the S^D words, the four procedures, and the order of sessions across subjects (see Table 5). Three of the four training methods in this experiment were the same as corresponding methods in Experiment I and the experiment had two phases; identical with those in Experiment I. In addition, the number of steps for the fading procedures was identical, seven. Other similarities to Experiment I are found in the S^{Δ} words associated with S^D words. Table 6 shows that each S^D word had a set of

TABLE 5

Experimental Design Employed to Teach Number Words to Subjects in Experiment II.

Subject	Number Word Phase 1	Number Word Phase 2	Teaching Method	
S_1	TEN	FOUR	Traditional	1
	THREE	EIGHT	Fading	2
	FIVE	NINE	Fading	1
	ONE	TWO	Traditional	2
S_2	TEN	FOUR	Traditional	2
	THREE	EIGHT	Traditional	1
	FIVE	NINE	Fading	2
	ONE	TWO	Fading	1
S_3	TEN	FOUR	Fading	1
	THREE	EIGHT	Traditional	2
	FIVE	NINE	Traditional	1
	ONE	TWO	Fading	2
S_4	TEN		Fading	2
	THREE		Fading	1
	FIVE		Traditional	2
	ONE		Traditional	1

TABLE 6

S^D and S^Δ Word Pools Used in Experiment II.

Word Pool	S^D_1	S^Δ_2	S^Δ_3	S^Δ_4	S^Δ_5
1. Phase I	TEN	SUN	DEN	ARE	TEA
Phase II	FOUR	FORM	TOUR	FEAR	FROM
2. Phase I	THREE	SPREE	THROW	PLATE	NIGHT
Phase II	EIGHT	SIGHT	FIGHT	ELITE	TIGHT
3. Phase I	FIVE	DIVE	FISH	LADY	KNAP
Phase II	NINE	NITE	SINE	MINE	NOTE
4. Phase I	ONE	CUT	ORE	ATE	NOT
Phase II	TWO	SOW	TIC	TOO	WIT

S^{Δ} words associated with, and only with, that particular S^D word. In this experiment reinforcement and data collection procedures were also identical to Experiment I.

Experiment II was designed to present much more difficult discriminations to the subjects. This accounted for some of the differences in the general procedures between the two experiments. The discriminations were made more difficult by manipulating three variables. First, the dimensions of the stimulus cards and lettering were reduced in size. Stimulus cards measured 4 in. by 6 in. and lettering was 3/4 in. high, solid Gothic, printed in black. Second, S^{Δ} words were made much more similar to the S^D words they were associated with in terms of the number and position of similar letters (see Table 6). Third, the discrimination involved the presentation of five stimulus cards on every trial, one S^D and four S^{Δ}'s. The number of trials per session was fifteen and the order of presentation of stimulus cards is presented in Table 7. The experimenter numbered the backs of the stimulus cards as shown in Table 7 and kept a presentation list beside him to enhance the quick manipulation of the cards to the appropriate positions for succeeding trials. These manipulations were conducted out of the subject's visual path.

Training Methods

a) Traditional 1. This method was identical to the same condition in Experiment I. The only stimulus differences in the five stimulus cards were differences in letters and letter positions.

b) Traditional 2. This method was also identical to its corresponding condition in the previous experiment. The additional cue

TABLE 7

Presentation Order of the S^D and S^Δ Stimulus Cards in Experiment II.

Trial	Far Left	Near Left	Middle	Near Right	Far Right
1.	1	2	3	4	5
2.	2	3	4	5	1
3.	3	4	5	1	2
4.	4	5	1	2	3
5.	5	1	2	3	4
6.	1	2	3	4	5
7.	5	1	2	3	4
8.	4	5	1	2	3
9.	3	4	5	1	2
10.	2	3	4	5	1
11.	1	2	3	4	5
12.	5	4	3	2	1
13.	2	1	5	4	3
14.	3	2	1	5	4
15.	4	3	2	1	5

Note - Number 1 refers to the position of the S^D stimulus card while numbers 2, 3, 4, and 5 refer to the position of the S^Δ stimulus cards relevant to the subject.

was provided by a 3/4 in. numeral located above the S^D word standing for that numeral. For example, the numeral 2 would be located above the word TWO. This numeral remained constant on all but the last fifteen trials of the procedure at which point it was completely removed.

c) Fading 1. This procedure was different than the Fading 1 procedure of Experiment I. In this procedure the S^D word remained constant across all seven fading steps. The four S^Δ words, however, were initially blank stimulus cards on step 1 and were faded in systematically over the next six steps such that on step seven they were complete words. Therefore, the S^Δ words and the S^D word were identical to S^D and S^Δ words in the traditional procedure over the last fifteen trials. The fading sequence of the S^Δ words was accomplished by making a light outline of the S^Δ words on the second step, darkening these outlines on the third step and then filling in the outlines with black ink from the middle, towards the top and bottom, at about 1/8 of an inch per step over the remaining four steps.

d) Fading 2. This method was very similar but not identical to the corresponding method of Experiment I. The difference in the two procedures was in terms of the method used to systematically fade out the additional cue. The numeral located above the S^D word did not reduce the physical size of the cue, but was faded out by gradually reducing the amount of coloring it contained in an identical method, but opposite sequence, to that described above for fading in the S^Δ words in the Fading 1 procedure of Experiment II. The numeral was no longer present by step seven making the last fifteen trials identical to those of the other three training methods.

