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TEACHING BEGINNING READERS TO DISTINGUISH BETWEEN SIMILAR LETTERS OF THE ALPHABET. FINAL REPORT.

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DESCRIPTORS- *READING, *DISCRIMINATION LEARNING, *VISUAL PERCEPTION, *PROGRAMED INSTRUCTION, *BEGINNING READING, VISUAL DISCRIMINATION, MENTAL AGE, READING READINESS, ORTHOGRAPHIC SYMBOLS, LATERAL DOMINANCE,

RECENT RESEARCH ON THE DISCRIMINATION PROCESS INDICATES THAT ERRORLESS LEARNING CAN OCCUR IF STIMULI ARE CAREFULLY PROGRAMED SO THAT THEY ARE DISSIMILAR AND GRADUALLY BECOME MORE SIMILAR AS TRAINING PROCEEDS. TO ASSESS THIS APPROACH IN TEACHING THE LOWER- CASE LETTER B AND D WITH KINDERGARTEN SUBJECTS, TWO SETS OF STIMILI CONSTITUTED THE FIRST EXPERIMENTAL VARIABLE. IN THE PROGRESSIVE VALUE OF THIS VARIABLE, COLOR, SIZE, PRESENCE OF PROMPTS, AND DURATION OF PRESENTATION WERE PROGRESSIVELY FADED TO THE TERMINAL DISCRIMINATION. THE SECOND VALUE OF THIS VARIABLE WAS THE TERMINAL DISCRIMINATION IN THE PROGRESSIVE STIMULI--THE B AND D CONSTANT IN THE ATTRIBUTES OF COLOR, SIZE, DURATION OF PRESENTATION, AND ABSENCE OF PROMPTS. THE SECOND VARIABLE WAS THE TIME OF INTRODUCTION OF THE SECOND LETTER. TWO SEPARATE ANALYSES OF COVARIANCE REVEALED SIGNIFICANT EFFECTS FOR THE TIME VARIABLE, BUT NOT FOR THE PROGRESSIVE-CONSTANT VARIABLE. THE EARLY-PROGRESSIVE COMBINATION RESULTED IN 81 PERCENT OF THE SUBJECTS LEARNING THE DISCRIMINATION WITH UNDER 10 PERCENT ERRORS. WHEN SUBJECTS WERE CATEGORIZED INTO SAME, MIXED, OR CROSSED LATERAL DOMINANCE, NO DIFFERENCES IN ERRORS ON THE TASK WERE OBSERVED. THE SUBJECTS WHO LEARNED THE DISCRIMINATION WITHOUT ERRORS SUBSEQUENTLY COULD NOT DRAW THE LETTERS. FIFTY-FIVE REFERENCES ARE INCLUDED. (AUTHOR/KJ)

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March 1968

U.S. DEPARTMENT OF
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TABLE OF CONTENTS

INTRODUCTION

The learning process of discrimination has been described as being basic to all learning (Kimble, 1961, p. 361). William James' well-known description of the infant's reaction to the world as "big, buzzing booming confusion" is still appropriate. The infant must differentiate and discriminate from this "confusion" and learn to respond differentially to stimuli in the environment. We now have considerably more data at our disposal than was available to James regarding how an organism does differentiate stimuli in the environment, but this process is still the topic of theoretical dispute among experimental psychologists.

Conditioning - Extinction Theory

The early theory of discrimination learning emphasized that the process depends on a combination of "conditioning and extinction" (Spence, 1936; Hull, 1950; Keller and Schonfeld, 1950). The organism must emit some behavior in the presence of a discriminative stimulus, usually abbreviated S^D, and not reinforced for emitting this behavior in the presence of other stimuli, abbreviated S^Δ.

This differential reinforcement-extinction procedure is typically accomplished in one of two methods. These two methods have been termed successive and simultaneous presentation of stimuli (Hunter, 1914). In the successive presentation of stimuli, only one of two stimuli to be discriminated is presented on each trial. The stimuli are then presented in random order, and training then consists of reinforcement following a response in the presence of the S^D, and no consequence following a response in the presence of the S^Δ.

The method of simultaneous presentation of stimuli is accomplished by presenting both stimuli, and the organism is required to choose or select one stimuli in the presence of other stimuli. Experimental psychologists have been ingenious in devising many types of apparatuses to study simultaneous discrimination learning (Kimble, 1961, p. 363).

The conditions under which one method of presenting stimuli is superior to another is an area of investigation that is still equivocal. Simultaneous discriminations have been found to result in faster acquisition by two investigators (Spence, 1952; North and Jeeves, 1956), while others have found the successive method more appropriate (Bitterman and Wodinsky, 1953; Weise and Bitterman, 1951; Teas and Bitterman, 1952). Two investigations report that if the two stimuli to be discriminated are similar, the simultaneous method is superior (Loess and Duncan, 1952; McCaslin, 1954). In both successive and simultaneous discrimination learning, the organism must respond to the S^D to permit extinction of the response during S^Δ.

Errorless Discrimination Learning

Terrace (1963a; 1963b; 1963c) has recently published a series of articles which challenges the "conditioning-extinction" theory of discrimination learning. In Terrace's first study (1963a) he found that the most efficient way to teach pigeons to discriminate between two color stimuli (red-green) was to (1) present the S^Δ very early in the learning sequence, and (2) initially make the difference between S^D and S^Δ very obvious and gradually reduce the dissimilarity in a "progressive" manner. Terrace varied the brightness, duration of presentation, and wave length of stimuli to accomplish the gradual introduction of the terminal S^Δ. The effect of this procedure was to minimize the number of responses in S^Δ for the progressive group. In addition, the terminal discriminatory behavior of the progressive group was much more accurate. Also, the progressive group engaged in less "emotional" behavior in the presence of S^Δ.

Terrace's second study (1963b) used the discrimination the pigeons learned in the first study (1963a) to teach a different, more difficult discrimination by superimposing the new stimuli (vertical and horizontal lines) over the stimuli from the first study (red-green). Terrace gradually "faded" out the original red-green stimuli, and this procedure resulted in errorless vertical-horizontal discrimination accompanied by continued successful performance on subsequent red-green discriminations. His third study (Terrace, 1963c) indicated that under the influence of drugs, the performance of pigeons which had learned a discrimination with errors (but had met criterion) became extremely inaccurate. There was no influence upon the performance of pigeons which had learned the discrimination without errors.

Goldiamond (1964) applied Terrace's method to shift a discrimination under the control of the letter "b" to stimulus control of the abstract conception "male." By superimposing the stimulus class "male" over the controlling stimulus "b" within certain of the paired words in his sequence, and by fading out "b-ness" in successive trials, Goldiamond has designed a series of trials over which the probability of a correct response is progressively increased.

Morse and Goldiamond (1964) accomplished errorless discrimination in a matching to sample task. The sample, a triangle, was presented briefly, then two matches appeared. Only one of the matches was in the same degree of rotation as the sample. The brightness difference between the two matches was gradually reduced by increasing the intensity of the incorrect match until the two matches were identical to the sample in brightness. Morse and Goldiamond mention in a footnote in this article that discrimination of selected letters of the alphabet was established using fading procedures, but no data are presented.

Schutz (1964) reports considerable difficulty in establishing errorless discrimination learning of the lower-case letters b and d with 4 year olds. His research indicates Ss responded to color instead of form, and numerous attempts at fading color from red to black were unsuccessful. The fading of shades of gray to black was equally unsuccessful. Ss did learn the discrimination when form itself was successively faded by hollowing out "flags" to make letters.

Taber and Glaser (1962) report teaching kindergarten Ss color names through a procedure of "vanishing" or "fading," but Duell and Anderson (1967) were unable to replicate their results.

Although the procedure of errorless discrimination learning is congruent with some recent theories of programmed learning (Skinner, 1958; Holland, 1960), the effectiveness of errorless discrimination with human Ss is not clear.

Automated Responsive Environments

In addition to the field of discrimination learning this study was influenced by the work of O. K. Moore (Moore, 1966; Moore and Anderson, 1966). Moore describes a responsive environment in which young children learn speaking, writing, listening, and reading. Moore (1966, p. 170) lists the following criteria for a responsive environment:

1. It permits the learner to explore freely.
2. It informs the learner immediately about the consequences of his actions.
3. It is self-pacing, _i.e._ events happen within the environment at a rate determined by the learner.
4. It permits the learner to make full use of his capacity for discovery relations of various kinds.
5. It's structure is such that the learner is likely to make a series of interconnected discoveries about the physical, cultural, or social world.

Moore (1966, p. 170) further describes the responsive environment as autotelic. An autotelic behavior is one in which the behavior occurs for its own sake rather than for obtaining rewards or avoiding punishment.

