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This study involved fifty-eight 3-year-olds. It sought to determine whether the preschoolers could learn to discriminate visually the critical elements of shape through a program of perceptual-motor training, transfer such knowledge to similar but different shapes, and then resist the process of forgetting the critical elements. The children were randomly assigned to an experimental group and a control group. The experimental group took part in a 14-session program designed to teach the critical elements of shape through perceptual-motor activity. The control group received indirect perceptual training through puzzles and matching games, none of which contained the shapes used in the experimental program. A pretest, a posttest, and a post-posttest, involving geometric line drawings, were administered to the two groups. It was found that the experimental group did not perform significantly better than the control group on the posttest and post-posttest in copying the geometric figures used in the experimental program; and on the posttest, in copying criterion figures (figures not used in the experimental program). The experimental group, however, did better in copying the criterion figures on the post-posttest. (WD)

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THE EFFECTS OF A LEARNING PROGRAM IN PERCEPTUAL-MOTOR ACTIVITY UPON THE VISUAL PERCEPTION OF SHAPE

FINAL REPORT
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Ruthan Brinkerhoff Kannegieter, Ph.D.

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CHAPTER I

THE PURPOSES AND GENERAL DESCRIPTION OF THE STUDY

Child developmentalists who have studied the results of children's copying behavior have devised schedules describing the geometric figures which normal children can draw at various ages (9, 28). For example, Piaget and Inhelder have found that children between three and one-half and four years of age depict topological (closed, rounded) shapes when copying from a model but cannot represent the differences between angular and circular shapes. Between four and five, they can reproduce a square. Between five and five and one-half, these children can copy a diamond; from six and one-half to seven, they can accurately copy complex figures (52).

These researchers state that older children draw more accurately because they utilize visual decentrations (movements of the eye from one part of the object to another) in contrast to the younger children who rely upon visual centrations (fixations upon only one part of the object). Piaget and Inhelder further state that visual decentrations develop through perceptual activity; the older children manipulate objects reciprocally with their hands and eyes more thoroughly than do the younger children; therefore, they visually apprehend more and, consequently, draw more precisely (52).

Developmental studies, such as those of Gesell are based on the premise that visual perception is an inherent phenomenon which becomes refined with age. Thus, no credence is afforded to the effects of systematic learning experiences upon perception (28), although it is recognized by many psychologists that perception is the result of both inherent factors and learning (64). A recent statement by the director of research at the Gesell Institute of Child Development reveals the attitude of many developmentalists toward directed learning programs in early childhood:

> That behavior is highly patterned and structured and that much of what the child does literally unfolds from within rather than being taught or imposed from outside is an extremely important factor for those who may be tempted to overteach the preschool child in formal academic ways. Little good is done by such efforts and often, probably, considerable harm (1:35).

For the past two decades art educators have adhered to variations of a developmental theory of child art based essentially on self-expression through unfolding. Self-expression refers to an innate need to communicate feelings, emotions, and thoughts; while unfolding refers to the emergence, through specified stages, of art forms beginning with the simple and progressing to the complex. Kinesthesia and affect are important sources for self-expression; while direct teaching is considered undesirable.

> Generally speaking, the activity of self-expression cannot be taught. Any application of an external standard, whether of technique or form, immediately induces inhibitions, and frustrates the whole aim. The role of the teacher is that of attendant, guide, inspirer, psychic midwife (56:206).

Explicit to the general approach described above is the fact that prior to adolescence, vision, per se, plays at best a secondary role in art production.

> The child's creative expression is mainly connected with such subjective experiences as bodily feelings, muscle sensations, and touch impressions. It is obvious that the child's way of perceiving space is determined by his subjective relationship to it, since the child's perception is derived from bodily, not from visual experiences (44:254-55).

It has been advocated that children draw emotions and feelings (37, 44, 56), progressively structured configurations, inventions, or symbols (61, 2, 39); but not until early adolescence do students begin to draw realistically or naturalistically, at which time vision becomes somewhat more important as a factor in art education.

Recently, art educators have begun to challenge this approach to art. Of prime concern is the role of visual perception in art and the time at which visual skills should be made available to students. The impetus behind this new direction is the perception-delineation theory, which postulates that visual perception is the basis of art, that the process is a learned as well as a developmental phenomenon, and that direct teaching of perceptual skills in relation to art production is possible (48).

> Visual perception is in large part learned. To learn to see things both cognitively and visually requires training. Unless people use their visual capacities fully they...remain perceptually illiterate (47:10).

The two positions outlined are not irreconcilable, however. The position advocating perceptual training holds that such training need not interfere with self-expression but would provide alternatives so that if a child chose to draw naturalistically, he would possess the perceptual skills requisite for the task. There is available evidence indicating that children tend to lose interest in art at approximately the third or fourth grade; one reason advanced is the fact that the children have not learned the necessary perceptual skills (8, 19).

Since it has been posited that children can learn many subjects at an earlier age than previously thought, provided the material is structured on a level comprehensible to the learner (12), art educators have an opportunity to reassess the various developmental premises, and consider whether art learning must be restricted to stages of development or whether active teaching may intervene to provide a substantial basis for growth. Within the field of art education alternatives to the developmental approach might be considered and experimentally tested. Such alternatives include visual perceptual training.

Directly pertinent to the present study is the question of why perceptual training would be considered at the preschool level rather than at some later age. Hebb's theory and the studies of Riesen and Senden support the contention that early learning of discrimination and identification of stimuli is necessary for visual perception and that time is an important factor for integration. The former's theory asserts that shapes, such as triangles and rectangles require prolonged learning for cognition and differentiation. Such shapes are complex and are apprehended serially rather than simultaneously (35).

Riesen studied two chimpanzees who were reared in darkness for sixteen months. After such confinement, the animals needed fifty hours of exposure to light before any mediated visual learning occurred. In another study, Senden's patients who had been born blind but later had their vision restored by the removal of their cataracts had similar slowness and much difficulty in learning visual tasks (59).

When discussing the concept of early learning, it is necessary to consider the related factor of age. Based in part on Hebb's theory, which distinguishes infant learning from adult learning, Travers recommends that since early learning is a slow process, it should probably be undertaken before the child enters school (66). His statement is given support by Frostig and Horne who contend from the results of their work and that of others that the period of maximum growth in visual perception is between three and one-half and seven and one-half years of age (22). Travers, furthermore, states that it is not presently known if early deprivations in perceptual learning can be completely mitigated (66).

The above studies support the argument that a delay in perceptual training in art education until adolescence or even until the third or fourth grade may be anathema to continued growth in art. Students in the middle elementary years or beyond may not be able to overcome a perceptual deficit incurred in early childhood. Thus, the developmental studies raise questions for art educators interested in visual perception and one of its components--learning. Of fundamental concern is whether a learning program in visual perception would affect the developmental sequence in that area. Could a child learn to perceive more effectively at an earlier age than indicated in developmental schedules as a result of a directed learning program? Would such learning be permanent? Would it transfer? What variables would be endemic to such learning? How would such learning affect an art program?

Since the concept of shape is basic to early perceptual learning and is fundamental to art, the present study sought to determine whether preschool children could learn to discriminate visually the critical elements of shape through a program in perceptual-motor activity, transfer such knowledge to similar but different shapes, and resist the process of forgetting such critical elements.

Background of The Study

The subjects were fifty-eight preschool children who ranged in age from three years and three months through three years and eleven months at the time the experiment began. These subjects were enrolled in fourteen preschools located in San Francisco and Daly City, California. The family backgrounds of the children ranged from professional and managerial to that of laborer, with the exception of two subjects whose families were on welfare.

The subjects were randomly assigned to an experimental group and a control group. Each child in the experiment participated in fourteen individual learning sessions of approximately ten to fifteen minutes duration. The members of the experimental group were taught the critical elements of shape through a program involving perceptual-motor activity, which consisted of tactile stimulation to the hands, tactual tracing of wire and solid geometric shapes, and manipulation of shapes through construction and measurement. The program is discussed below and is reproduced in its entirety in Appendix E-1.

The control group received indirect perceptual training through puzzles and matching games, none of which contained the shapes used in the experimental program. Appendixes B-2 and E-2 contain information on the control program.

There were four experimenters, each of whom worked with members from both the experimental and control groups. For both groups, the experimenters followed prescribed lesson plans designed to provide a uniform approach to the programs. Language was kept at a minimum, but the names of the elements and shapes were taught to the subjects in the experimental group.