Generalization and Retention Tests

Tests for generalization and retention in Experiment II were conducted once per day, in the late afternoon following training sessions. The testing procedure was identical to the test employed for phase II in Experiment I which was a simultaneous discrimination of the eight S^D words positioned on a bulletin board on the wall of the classroom.

Five Month Follow-up Tests

Five months after termination of Experiment II all subjects were given the generalization and retention tests described in the preceding section. Each subject was given two tests. The first tested the S^D words of Experiment I and the second the S^D words of Experiment II.

Inter-Observer Reliability

The nature of the training sessions did not seem to warrant the use of inter-observer reliability measures. That is, the response of pointing to a card by the subject and the subsequent judgement by the experimenter that the response was correct or incorrect was in no way subjective. Inter-observer reliability data was gathered on three occasions during the initial phase of Experiment I for generalization and retention tests. The test procedure in this phase involved a verbal response by the subject. Since two of the subjects had some degree of difficulty in pronouncing some of the words the experimenter had to judge whether what the subject verbalized was the correct word or not.

Data was gathered by a female psychology graduate employed at Kin Kare for the summer to work on various behavior modification programs with the residents. The procedure for gathering inter-observer reliability data had the female observer sitting behind the subject with her back to the subject so that she could not see the S^D cards as they were presented. She wrote down the words that she heard the subject say, or indicated if she could not tell what the word was that was spoken. Following the generalization and retention sessions, her written report was broken down into trials and compared with the experimenter's data sheet. Scores were computed by dividing the number of agreements by the number of agreements plus disagreements and multiplying the resulting number by 100. Data for the three sessions showed inter-observer reliability of 93.7%, 100%, and 96.8%.

Criterion for Learning in Experimental Conditions

Words taught by any of the four training procedures were considered learned if the subject could correctly identify them at a level of 90% or above in two successive training sessions. Performance measures for generalization and retention, during training, following training, and after five months were developed from the data of Corey & Shamow (1972). These criteria levels for generalization and retention were as follows: During training, 75% correct averaged across sessions corresponding to the final two training steps for that experimental phase. During post training, (i.e. the second experimental phase when the first four words were no longer being taught in training sessions) the criterion level of performance was established at an average of 50% over all seven steps for that phase. Criterion on the five month follow-up test was also set at 50%.

These criteria are slightly higher than the levels obtained by Corey & Shamow (1972) which were measured at 66%, 45%, and 33%, for corresponding experimental conditions.

Because of the nature of the experimental design, these criteria were considered to be reasonable. Subjects were never reinforced for correct responding in these conditions. The discriminations were much more difficult than training session discriminations, i.e. eight stimulus words as opposed to five. Chance level of responding correctly, therefore, was 12.5%.

CHAPTER V

RESULTS

Results of Experiments I and II are presented first by individual subject for all experimental conditions and all training procedures and second, as mean percentage scores for subjects by training methods for each of the experimental conditions.

Individual Results

Training Sessions

Table 8 summarizes the number of errors each subject made over the number of trials in each phase of each experiment under a given teaching method. In general, the Traditional 1 method, as expected, had the highest percentage of training errors associated with it. These errors, however, usually occurred in the early sessions of training. All subjects, with the exception of subject 2 in phase 2 of Experiment II, met the criterion of learning set at 90% correct responses in two successive sessions using this procedure.

Very few errors occurred in training sessions for any of the other training methods. The few errors that did occur in these methods were usually in the last sessions of training when the additional cues associated with these methods had been faded out completely. All subjects met the training performance criterion in all phases of both experiments under all three of these training methods.

TABLE 8

Percent Training Errors for Individual Subjects by Method and Experimental Phase.

			Trad. 1	Trad. 2	Fading 1	Fading 2
Subject 1	Expt. 1	Phase 1	25.4	.0	1.5	1.5
		Phase 2	3.1	.0	1.5	.0
	Expt. 2	Phase 1	13.3	.0	.95	13.3
		Phase 2	65.2	.0	.0	.0
Subject 2	Expt. 1	Phase 1	.0	.0	.0	.0
		Phase 2	3.1	.0	.0	.0
	Expt. 2	Phase 1	13.3	.0	.0	.0
		Phase 2	14.2	.0	.0	8.5
Subject 3	Expt. 1	Phase 1	11.1	.0	.0	.0
		Phase 2	3.9	.0	2.4	.0
	Expt. 2	Phase 1	10.9	.95	.0	.0
		Phase 2	25.7	.95	.0	.0
Subject 4	Expt. 1	Phase 1	.79	.0	1.5	14.2
		Phase 2	33.3	.79	3.1	12.6
	Expt. 2	Phase 1	39.04	.95	.0	15.2
		Phase 2	-	-	-	-

Generalization Test Results

Subject 1

Results of daily generalization and retention tests conducted during training, post training, and the five month follow-up test are presented in Figure 1 for subject 1. For the words taught using the Traditional 1 method, criterion (mean of 75% correct over final two days of training) was met for three of the four words, with respect to generalization corresponding to daily training sessions, while these words were being taught. Post training criterion (mean of 50% correct over entire phase) was met for each of the two possibilities, i.e. words taught in phase 1 were tested in phase 2 while new words were taught in training sessions. Criterion (mean of 50% correct) on the five month follow-up test was met for both words taught in Experiment I.