The environment designed and employed in this experiment is responsive but not autotelic. The features of the responsive environment that are incorporated in this apparatus include: (1) the responsiveness of the environment is accomplished through immediate knowledge of results and incorrect responses are ignored or extinguished. (2) stimuli are visual and oral, with arrows pointing to the essential features of the stimuli. (3) the child works at the task without interacting with another individual who might threaten "loss of love" or use "bribes," There is no extrinsic reinforcer. (4) the child does not compete with others. (5) the apparatus is constructed in such a way that the child's attention focuses only on the intended stimulus materials, and the enclosure and sound-proofing prevents extraneous sounds from distracting the child from the task. (6) there is a continuous record of behavior.

Moore and Anderson (1960) describe the results of their responsive environment in a film series distributed by Basic Education, Inc. The author has been unable to find any numerical descriptions of their data, or detailed procedures with which to compare the performance of children in this experiment.

Organismic Variables in Discrimination Learning

Organismic variables in discrimination learning include mental age, lateral dominance, and visual perception.

1. Mental Age

Mental age is a potential variable associated with discrimination learning. In relationship to reading Nicholson (1958, p. 24) states, "High mental age does not assure a high learning rate in beginning reading. Although children who have high mental age have better letter knowledge it is apparently the letter knowledge rather than the mental age which produces the high learning rate."

2. Lateral dominance

During the 1930s a number of research articles appeared which supported the finding that differential eye and hand preferences for performing certain tasks were related to reading achievement. Monroe (1932) found that retarded readers showed significantly greater left eye and right hand dominance. Similar findings have been reported by Teegarden (1932); Harris, (1957); Berner and Berner, (1938 and 1953); Crider, (1944); Delacato, (1959); and Silver and Hagin, (1966).

However, a number of studies report no relationship between dominance and reading (Fendrich, 1935 ; Johnston, 1942; Smith, 1950; Drew, 1954). Hillrich (1963) reports most public school research to show no relationship between dominance and reading, while the clinical studies indicate cross-dominance and mixed-dominance are a handicap to reading achievement.

All of these studies are concerned with reading difficulties of children after exposure to reading instruction. The relationship of eye-hand dominance to basic discrimination learning of kindergarteners has not been explored.

3. Visual Perception

The focus of this experimenta is intimately related to the field of visual perception. Gibson (1963) explains the development of perception in the child as a process of "learning to detect differences." With this definition of perception, it is difficult to assess how the field of perception differs from discrimination learning.

Gates (1922, p. 31) reported in 1922 that "success in reading and spelling is dependent upon some ability to perceive clearly the significant features of words." Marianne Frostig (1961) has developed the most widely used test of visual perception. Several investigators (Bryan, 1964; Olson, 1966; Robinson, 1946; Johnson, 1955; Frostig, et. al., 1964) have reported that performance on the Frostig Developmental Test of Visual Perception is related to reading performance in the first and later grades, but the test has not been employed to determine its relationship to discrimination learning with younger children.

Purposes of this Research

The purposes of this research were to:

1. devise an apparatus and procedure to study discrimination learning in kindergarten children. Kool (1967) reports that children make fewer errors when the experimenter is available to answer questions immediately, but at the same time investigators should not be "looking over children's shoulders." This finding was taken into account in designing the apparatus (See Figure 1).

2. construct stimulus materials using color, size, pictorial objects, and duration of presentation that could be "faded" in or out progressively such that kindergarteners would make few errors

during acquisition of knowledge of two letter names. Letter names, rather than sounds, were chosen as the response. Durrell and Nicholson (1961, p. 265) has indicated, "The child who knows the names of the letters, even though he has not been taught their sounds, has some basis for word analysis. Since the names of all letters (except h and w) contain their sounds, the tie between letters and their sounds is partially made."

The lower case letters b and d were chosen as data indicate this is a difficult discrimination (Davidson, 1935; Popp, 1964), and they are mirror images. Also, Durrell and Nicholson (1961, p. 262) have indicated children are less likely to already know the lower case letters.

3. explore the relative effectiveness of these "progressive" stimuli with the "constant" stimuli (i.e. equal in color, size, lack of pictorial prompts and duration of presentation).

4. explore the time of introduction of the "progressive" stimuli--early or late in the instructional sequence.

5. control the effect of three organismic variables--mental age, visual perception, and lateral dominance.

6. observe if children who learned the discrimination during the instruction could then write the letters without instruction in the motor skill of drawing the letters. (Hunt (1964) reports that O. K. Moore has found that children who learn to press the proper keys of a typewriter can then spontaneously draw the letters. Hunt cites this as evidence insupport of an "image-primacy" thesis, but no data are presented.

METHOD

Subjects

Bancroft Elementary School (In Kansas City, Mo.) provided subjects (Ss)[1]. The experiment concluded with 64 Ss who had completed training and criterion sessions. There were 16 Ss in each of four treatment groups. The range in age was 5.5 to 6.6 and the mean age was 5.9.

Organismic Data

The Van-Alystyne Picture Vocabulary Test, the Frostig Developmental Tests of Visual Perception,[2] and the Balch and Klug Kindergarten adaptation of the Harris Tests of Lateral Dominance were administered during November and December of 1966[3]. The adaptation of the Harris tests was administered twice, a month apart, and any S who scored differently on the second testing was omitted from the comparisons involving lateral dominance.

The VanAlystyne and Frostig data were used as the covariate in two separate analyses of covariance. The Frostig sub-tests administered were Figure-Ground, Form Constancy, Position in Space, and

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[1]A special note of thanks is due to Mrs. Louise Zimmer, Mrs. Alberta Meyne, and Mr. Earl Kenyon of the Kansas City School District for their excellent cooperation during the course of the investigation.

[2]The UMKC Reading Center assisted in the administration of the Frostig Tests. A special thanks is due to Drs. John K. Sherk, Jr. and Robert E. Leibert for information about the broad field of reading instruction.

[3]See Appendix A for a description of this adaptation.

Spatial Relations. The scaled scores were used and a composite score for each subject derived.

The scores on the Harris adaptation tests were categorized into three groups. Same dominance (SDo) defined those Ss who, without exception, employed the same eye, hand, and foot in performing the assigned tasks (see Appendix A). Crossed dominance (CDo) defined those Ss who employed the R or L eye, but the opposite hand and foot. The Mixed Dominance (MDo) Ss showed inconsistency in preference for R or L dominance eye, hand or foot.

Apparatus

The experimental chamber was one 3'x5'x6' enclosure constructed of plywood and fitted at one end with a 10"x10" stimulus screen and on one side with a 6"x6" one-way mirror and an audio intercom. A chair positioned about midway in the box was separated from the stimulus screen by a partition fitted with a viewing aperture. Glare from projector lamps was eliminated by a filter which covered the viewing aperture. Glare from projector lamps was eliminated by a filter which covered the viewing aperture, and peripheral vision was occluded by means of a shielding apparatus on each side of the aperture. Adequate circulation of air within the closed chamber was attained by means of a small, quiet ventilation fan. The interior of the experimental chamber was covered with acoustic tile to eliminate most external noises.

Stimuli were presented by a Kodak Carousel #580 slide projector which was positioned external to the experimental chamber, about two feet behind the stimulus screen. In this manner, stimuli approximately two inches in height could be brought into view of a seated subject whose head was positioned near to the viewing aperture. Experimenter verbalizations were recorded upon a Wollensak #1500 tape recorder. Slides within the carousel magazine were automatically advanced by appropriately-spaced impulses on the tape. The tape could be stopped and started by means of an experimenter-operated foot pedal located outside the chamber just beneath the one-way mirror (see Fig. 1).

<u>Procedure</u>

Each S was run individually. Ss were introduced to the experimental chamber and seated before the stimulus viewing aperture (with eyes at the appropriate level). Prior to the beginning of each session the chamber was slightly illuminated by light from the projector lamp. After closing the chamber door, the experimenter seated himself before the one-way mirror (by means of which both the subject and the stimulus presentations could be observed). He then initiated the session by releasing the lock on the foot pedal which controlled tape movement.

Each session began with "Hi. We're going to have some fun. Put your eyes up to the hole in front of you and see what happens." The first four slides of each session were referred to as the prompt series (see Fig. 2). If a child in this pre-training phase failed to respond appropriately in the presence of sketches of a dog, a bat and ball, and a bow and arrow and a recorded "What is that?" accompanying each stimulus, the experimenter instructed the naming response. No slide was advanced until an appropriate naming response for each prompt had been emitted by the child and reinforced by a "very good," "that's fine," or "that's right" from the experimenter.

Instruction of "b" and "d" responses and discrimination training for each subject took place over two sessions of 80 slide presentations each. The 1st two sessions differed basically with regard to which stimulus, b or d, was defined as S^D. Various treatments were defined by the arrangement of slides within the training sessions. Four methods of stimulus presentation were developed: Early Progressive (EP) -- Introduction of faded S^{Δ}'s early in the training series; Early Constant (EC) -- introduction of unfaded S^{Δ}'s early in training; Late Progressive (LP) -- introduction of faded S^{Δ}'s late in training; and Late Constant (LC) -- introduction of unfaded S^{Δ}'s late in training.