A pretest was administered prior to the training program, after which a posttest was given, followed by a post-posttest administered four weeks later. These tests constituted the Geometric Figures Test, composed of three random distributions of ten line drawings of geometric figures, which indirectly measured the desired outcomes of the study. Within the ten drawings were two sets of five figures each. One set contained drawings of figures used in the training program; these were termed the training figures. If these figures were reproduced accurately on the posttest, it would be assumed that visual discrimination learning had occurred; if reproduced correctly on the post-posttest, that the critical elements of shape had been remembered. The second set contained drawings of figures which were not used in the experimental treatment; these were termed the criterion figures. Correct reproduction of these figures on the posttest would indicate transfer of the critical elements of shape to similar figures; on the post-posttest, resistance to forgetting.

Discussion of Concepts Pertinent to the Study

The Critical Elements of Shape

The shapes used in the training program were the horizontal and diagonal cross, the square and the rectangle, the equilateral and right triangle, and the zigzag. These are reproduced as Figure 1 in the Geometric Figures Test Manual, page 93. The critical elements of these shapes were considered to be straight line, parallel lines, and angle. Basic research with stabilized retinal images (those which are experimentally fixed upon the retina, in contrast to normal images which fall upon the tremulous retina and are, therefore, in constant motion) tends to substantiate the elements of straight line and parallel lines as perceptual entities. Such research has shown that a single line or two parallel lines tend to act as individual units. Thus, a single line of a square may remain visible even though the figure as an entity disappears, or two parallel lines may disappear, then reappear as a unit (54).

Curved lines were not considered to be critical for the preschool population under study because, according to developmental schedules, most children within the age range can draw circular figures. Furthermore, they tend to close angular shapes with circular lines whenever they are unable to construct the appropriate angle which would lead to closure (52).

The evidence for the selection of the angle as a perceptual element is not quite as cogent as for the straight line and parallel lines. Again, Pritchard, Heron, and Hebb (54), using stabilized images, found no support for the contention that angles were perceptual elements as hypothesized by Hebb in his theory of cell assemblies (35). It was found, however, that if straight lines, acting as units, were broken into parts, such breaks occurred at intersections within figures. Jagged lines were found to be less stable than curved lines, a fact also established by Ditchburn and Fender, who reported that with stabilized images and the utilization of patches of light rather than figures, sharp corners were the first elements to disappear, causing an individual patch to become rounded before it too disappeared (17). These findings would seem to indicate that the angle has a definite influence upon perception, but further basic research is needed to clarify its status as a perceptual element.

Within the realm of applied research, however, there is a large quantity of evidence which sustains the angle as an important element in perception. Harris' review of the literature and discussion of the role played by the corner in perceptual activities suggests that angles may have importance as orientation or anchoring cues (34). Using information theory as a basis for research, Attneave found that change in direction, as well as in color and texture, was an important factor in shape discrimination (3).

Piaget and Inhelder argue that an analysis of the angle through motor activity (as in drawing) helps the child develop the concept of the straight line--a more difficult concept than that of the angle itself. Nevertheless, it is the discovery of the angle which makes the drawing of Euclidean shapes possible (52). Graham, Berman, and Ernhart have reported, however, that when asked to copy geometric forms, young children had more difficulty with the angle than with either the curved or straight line (33).

Slochower discovered that in the process of copying geometric shapes in several media children between the ages of five and seven years of age tended to change non-parallel lines and non-right angles to parallel lines and right angles much more frequently than the reverse (63).

In light of the above observations, it was decided to use the angle as a perceptual element in the present study.

Perceptual-Motor Activity

Tactile stimulation, tactual tracing, and manipulation were termed perceptual-motor activity. Tactile stimulation included the palmar rubbing of variously textured boards. Tactual tracing involved the finger and palmar tracing of simulated two-dimensional geometric shapes constructed of wire and magnetized cardboard. Manipulation included the construction and manual comparison of the geometric shapes.

In addition to the factor of manipulation which Piaget and Inhelder contend directs visual decentrations and is the basis for the accurate reproduction of shape, Hebb's theory stressing the neurological involvement of the motor area of the cortex in visual perception supports the use of motor activity in visual perceptual training. According to Hebb, activation of the motor area of the brain is an essential but not sufficient condition for visual perception. Eye movements tend to sharpen the perception of a shape in an experienced observer, but in a naive observer, the shape is originally learned through multiple eye fixations (35).

From an analysis of children's drawings in relation to the development of the Visual Motor Gestalt Test, Bender concluded that a gestalt evolves in young children from an interaction of motor and visual elements; the two elements are inseparable, but one might be more advanced at a particular time than the other (9, cf. 42).

Spontaneous head movements were observed by Gellermann when children, as well as chimpanzees, attempted to recognize familiar geometric shapes which had been rotated in space (26, 27). Hunton observed similar movements with children when familiar visual stimuli in the form of pictures were rotated in space (36). Thus, motor movements appear to be germane to perceptual integration.

Based upon current neurological evidence, Ayres has suggested that tactile perception developmentally precedes the visual perception of form and space; a disturbance in the former unfavorably influences the latter. She has discussed the existence of two cutaneous afferent systems--one discriminative; the other, protective. The discriminative system facilitates perception and provides the basis for motor activity; while the protective system guards against injury to the body through tactile sensations. For normal perceptual-motor responses, these two systems must be neurologically balanced. However, when the protective system is overactivated, it becomes dysfunctional; the child becomes tactually defensive and protects himself against tactile stimulation which would normally facilitate visual perception (5, 6).

Prior to perceptual-motor training for the tactually defensive child, Ayres suggests that cutaneous stimulation be provided in order to balance the two cutaneous systems. She further suggests that stimulation be applied to those parts of the body supplied by the discriminative system, which includes the hands (5).

In the present study, it was assumed that the subjects had normal cutaneous systems; however, tactile stimulation was provided to arouse and augment the discriminative tactile system, thus more readily activating the visual perceptual processes.

Considering the factor of tracing, Gellermann observed that chimpanzees and two-year-old children, in the process of identifying figures, spontaneously traced them with their fingers. After such tracing, the correct identifications of the figures were made (26, 27). Levin reported several studies in reading which utilized the tracing of letters as a pretraining condition (43). Ayres has stated, "Skill in all motor activity involving the hands is dependent upon finger gnosis" (6:223).

Since imitative movements represent an earlier form of motor behavior than copying forms (9, 28), each pattern of tracing in the present experiment was demonstrated for the subject. The patterns involved both gross and fine motor movements performed with either one or two hands (5, 41) in a variety of sequences, including continuous tracing [starting at, and returning to, the same point (33)] and interrupted tracing [outlining parts of a figure as a single entity (29, 57)]. Considering the fact that under laboratory conditions it has been shown that the index finger is the most sensitive when used purposefully, but the third (middle) finger is the most sensitive when passively stimulated (21), these two fingers were given special attention, although all of the fingers and the two thumbs were employed in tracing.

In short, there is evidence to uphold the argument that hand activities, such as manipulation and tracing of objects preceded by tactile stimulation are important factors in learning to perceive visually for children under the age of seven or seven and one-half years. Thus, tactile stimulation, tracing, and manipulation comprised the dependent variable of perceptual-motor activity in the study under consideration.

Copying Ability

Although motor activity seems to be closely related to early perceptual manifestations, several investigators have ascertained that lack of motor skill does not entirely account for the difficulties encountered in shape reproduction. Harris reported an unpublished study by D. T. Campbell in which the later found that mistakes in copying from a model were caused by perceptual rather than motor inabilities (34).

Using 226 subjects, aged two years and seven months through nine years and three months, Rice attempted to show the relationships among form perception, motor development, and copying ability. She concluded that perceptual development seemed to be more closely affiliated with copying ability than was motor development (58), a conclusion later substantiated by Townsend (65).

If motor skill is not a sufficient condition for correct copying behavior, and perceptual ability is an important component, then children might profit from a directed learning experience in visual perception, an approach not actively pursued by most developmentalists. The results could be more accurate perception as observed through more accurately copied shapes.

Visual Perception

In the present study, visual perception was defined, in part, as a discrimination process influenced by perceptual-motor activity. It was assumed that the accurate perception of shape could be achieved, essentially, by the differentiation of the critical elements through eye movements directed by tactual tracing and manipulation of shapes.

This approach to visual perception is consonant with that of Gibson and Gibson who theorize that, since all of the cues necessary for perception are contained in the stimulus, perception improves as the perceiver learns to differentiate in greater numbers the cue properties of stimulation. The perceiver learns, in essence, to respond to a greater number of distinctive or critical features of stimulation; he learns to comprehend objects by seeing the differences between them (32).

