THE EFFECT OF DIRECT AND IMAGINAL TRACING ON LETTER ACQUISITION AND RETENTION IN SLOW AND FAST LEARNERS

by

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A Thesis Submitted to the Faculty of the DEPARTMENT OF EDUCATIONAL PSYCHOLOGY
In Partial Fulfillment of the Requirements For the Degree of MASTER OF ARTS
In the Graduate College
THE UNIVERSITY OF ARIZONA

1976
STATEMENT BY AUTHOR

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ACKNOWLEDGMENTS

The author wishes to thank Dr. T. R. Kratochwill for his guidance and attention to detail in the execution of this thesis. Dr. J. E. Lyons' extensive data analysis and manuscript corrections are greatly appreciated. Dr. J. R. Bergan is thanked for his approval of this work.

The author appreciates the cooperation of the staff involved in data collection at Flowing Wells and Santa Cruz County Schools, especially Leslie Green, and the efforts of Jo Lumpkin and Harold Rasp for their role as experimenters.

Most of all, the author wishes to thank Gary Lubers, without whose emotional support, nagging, and meal preparation, the successful completion of this work would have been severely restricted.
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Seventy-six kindergarten children, divided into slow and fast learners on the basis of a five item artificial letter learning task, were randomly assigned in equal numbers to one of three conditions where they learned eight artificial letters. The first condition served as a control in which subjects learned a verbal associate for each letter for five trials. In the second condition, subjects traced each stimulus before learning the verbal associate during each of the five trials. In the third condition, subjects traced a mental image of the stimulus before learning each verbal associate. Retention measures were taken 24 hours after letter learning. Results indicated no effect of treatments and no interaction. When the two groups were combined, approximately equal asymptotic learning occurred for all conditions while the direct trace technique significantly improved retention scores. Implications for instruction and future research are discussed.
CHAPTER 1
INTRODUCTION

The factors required to successfully analyze the reading process in children have been studied by educators and psychologists alike. As much as fifty years ago, the literature recommended the use of various techniques to improve reading instruction. An important tactile-kinesthetic technique is the Fernald method (Fernald, 1943; Fernald and Keller, 1921), in which the child watches the teacher write a word, then traces the word with his finger, pronouncing it at the same time. Later in instruction the child may copy the teacher's model, still pronouncing the word as he writes. Fernald and Keller (1921) reported that subjects in their early case studies did not benefit from tracing the word in the air.

The amount of attention focused on stimuli is thought to be effective in facilitating the learning to read process. Research has been based on Gibson's (1963) hypothesis that improvement of visual discrimination depends on learning the distinctive features of the forms to be discriminated. Improvement of this function has been attempted by means of tactile-kinesthetic and other training. Also, visual discrimination training is used to enhance children's ability to write or copy (Bee and Walker, 1968; Hirsch and Niedermeyer, 1973; Williams, 1975).
This ability is especially important if training helps generalization to novel stimuli.

Tactile-kinesthetic feedback, provided by direct manipulation and play of objects, has been effective in children's discrimination and paired-associate learning (Thornburg and Fisher, 1970; Wolff, Levin, and Longobardi, 1972). These rehearsal strategies have been used to determine the role imagery production plays in the facilitation of such learning (Levin et al., 1975a; Levin et al., 1975b). Levin and his associates have developed a technique similar to Fernald and Keller's (1921) procedure of having students trace a word in the air. While tracing, the child is required to imagine the visual representation of the correct word or the correct word's referent (the visual image represented by the word). This image trace condition approached one trial discrimination learning.

The effectiveness of tactile-kinesthetic training in a paired-associate paradigm is at issue. The present work attempted to determine how this strategy compares to an image trace condition. Types of training appear to have a differential effect on learning acquisition dependent on the ability of the learner (Roberts and Coleman, 1958). Therefore, slow and fast learning groups of kindergarten children were used to study these effects.

**Review of Literature**

Paired-Associate Learning

Paired-associate learning is an important element in analyzing the child's conceptual processes. This type of learning requires the
child to correctly pair the names of letters, words, and objects with their proper visual manifestations. In reviewing paired-associate learning, Keppel (1968) states that this learning has generally been viewed as occurring in two stages: the response learning stage and the S-R hookup or associative stage. He emphasizes that associational learning is an intricate, multistage phenomenon. Samuels (1973) attempted to separate out of this complicated process the perceptual learning phase which had previously failed to transfer to reading. He hypothesized that distinctive feature training of the discriminability of a stimulus would facilitate the S-R hookup. In a previous study, Samuels (1971) indicated that letter name knowledge does not directly facilitate the decoding process in reading, yet it is seen as a skill necessary for communication between teacher and child. Since letter name learning is the first step in paired-associate learning, Samuels (1973) tested his hypothesis by teaching children to associate letter names with their symbols. Kindergarten children were assigned to one of three treatment groups. The first received visual discrimination training on noting the distinctive features of letters. A second group received the same discrimination training but attention was not drawn to the distinctive features. A third group got equal exposure to the same material as the first but did not receive visual discrimination training. In support of the hypothesis, the group trained to attend to distinctive features learned the letter names in fewer trials and with fewer errors.