Instruction of the response.

Visual and auditory stimuli within each session were correlated on separate tracks of the recording tape (Scotch cat. no. 175-$\frac{1}{4}$-1200). Responses appropriate to the S^D in each training session were instructed (see Table 1). For example, immediately following presentation during b training of a large orange b superimposed over a drawing of a bat and ball came the recorded verbalization "That is a b, as in bat and ball. Now you say it. The response "b, as in bat and ball," was followed immediately by social reinforcement delivered by the experimenter over the intercom. Reinforcers again took the form "very good," "that's fine," "that's right," etc. For all other responses the tape stopped, reinforcement was withheld, and after approximately ten seconds of no responding, the verbalization "That is a b as in bat and ball. Now you say it." was repeated over the intercom. The tape advanced only after the subject had emitted the appropriate response and had received social reinforcement.

Within the next six slides of the series the pictorial prompt was separated from the S^D and faded out. Slides with both a letter and a picture were accompanied by an arrow pointing to S^D, the left-right position of which was randomly scheduled, and a verbalization "What is the arrow pointing to?" Subsequently, S^D was gradually faded to black and decreased in size. Hence, slide number seven consisted simply of a lower-case b or d (see Fig 3).

The recorded question "What is that?" or "What is the arrow pointing to?" immediately followed presentation of each of these slides. To establish stimulus control and response differentiation, only the response "bat and ball" was reinforced when the arrow pointed to the picture of a bat and ball. Likewise, only the response "b, as in bat and ball" was reinforced when the arrow pointed to the letter b (or when only a b was presented).

Instruction during d training occurred by a similar method (see Fig. 3). In this case, however, the seven-slide sequence progressed from a large light-green d superimposed over a drawing of a dog, through separated pictorial prompts and ds, finally to a black, lower-case d on the seventh slide. The response instructed in the presence of d was "d, as in dog."

Discrimination training.

Immediately after reinforcement on slide eleven and just prior to presentation of slide twelve, the following recorded instructions were delivered: "After this, each time something new comes onto the screen, say what it is" (see Table 1). Succeeding b and d presentations were no longer accompanied by auditory stimuli. S^{Δ} presentations began with slide no. 13 in Early Progressive and Early Constant treatments and with slide no. 45 in Late Progressive and Late Constant treatments (see Table 2). Randomly alternated with S^D slides, these S^{Δ} presentations appeared in an order corresponding to that of stimuli in the fading series (b1 to b7 and d1 to d7) for Progressive treatments, and consistently as a small, black, lower-case letter for Constant treatments.

Movement from an S^D in the series to the next slide was at all times contingent upon the emission of the "correct" response. S^{Δ} durations, on the other hand, were defined independent of the subject's behavior. They were gradually increased from approximately one second for the initial S^{Δ} slide to about five seconds for the final S^D slide in Early and Late Progressive treatments, but remained constant (about five seconds) for both Early and Late Constant treatments. Hence, for Progressive groups S^{Δ} fading occurred along four dimensions: color, size, prompt, and stimulus duration. For Constant groups, however, values along each of these dimensions remained fixed from the initial S^{Δ} presentation.

Blank slides and cartoons were interspersed randomly within the training series (see Table 2). The duration of blank slides, referred to as time-out periods, was set at ten seconds following the last verbalization since the beginning of time-out. Cartoon durations varied for each subject. Upon presentation of each cartoon the experimenter would say "Tell me something about that." Following each cartoon description from the subject and consequent social reinforcement from the experimenter, the series would again continue.

The criterion session.

A third stimulus series was devised to be presented to every subject subsequent to b and d training sessions. This "criterion series" was composed of stimulus situations requiring first a series of simultaneous b-d discriminations, followed by randomly-alternated presentations or slides b7 and d7 (see Table 3). Slides 5 through 18, the simultaneous discrimination phase, employed stimulus items from the b and d discrimination series illustrated in Figure 4. (see Fig. 4).

S^{Δ}'s in slides b1D through b6D and d1D through d6D were smaller than S^{D}'s, which were gradually decreased in size until, by slides b7D and d7D, both S^{D} and S^{Δ} appeared as same-sized, lower-case letters. In addition, color fading was employed -- S^{D}'s from red (d Discrimination Series) or green (b Discrimination Series) to black, and S^{Δ}'s from green (d Discrimination Series) or red (b Discrimination Series) to black. Position response bias was again controlled for by varying the right-left placement of S^D's in both the b and d discrimination series. An arrow pointed to the S^D in each slide. Slides 5 through 18 were also accompanied by a pre-recorded "What is the arrow pointing to?" simultaneous to presentation of each new stimulus pair (see Table 3). Inappropriate responses, such as "d, as in dog" in the presence of a slide from the b discrimination fading series, were counted as errors.

Subsequent to slide 18 auditory stimuli were discontinued, except to accompany cartoon slides, which were interspersed within the 80 slide sequence in a manner identical to that within b and d training sessions. Time-outs, too, occurred at the same points in the criterion sequence as they had during training.

The successive discrimination phase of criterion which followed the simultaneous phase consisted of randomly alternated lower-case b's and d's (slides b7 and d7). Progression from one slide to the next, as well as social reinforcement, was contingent upon emission of the appropriate response in the presence of each stimulus. Inappropriate responses, such as "b, as in bat and ball" in the presence of a d, were counted as errors.

RESULTS

Error Curves of Treatments

Figure 5 illustrates the results of the four treatments on mean errors graphed in 5 trial blocks (see Figure 5). The curve of these mean errors in each treatment validates the label attached to the treatments.

The E-P curve shows a gradual increase in the mean errors with the variability of mean errors ranging only from .1 to 1.1 errors. The E-C curve reflects variability ranging from .8 to 2.5 errors per 5 trial block. Both the L-P and L-C curves reflect a sudden increase in mean errors with the late introduction of the S^{Δ}. The most errors occurred in the L-C treatment where a mean of 3 errors occurred in block 45. Since E-C, L-C, and L-P all show a sharp increase in the mean errors during trial block 45, further analysis revealed only the possibility that the duration of the S presentations during this trial block might account for this increase.

One method of analysing the data was to determine what percentage of each treatment group emitted less than 10% errors during the criterion session. The 10% figure was selected since some programers (Holland and Skinner, 1961) have demonstrated the effectiveness of instructional programs with this error rate. The E-P treatment had 13 of 16 Ss who emitted less than 10% errors, the E-C 11 of 16, the L-P 6 of 16, and the L-C 4 of 16. The two Early treatments collectively had 24 of 32 Ss while the two Late treatments have only 10 of 32.

Analyses of Covariance

The mental age and visual perception scores were linearally related. The correlation between these two sets of scores was .45. Since the relationship was linear, separate analyses of covariance (Winer, 1962, p. 600) were performed on the number of errors during criterion, first with the mental age scores as the covariate, then with the visual perception scores. Both of these analyses resulted in significant F's for the Early-Late variable, but not for the Progressive-Constant variable (see next two paragraphs).

The mean errors on criterion for the four groups adjusted for the effects of visual perception were E-P 5.65, E-C 9.77, L-P 14.99, and L-C 16.98. The analysis of covariance with mental-age as the covariate revealed a significant F for the Early-Late variable ($F=8.30$; $df=1/59$; $p=<.01$) while the F for the Progressive-Constant variable was not significant ($F=1.78$; $df=1/59$; $p=>.05$;) (see Table 4.)

The mean errors on criterion for the four groups adjusted for the effects of mental age were E-P 4.79, E-C 6.91, L-P 15.33, and L-C 16.18. The fact that in both analyses the rank order of the means is identical reflects the very small adjustment factor for visual perception, ($b=-.689$) and mental age ($b=-.47$).

An analysis of covariance with the Frostig composite score as the covariate revealed a significant F for the Early-Late variable ($F=9.4$; $df=1/59$; $p=<.01$), while the F for the Progressive-Constant variable was again not significant ($F=1.3$; 1/59; $p=>.05$) (see Table 5).

"t" tests

There were 40 Ss who were same-dominance (SDo), and 10 each were randomly assigned to the four treatment groups. There were 16 Ss of crossed-dominance (CDo) and 4 each were randomly assigned to the 4 treatment groups. Eight Ss were of mixed dominance (MDo) and 2 each were randomly assigned to two of the treatment groups

Separate "t" tests were run on the errors on criterion between all possible comparisons of the three dominance groups. The "t" test comparisons of SDo and CDo yielded a "t" of .943, df=54. A "t" between SDo and MDo resulted in a "t" of 1.99, df=46, and the CDo and MDo comparison yielded a "t" of 1.65, df=22, all of which were not significant.