The above definition would obtain, in part, also to the theory of schema-formation and perceptual categorizing as advanced by Vernon. Within this approach the perceiver compares incoming sensory data with information already held in a particular schema; the subject must discriminate sensory input and place it in an appropriate category. When a particular function for the perceived object is suggested by the sensory patterns, and appropriate actions can be based on the information, the perception is considered to be correct; thus, in this conception of the perceptual process, as opposed to that of the Gibsons', thinking, perceiving, and behaving are interrelated (69, 70). Vernon's theory is not unlike Bruner's model of perception as a decision-making process. Accordingly, the perceiver responds to a stimulus, tentatively categorizes it, checks the appropriateness of the action by inferences based on past experince, attends to additional confirmatory cues, and finally makes a decision (11).

Pick experimentally compared both of the above approaches to discrimination learning and found that the group who ostensibly learned schemata was superior to a control group in the matching of letter-like forms to a standard; while the group who learned to perceive differences between forms was superior to both of the other groups (53).

In the early part of the present learning program, the subjects were taught to attend to the critical elements of shape as single entities, as well as parts of figures. Schemata could have been developed during this part of the training. Differentiation would become progressive as the subject applied the more general concepts of straight line, parallel lines, and angle to the more specific requirements of particular shapes. For example, having learned through perceptual-motor activity to differentiate a square by its patterns of lines and right angles, the subject would be in a position to learn that a rectangle with the same basic features as a square could be differentiated from a square by responding to the differences in length between the two sets of parallel lines. Specific comparative experiences were devised to accomplish this kind of learning.

Concept Development

Concept development was facilitated by focusing on the essential characteristics (critical elements) and by using simplified examples (shape outlines without internal detail), thus providing a foundation for the learning of more complex concepts at a later time (46).

That perceptual and conceptual development are related is emphasized by Arnheim who stated:

> It seems now that the same mechanisms operate on both the perceptual and the intellectual level, so that inevitably terms like concept, judgment, logic, abstraction, conclusion, computation have to be applied to the work of the senses (2:37).

In a review of cognitive learning in early childhood, Fowler commented that cognition has increasingly been recognized as a factor in discrimination and perceptual processes (20). As a result of work with the culturally deprived, the relationship between perception and cognition has been extensively studied in the classroom environment (10, 16). Although the basic program in the current experiment was essentially non-verbal, evidence that concept formation is possible without verbalization is presented by McDonald (46).

The naming of the elements of shape and of the shapes themselves was a part of the program, but no child was penalized for failure to recall any name. Jensen reported that preschool children who were told the name of an object and given the object to handle developed concepts about the object faster than those who were merely shown the object while it was named by the experimenter (38). Gibson and associates have demonstrated the relation between perception and concept formation in an experiment using pseudo-words. It was found that pronounceable pseudo-words were more frequently recognized when presented tachistoscopically than were unpronounceable pseudo-words (31). Again, Bloom, Davis, and Hess stress the fact that perceptual development is closely linked to linguistic development (10). In the current work, names were used to aid perceptual development, to lay the foundation for future concept development, and to facilitate communication.

Practice and Transfer

It appears that most theories of perception, with the possible exception of Gestalt Psychology, include the element of time in the form of practice, experience, and/or development as an essential component.

In a review of developmental studies of perception, Wohlwill noted that across content modalities young children need a redundancy of information for correct perception and, further, tend to follow a linear outline of a figure (time factor) when perceiving shape (73). This conclusion concurs with Hebb's theory that the time factor is important in perceptual integration (35). In a review of studies in perceptual judgment and the effect of practice, Gibson concluded that "practice results in a closer approximation of discriminative responses to differential stimulation" (30:422).

In the present learning program, practice or overlearning occurred when the subject throughout the program repeatedly traced the elements of shape in various positions, sizes, and patterns and when, upon being questioned, he attempted to recall the names of the elements and shapes.

It was assumed that transfer would occur through response generalization. This means that subsequent to the training, particular stimuli used in the training would evoke in the viewer new but analoguous responses. The process of response generalization is complex, but it appears that the phenomenon is affected by meaningfulness, degree of original learning, and the similarity of the responses required in the transfer situation to those required in the original situation (4, 67, 68). Thus, prior to training, the critical elements of shape would produce undifferentiated perceptual responses in the subject; after training, which emphasized meaningfulness of response (perceptual-motor activity) and differentiation through practice, the responses to the elements in the training figures would change. They would become more accurate as indicated by the subject's drawings. Transfer would be observed in the posttest when the subject correctly perceived the elements in new but similar figures to those used in the training program and, consequently, drew the new geometric figures correctly. The shapes assumed to effect transfer (the criterion figures) are listed in Table 3, page 30.

The Learning Model

As has been implied, children three and one-half to four years of age utilize stimulus generalization when asked to draw various geometric forms. When they attempt to copy geometric shapes, they tend to respond with similar figures for different models. A square may be drawn as a circle, although the circle itself is copied correctly from the stimulus model; the diagonal cross is often reproduced as a horizontal cross. Thus, it was postulated that, if given a discrimination learning program, the children of the above age range could learn to respond to fewer general stimuli or to a narrower range of undifferentiated stimuli. They could learn to respond to the cue properties of the stimuli, the perceptual elements and their individual patterns within each unique geometric shape. As a result, the training figures would be drawn correctly in the posttest, and transfer would be evidenced when figures similar to those used in the training were drawn correctly.

The model included the following categories: (1) Antecedent conditions--stimulus generalization; (2) Learning conditions--discrimination learning; (3) Performance conditions--accurate perception and, therefore, accurate drawing of the training figures; (4) Transfer conditions--response generalization, accurate perception and, therefore, accurate drawing of the non-training figures.

Related Research

Dubin discovered that nursery school children progressed through the developmental stages more rapidly in relation to their picture-making (easel painting) when given a minimum amount of training. The treatment program, however, consisted of encouragement and suggestions about such components as content, complexity, and relationships; it did not include a specific type of visual discrimination training (18).

Frostig, et al., reported the results of a pilot study in which kindergarten children who were given training in the Frostig Program for the Development of Visual Perception scored significantly higher on the Frostig Developmental Test of Visual Perception compared to children in the control groups who received a regular kindergarten program (24). The Frostig program is designed to prepare for, or to improve, reading achievement. The training program concentrates on six perceptual areas: position in space, spatial relationships, the constancies, visual-motor coordination, and figure-ground relationships. Activities within these categories consist of bodily exercises, manipulation of three-dimensional objects, and pencil and paper worksheets (22). McBeath tested the program in the first grade and found only indications that it improved reading abilities (45).

Although the program reportedly emphasizes tactile and kinesthetic responses, finger tracing is limited to those children having immature fine motor coordination or a motor handicap. Tactile stimulation is limited to the manipulation of three-dimensional objects and to pointing to parts of the body and to objects on the worksheets (22).

Concerning sex differences, Frostig did not find significant differences between boys and girls and their results on the Frostig Developmental Test of Visual Perception at the kindergarten level (25); however, in a pilot study, Efland found differences between scores of first grade boys and girls on a Simple Embedded Figures Test and a Man Drawing Scale. In the present study, the effect of the variable of sex was considered in the analyses.

The Montessori method, currently receiving renewed interest in the United States, stresses sensory-motor training for children, including visual and tactile perception. Stereognostic perception, the recognition of three-dimensional objects through feeling or an interaction of tactile and muscular cues, is employed in the program. Tactual tracing with the tips of the index and middle fingers is utilized as an aid to form recognition. By seeing and touching the edge of a thin wooden geometric shape (positive shape) which can be inserted into its corresponding frame (negative shape), the child learns to match the forms by fitting the first into the second. Manipulation is accomplished by picking up the positive shape by a small button placed on its surface. This type of sensory-motor exercise precedes drawing exercises which are designed to prepare four-year-old children for proficiency in writing. Drawings are made by tracing around both the negative and positive wooden shapes with colored pencils. The children are then taught to fill in the areas with fine lines (50, 51).

Montessori cites examples of children who recognized the shapes, for example, triangles and rectangles, outside of the training situation, thus suggesting that transfer had taken place (51).

Although the present study does not propose to test the didactic aspect of the Montessori method, it is important to consider the fact that the Montessori teaching procedures, per se, have not yet been experimentally investigated.[1] The results of the experiment under discussion might provide information about the effect of tactile perception upon visual perception which could conceivably be applicable to the system.

Efland provided training for first grade children in which

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[1]Currently under investigation is a project designed to develop testing instruments for the evaluation of early childhood educational practices. The Montessori approach is subsumed under this larger concept (7).

oblique lines and angles were the cues for the learning of shape. Instruction was based upon horizontal and vertical lines, which art educators have stressed as developmentally preceding the comprehension of the oblique (2, 61). Efland found that the children from the upper middle class benefited from the treatment; while the children from the lower middle class did not. Furthermore, he discovered by an indirect measurement that the first grade children for whom the training was effective drew with more differentiation than did a control group in the second grade. The investigator stated, "This tends to cast some doubt upon the rival hypothesis that maturation alone could account for development of artistic expression" (19:104).