Results for the Traditional 2 method show that none of the four words met any of the criterion for generalization, during training, post training, or follow-up.

Tests of words taught using the Fading 1 method of Experiment I show that only the word taught in phase 2 met the generalization during training criterion. No other criterion were met for this method.

Performance on tests was enhanced by the Fading 1 procedure in both phases of Experiment II. Subject one was able to meet criterion on all tests except follow-up for the phase 2 word.

Results of the Fading 2 procedure were generally poor. Criterion was met only for training and post training generalization

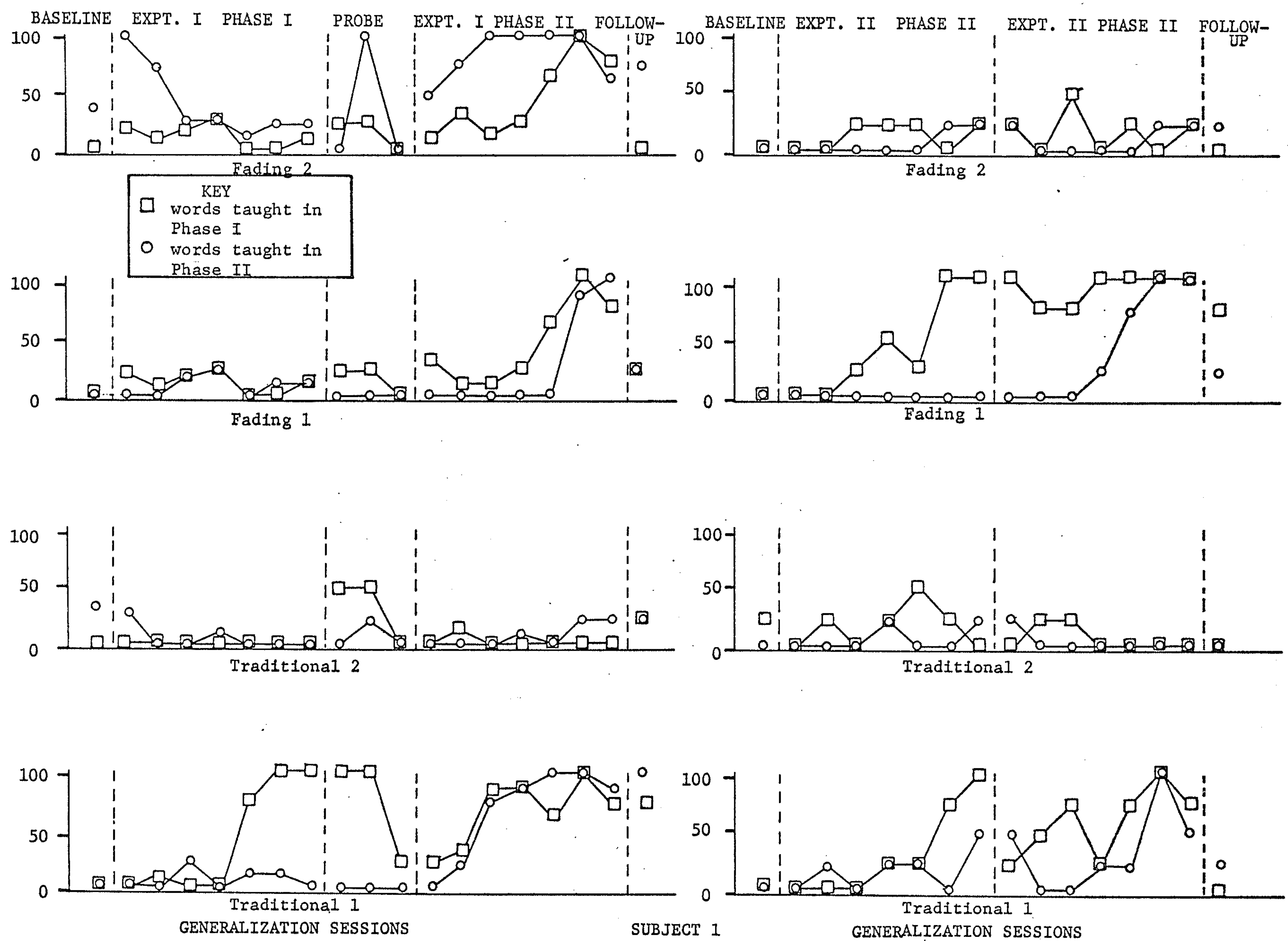

Fig. 1 Per Cent Correct Generalization Scores of Subject 1 in Sessions Across all Experimental Phases and Conditions.

for the phase 2 word of Experiment I. Results in Experiment II were extremely poor, relative to the Traditional 1 and Fading 1 methods in Experiment II.

Subject 2

Results for subject 2 are presented in Figure 2. This subject performed consistently well in tests of words taught in the Traditional 1 procedure. Criterion was met on all words for generalization during training except the phase 2 word of Experiment I. Criterion performance was also obtained on both possible words on post training and the same two words on the follow-up test.

Results for the words taught under the Traditional 2 procedures were much more inconsistent. Generalization during training criterion was met for both phase 2 words and post training and follow-up criterion for only one word.

The Fading 1 procedures for this subject present an interesting contrast. None of the words taught using this method in Experiment I met any of the test criteria while all of the criteria were met when the procedure was changed in Experiment II.