A study investigating a different approach to pretraining for subsequent associational learning utilized writing to direct attention
to relevant cues (Levin, Watson, and Feldman, 1964). First grade children were pretrained on artificial graphemes using various tracing techniques or no tracing, with each focusing on initial, medial, or terminal graphemes. Following training, subjects were asked to label the grapheme complexes in addition to completing a recognition task. Results showed that when the relevant stimulus characteristics for associational learning are known, pretraining on the specific cues facilitates learning.

Following the Fernald (1943) tracing tradition, Pulliam (1945) indented words in heavy cardboard and taught second through fifth grade subjects to first trace the word with a finger and then with a pencil. A second condition stressed the differences between words, phonetically and visually. Following this presentation, conditions were reversed. The effect of tracing on acquisition was not specified, but the author reported a facilitation of retention of learned words under the tracing condition.

Another investigation using tactile-kinesthetic training tested the hypothesis that learning to read would be more effective in retarded readers if kinesthetic elements were added (Roberts and Coleman, 1958). The results indicated that retarded readers were significantly better at learning new materials if kinesthetic training was included. However, normal readers failed to improve with this training. It is unfortunate that the kinesthetic methods employed in this study were not fully described.

Questioning the validity of the latter study, Ofman and Shaevitz (1963) investigated the effects of tactile-kinesthetic variables and
controlled attention to cues. It was hypothesized that retarded readers would show an increase in reading ability as a function of the addition of tactile-kinesthetic cues to the paired-associate task. Subjects viewed nonsense syllables under one of three conditions: eye tracing, in which the word was outlined by a point of light the subject was to follow with his eyes; finger contact tracing, where the subject outlined the word with his finger; and finally, simple reading in which the subject read the word after the experimenter pronounced it. Results indicated that eye tracing was equally effective as finger tracing. Therefore, the addition of tactual stimulation did not increase the learning ability of this population, although tracing methods were superior to simple reading. The authors speculated that attention, rather than tactual-kinesthetic cues, could be the relevant variable.

In comparing the results of visual, auditory, and tracing cues with good and poor decoders, Vandever and Neville (1972-1973) explored the effect of tracing on decoding in first grade readers. Decoding was defined as the ability to respond to written words in terms of their verbal equivalents measured by the Word Knowledge subtest of the Metropolitan Achievement Test. Stimulus words were presented by the use of an artificial alphabet with each subject learning words presented visually, auditorily, and by tracing. No significant differences between number of words learned under these conditions occurred among the high word knowledge subjects. Low word knowledge subjects learned more words auditorily than by tracing. The authors reported that the low word knowledge group appeared so involved with the
mechanics of tracing that attention to the stimulus was lost. They concluded that tracing is not beneficial to first grade students with decoding problems. Furthermore, the effects of attention on learning has been investigated in preschoolers (Weiner and Goodnow, 1970). These authors compared a seen and handled condition with a seen only condition reasoning that if manual activity increases attention, then there should be no differences between the two conditions when the visual objects are attention getting in themselves. Two days following a thirty second exposure to geometric forms encased in plastic globes, 16 out of 20 subjects correctly remembered objects seen and handled, while 15 out of 20 subjects correctly identified objects seen only. It was concluded that looking and handling are important only for stimuli which are visually uninteresting.

It is not apparent from the discussed research what effect tactile-kinesthetic training has on paired-associate learning. It may be that this training serves only to direct attention to the discriminative stimuli inherent in the paired-associate task. Therefore, it is important to discuss tactile-kinesthetic effects on this more fundamental type of learning—discrimination learning.

Discrimination Learning

In a discrimination task the child must learn which item out of several is correct. The differences between the letters 'c' and 'a' must be apparent for the child to correctly respond. The ability to distinguish one letter from another has been used in an approach to analyze the reading process in children. Gibson and her associates
(1962) introduced a procedure designed to study the qualitative aspects of the types of errors made by different age groups on the critical features of the letters. Transformations of letterlike forms were chosen on an intuitive basis with regard to the distinctive features of the letters as a set and used in a match to sample format with four to eight year old children. Twelve letters were chosen for standards with twelve specified transformations of each. The discrimination task required subjects to match a standard form with an identical form. Errors were classified according to the incorrect transformation identified with the standard. Overall error rates decreased with age. However, the major finding of this work dealt with the difficulty of discrimination as it differed by type of transformation. Perspective transformation produced the greatest initial error while topological transformations produced the least. When the discrimination test was validated with real letters in five year old subjects, errors correlated significantly with errors made to artificial letters. The authors interpreted their findings in terms of the distinctive feature hypothesis. It was concluded that features which previously are critical for distinguishing objects transfer to discrimination of graphemes. Discrimination learning continues from this for distinctive features of letters, but for those features of graphic discriminations which are not critical, this discrimination occurs slowly, if at all.