Kensler reported that learning to attend to visual space cues did not affect sixth graders' ability to draw in perspective. As a result of this study, he recommended that art educators "identify and differentiate the relevant variables of perceptual training...[and] investigate the relationship of age and various kinds of perceptual training" (40:62).

Salome provided discrimination training for fourth and fifth grade students and found that fifth graders could be taught to locate directional changes in both straight and curved contours of objects and thus improve their renditions of them (60). Fourth graders did not significantly improve their responses after training.

These studies do not seem to refute the fact that visual perception can, in part, be learned. They would appear, rather, to indicate, as Kensler has stated, a need to investigate the relationship between type of training (with its concomitant variables) and age at which such training might be profitable. If tactile functions form the foundation for visual perception as hypothesized by Ayres, perhaps, an early deficit in tactile perception was associated with the failure of some of the children in the studies cited above to improve in visual perceptual responses after training.

Implications for Art Education

Since learning has been demonstrated to be a factor in perceptual integration, it is important for art educators to know what kind of visual perceptual training can be profitable for young children--what kind of visual perceptual training might form the foundation for a structured program in art education. Experimental research which investigates the relationships of the basic factors composing complex responses may provide information useful in the formation of such a structured curriculum. Learning to cope with the invariants of shape--straight line, parallel lines, and angle--could lay the foundation for the more adequate perceiving of complex shapes and their interactions.

The visual perceptual skills of shape analysis might also provide the basis for technical and representational skills which would allow a child more alternatives for self-expression than if he merely attempted such expression on the basis of affect or kinesthetic experiences alone.

The visual perceptual skills of shape analysis might prove of value in making aesthetic responses and might mitigate, in general, the loss of interest in art which seems to occur in the middle elementary or beginning secondary years.

The Hypotheses

Based upon the evidence presented, the following hypotheses were formulated and tested.

> I. Training in visual perception which emphasizes perceptual-motor activity increases the ability of preschool children to copy accurately geometric line drawings. Thus, the subjects in the experimental group (trained) will achieve higher scores than the subjects in the control group (untrained) on that part of the posttest which requires the copying of the geometric figures presented in the training program.

II. Learning as a result of a training program in visual perception emphasizing perceptual-motor activity transfers to the criterion figures (those which are similar to, but not identical with, the figures in the training program). Thus, the subjects in the experimental group will achieve higher scores than the subjects in the control group on that part of the posttest which requires the copying of the criterion figures.

III. Learning as a result of such a program resists the process of forgetting.

A. The subjects in the experimental group will achieve higher scores than the subjects in the control group on that part of the post-posttest which requires the copying of the training figures.

B. The subjects in the experimental group will achieve higher scores than the subjects in the control group on that part of the post-posttest which requires the copying of the criterion figures.

CHAPTER II

THE RESEARCH DESIGN

In the present chapter the research design established to test the stated hypotheses will be discussed.

The Sample

Fourteen preschools in San Francisco, California, and one of its suburbs, Daly City, participated in the experiment. Within this group of schools, ten were private nursery schools, three were cooperative nurseries, and one school operated under a Title I, OEO 1331 Compensatory Pre-Kindergarten Program.

The schools were grouped by geographical proximity and by the number of subjects of the required age range attending on either a Monday-Wednesday-Friday or a daily basis. Thus, two groups of schools were formed: Group I, which included those schools to be visited on Monday, Wednesday, and/or Friday, and Group II, which included those to be visited primarily on Tuesday and Thursday. The schools assigned to each group are indicated in the footnote of Appendix B-1.

Thirty boys and twenty-eight girls completed the entire test battery and missed no more than three treatment sessions. At the beginning of the experiment, the mean age of the group was three years and seven months, with a range of from three years and three months to three years and eleven months. The IQ scores of the subjects were determined by the Goodenough-Harris Draw-a-Man Test and ranged from 66 to 140, with a mean of 93.91. The eye-motor coordination scores, measured by Test I of the Marianne Frostig Developmental Test of Visual Perception, ranged from 0 through 5, with a mean of 2.12. When these scores were converted into perceptual age equivalents for the Eye-Motor Coordination Test, the range was from two years and nine months through four years and zero months. Appendix A-1 contains a listing of the ages and scores of the subjects.

The social class of the sample, measured by the occupation of the principal supporter of the family, ranged from the lower to the upper class, with the largest number of such supporters belonging to the middle class. This occupational information was provided by either the school records or the directors of the schools. Table 1 indicates the number of students in the various categories. (See also Appendix A-1.)

TABLE 1

CLASSIFICATION OF PRINCIPAL FAMILY SUPPORTER ACCORDING TO CENTERS' OCCUPATIONAL INDEX (14)*

Category	Number of Subjects
1. Large business	3
2. Professional	18
3. Small business	2
4. White collar worker	20
5. Student	2
6. Skilled worker	9
7. Semi-skilled worker	1
8. Unskilled worker	1
9. Welfare recipient	2
	(58)

*This scale was modified to include the categories of student and welfare recipient.

Based upon the records kept at each school, the mean enrollment in preschool for all subjects was approximately five months, with a range from one month to sixteen months. This figure includes the fact that the number of days per week and the number of hours per day for each student varied considerably, ranging from one-half day, two times a week (prior to the experiment), to a full day, five times a week. Attendance records were not kept in most schools; thus, the number of actual days present could not be determined for the individual children. In most cases, whether prior nursery school attendance had occurred was unknown; if such attendance were known, the exact number of months was often uncertain. The influence of the number of months of attendance at preschool sessions upon the treatment could not, therefore, be calculated.

The Experimental Design Pattern

The design pattern was

$$\begin{array}{ccccc} R & 01 & Xe & 02 & 03 \\ R & 04 & Xc & 05 & 06 \end{array}$$

where *R* stands for random assignment; *0* stands for the testing sessions; *Xe*, for the experimental group treatment; and *Xc*, for the control group treatment. It was a modified version of a design recommended by Campbell and Stanley which provided for internal validity. Such factors as history, maturation, testing, instrumentation, selection, mortality, regression, and various interactions of these factors as hypotheses rival to the experimental variable, perceptual-motor activity, were controlled (14); these will be discussed below in relation to the present study.

The subjects were randomly assigned to the experimental and control groups by a randomized block design which utilized schools as blocks. Into each block subjects were assigned in such a manner that in each school there was a difference of no more than one subject in any of the following categories: the experimental group versus the control group, the experimental boys versus the control boys, and the experimental girls versus the control girls. This design allowed for the investigation of the influence of schools upon the experiment and also assured that each of the four experimenters would work with approximately the same number of subjects in the experimental and control groups in each school. Table 2 summarizes the distribution of the subjects within the two groups according to schools and experimenters at the beginning and end of the experiment.

TABLE 2

DISTRIBUTION OF SUBJECTS ACCORDING TO EXPERIMENTER, SCHOOL, AND GROUP AT BEGINNING AND END OF EXPERIMENT

Experimenter	School	Number of Subjects: Experimental Group		Control Group		Totals		
		Boys	Girls	Boys	Girls	Beginning	Lost	End
I	3	(2)*	1	1	2	6	(2)	4
	4	2	(1)	2	0	5	(1)	4
	7	1	1 (1)	1 (1)	1 (1)	7	(3)	4
	8	1	(1)	1	1	4	(1)	3
								15
II	10	1	0	1	1	3	(0)	3
	11	1 (1)	2	2	(1)	7	(2)	5
	13	3 (1)	2 (1)	2 (1)	3 (1)	14	(4)	10
								18
III	1	(1)	(1)	0	2	4	(2)	2
	2	1 (2)	0	1 (1)	1	6	(3)	3
	6	1 (1)	1	2	1	6	(1)	5
	12	1 (1)	1 (1)	(2)	1 (1)	8	(5)	3
								13
IV	5	(2)	(2)	1 (2)	1	8	(6)	2
	9	2	2	2 (1)	1	8	(1)	7
	14	0	2	0	1	3	(0)	3
								12
		14 (11)	12 (8)	16 (8)	16 (4)	89	(31)	58

*Numbers in parentheses indicate subjects eliminated from experiment.

Internal Validity

This concept refers to the control within the research design of those factors, such as history, mortality, and testing which if not controlled would make the results of the research uninterpretable.

Mortality. Any subject who missed four or more lessons (29 per cent of the total number), one or more of the testing sessions, or who left blank three or more protocols within the three distributions of the Geometric Figures Test was eliminated from the experiment. Fifty-eight children out of an original 89 fulfilled the requirements for participation. Table 2 includes the number of subjects eliminated according to schools and groups.