The mental age scores were compared by dominance and one of these "t" tests were significant. The SDo-CDo comparison "t" was .865, df=54, and the SDo-MDo "t" was 1.34, df=46. Neither of these is significant. The CDo-MDo "t" was 2.08, df=22, and this is significantly below the .05 level.

The Frostig scores were compared by dominance and none of these comparisons was significant. The SDo-CDo t=1.02, df=54; SDo-MDo t=1.26, df=46; CDo-MDo t=1.94, df=22.

Correlations

The correlation of the mental age and visual perception data result in a Pearson-Product Moment Correlation of .45 (df=62; $p=<.01$). When correlations are run between these variables by their lateral dominance, the correlations are SDo=.55 ($df=38$; $p<.01$), CDo=.34 ($df=14$; $p>.05$), and MDo=.47 ($df=6$; $p>.05$).

Letter Drawing

One further analysis was to observe if those Ss from E-P who had less than 10% errors on criterion could write the letters when asked to do so. As a result of absences, etc., only 10 of these 13 were tested. Not one of these 10 Ss could write both letters such that three kindergarten teachers could identify correctly the letters. One child wrote a b when instructed, but also wrote a b when instructed to write a d. The instructions were altered to ask Ss if they could write a b as in bat and ball, and a d as in dog. Ss could still not emit the behavior. These Ss were then taken through the criterion series again. All 10 Ss could still identify the letters (Ss did make a few errors, probably as a result of inattention),but could not draw them. Ss were daily run through the criterion series, and immediately after completing the series, asked again to write the two letters.

One S could write the letters after three more runs through the criterion series (180 additional correct responses to randomly presented b and d slides), and one S wrote them correctly after five more runs (300 additional correct responses), but the 7 remaining Ss were run 10 times (600 additional correct responses) and still could not write the letters. One Ss' data was thrown out as he volunteered the information that his mother had taught him to write the letters at home.

DISCUSSION AND CONCLUSIONS

The fact that Schutz(1964) and Duell and Anderson (1967) had difficulty in demonstrating errorless discrimination learning of letters of the alphabet is certainly not surprising to the author after conducting this investigation. The author and a graduate assistant devoted three months practically full-time in development of the fading series, and then only 13 of 16 Ss in the E-P group achieved this performance. Schutz's (1964) finding that color fading was very difficult to achieve was confirmed. Slides were reproduced and empirically tested several times before the final set of slides was accepted.

One critical variable was the duration at which the S^{Δ}'s were presented, and the gradual lengthening of this duration. Tape after tape was programed in attempts to establish errorless discrimination learning. Much more information in regard to this duration variable is required. During the pilot studies, when Ss began making errors, it was often possible to modify this error rate by more carefully extending the S^{Δ} durations. The interaction of the color fading with the S^{Δ} durations should be explored.

During these pilot studies, some Ss were responding indiscriminately to the advancement of the next slide. Observation of the Ss revealed that they were often simply not looking at the screen, but still emitting a response. To correct this, the time-out procedure was introduced so that the stimuli associated with the advancement of the next slide would not elicit a response. Cartoon slides were interspersed randomly in the training series to increase attentional responses.

The Early-Late variable apparently was more critical than the Progressive-Constant variable. Presenting the S^{Δ} early resulted in significantly fewer errors than introducing them late in the learning sequence.

The Early-Progressive series was effective in producing more errorless discrimination performance than any of the other three groups. However, it would appear to be a rather fragile phenomena that can be produced more easily in the laboratory with infra-human Ss (Terrace 1963a; 1963b; 1963c). It would be interesting to compare the E-P treatment with more conventional classroom instruction, and also with teacher-presented stimulus materials which would utilize the prompt and color fading components.

Visual perception as measured by four of the Frostig sub-tests was not an important variable as the analysis of variance resulted in the same significant relationships as the analysis of covariance, as the adjustment factor was quite small ($b=.689$). While visual perception may be related to reading disabilities in the older child, there is no evidence from this study it is a factor in discrimination learning in kindergartners.

Mental age as measured by a group test was also not an important variable in discrimination learning. The analysis of variance revealed the same significant relationships as the analysis of covariance with mental age as the covariate, and again the adjustment factor was small (b=-47). This substantiates the assertion made by programers that when instructional materials are carefully sequenced and self-paced, mental age may not be predictive of the amount of learning (Klaus, 1965, p. 141).

When Ss's performance on the criterion series was compared by lateral dominance, none of these comparisons was significant. Lateral dominance as determined by the adaptation of the Harris Tests of Lateral Dominance was not related to kindergarten Ss' discrimination learning of the lower-case letters b and d. This finding coincides with the contention of Hillerich (1963) and others that older Ss from non-clinic populations typically do not demonstrate any significant relationship of reading disability and lateral dominance.

Hunt (1964) reports that O.K. Moore's research with the autotelic Responsive Environment indicates that once children have learned to recognize letters by pushing the appropriate keys of a typewriter, children can subsequently draw the letters with chalk on a blackboard. Hunt cites the evidence in support of an "image-primary" thesis.

The author has been unable to find descriptions or data from the work of Moore (1960; 1966; in press) that are detailed sufficiently to compare why after approximately 600 correct responses recognizing the letters, Ss in this study could not write the letter. It would have been interesting to determine the performance of these Ss in motor training in drawing the letters, but the school year was ending and other school related activities were incompatible with continuing the research.

SUMMARY

Recent research on the discrimination process indicates errorless learning can occur if stimuli are very carefully programed such that the stimuli are very dissimilar and gradually become more similar as training proceeds. To assess this general approach in teaching the lower-case letters b and d with kindergarten Ss, two sets of stimuli constituted the first experimental variable. In the Progressive value of this variable, color, size, presence of prompts, and duration of presentation were progressively "faded" down to the terminal discrimination. The second value of this variable was the terminal discrimination in the progressive stimuli---the b and d Constant in the attributes of color, size, duration of presentation, and absence of prompts. The second variable was the time of introduction of the second letter to be learned---Early or Late.

Two separate treatment x level analyses of covariance (mental age and visual perception as covariates) both revealed significant effects for the Early-Late variable, but not for the Progressive-Constant variable. However, the Early-Progressive combination resulted in 81% of the Ss learning the discrimination with under 10% errors. When Ss were categorized into same, mixed, or crossed lateral dominance, no differences in errors on the task were observed. Ss who learned the discrimination without errors could not subsequently draw the letters.

REFERENCES

Berner, G. E., and Berner, Dorothy E. Reading difficulties in children, Archives Ophthalmology, 20: 829-838 (Nov.), 1938.

Berner, G. E., and Dorothy E. Relation of ocular dominance, handedness, and the controlling eye in binocular vision. A. M. A. Archives of Ophthalmology, November, 1953, 603-608.

Bitterman and Wodinsky. Simultaneous and successive discrimination. Psychological Review, 1953, 60, 371-376.

Bryan, Q. R. Relative importance of intelligence and visual perception in predicting reading achievement. California Journal of Educational Research, Vol. XV, 1964, 44-48.

Crider, Blake. A battery of tests for the dominant eye. Journal of Genetic Psychology, XXXI, 1944, 179-90.

Davidson, Helen P. A study of the confusing letters d, b, p, and q. Journal of Genetic Psychology, 1935, 47, 450-468.

Delacato, C. H. Treatment and Prevention of Reading Problems. Springfield: Thomas, 1959.

Duell, Orpha K., and Anderson, R. C. A Failure to Teach a Sight Vocabulary by Vanishing Literal Prompts. Paper read at American Educational Research Association, New York, 1967.

Drews, Elizabeth M. The significance of the reversal error in reading. Unpublished Ph.D. dissertation, University of Michigan, 1954.

Durrell, D. D., and Michalson, Alice K. Preschool and Kindergarten Experience. In Henry, N. B. (Ed.) Development in and through Reading, Chicago: University of Chicago Press, 1961, 257-269.

Fendrich, P. Visual Characteristics of Poor Readers. New York: Bureau of Publications, Teachers College, Columbia University, 1935.

Frostig, M. Developmental test of visual perception. Palo Alto, California: Consulting Psychological Press, 1961.

Frostig, M., Maslow, P., Lefever, W., and Whittlesey, J. R. B. The Marianne Frostig developmental test of visual perception, 1963 standardization. Perceptual and Motor Skills, 1964, 19, 464-499.

Gates, A. I. The psychology of reading and spelling. New York: Teachers' College, Columbia University, 1922.

Gibson, E. J. Perceptual developmental. National Society for the Study of Education Yearbook, LXII, 1963, Part I, Chapt. iv, 144-195.

Goldiamond, I. A research and demonstration procedure in stimulus control, abstraction, and environmental programming. Journal of Experimental Analysis of Behavior, 1964, 7, 46.