Using Gibson's et al. (1962) work as a theoretical framework, Williams (1969) evaluated the effectiveness of tactile-kinesthetic training on visual discrimination of the same letterlike forms.
Reproduction training, involving tracing and copying these forms, was compared to two types of discrimination training. In the first comparison, stimuli differed greatly from the standard, while in the second, the transformations were rotated or reversed from the standard. It was hypothesized that the second discrimination training condition would be superior to the first. A set of match to sample tasks involved artificial letters used in training and their transformations, presented alone and in clusters. The results supported the hypothesis. Additionally, Williams (1969) suggested content of stimulus material is the critical determiner of performance in kindergarten subjects due to the forced attention to more distinct features of the stimuli.

Jensen and King (1970) compared the effects on reading of three different kinds of tactile-kinesthetic training: (a) tactile word tracing, (b) rearrangement of individual letters to form words, and (c) visual matching of word forms with one of four choices. Kindergarten children were asked to read words taught during a training and testing period of about 25 minutes. No significant differences on the reading task were found for the three training methods. The discrimination training indicated that tracing was easier than matching word forms while matching was easier than rearranging letters. The authors reported subjects in the tracing condition were observed to be tracing rapidly and with little effort which appeared to produce boredom with the task. When the constituent letters were spilled from their container to be rearranged, they often landed upside down, reversed or rotated. This slowed the task of forming letters to match
words, but appeared to keep the interest of the subjects and force attention to each letter. While the results are equivocal due to the short training session, the authors claimed support for the distinctive feature theory.

Bee and Walker (1968) utilized two types of discrimination training in an attempt to improve the drawing of geometric figures by preschool children. They hypothesized that the number of attributes of two distinct figures attended to is smaller for discrimination of the figures than for copying them. If correct, discrimination training which focuses on more detailed features of a figure should lead to better drawings. Triangles and non-triangles (errors in triangles) were used to train distinctive features of triangles. Group I was required to point to the correct item pair while a second group traced around the correct figure with their finger. A separate control group was trained to discriminate color rather than shape. All subjects were assessed by pre- and posttest drawings of circles and triangles. Group I improved while posttesting revealed a debilitation in performance in the second group. The former results partially supported the hypothesis while the latter results run counter to it. The authors observed fatigue in the tracing condition and by posttest time the subjects were distracted and hurried through their drawings. More definitive interpretation of the results was not possible due to the small number of errors which occurred on discrimination training trials. There was no obvious connection between the number of errors made in training and the adequacy of drawing on either pre- or post-tests.
Because of the wide variety of assessment procedures utilized in determining the effects of training on discriminability of words and letters, it is difficult to adequately evaluate these effects. Asso and Wyke (1971) indicated that studies up to that time had explored the discrimination of spatially confusable letters almost exclusively in the context of difficulty. The authors questioned this assumption and proposed that the assessment procedures employed to test the discrimination of confusable letters may in fact be testing different abilities. In comparing four different methods of discrimination—copying, matching, naming and writing to dictation, they determined whether or not one method is easier than another. Each subject used each of the four methods to discriminate spatially confusable alphabet letters. Results showed that the accuracy of the discrimination is dependent on the method of assessment employed. Copying was easier than matching, while in turn matching was easier than both dictation and naming. All results were reliable. The authors discussed the findings in terms of visual-spatial ability versus those requiring verbal-visual spatial ability, yet the parallel to Jensen and King's (1970) findings is obvious. The importance of these results appear to indicate the problems of comparing discrimination studies when different methods of assessment are used.

Much of the work discussed has been concerned with the effectiveness of tactile-kinesthetic training on visual discrimination. Hirsch and Niedermeyer (1973) reversed this process by investigating the effects of visual discrimination training on the ability to copy. The type of letter formation practice (copying and faded tracing) and letter discrimination training (presence and absence) were variables of concern when
studying handwriting performance of kindergarten children. Two tests were constructed for pre- and post-instruction assessment. The first required subjects to copy both upper and lower case letters. The second sought to determine how well the subjects discriminated between correct letter forms. The four training groups consisted of: (a) copying only, (b) copying plus discrimination, (c) faded tracing only, and (d) faded tracing plus discrimination. Performance scores on the letter formation posttest indicated the copying treatment was superior to the faded tracing condition. Discrimination training was not significant on this test but it did reliably improve performance on the letter discrimination posttest. The type of discrimination training provided did not appear to be an effective treatment for promoting correct letter formation as the authors had hoped. Nor did the tracing prompts facilitate handwriting, contrary to the author's assumptions. It must be concluded that it is necessary to make the distinction between tracing and copying when considering tactile-kinesthetic techniques. Asso and Wyke (1971) speculated that copying is a relatively easy task for young children while Bee and Walker's (1968) subjects had difficulty drawing circles and squares, perhaps due to the subject's inability to draw what he discriminates. The tactile-kinesthetic differences between tracing and copying have not been sufficiently investigated. Furthermore, it appears that the effectiveness of either visual discrimination training on copying or tactile-kinesthetic training on visual discrimination is limited to performance tests involving similar procedures with no generalization to tests involving the same stimuli.
Williams (1975) sought to determine the relative effectiveness of copying and visual discrimination training on the ability to reproduce letterlike forms and visual discrimination. In addition, she studied the ability of such training to generalize to novel, untrained material of the same type as that used in training. Preschool subjects were divided into four groups: (a) reproduction training, (b) discrimination training, (c) combination training, and (d) no training. All subjects were taught with letterlike forms. Both reproduction and discrimination post-tests consisted of two parts. The first was identical to the appropriate pretest while the second part included items not used in training, but were transformation of those forms. The results indicated that discrimination training facilitated performance on the discrimination test but not on the reproduction test, while reproduction training produced the opposite effect. The issue remains cloudy because combination training was as effective as reproduction training on the reproduction test, but not as effective as discrimination training on the discrimination test. Additionally, the effects of the discrimination procedure generalized to items not used in training while the effects of reproduction training failed to. The author interpreted the data as supporting the notion that the acquisition of the ability to copy letters and the ability to discriminate letters are two separate tasks.