Four subjects were removed because of unusual conditions surrounding their participation. Of these subjects, three were in the experimental group, and one was in the control group. The latter child refused all of the treatment sessions but took each of the three tests which were administered by personnel other than the experimenter. Of the former group, two children from the same school were uncooperative and refused a number of treatments; one, refusing also to take the posttest. The third child from the experimental group demanded such unusual handling during the treatment sessions that the situation seemed quite different from that provided for the other participants; furthermore, the subject was uncooperative during the testing situations, refusing to complete all of the protocols in the Geometric Figures Test.

The other 27 subjects were eliminated because of such factors as absences due to illness, moving away, vacations, rainy weather, lack of funds, and lack of transportation. Among these was one child who had an attendance record composed of three refusals and one absence and a second subject who had three incomplete protocols for the Geometric Figures Test.

It appeared that the experiment was not biased in favor of the healthy, but rather what may have been demonstrated was a parental attitude ranging from unawareness of the importance of early childhood learning to awareness of the fact that the preschool was not offering the type of cognitive program desired by the parent for his child.

History, experimenters. History refers to the events which occur that might affect one group, but not the other. Four trained experimenters, two women and two men, were used to prevent the possible confounding of the effects of intrasession history (the unique influence of the experimenter) with the effects of the dependent variable. Appendix A-3 presents the means and standard deviations of the total scores on the pretest, posttest, and post-posttest for each school visited by each experimenter.

The four experimenters were randomly assigned to a set of schools in such a manner that the difference between the number of schools in Group I (Monday, Wednesday, Friday) and the number in Group II (Tuesday, Thursday) was not more than one. Each experimenter administered the experimental as well as the control group treatment. Each was urged to follow whenever possible a schedule which provided for alternate treatment presentation according to groups and sex with the reversal of members within each group, so that the first member treated on one day would be the last treated on the next day. Exceptions were made if adherence to the schedule at any particular time would have caused great inconvenience for a subject or for a teacher. The master schedule is reproduced in Appendix B-1. Since most of the subjects attended school during the morning only, all of the sessions occurred during these hours.

The experimenters were not observed by the project director during the treatment sessions, although they were led to expect some observation. Visitors, such as parents or teachers were discouraged from observing the sessions. These precautions were taken to avoid a confounding of history with the experimental variable.

Prior to each new lesson, the experimenters met as a group for training. The lesson plan presented to them was discussed in detail, and any necessary changes were made at that time. New equipment was also issued at these sessions. Appendix C-2 contains the general instructions which were given to the experimenters.

Maturation. The subjects were chosen to represent an age range during which, according to child developmentalists, most children do not draw accurately the forms in the Geometrics Figures Test. In the present experiment, age was the weakest predictor of the dependent variable, becoming, in every case, non-significant when the other covariates considered in the experiment were entered into the analyses.

Testing, instrumentation, test administrators. Testing refers to the influence of the pretest upon the scores of subsequent tests. Instrumentation refers to changes in the tests during the progress of the experiment which might affect the outcome. Both were controlled by the research design.

A team of four test administrators, composed of one woman and three men, were responsible for all of the testing. They were trained by the project director and knew nothing about the purposes or format of the experiment. Their schedule for school visitations was so arranged that they tested only once in each school. Exceptions were tolerated when a test administrator had to substitute for another who was unable to return to a school to pick-up absentees or reluctant subjects. Thus, any bias connected with the personality or presentation of the test administrator was randomized over the entire group. Appendix B-3 contains the schedule for the test administrators; Appendix C-1, the general instructions given to them.

The subjects were administered four tests during the initial testing period: The Marianne Frostig Developmental Test of Visual Perception, 1963 Standardization, Test I, Eye-Motor Coordination Test; the Goodenough-Harris Draw-a-Man Test; a handedness test; and the

Geometric Figures Test presented as the pretest.

The Frostig test required the subject to draw a single, continuous line between two printed guide lines which followed straight, curved, and angular paths. The standardization and norms for the complete Frostig test are presented in a monograph by Frostig and her collaborators (25). The directions presented in the Administration and Scoring Manual (23) were followed in the present study.

The Goodenough-Harris test is a revised edition of the Goodenough Draw-a-Man Test. It is standardized, but Harris cautions that the norms for the three- and four-year-old children were calculated from less representative samples than those for the five- through fifteen-year-old group and, therefore, may be slightly high for "unselected or more adequately representative samples" (34:296). The test was chosen because of its appeal to children and because of its ease of administration. The manual was followed for administration and scoring (34).

Frostig reported correlations, based upon two different studies, between the Goodenough Draw-a-Man Test and the Frostig Developmental Test of Visual Perception, 1961 Standardization, which ranged from .235 to .460 in kindergarten. Thus, it was contended that the two tests measured different factors (25). It should be noted that the revised edition of the Goodenough Draw-a-Man Test used in the present study did not change the basic scoring for the man drawing.

The handedness test was administered because many of the tracing patterns in the experimental treatment varied according to this attribute. It was, therefore, necessary for each experimenter to know the handedness of each member of the experimental group with whom he worked. The test was given to all subjects and is reproduced in Appendix D-1.

The Geometric Figures Test was designed to test the effects of the treatment given to the experimental group. The dependent variable was the improvement of perceptual veridicality as measured by the posttest and post-posttest drawings of the subjects. The measurement of this improvement in visual perception was an indirect one. It was assumed that if the children drew the figures on the posttest more accurately following the training program, they would have learned to recognize and to transfer the critical elements of shape. If these same children received higher scores on the post-posttest than did the subjects in the control group, it would be assumed that the children had retained the material learned. Appendix A-2 lists the summary scores on the Geometric Figures Test for each subject.

The test consisted of ten geometric line drawings, five of which represented figures used in the learning program and five of which did not. The former (the training figures) measured perceptual learning and retention; the latter (the criterion figures), perceptual learning, transfer, and retention. The pretest, posttest, and post-posttest were each composed of these ten figures randomly arranged for each presentation. The order of presentation is shown in Table 3.

The figures, measuring approximately seven centimeters, were drawn with india ink on 5 x 8 inch cards and were presented to the subject one at a time in front of him and parallel to the edge of the table. The subject copied each design on a separate sheet of paper which was the same size as that of the model and which was placed directly below the model and in front of the subject. The complete test manual is reproduced in Appendix D-2.

During the development of the scoring procedure, eight people, working as six teams of two judges each, participated at various times by scoring samples of the drawings. Their reactions to both the training and the scoring procedures were considered in the evolution of the final scoring form. When it was completed, two new judges were selected to rate the experimental sample.

The cumulative scoring scale for each model ranged from one point for a scribble through five points for an accurate drawing. Within the scoring system the principal classifications were the open or closed quality of the drawing; straightness, parallelness, and angulation; intersection of lines; proportion; and rotation. The judges matched each drawing to the category descriptions, beginning with number one and proceeding through the scale until the drawing no longer fit the category. The assigned score was that of the highest category which accurately described the drawing in relation to the model being judged. The method of visual inspection was used whenever the drawing clearly met the established criteria; in all other cases, the drawing was measured for accuracy by a ruler, protractor, and/or tissue overlay. The overlay for straightness and length of line was found to be a fast and accurate form of measurement; while the overlays for angle and rotation proved to be less effective, the ruler and protractor being more often used by the raters.

TABLE 3

RANDOM ORDER OF MODEL PRESENTATION FOR THE PRETEST, POSTTEST, AND POST-POSTTEST (GEOMETRIC FIGURES TEST)

	Pretest	Posttest	Post-Posttest
	1*	6	7
	2*	4	6
	3*	8*	5*
Model	4	3*	8*
	5*	1*	4
Number	6	9	3*
	7	10	10
	8*	5*	1*
	9	7	9
	10	2*	2*

*Criterion figures.

During all of the rating sessions, the judges had access to the test manual, which contained many illustrative examples of terms and procedures used in the rating scales. Furthermore, two copies of the model being judged and two or three examples of drawings which were representative of each of the five categories for that particular model were displayed on a large board directly in front of the raters.

The training of the final pair of judges consisted of a familiarization with the scoring manual and practice on three drawings from each model. Following this period, the judges independently rated ten drawings for the first model to be judged, compared their scores, and discussed discrepancies. At the same time, correlations between the two sets of scores were obtained, with .80 established as the lowest acceptable correlation. Usually two samples were scored before the raters felt confident to proceed to the experimental sample, even though the first set of scores yielded a correlation above the acceptable level. None of the drawings used for practice purposes was taken from the experimental sample.