Harris, A. J. Lateral dominance, directional confusion, and reading disability. Journal of Psychology, XLIV (October, 1957) 283-294.

Hillerich, R. L. A study of the relationships between eye-hand dominance and the reading achievement of selected primary pupils. Unpublished Ed.D. dissertation, Colorado State College, 1963.

Holland, J. G. Teaching machines: an application of principles from the laboratory. Journal of Experimental Analysis of Behavior, 1960, 3, 275-287.

Holland, J. G. and Skinner, B. F. The Analysis of Behavior, New York: McGraw-Hill, Inc., 1961.

Hull, C. L. Simple qualitative discrimination learning. Psychological Review, 1950, 57, 303-343.

Hunt, J. McVicker. The psychological basis for using pre-school enrichment as an antidote for cultural deprivation. Merrill-Palmer Quarterly of Behavior and Development, Vol. 10, 3, July, 1964.

Hunter, W. S. The auditory sensitivity of the white rat. Journal of Animal Behavior, 1914, 4, 215-222.

Johnson, Marjorie. A study of diagnostic and remedial procedures in a reading clinic. Journal of Educational Research, Vol. XLIII, No. 8, 1955, 485-492.

Johnston, P. W. The relation of certain anomalies of vision and lateral dominance to reading disability. Monograph of the Society for Research in Child Development, Vol. VII, No. 2, 1942.

Keller, F. S., and Schonfeld, W. N. Principles of psychology. New York: Appleton-Century-Crofts, Inc., 1950.

Kimble, G. A. Hilgard and Marquis Conditioning and Learning. New York: Appleton-Century-Crofts, Inc., 1961, pp. 361, 363.

Klaus, D. J. An Analysis of Programing Techniques. In Glaser, R. (Ed.) Teaching Machines and Programed Learning, II. Washington, D.C.: Department of Audio-Visual Instruction, National Education Association, 1965.

Kooi, B. Y., Baker, R. L. and Schutz, R. E. Teacher-pupil interaction cues in learning: An experimental analysis. Paper read at American Educational Research Association, New York, 1967.

Loess and Duncan. Human discrimination learning with simultaneous and successive presentation of stimuli. Journal of Experimental Psychology, 1952, 44, 215-221.

MacCaslin, E. F. Successive and simultaneous discrimination as a function of stimulus similarity. American Journal of Psychology, 1954, 67, 308-314.

Monroe, Marion. Children Who Cannot Read. Chicago: University of Chicago Press, 1932.

Moore, O. K. Autotelic Responsive Environments and Exceptional Children. In Harvey, (Ed.), Experience, Structure, and Adaptability. New York: Springer Publishing Co., 1966.

Moore, O. K., and Anderson, A. R. Early Reading and Writing; Part 1: Skills; Part 2: Teaching Methods; Part 3: Development. Motion Pictures. Hamden, Conn.: Basic Education, Inc., 1960.

Moore, O. K., and Anderson, A. R. The responsive environment project. In R. Hess and R. M. Bear (Eds.) The challenge of early education. In press.

Morse, R., and Goldiamond, I. Errorless establishment of visual discrimination using fading procedures. Journal of Experimental Analysis of Behavior, 1964, 7. 269-272.

Nicholson, Alice. Background Abilities related to reading success in first grade. Journal of Education, 1958, 140, 25-36.

North and Jeeves, Interrelationships of successive and simultaneous discrimination. Journal of Experimental Psychology, 1956, 51, 54-58.

Olson, A. V. Relation of achievement test scores and specific reading abilities to the Frostig development test of visual perception. Perceptual and Motor Skills, Vol. XXII, 1966, 179-184.

Popp, Helen M. Visual discrimination of alphabet letters. The Reading Teacher, January 1964, 221-226.

Robinson, Helen. Why pupils fail in reading. Chicago: University of Chicago Press, 1946.

Schutz, R. E. Acquisition of alphabet-letter discrimination with and without "errors." Paper read at American Psychological Association, Los Angeles, 1964.

Silver, H. A. and Hagin, Rosa A. Maturation of perceptual functions in children with specific reading disability. The Reading Teacher, January, 1966, 253-259.

Skinner, B. F. Teaching machines. Science, 1958, 969-977.

Smith, Linda. A study of laterality characteristics of retarded readers and reading archives. Journal of Experimental Education, 1950, 18, 321-329.

Spence, K. W. The nature of discrimination learning in animals. Psychological Review, 1936, 43, 427-449.

Spence, K. W. The nature of the response in discrimination learning. Psychological Review, 1952, 59, 89-93.

Taber, J. I., and Glaser, R. An exploratory evaluation of a discriminative transfer learning program using literal prompts. Journal of Educational Research, 55, 1962, 508-512.

Teas and Bitterman, Perceptual organization in the rat. Psychological Review, 1952, 59, 130-140.

Teegarden, Laneen. Tests for tendency to reversal in reading. Journal of Educational Research, XXVII (October, 1933), 81-97.

Terrace, H. S. Discriminative learning with and without errors. Journal of Experimental Analysis of Behavior, 1963a, 6, 1-27.

Terrace, H. S. Errorless transfer of a discrimination across 2 continua. Journal of Experimental Analysis of Behavior, 1963b, 6, 223-232.

Terrace, H.S. Errorless discrimination learning in the pigeon: effects of chlorpromazine and imipramine. Science, 1963c, 140, 318-319.

Weise and Bitterman. Response selection in discriminative learning. Psychological Review, 1951, 58, 185-195.

Winer, B. J. Statistical Principles in Experimental Design. New York: McGraw-Hill, 1962.

SLIDE NUMBER	B TRAINING VISUAL	B TRAINING AUDITORY	D TRAINING VISUAL	D TRAINING AUDITORY
1	P1	"What is that?"	P1	"What is that?"
2	P2	"What is that?"	P2	"What is that?"
3	P3	"What is that?"	P3	"What is that?"
4	P4	"What is that?"	P4	"What is that?"
5	slide b1	"That is a b, as in bat & ball. Now you say it."	slide d1	"That is a d, as in dog. Now you say it."
6	slide b2	"What is the arrow pointing to?"	slide d2	"What is the arrow pointing to?"
7	slide b3	"	slide d3	"
8	slide b4	"	slide d4	"
9	slide b5	"What is that?"	slide d5	"What is that?"
10	slide b6	"What is that?"	slide d6	"What is that?"
11	slide b7	"What is that?"	slide d7	"What is that?"
		"		"
		"		"
		"		"
		"After this, each time something comes onto the screen, say what it is."		"After this each time something comes onto the screen, say what it is."

TABLE 1. Represented above is the sequence of auditory and visual stimuli presented to every subject during the response instruction phase of both b and d training sessions. Refer to Figure 2 for photographs of stimuli.

SLIDE NUMBER	EARLY PROGRESSIVE B TRAINING	EARLY PROGRESSIVE D TRAINING	LATE PROGRESSIVE B TRAINING	LATE PROGRESSIVE D TRAINING	EARLY CONSTANT B TRAINING	EARLY CONSTANT D TRAINING	LATE CONSTANT B TRAINING	LATE CONSTANT D TRAINING
12	B7	D7	B7	D7	B7	D7	B7	D7
13	P1	P2	B7	D7	D7	B7	B7	D7
14	B7	D7	B7	D7	B7	D7	B7	D7
15	D1	B1	B7	D7	D7	B7	B7	D7
16	B7	D7	B7	D7	B7	D7	B7	D7
17	B7	D7	B7	D7	B7	D7	B7	D7
18	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon
19	B7	D7	B7	D7	B7	D7	B7	D7
20	D2	B2	B7	D7	D7	B7	B7	D7
21	D3	B3	B7	D7	D7	B7	B7	D7
22	B7	D7	B7	D7	B7	D7	B7	D7
23	B7	D7	B7	D7	B7	D7	B7	D7
24	D4	B4	B7	D7	D7	B7	B7	D7
25	Time Out	Time Out	Time Out	Time Out	Time Out	Time Out	Time Out	Time Out
26	B7	D7	B7	D7	B7	D7	B7	D7
27	D5	B5	B7	D7	D7	B7	B7	D7
28	B7	D7	B7	D7	B7	D7	B7	D7
29	B7	D7	B7	D7	B7	D7	B7	D7
30	D6	B6	B7	D7	D7	B7	B7	D7
31	B7	D7	B7	D7	B7	D7	B7	D7
32	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon
33	B7	D7	B7	D7	B7	D7	B7	D7
34	B7	D7	B7	D7	B7	D7	B7	D7
35	Time Out	Time Out	Time Out	Time Out	Time Out	Time Out	Time Out	Time Out
36	D7	B7	B7	D7	D7	B7	B7	D7
37	B7	D7	B7	D7	B7	D7	B7	D7
38	B7	D7	B7	D7	B7	D7	B7	D7
39	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon
40	B7	D7	B7	D7	B7	D7	B7	D7
41	B7	D7	B7	D7	B7	D7	B7	D7
42	D7	B7	B7	D7	D7	B7	B7	D7
43	B7	D7	B7	D7	B7	D7	B7	D7
44	B7	D7	B7	D7	B7	D7	B7	D7
45	D7	B7	D1	B1	D7	B7	D7	B7
46	Time Out	Time Out	Time Out	Time Out	Time Out	Time Out	Time Out	Time Out
47	B7	D7	B7	D7	B7	D7	B7	D7
48	D7	B7	D2	B2	D7	B7	D7	B7
49	B7	D7	B7	D7	B7	D7	B7	D7

TABLE 2. Represented above is the sequence of stimuli in b and d discrimination training phases for all four treatment groups. Asterisks mark the initial S slide in each sequence. Refer to figure 1 for drawings of stimuli.