Egeland (1975) has extended the distinctive feature research by introducing an errorless training approach in teaching children to discriminate alphabet letters. He compared groups of preschool children receiving (a) an errorless training technique in which the obvious cue
used during training highlighted the distinctive feature of the letter to be discriminated, (b) an errorless training technique in which the obvious cue did not highlight the distinctive feature, and (c) the traditional reinforcement-extinction approach. Errorless training requires gradual withdrawal or fading of the salient cue during training. The other paired comparison has no such salient cue. The effectiveness of errorless discrimination training depended on whether or not the obvious cue had been used to highlight a relevant dimension of the letter to be discriminated. The author reported that many of the high error rate children in the reinforcement-extinction group appeared to have difficulty attending to the task and were less interested in completing the posttest.

Unlike most of the paired-associate research, discrimination training has been evaluated using both words and letters in the discrimination test. When the discrimination of letters is of concern, training which stresses the distinctive features of the form to be distinguished appears to be effective (Egeland, 1975; Williams, 1969; Williams, 1975). If words are to be discriminated, tactile-kinesthetic training may not be effective (Jensen and King, 1970). Williams (1969) suggests that the ability to discriminate is a separate function from that of copying or tracing. Therefore, it is necessary to discuss research which has directly manipulated motor activity under a range of conditions.

Motor Activity

An important aspect of the tactile-kinesthetic interaction is that of the motor activity necessary for discrimination or associational
learning to occur. How does the child's handling of the objects to be learned effect subsequent rates of correct responding? An investigation of discrimination learning utilized three-dimensional letters to improve tactile-kinesthetic training (Thornburg and Fisher, 1970). Preschool children were given a two-dimensional task for pre- and posttesting. A similar three-dimensional posttest was included. The first group received play sessions with two-dimensional alphabet letters while another group participated in similar play with three-dimensional letters. Both groups haptically manipulated either three-dimensional letters or cards with letters printed on them. The control group was assessed by pre- and posttests but had no further contact with the letters. The authors hypothesized that active manipulation of three-dimensional letter forms would improve visual discrimination. This is derived from the theory that learning is dependent on spatially defined sensory feedback relationships, linking motor and sensory systems of the body. The three-dimensional group performed better on both posttests than the other two groups. However, to control for practice effects, the study was repeated with alternation of two-dimensional and three-dimensional tasks. The three-dimensional task reduced errors on the subsequent two-dimensional task; two dimensional task experience did not serve to reduce errors on the subsequent three-dimensional task. The authors concluded that young children discriminate three-dimensional forms more accurately than two-dimensional, and haptic experience may contribute to greater accuracy on both two-dimensional and three-dimensional forms.

Further assessment of the effects of motor involvement on letter learning included size and dimensionality factors (Kratochwill, Severson,
and Demuth, 1976). Artificial letters used in the research of Gibson and her associates (Gibson et al., 1962) were employed as stimuli in a paired associate task. The first experiment utilized preschool children with no formal school instruction in letter learning. Condition I employed two-dimensional stimuli which were presented in 1/2 inch size print. In a second condition, three inch stimuli were used. A two-dimensional large print trace condition instructed subjects in the previous manner with the addition of a tracing strategy. The fourth condition was identical to the first two except the subject viewed three-dimensional stimuli mounted on cards. The last condition included a manipulation instruction (subjects were told to hold and run their fingers around three-dimensional three inch letters). Subjects in the 3-DM condition made fewer errors than subjects in the 2-DS, 2-DT and 3-DL conditions. Furthermore, the subjects in the 2-DL condition made fewer errors than subjects in the 2-DS condition. The authors found it interesting that while the 2-DT condition did not improve learning over other conditions, the 3-DM was better than both 2-DT and 3-DT. A second experiment replicated the first with kindergarten children as subjects. The replication was based on two considerations. First, it was thought that experimental treatments may be differentially effective when considering the age variable. Also, if strategies effective with preschool children also improve letter learning in older children, results would have importance for school based instruction. However, no differences between experimental conditions were found for these subjects. The authors interpreted these findings as indicative of the facilitative effect of motor involvement in young children's letter learning. Active
manipulation rather than tracing was superior, especially with 3-D stimuli. It was thought that the kindergarten children's prior school experience increased learning verbal associates which in turn encouraged such strategies over all conditions.