The protocols for the pretest, posttest, and post-posttest within each model were assigned a position by the use of a table of random numbers. Following this assignment, the models themselves were randomly assigned a position for scoring. Within each model, half of the protocols were simultaneously and independently scored by each judge; upon completion of this procedure, the judges scored ten protocols randomly selected from the experimental sample and then compared and discussed their scores. In no case were any of these scores changed because of disagreements. The judges next exchanged protocols in such a manner that the first drawing rated by one judge was rated last by the other judge. For only one model, the rectangle, was an additional practice provided at the midpoint juncture because the initial correlation of the raters' scores fell below .80. Table 4 presents the interjudge correlations for the entire experimental sample, according to model number and the randomized order in which the models were judged.

External Validity

This aspect of a research design refers to the representativeness of the study or to the generalizability of the results. Those of the present study should be generalizable to a population comparable to that of the sample.

Interaction of testing with the experimental variable. Within the design itself, Campbell and Stanley regard the interaction of the testing with the experimental treatment as a threat to generalizability (14). However, since developmental data indicate that most children in the age group treated do not correctly reproduce the geometric shapes composing the experimental tests, and since it was postulated that tests would not provide an active learning situation, it was predicted that such an interaction would not occur, or if it did, it would have insignificant effects.

TABLE 4

INTERJUDGE CORRELATIONS FOR INDIVIDUAL MODELS OF GEOMETRIC FIGURES TEST

Model Number	Random Order in which Rated	Number of* Protocols	Correlation Between Two Judges
1	(1)	189	.92
2	(9)	189	.90
3	(8)	189	.86
4	(4)	189	.97
5	(2)	189	.85
6	(6)	189	.95
7	(5)	189	.96
8	(7)	189	.85
9	(3)	189	.88
10	(10)	188	.92

*Number includes protocols for five subjects eliminated from the study.

Reactive arrangements. According to Campbell and Stanley, reactive arrangements may constitute another weakness in the design used for the current study (14). Again, it was postulated that such effects could be positive if a child believed he was receiving special attention and, therefore, made an extra effort to perform effectively; or they might be negative if the child felt that being called from the group was an imposition and, therefore, refused to participate fully, or not at all.

However, since nursery school children often receive individual attention and usually have more than one teacher (62), it was thought that such effects would be minimal if they occurred. As discussed under Mortality above, only four subjects were uncooperative to such a degree that they were eliminated from the study.

The Schedule

The experiment began on March 13, 1967, with the pretesting sessions which continued through March 17. On March 28, 1967, the training sessions began and continued through May 5, 1967. From May 8 through May 10, the posttests were administered, and from June 8 through June 13, the post-posttests were given.

Each of the fourteen lessons in the experiment ranged from ten to fifteen minutes in length, and the length of the sessions for each group was identical. All subjects were treated within a two-day unit. An examination of the training schedule reproduced in Appendix B-1 indicates at times an unevenness of unit presentation. This was due to the fact that the members of one school went on weekly excursions (the day varied each week), and the experimental schedule was prepared around the school's program.

The Treatment

Prior to the development of the final experimental program, an informal study was conducted in which three children were pretested, trained with two modified lessons, and posttested. Observations made during these trial sessions were included in subsequent considerations of the treatment program.

During the experiment, the teachers in the various schools continued their regular programs. Each child left the program only for the time required for the lesson. When a special group activity was being conducted, the experimenter was instructed to wait until it was over if calling the child from the group would cause a disruption. The treatment took place in a separate room or in a quiet area of a large room as far from distractions as possible.

The Experimental Program

In general, the treatment consisted of a warm-up period during which the subject rubbed his hands together or rubbed textured materials, ranging from smooth and soft to hard and rough. Gross tracing then followed. The subject stood in front of one or two cardboard shapes adhered to a magnetic board and with one or two arms outstretched from the shoulder traced the shapes with his palms or with his finger tips according to prearranged patterns. Subsequent to these activities, the subject was seated at a table and engaged in finger and palmar tracing around cardboard and wire templates, solid shapes, and line drawings; construction of geometric figures; and comparative measuring, composed of matching exercises. For all tracing activities, the shapes were securely adhered to a magnetic or steel board.

All of the major training equipment was either black or white with the exception of a green chalkboard. Each figure was presented against its opposite value in order to maintain maximum contrast, again, with the exception of the chalkboard on which were placed only white shapes. Color was excluded from the main treatment in order to avoid any complications which might arise from the introduction of another variable and to avoid the possibility of learning the figures by a color-coding process. Color was introduced for variety three times as an auxiliary feature of a matching game and two constructions. The figures varied in size, but those used for tracing and manipulation ranged primarily from 9 centimeters through 20 centimeters. Photographs of the equipment are reproduced in Appendix E-1, page 116.

The experimenter demonstrated each action to be executed within each component of the perceptual-motor activity. The subject was expected to imitate these movements, which were presented as units; for example, after having the experience of tracing completely around a square, the subject might be shown a parallel line pattern beginning with a top to bottom movement on each of the two vertical sides, followed by a right to left motion on the horizontal sides. If a subject could not imitate this pattern correctly, the experimenter demonstrated it a second time. If the child could not repeat the action, the unit was broken into parts; for example, the two vertical sides were traced for the subject's imitation, then the two horizontal sides. If the subject did not respond to this simplified procedure, the experimenter guided his hand through the correct motions. The subject was then given an opportunity to perform the tracing task unassisted.

Manipulative procedures for the constructing and measuring of figures were demonstrated by the experimenter whenever necessary, and corrections of errors were made. The complete program is reproduced in Appendix E-1.

The Control Program

The control group worked puzzles and played games requiring the matching of figures, none of which were geometric or related to those used in the experimental group.

The experimenter demonstrated the procedures for each game and sometimes played the game with the subject. If a subject made a mistake in a puzzle or a game demanding matching, the experimenter asked him to look carefully. If after a second suggestion, the subject persisted in the error, the experimenter removed the incorrect element. This approach to error was utilized to insure that no inadvertent training in perceptual discrimination was provided. When puzzles were used, the picture was shown to the subject prior to being disassembled and then reassembled by the subject. Appendix B-2 contains a schedule of the activities in which the members of the control group engaged; while Appendix E-2 provides examples of lessons presented to these subjects.

CHAPTER III

THE ANALYSIS OF THE DATA

The hypotheses were tested by analyses of covariance. The dependent variable, perceptual-motor activity, was measured by a set of scores from the pretest, posttest, and post-posttest (the three distributions of the Geometric Figures Test), each of which was divided into two subsets representing the scores for the training figures and those for the criterion figures. Treatment and sex were the independent or discrete variables used in all of the analyses with the exception of those in which the influence of school was investigated. In these analyses, treatment and school were entered as discrete variables; while sex was considered a covariate. An analysis of covariance using sex as a covariate or pseudo-variate carrying a value of one for male and zero for female was permissible, according to Quenouille, because in no analysis in which treatment and sex were entered as independent variables was the interaction between the two significant (55). The principal covariates considered for, but not necessarily entered into, every analysis were age, IQ scores, motor scores, pretest training, and pretest criterion scores.

All hypotheses were tested for significance at the .05 level. A one-tailed _t_-test was utilized to determine the significance of the effect of the treatment; while an _F_ ratio of significance was utilized for all other effects. The one-tailed _t_-test was used because each hypothesis predicted a gain for the experimental group in a particular direction; one-tailed tests are appropriate for these types of statements (71, 72).

The data were processed by the UCLA Health Sciences Computer Program Number BMD 05V (General Linear Hypothesis) designed for analysis of covariance. The means, standard deviations, and correlations were processed under Program Number BMD 02D.

Hypothesis I

Training in visual perception which emphasizes perceptual-motor activity increases the ability of preschool children to copy accurately geometric line drawings. Thus, the subjects in the experimental group (trained) will achieve higher scores than the subjects in the control group (untrained) on that part of the posttest which requires the copying of the geometric figures presented in the training program.

To test whether the experimental subjects received higher scores on the posttest training figures than did the control subjects, a two-way analysis of covariance by treatment and sex was run with age, IQ scores, motor scores, pretest training, and pretest criterion scores considered as covariates. Of these, the pretest training scores and the motor scores were the only significant covariates at the .05 level. The *t*-test indicated that there was no significant difference between the two groups of subjects. Tables 5 and 6 present the statistical results.

A second analysis using treatment and school as bases for classification indicated no significant difference between schools at the required level, although the effects of schools reached the .10 level of significance. Tables 7 and 8 summarize these results.

Since neither of the *t*-tests was significant at the .05 level, the research hypothesis was not supported, and the null hypothesis was accepted.