TABLE 2 continued

SLIDE NUMBER	EARLY PROGRESSIVE B TRAINING	EARLY PROGRESSIVE D TRAINING	LATE PROGRESSIVE B TRAINING	LATE PROGRESSIVE D TRAINING	EARLY CONSTANT B TRAINING	EARLY CONSTANT D TRAINING	LATE CONSTANT B TRAINING	LATE CONSTANT D TRAINING
50	D7	B7	D3	B3	D7	B7	D7	B7
51	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon
52	B7	D7	B7	D7	B7	D7	B7	D7
53	B7	D7	B7	D7	B7	D7	B7	D7
54	D7	B7	D4	B4	D7	B7	D7	B7
55	B7	D7	B7	D7	B7	D7	B7	D7
56	D7	B7	D5	B5	D7	B7	D7	B7
57	B7	D7	B7	D7	B7	D7	B7	D7
58	B7	D7	B7	D7	B7	D7	B7	D7
59	Time Out	Time Out	Time Out	Time Out	Time Out	Time Out	Time Out	Time Out
60	D7	B7	D6	B6	D7	B7	D7	B7
61	D7	B7	D7	B7	D7	B7	D7	B7
62	B7	D7	B7	D7	B7	D7	B7	D7
63	D7	B7	D7	B7	D7	B7	D7	B7
64	B7	D7	B7	D7	B7	D7	B7	D7
65	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon	Cartoon
66	B7	D7	B7	D7	B7	D7	B7	D7
67	B7	D7	B7	D7	B7	D7	B7	D7
68	D7	B7	D7	B7	D7	B7	D7	B7
69	D7	B7	D7	B7	D7	B7	D7	B7
70	B7	D7	B7	D7	B7	D7	B7	D7
71	B7	D7	B7	D7	B7	D7	B7	D7
72	D7	B7	D7	B7	D7	B7	D7	B7
73	Time Out	Time Out	Time Out	Time Out	Time Out	Time Out	Time Out	Time Out
74	B7	D7	B7	D7	B7	D7	B7	D7
75	D7	B7	D7	B7	D7	B7	D7	B7
76	B7	D7	B7	D7	B7	D7	B7	D7
77	B7	D7	B7	D7	B7	D7	B7	D7
78	D7	B7	D7	B7	D7	B7	D7	B7
79	D7	B7	D7	B7	D7	B7	D7	B7
80	B7	D7	B7	D7	B7	D7	B7	D7

SLIDE NUMBER	VISUAL	AUDITORY	SLIDE NUMBER	VISUAL	AUDITORY
1	P1	"What is that?"	41	D7	
2	P2	"	42	B7	
3	B1	"	43	D7	
4	D1	"	44	D7	
5	B1D	"What is the arrow pointing to?"	45	B7	
6	D1D	"	46	Time Out	
7	B2D	"	47	D7	
8	B3D	"	48	D7	
9	D2D	"	49	B7	
10	B4D	"	50	D7	
11	D3D	"	51	Cartoon	"Tell me something about that."
12	D4D	"	52	B7	
13	B5D	"	53	B7	
14	D5D	"	54	D7	
15	B6D	"	55	D7	
16	B7D	"	56	D7	
17	D6D	"	57	B7	
18	D7D	"	58	B7	
19	Cartoon	"Tell me something about that."	59	Time Out	
20	D7		60	D7	
21	D7		61	D7	
22	B7		62	B7	
23	D7		63	B7	
24	D7		64	B7	
25	Time Out		65	Cartoon	"Tell me something about that."
26	B7		66	D7	
27	B7		67	B7	
28	B7		68	D7	
29	D7		69	B7	
30	B7		70	D7	
31	B7		71	D7	
32	Cartoon	"Tell me something about that."	72	B7	
33	B7		73	Time Out	
34	D7		74	B7	
35	Time Out		75	D7	
36	B7		76	D7	
37	D7		77	D7	
38	D7		78	B7	
39	Cartoon	"Tell me something about that."	79	B7	
40	B7		80	B7	

TABLE 3. Represented above is the sequence of visual and auditory stimuli in the criterion phase for all four groups. Slides 5 through 18 require a simultaneous discrimination; slides 19 through 80, an alternating discrimination. Refer to figures 1, 2 and 3 for drawings of the stimuli.

TABLE 4

Summary of Analysis of Covariance for Errors on Criterion with Mental age as Covariate

Source of Variation	Sums of Squares	df	Mean Square	F
E-L	973	1	973	8.3*
P-C	208	1	208	1.78
E-L x P-C	117	1	117	
Error	6904	59	117	

*p=<.01

TABLE 5

Summary of Analysis of Covariance for Errors on Criterion with Visual Perception as Covariate

Source of Variation	Sums of Squares	df	Mean Square	F
E-L	1086	1	1086	9.4*
P-C	151	1	151	1.3
E-L x P-C	17	1	17	
Error	6791	59	115	

*p=<.01

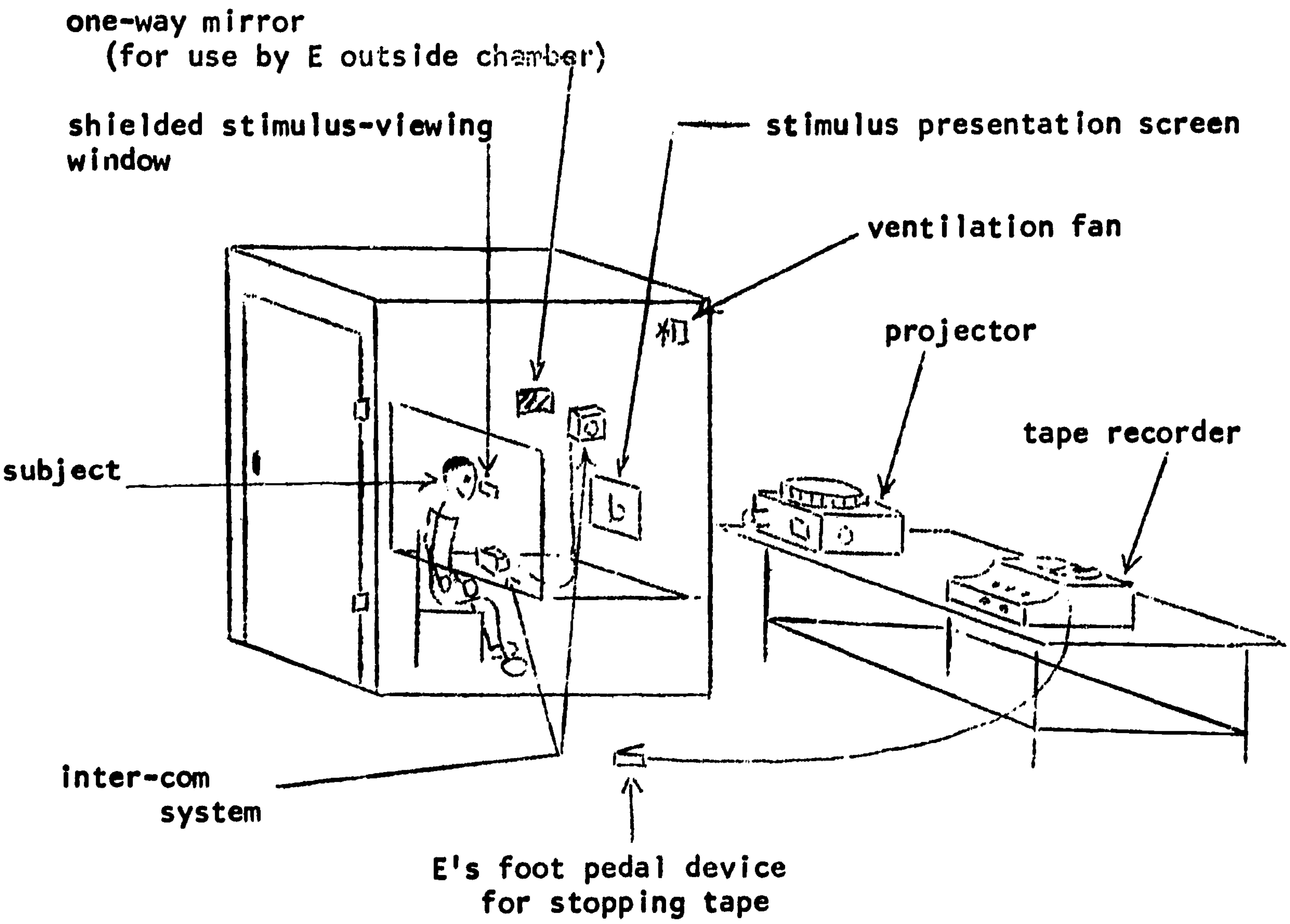

Figure 1 Represented above are the experimental chamber, the subject, and the programing equipment as they were arranged during the investigation.