An extended study utilizing a similar manipulatory technique was performed by Levin and his associates (Wolff, Levin, and Longobardi, 1972). However, the theoretical orientation of these investigators was quite different. They manipulated conditions of tactile contact with materials necessary for a motoric facilitation of paired-associate performance to occur. Based on Piaget and Inhelder's model (1971), dynamic images, involving movement of objects in space, are not produced in children until approximately age seven. However, the child can, at least partially, represent familiar objects by a static image at two years or earlier, the age at which most children begin to exercise this symbolic function. Kindergarten children were used in the Wolff, Levin, and Longobardi (1972) work to determine if mental imagery is based on overt activity at these ages, as Piaget and Inhelder's (1971) model suggests. The authors evaluated the effect of visual or haptic contact on paired-associate learning when the stimuli are disrupted. Factorial combinations of three bilevel variables produced eight experiment conditions: visual contact (present-absent), tactual contact (present-absent), and manipulation (manipulate-control). Toy pairs were presented as in the manipulate condition, in which the subjects were told to "make the toys do something together and at the same time try to make up a picture in your head of what the toys are doing together." For the no-visual
conditions, the toys were taken behind a curtain and the subjects either manipulated them there or pantomimed an interaction by moving their hands as if they contained toys. The results demonstrated that when pre-imagery children were allowed to haptically manipulate the stimulus materials, the overt formation of an interaction between pairs facilitated performance on the recognition task more than when no tactual contact was allowed. Visual deprivation did not inhibit effective activity with toys. These results are consistent with Piaget and Inhelder's (1971) contentions.

A similar study investigated the effects of motor involvement on imagery production in kindergarten and first grade children (Varley et al., 1973). Again, toy pairs were utilized with subjects either manipulating the pairs or drawing pictures of possible interactions. Results showed that motor training facilitated the performance of kindergartners compared to simple imagery involvement. These differences failed to be manifested in the first graders. Imagery practice alone was as effective as each of the motor procedures. The authors viewed the finding that playing and drawing activity did not differ for the latter subjects as support for Piaget and Inhelder's (1971) imagery theory. This is because both represent a means for visually internalizing external stimuli. An extension of this work evaluated the effects of verbal and imaginal rehearsal strategies in fifth and sixth grade children's discrimination acquisition (Levin et al., 1975b). This series of experiments indicated that overt imagery is more effective than vocalization in children's discrimination of words while both appear equally effective for pictorial discrimination learning. The authors suggested that the benefits of vocalization rehearsal with words
is primarily due to attentional, articulatory or acoustic effects, as opposed to constructive or interpretive cognitive activity invested by the learner. A major by-product of this study was thought to be the most effective rehearsal strategy yet developed. The strategy consists of instructing the child to observe the correct item in each discrimination. He then turns his head away from it and traces the correct word or the correct word's referent in the air in front of him while visualizing the constructed response. It is assumed that the success of a particular rehearsal strategy depends on the degree to which relevant cognitive processes are activated in the learner. In the case of verbal discrimination pairs, the tracing activity appears to aid the child in generating a memory image of the correct item's referent. This, in turn, improves discrimination performance when tested with verbal discrimination pairs. This assertion evolved when subjects engaged in tracing activity directed toward the "writing out" of the word in the air failed to perform as well as those simply instructed to trace the correct word's referent (outlining the visual image). In the pictorial discrimination pairs, the tracing strategy appeared to require the child to perform constructive activity in order to produce the picture from memory. Both types of material (verbal and pictorial) seem to require an active construction of a visual stimulus from memory. Albeit the activity demanded by the strategy with words is apparently more complex in that a transformation of a stimulus from a verbal to a pictorial code and reproduction of the resulting image are required. This is not so with pictures, which merely require storage and reproduction of a pictorial stimulus.
Employing discrimination of pictorial stimuli, Levin and his associates (Levin et al., 1975a) investigated the implications of the image trace hypotheses. The first study assigned fifth grade children to either a control condition following Levin's et al. (1975b) procedure, or a trace condition, where the subject was instructed to trace the outline of the correct word (on top of the picture itself rather than from memory). Results indicated that tracing the correct stimulus directly is not as effective as the image trace procedure. No significant differences occurred between the trace and control conditions, whereas the image trace technique produced reliably better performance on the test trials. The second experiment tested the hypothesis that, if the trace image condition does in fact contain an imagery component, it should be less beneficial for younger children in comparison to older children. This is based on previous work (Wolff, Levin, and Longobardi, 1972) and the conceptual framework of Piaget and Inhelder (1971). Kindergarten children were exposed to pictorial discriminations and instructed to use either a no rehearsal strategy, a vocalization strategy or the image trace strategy following established procedures (Levin et al., 1975b). The image trace strategy improved performance but to a lesser degree than did the verbal strategy. The authors theorized that this latter result may have been due to the age of the subjects and that motor activity becomes more important with increasing age. This finding does not parallel that obtained when an associative learning paradigm is used (Wolff, Levin and Longobardi, 1972). Here image pantomiming is presumed to be analogous to image tracing. The authors explained the facilitation of discrimination learning under these conditions in terms
of Piaget and Inhelder's (1971) static imagery model. Recall that pre-operational children are presumed to be capable of imaging simple imitations of previously represented objects and events, while dynamic imagery does not emerge until age seven or eight and consists of novel transformations of previously represented stimuli. However, the authors advise caution be given to interpretations grounded on studies in which materials, subject populations and other variables differ considerably.