Fading 2 procedures were less effective on generalization during training, post training, and follow-up than the Traditional 1 procedures for both experiments and the Fading 1 procedure of Experiment II. Results for this procedure were about the same as those for the Traditional 2 procedure. Generalization criterion during training was met for the first phase word of both experiments. Acquisition of this generalization was slow, however. The post

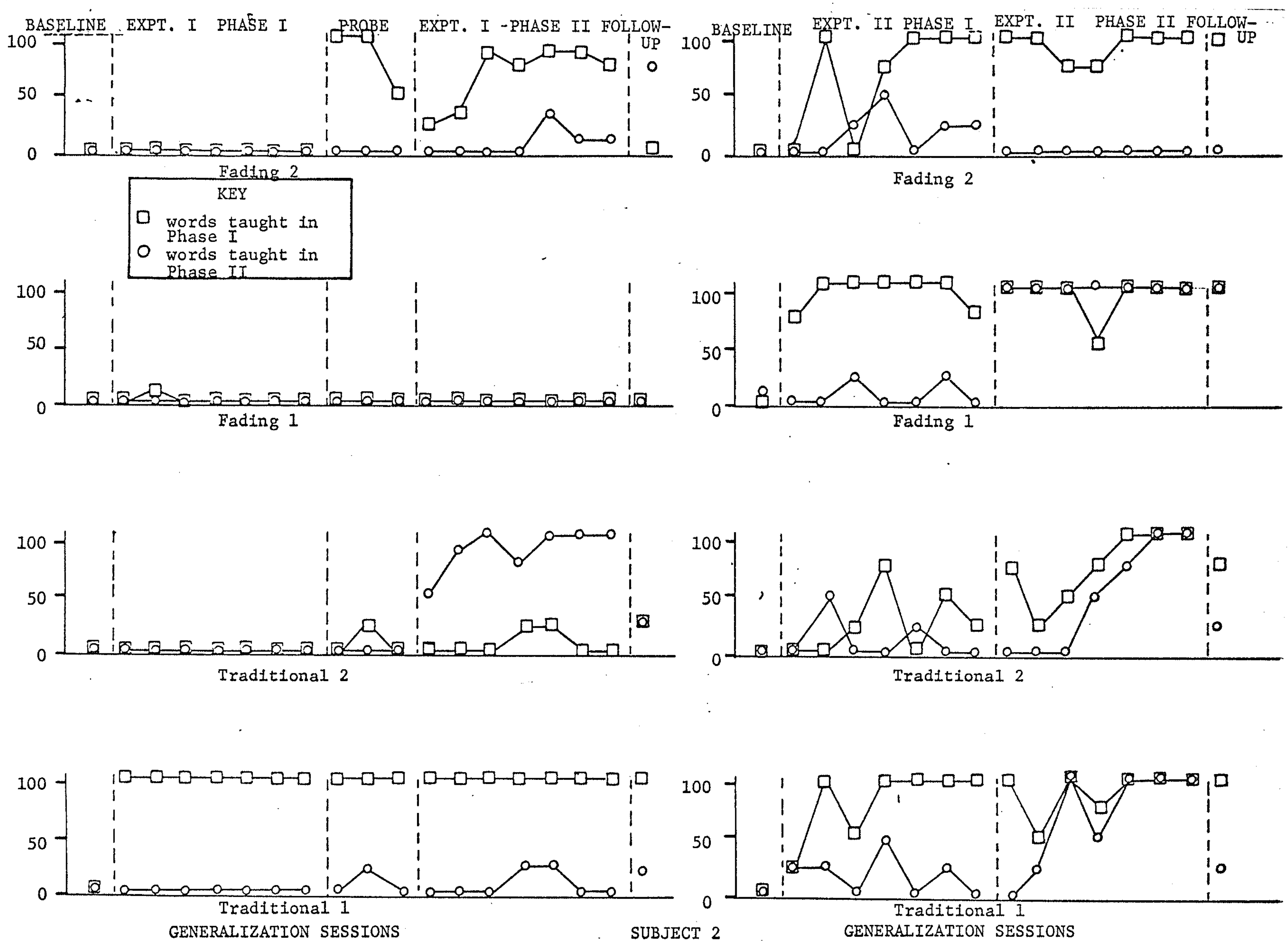

Fig. 2 Per Cent Correct Generalization Scores of Subject 2 in Sessions Across all Experimental Phases and Conditions.

training criterion was met for both of these words and follow-up for the Experiment II word.

In general, subject 2 was the best and most consistent of all four subjects in terms of the generalization tests. Acquisition and retention of words meeting criterion was usually rapid and at a very high level. Six of the nine words that met the initial generalization criterion also met the follow-up criterion.