TABLE 5

ANALYSIS OF VARIANCE OF POSTTEST TRAINING SCORES BY TREATMENT AND SEX WITH COVARIANCE ADJUSTMENT BY PRETEST TRAINING AND MOTOR SCORES*

Source	s.s.	df	m.s.	F
Treatment	0.78	1	0.78	
Sex	32.61	1	32.61	1.88 (n.s.)
Interaction	4.57	1	4.57	0.26 (n.s.)
Residual	901.73	52	17.34	
Total	939.69	55		

One-tailed t-test for Treatment: t = 0.20 (n.s.)

*Covariates significant at .05 level. (Age, IQ, and pretest criterion scores = n.s.)

TABLE 6

MEANS AND STANDARD DEVIATIONS OF POSTTEST TRAINING SCORES: DATA OF TABLE 5

	Experimental Group			Control Group		
	Boys	Girls	All	Boys	Girls	All
n	14	12	26	16	16	32
$\bar{Y}$ (raw)	22.43	24.92	23.58	24.81	23.25	24.03
SD	8.98	6.72	7.97	5.24	9.18	7.39
$\bar{Y}$ (adjusted)	25.02	22.88	23.95	24.18	23.24	23.71

Symbols used: n = number; $\bar{Y}$ = mean; SD = standard deviation.

TABLE 7

ANALYSIS OF VARIANCE OF POSTTEST TRAINING SCORES BY TREATMENT AND SCHOOL WITH COVARIANCE ADJUSTMENT BY PRETEST TRAINING AND MOTOR SCORES*

Source	s.s.	df	m.s.	F
Treatment	16.72	1	16.72	
School	350.52	13	26.96	1.89 (.10)
Residual	586.45	41	14.30	
Total	953.69	55		
One-tailed t-test for Treatment: t = 1.08 (n.s.)				

*Covariates significant at .05
F at .10 with 13 and 41 df = 1.70

TABLE 8

MEANS AND STANDARD DEVIATIONS OF POSTTEST TRAINING SCORES: DATA OF TABLE 7

	Experimental Group	Control Group
n	26	32
$\bar{Y}$ (raw)	23.58	24.03
SD	7.97	7.39
$\bar{Y}$ (adjusted)	24.41	23.25

Hypothesis II

Learning as a result of a training program in visual perception emphasizing perceptual-motor activity transfers to the criterion figures (those which are similar to, but not identical with, the figures in the training program). Thus, the subjects in the experimental group will achieve higher scores than the subjects in the control group on that part of the posttest which requires the copying of the criterion figures.

Hypothesis II dealt with the increased ability of the experimental subjects as compared with the control subjects to reproduce the criterion figures of the Geometric Figures Test--the five figures not included in the training program. If the first group attained significantly higher scores on the posttest criterion figures, this fact would be interpreted as evidence of transfer of learning. Tables 9 and 10 delineate the statistical results. Again, they were not significant at the required level.

TABLE 9

ANALYSIS OF VARIANCE OF POSTTEST CRITERION SCORES BY TREATMENT AND SEX WITH COVARIANCE ADJUSTMENT BY PRETEST TRAINING AND PRETEST CRITERION SCORES*

Source	s.s.	df	m.s.	F
Treatment	3.20	1	3.20	
Sex	11.91	1	11.91	0.67 (n.s.)
Interaction	57.46	1	57.46	3.24 (.10)
Residual	923.30	52	17.76	
Total	995.87	55		
One-tailed t-test for Treatment: t = -0.42 (n.s.)				

*Covariates significant at .05 level
F at .10 with 1 and 52 df = 2.81

TABLE 10

MEANS AND STANDARD DEVIATIONS OF POSTTEST CRITERION SCORES: DATA OF TABLE 9

	Experimental Group			Control Group		
	Boys	Girls	All	Boys	Girls	All
n	14	12	26	16	16	32
$\bar{Y}$ (raw)	20.57	21.33	20.92	21.63	21.81	21.72
SD	7.43	4.23	6.06	5.63	7.09	6.30
$\bar{Y}$ (adjusted)	22.62	19.62	21.12	21.02	22.18	21.60

In a second two-way analysis of covariance using treatment and school as the classification variables, the results were not significant. Tables 11 and 12 summarize these results. Research Hypothesis II was not supported; the null hypothesis was accepted.

TABLE 11

ANALYSIS OF VARIANCE OF POSTTEST CRITERION SCORES BY TREATMENT AND SCHOOL WITH COVARIANCE ADJUSTMENT BY PRETEST CRITERION AND PRETEST TRAINING SCORES*

Source	s.s.	df	m.s.	F
Treatment	1.77	1	1.77	
School	344.87	13	26.53	1.694 (.10)
Residual	641.86	41	15.66	
Total	988.50	55		
One-tailed t-test for Treatment: t = 0.33 (n.s.)				

*Covariates significant at .05
F at .10 with 13 and 41 df = 1.691

TABLE 12

MEANS AND STANDARD DEVIATIONS OF POSTTEST CRITERION SCORES: DATA OF TABLE 11

	Experimental Group	Control Group
n	26	32
$\bar{Y}$ (raw)	20.92	21.72
SD	6.06	6.30
$\bar{Y}$ (adjusted)	21.55	21.17

Hypothesis III

Learning as a result of a program in perceptual-motor activity resists the process of forgetting.

A. The subjects in the experimental group will achieve higher scores than the subjects in the control group on that part of the post-posttest which requires the copying of the training figures.

B. The subjects in the experimental group will achieve higher scores than the subjects in the control group on that part of the post-posttest which requires the copying of the criterion figures.

According to Hypothesis III, if the children in the experimental group received higher scores on the training figures of the post-posttest, it would be assumed that they had learned and retained the essential elements of shape presented in the training program. If the experimental subjects received higher scores on the criterion figures in the post-posttest, this fact would be construed as evidence that the subjects retained basic principles assumed to have been transferred from the material learned in the experimental treatment sessions.

In order to test Hypothesis IIIA, a two-way analysis of covariance by treatment and sex was used with the usual covariates considered. Tables 13 and 14 outline the statistical findings. As can be observed, the treatment appeared not to be effective. The experimental group as a whole did not receive significantly higher scores than did the control group on the post-posttest training figures.

TABLE 13

ANALYSIS OF VARIANCE OF POST-POSTTEST TRAINING SCORES BY TREATMENT AND SEX WITH COVARIANCE ADJUSTMENT BY PRETEST TRAINING AND PRETEST CRITERION SCORES*

Source	s.s.	df	m.s.	F
Treatment	27.70	1	27.70	
Sex	1.47	1	1.47	0.07 (n.s.)
Interaction	76.72	1	76.72	3.55 (.10)
Residual	1124.42	52	21.62	
Total	1230.31	55		
One-tailed t-test for Treatment: t = 1.13 (n.s.)				

*Covariates significant at .05
F at .10 with 1 and 52 df = 2.81

TABLE 14

MEANS AND STANDARD DEVIATIONS OF POST-POSTTEST TRAINING SCORES: DATA OF TABLE 13

	Experimental Group			Control Group		
	Boys	Girls	All	Boys	Girls	All
n	14	12	26	16	16	32
Y (raw)	25.36	27.67	26.42	25.19	25.75	25.47
SD	9.44	5.63	7.85	4.94	9.53	7.47
Y (adjusted)	27.96	25.24	26.60	24.16	26.24	25.20

When treatment and school were run as classification variables, the treatment was effective at the .05 level of significance. (See Tables 15 and 16.) The children in the experimental group received higher scores than those in the control group on the post-posttest training figures when the variance due to schools was considered. What this result might mean will be discussed below.

TABLE 15

ANALYSIS OF VARIANCE OF POST-POSTTEST TRAINING SCORES BY TREATMENT AND SCHOOL WITH COVARIANCE ADJUSTMENT BY PRETEST TRAINING AND PRETEST CRITERION SCORES*

Source	s.s.	df	m.s.	F
Treatment	63.90	1	63.90	
School	344.78	13	26.52	1.27 (n.s.)
Residual	856.39	41	20.89	
Total	1265.07	55		
One-tailed t-test for Treatment: t = 1.75 (.05)				

*Covariates significant at .05
t at .05 with 1 and 41 df = 1.69

TABLE 16

MEANS AND STANDARD DEVIATIONS OF POST-POSTTEST TRAINING SCORES: DATA OF TABLE 15

	Experimental Group	Control Group
n	26	32
$\bar{Y}$ (raw)	26.42	25.47
SD	7.85	7.47
$\bar{Y}$ (adjusted)	27.03	24.77

The analysis of Hypothesis IIIB, using treatment and sex as classification variables and entering the usual covariates, showed that the treatment was significant at the .05 level; thus, the experimental subjects received higher scores on the post-posttest criterion figures than did the control group members. It would appear that these subjects had learned basic concepts during the treatment and had transferred such concepts to similar situations. Tables 17 and 18 present a statistical summary of the first analysis of Hypothesis IIIB.