The purpose of the present study was to determine the effects of two tracing strategies on associational letter acquisition in slow and fast learners. Tactile-kinesthetic methods have been shown to both facilitate and inhibit paired-associate tasks with no firm support for either conclusion. In discrimination learning, tracing and copying techniques appear to be separate tasks from the ability to discriminate letters (Williams, 1975). Because of these findings, a paired-associate task was selected to train kindergarten children by tactile-kinesthetic means and also to investigate the effects of the image trace strategy on artificial letter learning. Categorization of children into slow and fast learner groups was designed to resolve conflicting evidence concerning these two populations of subjects. Kindergarten children were thought to be least experienced in rehearsal strategies when learning letter names. It was hypothesized that because of the powerful effect the image trace condition had on discrimination learning (Levin et al., 1975b), letter name learning would be effected in both the slow and fast learners. Also, a direct tracing method involving tactile-kinesthetic activity would effect learning of paired-associates for these groups of subjects. Of main interest was the interaction between type of
training technique and learner group. What method is more or less effective with either a slow or a fast learner? If discovered, application to the classroom is pertinent. It is assumed that whatever training facilitates acquisition of letter learning, it will also improve retention of learned associates. However, if the image trace condition does cause the child to cognitively represent or construct an image of the letter, this method may produce increased retention.
Subjects

Subjects were 76 normal kindergarten children from three schools in Tucson, Arizona. The 40 boys and 36 girls ranged in age from 5 years 4 months to 6 years 7 months of age with a mean age of 5 years 10 months. Thirty-eight subjects were qualified for each of the two learner categories. From these, 13 subjects were randomly assigned to each of two treatment conditions, with 12 subjects each in the remaining condition. Subjects were from the upper-lower socioeconomic strata.

Materials

Stimuli employed in the study consisted of 13 artificial letters used in the research of Gibson et al. (1962). During the first phase of the experiment, five letters were employed to pretest the subjects. Eight letters were utilized for the learning (acquisition) and retention phases. All letters were three-dimensional wood cuts (2.5 x 3.0 x .25 inches), painted black, and paired with a common noun (e.g., cart).

Procedure

A total of 109 subjects were pretested with a paired-associate letter learning task (Phase I). Each subject was taught the names of the five letterlike forms prior to each recall test. This continued for
five test trials. Cumulative correct scores over the five test trials were computed for each subject. The fast learner group obtained a mean score of 15.5 correct items. Thirty-eight subjects were identified for each of the learner groups and randomly assigned to one of three experimental conditions (Phase II): Control, Direct Trace, and Image Trace. All subjects were assessed for retention (Phase III) 24 hours after initial learning. Each subject was tested individually by a female experimenter (for Phases I and II), and a male experimenter (Phase III). To assure proper placement of the symbols, a white easel, capable of holding individual letters, was placed in front of the subject during acquisition trials and the retention test.

Pretest (Phase I)

During this phase subjects were exposed to five symbols in a paired-associate fashion. Each symbol was called by a labeled noun and presented as follows:

Today you are going to learn some new letters. They will not look like anything you will see in school, but we will have fun learning them. First, I will show you a letter and tell you what it is called. Listen carefully and try to remember. Be sure to say the letter's name each time I say it. This is ______, this is ______, etc.

Each symbol was exposed for two seconds and paired with its associate. Following exposure of the five letters, the subject was tested for five trials.
Acquisition (Phase II)

**Control.** The subjects in this condition received information similar to that in Phase I. However, eight letterlike forms were used and a training trial was included so the subject would understand the task. The training symbol was placed on the easel and the experimenter demonstrated (i.e., modeled) the correct manner of learning with the following instructions:

This is ______. First I look closely at the letter and then say the name again. Now you look at it, now say the name. Good.