Subject 3

Results for subject 3 are presented in Figure 3. Phase 1 results across all conditions in Experiment I show no correct responses at all. Results of this phase for subject 4 were identical. It was at this point that the second generalization procedure requiring identification of a word by pointing rather than verbal identification was introduced. This new generalization procedure introduced as a probe in phase 1 of Experiment I resulted in some minor effects but no words taught in this phase reached criterion. Following phase 1 of Experiment I results on tests with subject 3 were still generally poor. Criterion was met for generalization during training on words taught using the Traditional 1 method in the second phase of both experiments and for the word taught in phase 2 of Experiment I by the Fading 1 method. Post training criterion was reached for the phase 1 word under the Traditional 1 and Traditional 2 methods in the second and first experiment respectively. Follow-up generalization criterion was only met for both phase 2 words taught under the Traditional 1 method. It is interesting to note that both Fading 1 procedures were

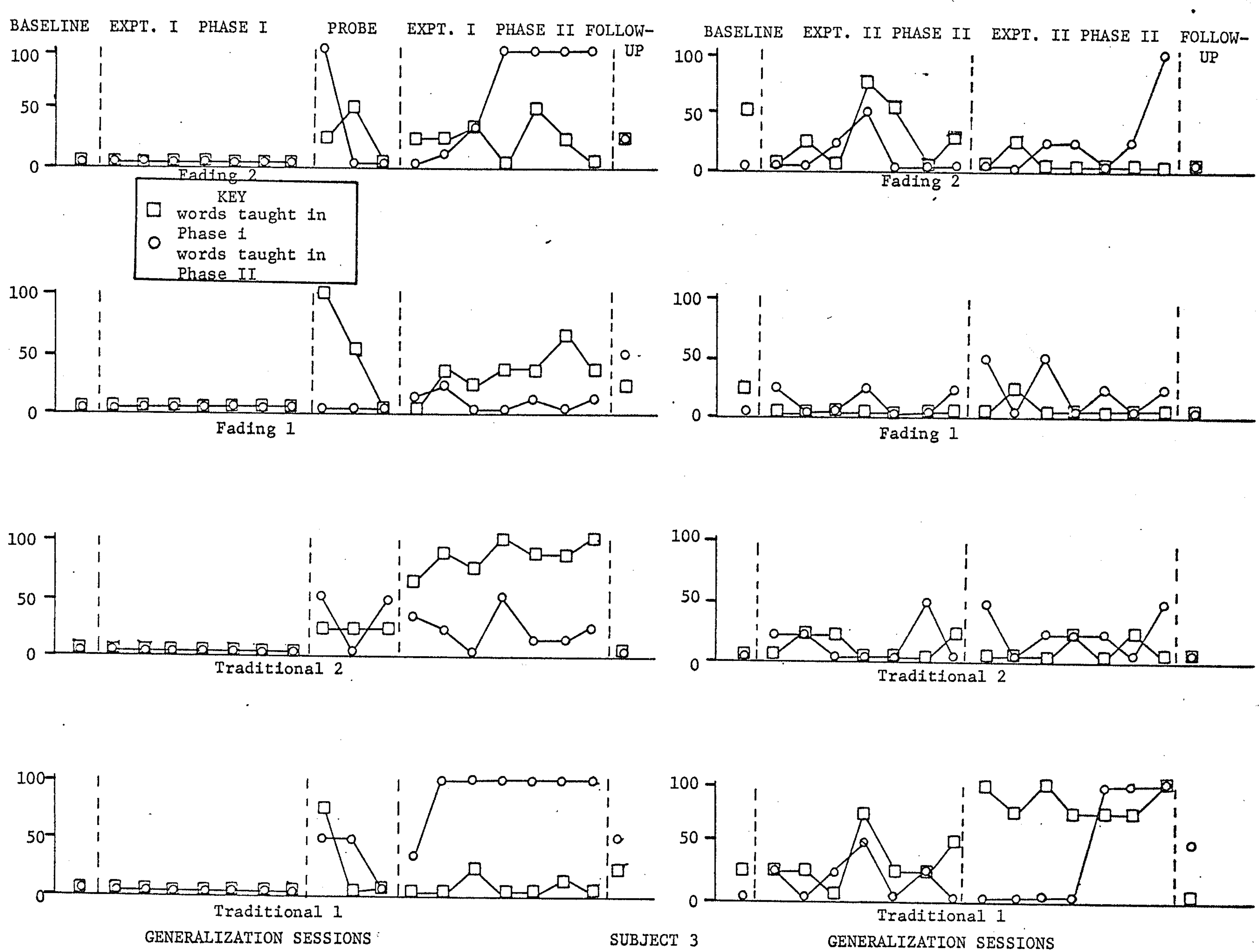

Fig. 3 Per Cent Correct Generalization Scores of Subject 3 in Sessions Across all Experimental Phases and Conditions.

completely ineffective in terms of generalization for this subject.

Subject 4

Due to illness subject 4 was not able to participate in phase 2 of Experiment II. Consequently generalization retention data for the words taught in phase 1 of Experiment II could not be obtained. As previously noted no correct responses occurred in generalization tests for words taught in phase 1 of Experiment I for this subject due to the nature of the generalization tests used in that phase.

The results for subject 4 are presented in Figure 4. Although generalization was not met during the probe phase for the Traditional 1 procedure the post training criterion was met for that word. This might indicate that possibly some generalization for that word was occurring and that the probe should have been extended for a few more sessions. Generalization during training criterion was met for the word taught in the second phase of Experiment I but was not met in Experiment II. Follow-up criterion was not met for any of the three words.

The Traditional 2 procedure and the Fading 2 procedure were completely ineffective for all words on all training, post training, and follow-up generalization tests.

Fading 1 procedures met generalization criterion during training for the phase 1 words of both experiments. Post training generalization was well above criterion for the phase 1 word of Experiment I and follow-up criterion was reached for the phase 2 word of this experiment.