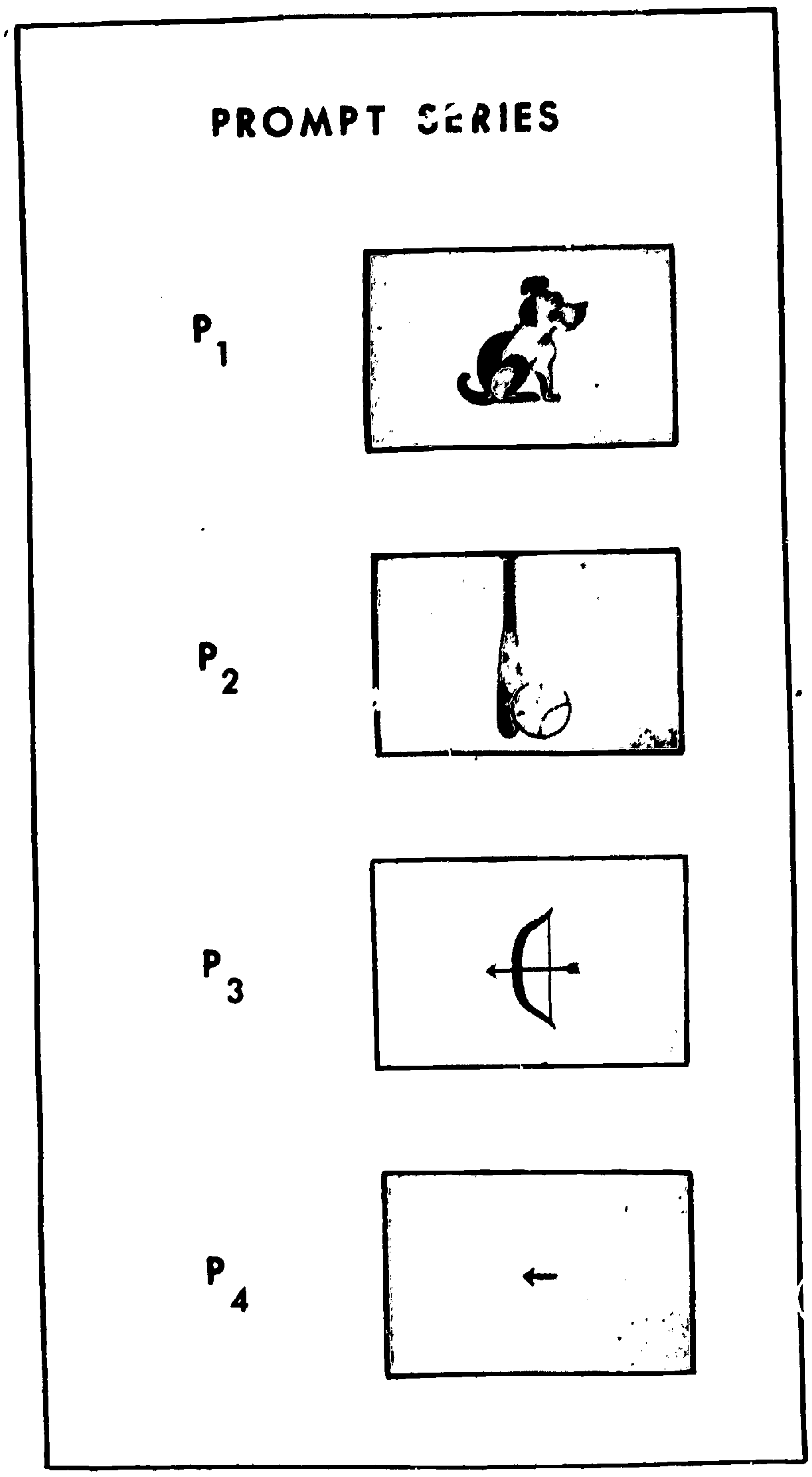

Figure 2 First four slides that constitute the Prompt Series

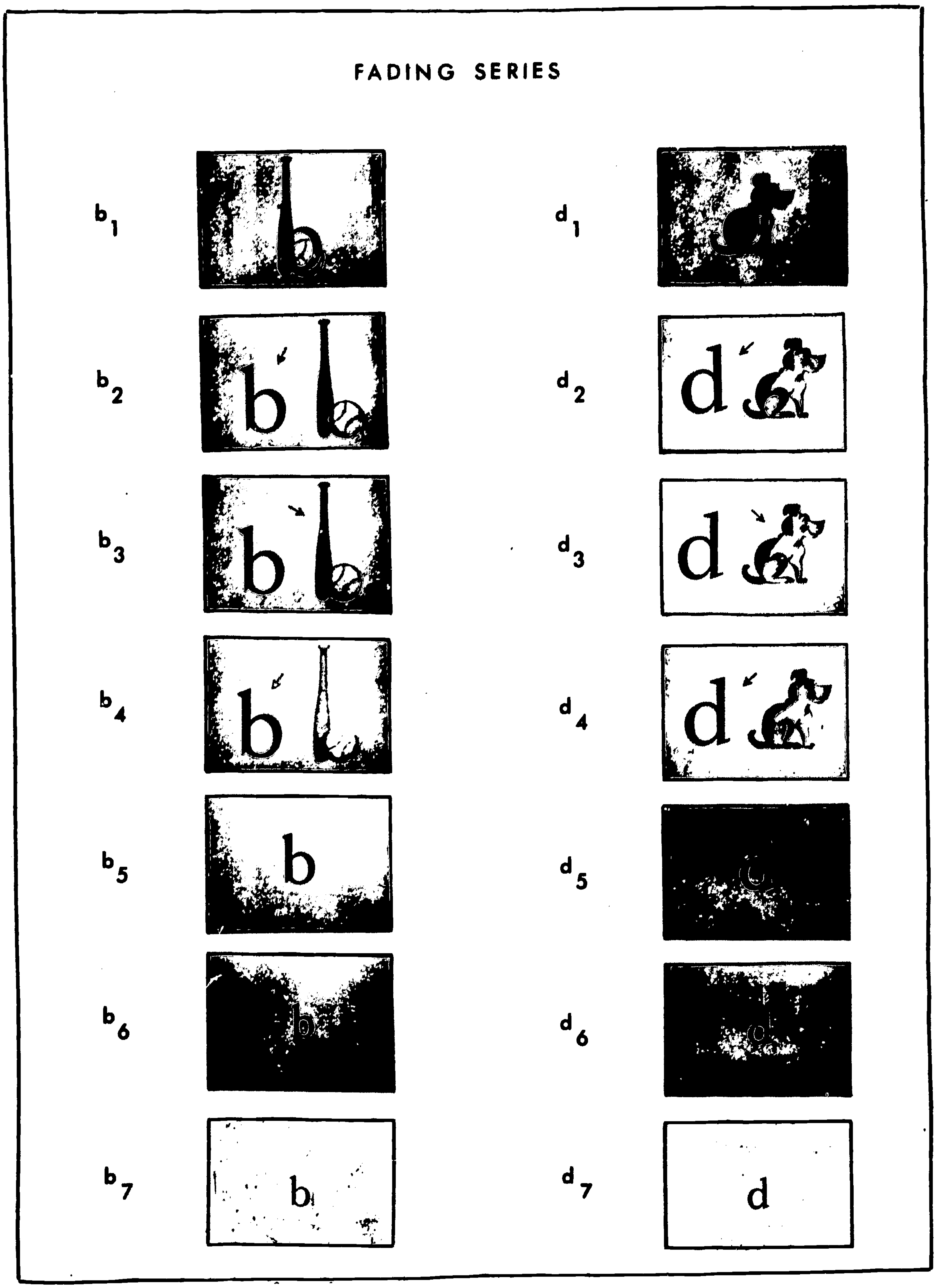

Figure 3 Slides in the b and d Fading Series

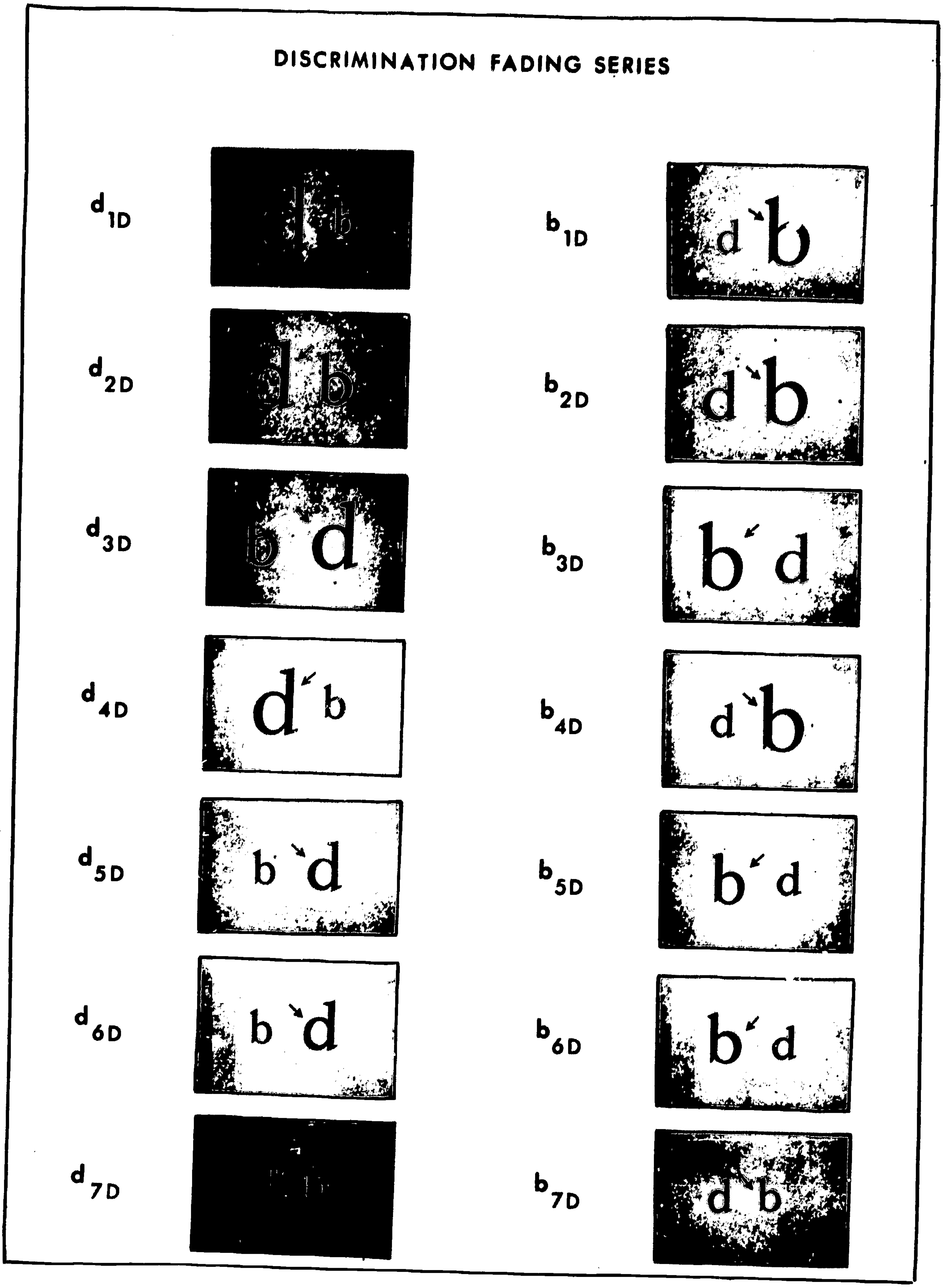

Figure 4 Slides that constitute the Simultaneous Discrimination Series.

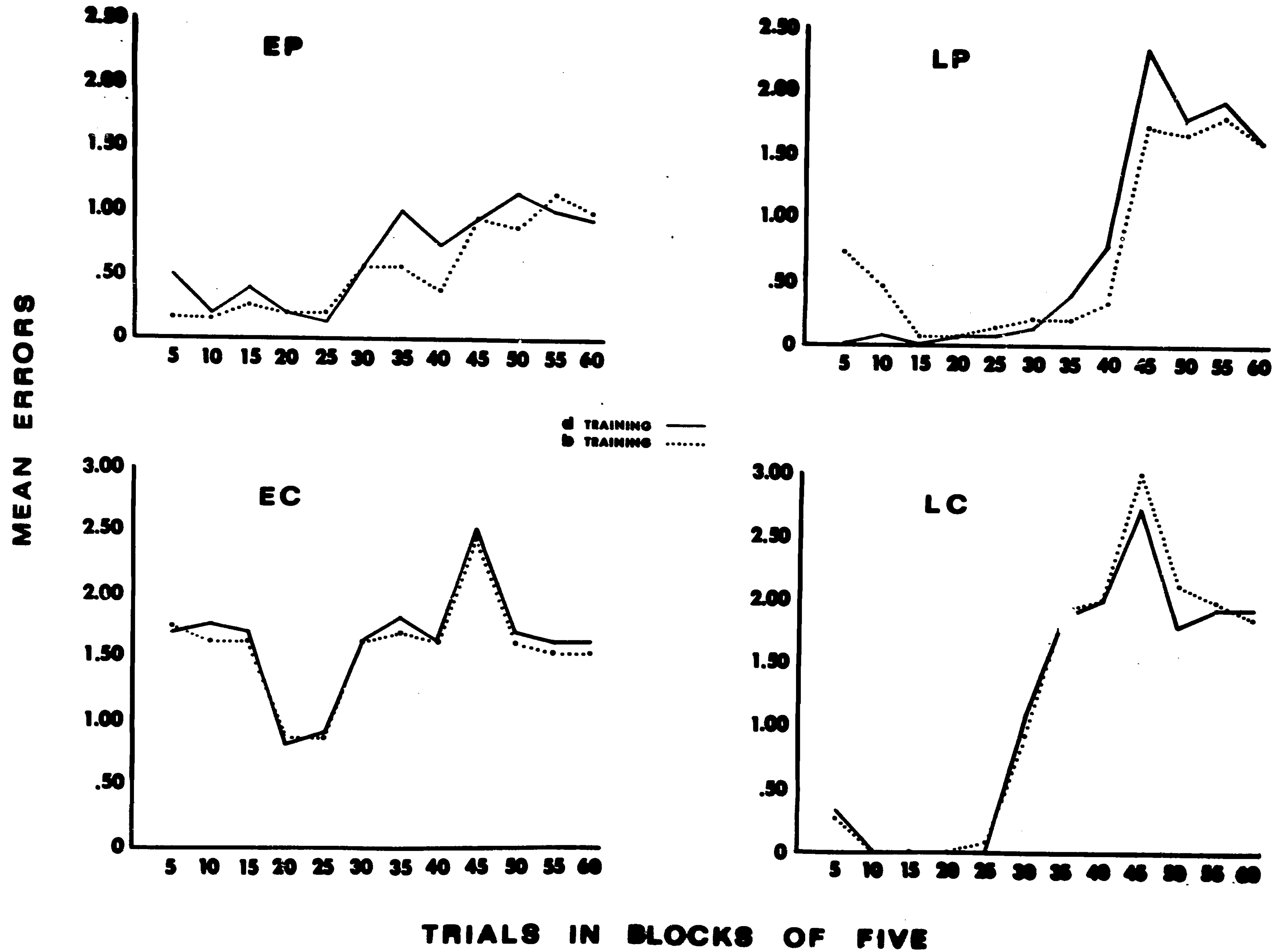

Figure 5 Mean errors in blocks of five

APPENDIX A

The Grace Klug Adaptation of the Harris Tests of Lateral Dominance

1. Hand Preference:

Students are asked to perform the following operations and the preferred hand (R or L) is recorded

	R	L	Both
1. Throw a ball			
2. Hammer a nail			
3. Brush teeth			
4. Write name			
5. Color a picture			
6. Comb hair			
7. Eat a lollypop			
8. Hold a toy gun			
9. Use a yo-yo			

2. Eye Preference:

Students are asked to view a picture, at a distance of approximately 8 feet, through a cardboard cone. The eye used (R or L) is recorded.

		R	L
1. Cone test	trial 1		
	trial 2		
	trial 3		

Same as #1, except the picture is viewed through a hole in a cardboard held at arms length from the student.

		R	L
2. Cardboard Test	trial 1		
	trial 2		
	trial 3		

3. Foot Preference:

The foot used (R or L) is recorded.

	R	L
1. Kick football		
2. Stamp out match		