Exposure time for each letter was 15 seconds. Following training, the subject was instructed to look at each of the eight acquisition letters for five seconds and to say each letter's name. The experimenter waited three seconds between letter presentation to control for the time required for tracing in the air in another condition. Next the subject was tested for recall. The experimenter would again place the letter on the easel and if the subject did not say the correct name within five seconds, the experimenter provided it. This continued for each of the five test trials. Order of the eight letters was constant for the first presentation and randomized for subsequent presentations.

**Direct Trace.** Subjects in this condition received instructions similar to those in the Control Condition. After the training symbol was placed on the easel, the experimenter said:

This is ______. First I look closely at the letter, then I trace over the letter with my finger, then I say the name
again. Now you look at it, trace over the letter (experimenter waits for subject to trace), and now say
the name. Good.

Exposure time was again 15 seconds. During the acquisition trials, and
directly preceding each of the test trials, the subject was instructed
to look at the letter as it was placed on the easel. Next the subject
traced over the letter and said it's name. Each of the eight symbols
was exposed in this way for five seconds followed by the three second
rest period between letter presentations. Test trials again required
recall of the eight letters. If the subject did not provide the correct
name within five seconds, the experimenter would say it. An acquisition
trial preceded each of the five test trials. All other procedures were
identical to the Control Condition.

Image Trace. In this condition the subject was specifically in-
structed to utilize an image trace strategy when learning the letter
name. A training procedure was first employed with a practice letter.
The following instructions were used during the 15 second presentation:

This is ______. First I look closely at the letter, and
then I turn away and trace the shape in the air with my
finger, then I say the name again. Now you look at it,
turn away and trace it with your finger (experimenter waits
for subject to trace) and now say the name again. Good.

Acquisition trials again preceded each of the test trials. After the
subject watched the letter being placed on the easel, instructions were
given to turn and trace the letter shape in the air and then say the
name. Exposure to each letter was five seconds. This did not include
the time it took for the subject to trace the shape of the letter in the air, which generally ranged from two to four seconds. The number of letters learned was assessed during recall. The experimenter would provide the correct response within five seconds. Again, other procedures were identical to the Control Condition.

Retention (Phase III)

Twenty-four hours following the acquisition phase, a retention test was given. These instructions were used when testing the subjects:

Today you are going to be asked the names of the letters you learned yesterday. I will put each letter on the pegboard and you tell me the name if you remember it.

Each of the eight letters was exposed for five seconds. No feedback of any kind was given to the subject during or following presentation of the individual symbols.
CHAPTER 3

RESULTS

The total number of correct responses in the five learning trials constituted the acquisition measure. Results of the acquisition phase are presented in Table 1. A two (learner) x three (condition) analyses of variance (ANOVA) showed a significant effect of learner type, \( F(1, 75) = 12.85, p < .001 \), no effect of treatments, \( F(2, 70) = 2.001, p > .05 \), and no interaction, \( F(2, 75) < 1, p > .05 \).

Table 1. Means and Standard Deviations for Letter Acquisition of the Slow and Fast Learners

<table>
<thead>
<tr>
<th>Group</th>
<th>Condition</th>
<th>Control</th>
<th>Direct Trace</th>
<th>Image Trace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \bar{X} )</td>
<td></td>
<td>26.62</td>
<td>23.42</td>
<td>21.69</td>
</tr>
<tr>
<td>SD</td>
<td></td>
<td>4.65</td>
<td>6.40</td>
<td>7.41</td>
</tr>
<tr>
<td>Fast</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \bar{X} )</td>
<td></td>
<td>28.77</td>
<td>29.58</td>
<td>27.46</td>
</tr>
<tr>
<td>SD</td>
<td></td>
<td>4.53</td>
<td>5.28</td>
<td>5.19</td>
</tr>
</tbody>
</table>
The retention dependent variable consisted of the total number of letters retained out of eight. Results of the retention phase are presented in Table 2. A 2 x 3 ANOVA indicated a reliable effect of learner type, $F(1, 75) = 9.04, p < .005$, no effect of treatments, $F(2, 70) = 1.86, p > .05$, and no interaction, $F(2, 75) = 1.00, p > .05$.

Table 2. Means and Standard Deviations for Letter Retention of the Slow and Fast Learners

<table>
<thead>
<tr>
<th>Group</th>
<th>Condition</th>
<th>Control</th>
<th>Direct Trace</th>
<th>Image Trace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow</td>
<td></td>
<td>6.38</td>
<td>6.25</td>
<td>5.31</td>
</tr>
<tr>
<td></td>
<td>$\bar{X}$</td>
<td>6.38</td>
<td>6.25</td>
<td>5.31</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>1.80</td>
<td>1.60</td>
<td>1.97</td>
</tr>
<tr>
<td>Fast</td>
<td></td>
<td>6.15</td>
<td>7.00</td>
<td>7.08</td>
</tr>
<tr>
<td></td>
<td>$\bar{X}$</td>
<td>6.15</td>
<td>7.00</td>
<td>7.08</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>1.82</td>
<td>1.04</td>
<td>.86</td>
</tr>
</tbody>
</table>