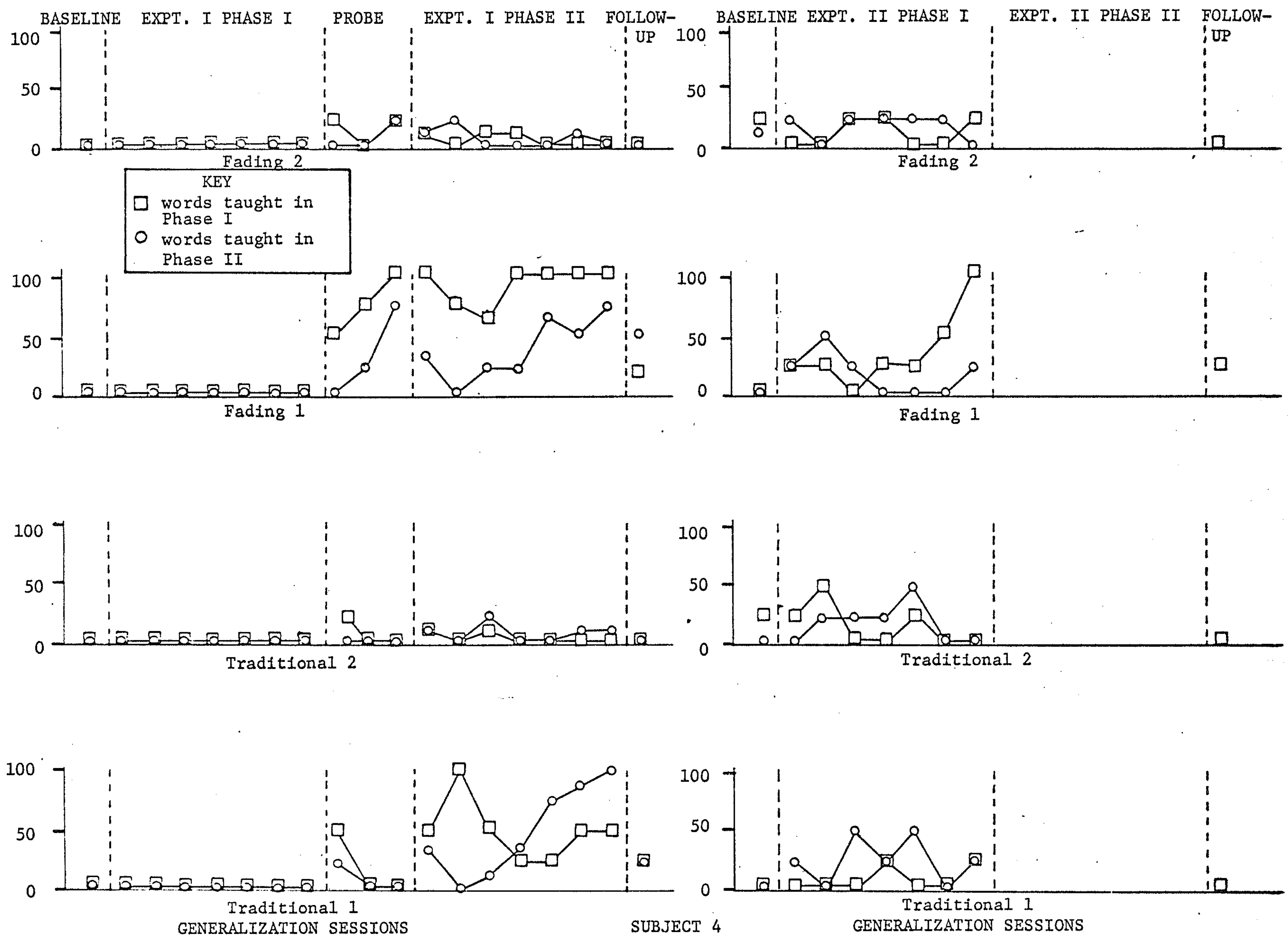

Fig. 4 Per Cent Correct Generalization Scores of Subject 4 in Sessions Across all Experimental Phases and Conditions.

To summarize, all of the subjects performed extremely well in terms of meeting the learning criterion in training sessions across all methods. The Traditional 1 method had the greatest number of errors associated with it for all subjects, however, these errors usually occurred in the early training sessions. In terms of meeting generalization criterion subjects 1 and 2 performed at much higher levels than subjects 3 and 4. The most effective training methods for producing generalization as shown by the data would seem to be the Traditional 1 procedure and the Fading 1 procedure used in Experiment II. A summary of generalization test results in presented in Table 9.

Training Method Results

The results in this section are presented as error percentages averaged across the four subjects. Their purpose is to demonstrate the consistency of phases within and across each experiment for each of the training methods employed. In addition they add strength to the results of the individual subjects.

Training Errors

Table 10 presents the mean percent generalization errors for words taught by each method and experiment in pre-experimental baselines and training. Table 11 is a further analysis of this data in terms of mean percent errors in each phase of each experiment by the four teaching methods. The highest baseline score was an average error of 90.6% and nine of the sixteen experimental phases had pre-experimental baselines of 100%.

TABLE 9

Summary of Training Methods and Experimental Phases in Which Individual Subjects Met Generalization Criterion.

		Generalization											
		During Training				Post Training				Follow-up			
Method		S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4
T 1	Expt. I Phase 1	+	+	0	0	+	+	0	+	+	+	0	0
	Expt. I Phase 2	+	0	+	+					+	0	+	0
	Expt. II Phase 1	+	+	0	0	+	+	+		0	+	0	0
	Expt. II Phase 2	0	+	+						0	0	+	
T 2	Expt. I Phase 1	0	0	0	0	0	0	+	0	0	0	0	0
	Expt. I Phase 2	0	+	0	0					0	0	0	0
	Expt. II Phase 1	0	0	0	0	0	+	0		0	+	0	0
	Expt. II Phase 2	0	+	0						0	0	0	
F 1	Expt. I Phase 1	0	0	0	+	0	0	0	+	0	0	0	0
	Expt. I Phase 2	+	0	0	0					0	0	0	+
	Expt. II Phase 1	+	+	0	+	+	+	0		+	+	0	0
	Expt. II Phase 2	+	+	0						0	+	0	
F 2	Expt. I Phase 1	0	+	0	0	0	+	0	0	0	0	0	0
	Expt. I Phase 2	+	0	+	0					+	0	0	0
	Expt. II Phase 1	0	+	0	0	0	+	0		0	+	0	0
	Expt. II Phase 2	0	0	0						0	0	0	

Note: + indicates that generalization criterion was met.
0 indicates that generalization criterion was not met.

TABLE 10

Mean Percent Errors During Pre-experimental Baselines and Training by Experiment and Teaching Method.

	Traditional 1		Traditional 2		Fading 1		Fading 2	
	Baseline	Training	Baseline	Training	Baseline	Training	Baseline	Training
Expt. I	100	10.1	95.	.09	100	1.29	100	3.6
Expt. II	97.8	25.9	96.8	.92	95.5	.13	92.1	5.3

TABLE 11

Mean Percent Errors during Pre-experimental Baselines and Training by Experimental Phase and Teaching Method.

	Traditional 1		Traditional 2		Fading 1		Fading 2	
	Baseline	Training	Baseline	Training	Baseline	Training	Baseline	Training
Phase I	100	9.3	100	.0	100	.79	100	3.9
Phase II	100	10.8	90	.19	100	1.7	100	3.3
Phase I	94.7	19.0	93.7	.47	94.7	.24	90.6	7.1
Phase II	100	34.9	100	1.5	96.3	.0	93.7	2.8

Mean percent errors during training show that the additional cues provided in the fading procedures and the second traditional procedure virtually eliminated errors in training for all subjects. Percent errors in the Traditional 1 procedure were much higher than any other training procedure for any experimental phase. Evidence that the discrimination in Experiment II was more difficult than Experiment I is shown by the fact that error percentages in both phases of Experiment II for the Traditional 1 method were much higher than the corresponding phases of Experiment I.

Generalization Errors

Results of generalization tests conducted during training, post training, and after five months are presented in Tables 12 and 13. Table 12 presents these results by experiment and training method in terms of mean percent errors while Table 12 provides the additional division of data into experimental phases.

The Traditional 1 procedure in both experiments and the Fading 1 procedure employed during Experiment II showed the highest degree of generality during training, following training, and on the five month follow-up test. That is, error percentages were lower for these two methods for the three generalization tests compared to the error percentages of the other teaching methods. These results were consistent within experimental phases and are consistent with the general results for individual subjects as stated previously.

TABLE 12

Mean Percent Generalization Errors by Experiment and Teaching Method During Training, Post Training, and on Five Month Follow-up Test.

		Traditional 1	Traditional 2	Fading 1	Fading 2
Experiment I	Training	55.3	84.3	88.9	78.2
	Post Training	40.6	75.9	57.1	73.2
	Follow-up	46.8	87.5	75	75
Experiment II	Training	56.1	79.1	53.1	77
	Post Training	22.6	60.7	36.9	61.9
	Follow-up	71.4	85.7	53.5	82.1

TABLE 13

Mean Percent Generalization Errors by Experimental Phase and Teaching Method during Training, Post Training, and on a Five Month Follow-up Test.

		Traditional I		Traditional II		Fading I		Fading II	
		Phase I	Phase II	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II
Experiment I	Training	63.9	47.3	100	69.6	96.0	82.1	99.0	58.9
	Post Training	40.7		75.9		57.1		73.2	
	Follow-up	43.7	50.0	87.5	87.5	81.2	68.7	93.2	55.0
Experiment II	Training	59.8	51.2	83.0	73.8	57.1	47.6	68.8	88.1
	Post Training	22.6		60.7		36.9		61.9	
	Follow-up	93.0	67.0	75.0	91.6	50.0	58.3	75.0	91.6

CHAPTER VI

DISCUSSION

The following conclusions can be made from the results presented in this study. (1) Each of the five methods employed to teach reading discriminations was effective in terms of training. There was only one instance of a subject failing to reach criterion for learning the discrimination from a total of 60 discriminations taught in the two experiments. (2) Differential effects on generalization tests were found for the five teaching methods. The Traditional 1 method in both experiments and the Fading 1 method of Experiment II were generally much more effective in producing generalization than the other three teaching methods. These results were consistent both within and between experiments for all generalization tests. (3) Results of generalization tests show a differential performance level for subjects 1 and 2 compared to subjects 3 and 4. Subjects 1 and 2 were much more consistent at meeting the various generalization criterion than subjects 3 and 4.