A second data analysis employed a repeated measure ANOVA. Results of this analysis again show a reliable effect of learner type, $F(1, 77) = 8.74, p < .01$, and no effect of treatments, $F(2, 72) = 1.00, p > .05$. During the pretest phase of the study, a one-way ANOVA
indicated that fifth trial scores reliably separated slow and fast learners. Thus, if it is assumed that the fifth trial of the acquisition phase is asymptotic learning, the number of correct responses on this trial can then be compared to those of the retention phase in order to assess treatment by subjects or conditions effects. A significant interaction between treatments and the learning-retention measure was found, $F(2, 72) = 48.0$, $p < .01$. A Newman-Keuls test indicated that the treatment conditions differentially effect retention in that all conditions produced about the same acquisition scores but the direct trace condition produced reliably better retention (see Figure 1). The comparisons of interest are as follows: direct trace versus control $F(1, 72) = 19.24$, $p < .05$; direct trace versus image trace $F(1, 72) = 13.3$, $p < .05$. 
Figure 1. Mean Correct Scores of Subjects during Acquisition and Retention Phases
CHAPTER 4

DISCUSSION

The purpose of the present study was to explore the efficacy of direct and imaginal tracing procedures on the letter-name acquisition and retention of slow and fast learners. The present results show no differential effects of treatment when the slow and fast learners are separated by group. When these groups are combined, Figure 1 shows that all three treatments produce approximately equal asymptotic learning. Twenty-four hour retention indicates that the direct trace technique results in greater retention. If the retention score is used as an index of learning, the direct trace method proved to be superior. Thus, the present results, in part, give some support to the use of Fernald's (1943) technique. However, if this technique had been followed explicitly, the paired-associate should have been pronounced as the child traced rather than following the motor response. However, subjects in the Kratochwill, Severson and DeMuth (1976) study did not benefit as much from the tracing condition as from manipulating the stimuli. Perhaps some form of guided practice should be included since certain subjects were observed to have difficulty tracing, whereas others would forget the name of the letter after tracing. Moreover, it seems that tracing over a three-dimensional letter increased the child's attention
directed to the stimuli thereby producing better retention. This interpretation is consistent with the Kratochwill, Severson and DeMuth (1976) study and Thornburg and Fisher's (1970) work, both employing three-dimensional materials.

Furthermore, the results suggest that Fernald and Keller's (1921) rejection of tracing a word in the air has some validity in a paired-associate task. Levin's (Levin et al., 1975a) effective use of the image trace strategy occurred in a discrimination learning paradigm. Therefore, the increased complexity of a paired-associate procedure may remove any beneficial effects of the image trace technique as it is employed in the discrimination learning situation. As in the Kratochwill, Severson and DeMuth (1976) work, active involvement with the stimuli appears to increase retention in the paired-associate task. Perhaps the fact that Levin et al. (1975a) subjects were instructed to actively imagine the correct word directed attention to the task which was lacking in the present work. It was assumed that the child necessarily visually imagined the shape of the letter in order to turn and trace in the air. However, it is possible that if children are not adequately instructed in what they are expected to acquire and retain, the mechanics of the task may interfere with learning.

Gibson et al. (1962) reported that the difficulty of discrimination of letter-like forms was different depending on the transformation. The present study, in utilizing these same stimulus materials, unfortunately did not determine the errors made by the subject to the different letters. It would have been interesting to note if a child called a particular letter by an incorrect name consistently throughout
the acquisition trials. In addition, if these same types of errors were made by other subjects, discriminability of stimuli could have been determined. This is important if inferences are to be made about the learning rates of slow versus fast learners. If the child cannot discriminate between the more difficult to distinguish letters, paired-associate learning may be affected. However, no conclusions can be made in regard to these variables with this work.

In evaluating the discrimination learning curves of children, Zeaman and House (1963) observed that slow learners exhibit the same type of learning gradient as fast learners given sufficient exposure (number of trials) to the slow learners. There was no difference between the slow and fast learners other than the number of initial trials which the authors view as the attention phase of the process. The present results support this, with neither tracing strategy interacting with the slow and fast learner variable. Vandeever and Neville (1972-1973), in reporting that auditory cues assisted poor decoders in learning words, noted that their younger subjects did not benefit from tracing activity. Our results run counter to this, although, as stated before, some method of guided practice might be included in future research. In order to tease apart direct tracing effects on slow as compared to fast learners, younger children might be used as subjects. Those children without prior school experience or kindergarteners tested earlier in the school year would fulfill this requirement.

The results of this work indicate that training children by the use of a direct tracing technique in a paired-associate letter learning
task produces greater retention than an image tracing strategy. All other results are equivocal. To assess the differential effect of tactile-kinesthetic training on slow and fast learners letter acquisition, kindergarten or younger subjects should be compared using both a discrimination and an associational task. The subjects should be sufficiently instructed in what is required during training with some form of guided practice included. Finally, the verbal labeling errors as they pertain to specific letter forms should be assessed.
REFERENCES