Perhaps the most surprising result of these two experiments was the fact that with only one exception all of the subjects were able to learn the training discriminations in the Traditional 1 procedure. Although the mean percentage of errors was much higher in this condition than in any other training method, almost all of the errors were made in early sessions and percent errors in later training sessions were comparable to error percentages in the other training methods.

In Experiment II when the discrimination was made more difficult and error percentages increased dramatically, subjects were still able to learn the discrimination, with the one exception. Previous studies (McDonald et al., 1973; Powers et al., 1970) have demonstrated that discriminations of seemingly comparable difficulty are sometimes not learned at all when a "trial and error" procedure, such as the Traditional 1 method, is used. Perhaps one explanation of these results can be derived from the subjects previous training history. All subjects in the present study had been involved in extensive behavior modification programs for at least five years. A major portion of these programs was devoted to teaching basic academic skills such as identifying pictures and objects, counting, and printing. The design of the procedures used in these programs,for the most part,was very much like the Traditional 1 procedure. In essence then, these subjects had a long history of "trial and error" type learning, the results of which may have biased this type of procedure in their favor in the present experiment.

Although all teaching methods were effective in terms of meeting the criterion for learning discriminations within the training sessions, perhaps the conclusion that the discriminations were learned is misleading. Generalization test results were very poor for the Traditional 2 and Fading 2 methods and the Fading 1 procedure of Experiment I. This indicates that although subjects had minimal error percentages in training sessions they were basing their discrimination strategies on the additional cues provided by these methods. Most training errors in these methods occurred in the last training session when the additional cues were no longer available to the subjects. McDowell (1969, 1970) has suggested that additional cues of this type will facilitate discrimination learning. The results of the present study, however, indicate that discrimination learning was hindered rather than enhanced using these procedures as shown in the results of the generalization tests and the drop in discrimination performance in the final training session when the additional cues were removed.

The same criticism would seem to apply to the Fading 1 procedure of Experiment I. It seems that, although error percentages were low, subjects were basing discriminations on differences in the colors of the S^D and S^{Δ} words rather than differences in the structure of the word. It was assumed that by fading out the color of the S^D word the subjects would first discriminate on the basis of color, but later in training,as the color was faded out,more attention would be drawn to the structure of the word itself. The poor results for this method do not support this assumption.

In terms of developing a technology for errorless learning or fading procedures the comparison of generalization tests for the different Fading 1 procedures offers some interesting information. The Fading 1 procedure of Experiment II (fading in S^{Δ} stimuli while holding S^D constant) was an effective training method for generating generalization for three out of the four subjects. The Fading 1 procedure of Experiment I (fading out stimuli associated with S^D while S^{Δ}'s remain constant), however, was ineffective for producing generalization (see Table 9). Since generalization results were consistent for all other methods between experiments and within experimental phases (Tables 12 and 13), it can be concluded that differences in generalization results for the Fading 1 procedures between experiments must be due to differences in the two Fading 1 procedures. Consistency within experimental phases lends further support to this conclusion. The comparison of these two procedures appears to isolate one of the critical variables of fading techniques. That is, for a fading procedure to be effective the S^D apparently must be held constant during the fading process. This, of course, is what previous studies have done. This aspect of the fading procedure to this author's knowledge has never before been tested empirically by comparing it to a procedure in which S^Δ conditions are held constant and the S^D is faded systematically.

The acquisition of generalization in tests conducted during training phases may reflect the actual acquisition of the learning of the discrimination in training to some extent as seen in the results of the individual subjects (Figures 1, 2, 3, and 4). If it is true that learning in terms of error percentages was confounded by the additional cues provided in all fading procedures and the Traditional 2 procedure, as previously noted, then perhaps the best indication of learning can be measured by generalization test scores. This experiment was not designed to test this specifically, but the data would suggest that this could be a plausible method of testing learning in the future.

Although error percentages were high on tests of generalization, even for the Traditional 1 and Fading 1 procedures on which criterion was met for several of the words, there are several contributing factors to consider. Subjects were never reinforced for correct responses during generalization tests. The tests were purposely designed to exclude reinforcement in an effort to approximate contingencies in applied settings where the density of reinforcement is much lower than training situations. High percentages of errors on generalization tests could be expected for tests conducted early in training before the response had been fully acquired by the subjects. This contributed to increasing overall error percentages. In addition, the discrimination on the generalization tests was much more difficult than training session discriminations. This was also an attempt to make the situation more like an applied setting and could have contributed to overall error percentages. An interesting possibility for future research on generalization following discrimination would be a comparison of various intermittent schedules of reinforcement during generalization tests and the effect on generalization performance.

The I.Q. scores of the subjects was not considered to be a relevant variable in selecting them for participation in the study since their repertoires for naming numbers and colors, and reading number words and color words were shown to be about equal on pre-experimental baselines. However, the results indicate that subjects 1 and 2 who scored in the moderately retarded range (see Table 1) on I.Q. tests performed at a much higher level on generalization tests than subjects 3 and 4, who scored in the severely retarded range. Possibly, then, the generalization tests were too complex for subjects 3 and 4. In subsequent research with this type of resident it might be more efficacious to program simpler generalization tests before a complex one such as was employed in this study, as suggested by McDonald et al., (1973).

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