TABLE 17

ANALYSIS OF VARIANCE OF POST-POSTTEST CRITERION SCORES BY TREATMENT AND SEX WITH COVARIANCE ADJUSTMENT BY PRETEST TRAINING SCORES*

Source	s.s.	df	m.s.	F
Treatment	77.18	1	77.18	
Sex	0.06	1	0.06	0.002
Interaction	4.14	1	4.14	0.16
Residual	1401.39	53	26.44	
Total	1482.77	56		
One-tailed *t*-test for Treatment: *t* = 1.71 (.05)				

*Covariate significant at .05
t at .05 with 1 and 53 *df* = 1.68

When treatment and school were used as the two classification variables, the experimental subjects showed improvement on scores for the criterion figures at the .01 level of significance; while, concurrently, the effects of schools were significant at the .05 level. These data are depicted in Tables 19 and 20. The adjusted means by school are presented in Table 21.

TABLE 18

MEANS AND STANDARD DEVIATIONS OF POST-POSTTEST CRITERION SCORES: DATA OF TABLE 17

	Experimental Group			Control Group		
	Boys	Girls	All	Boys	Girls	All
n	14	12	26	16	16	32
$\bar{Y}$ (raw)	21.64	23.83	22.65	20.75	20.38	20.56
SD	6.82	5.98	6.42	4.84	6.77	5.79
$\bar{Y}$ (adjusted)	22.91	22.41	22.66	20.03	20.65	20.34

TABLE 19

ANALYSIS OF VARIANCE OF POST-POSTTEST CRITERION SCORES BY TREATMENT AND SCHOOL WITH COVARIANCE ADJUSTMENT BY PRETEST TRAINING SCORES*

Source	s.s.	df	m.s.	F
Treatment	116.16	1	116.16	
School	571.10	13	43.93	2.21 (.05)
Residual	834.70	42	19.87	
Total	1521.96	56		
One-tailed t-test for treatment: t = 2.42 (.01)				

*Covariate significant at .05
t at .01 with 1 and 42 df = 2.42
F at .05 with 13 and 42 df = 1.98

TABLE 20

MEANS AND STANDARD DEVIATIONS OF POST-POSTTEST CRITERION SCORES: DATA OF TABLE 19

	Experimental Group	Control Group
n	26	32
$\bar{Y}$ (raw)	22.65	20.56
SD	6.42	5.79
$\bar{Y}$ (adjusted)	23.02	19.98

TABLE 21

ADJUSTED MEANS BY SCHOOL FOR POST-POSTTEST CRITERION SCORES

School	Adjusted Means	School	Adjusted Means
1	26.89	8	17.82
2	22.13	9	21.15
3	30.07	10	21.31
4	20.16	11	22.78
5	16.10	12	18.44
6	25.10	13	20.57
7	19.52	14	18.98

To determine whether IQ might account for the significant effects of schools, an analysis of variance was conducted. Table 22 presents the results which indicate that IQ was not a significant variable accounting for differences between schools.

TABLE 22

ANALYSIS OF VARIANCE OF IQ BY SCHOOL

Source	s.s.	df	m.s.	F
Between Schools	4093.6	13	314.9	.823 (n.s.)
Within Schools (residual)	16831.3	44	382.5	

As a further test of the power to resist forgetting as demonstrated by the experimental group, gain scores from the posttest to the post-posttest were investigated. Would the experimental group achieve higher gains, showing that they remembered the concepts taught in the experimental sessions as revealed by their drawings of both the training and criterion figures? The analysis of covariance revealed that the experimental group did indeed gain more points than the control group--a gain significant at the .01 level. Tables 23 and 24 indicate the outcomes of the analysis.

TABLE 23

ANALYSIS OF VARIANCE OF POSTTEST--POST-POSTTEST TOTAL GAIN SCORES BY TREATMENT AND SEX*

Source	s.s.	df	m.s.	F
Treatment	269.77	1	269.77	
Sex	28.27	1	28.27	0.67 (n.s.)
Interaction	0.35	1	0.35	0.008 (n.s.)
Residual	2279.19	54	42.21	
Total	2577.58	57		
One-tailed t-test for Treatment: t = 2.53 (.01)				

*Covariates: none significant
t at .01 with 1 and 54 df = 2.40

TABLE 24

MEANS AND STANDARD DEVIATIONS OF POSTTEST--POST-POSTTEST TOTAL GAIN SCORES: DATA OF TABLE 23

	Experimental Group			Control Group		
	Boys	Girls	All	Boys	Girls	All
n	14	12	26	16	16	32
$\bar{Y}$ (raw)	4.00	5.25	4.58	-0.50	1.06	0.28
SD	7.14	4.75	6.04	7.25	6.22	6.64
$\bar{Y}$ (adjusted)	4.00	5.25	4.58	-0.50	1.06	0.28

When the total gain scores were separated into posttest training and criterion scores and analyses performed, it was discovered that the experimental group gained significantly more points (.05 level of significance) than the control group on the criterion figures, but not on the training figures. The results are shown in Tables 25 through 28.

TABLE 25

ANALYSIS OF VARIANCE OF POSTTEST--POST-POSTTEST GAIN SCORES ON CRITERION FIGURES WITH COVARIANCE ADJUSTMENT BY IQ AND PRETEST CRITERION SCORES*

Source	s.s.	df	m.s.	F
Treatment	69.18	1	69.18	
Sex	8.79	1	8.79	0.38 (n.s.)
Interaction	35.79	1	35.79	1.54 (n.s.)
Residual	1205.74	52	23.19	
Total	1319.50	55		
One-tailed t-test for Treatment: t = 1.73 (.05)				

*Covariate significant at .05
t at .05 with 1 and 52 df = 1.68

TABLE 26

MEANS AND STANDARD DEVIATIONS OF POSTTEST--POST-POSTTEST GAIN SCORES ON CRITERION FIGURES: DATA OF TABLE 25

	Experimental Group			Control Group		
	Boys	Girls	All	Boys	Girls	All
n	14	12	26	16	16	32
$\bar{Y}$ (raw)	1.07	2.50	1.73	-0.88	-1.44	-1.16
SD	5.06	4.15	4.57	5.89	5.80	5.75
$\bar{Y}$ (adjusted)	0.05	2.47	1.26	-0.57	-1.39	-0.98

TABLE 27

ANALYSIS OF VARIANCE OF POSTTEST--POST-POSTTEST GAIN SCORES ON TRAINING FIGURES BY TREATMENT AND SEX*

Source	s.s.	df	m.s.	F
Treatment	28.09	1	28.09	
Sex	13.54	1	13.54	0.68 (n.s.)
Interaction	18.97	1	18.97	0.95 (n.s.)
Residual	1080.93	54	20.02	
Total	1141.53	57		

One-tailed t-test for Treatment: t = 1.18 (n.s.)

*Covariates: none significant

TABLE 28

MEANS AND STANDARD DEVIATIONS OF POSTTEST--POST-POSTTEST GAIN SCORES ON TRAINING FIGURES: DATA OF TABLE 27

	Experimental Group			Control Group		
	Boys	Girls	All	Boys	Girls	All
n	14	12	26	16	16	32
$\overline{Y}$ (raw)	2.93	2.75	2.85	0.38	2.50	1.44
SD	4.89	5.36	5.01	4.49	3.18	3.83
$\overline{Y}$ (adjusted)	2.93	2.75	2.85	0.38	2.50	1.44

In summary, the results of Hypothesis III indicated that the members of the experimental group significantly improved their ability to remember the critical elements of shape and to draw accurately the figures in the Geometric Figures Test when the variance due to schools was considered. When the effects of schools were not considered, the experimental training appeared to be effective only on the criterion figures. Post-posttest total gain scores and gain scores on the criterion figures were significant, but the post-posttest gain scores for the training figures were not. Upon this evidence, Hypothesis III was partially accepted.

In essence, the experimental group appeared to transfer their newly acquired knowledge to the criterion figures--the most difficult figures--and to remember such knowledge, but only after a time lapse. Can this rather startling phenomenon be explained, or must one accept the possibility that these results were statistical anomalies?

Discussion of the Main Results

When considering the results of the experiment, several questions arise. First, considering the nature of the training figures, one might ask why the experimental group did not perceive and draw these figures more correctly than did the control group. An investigation of the figures reveals that the group contained three closed figures--a square, a rectangle, and an equilateral triangle--and two open figures--a vertical cross and a diagonal cross. According to Gesell's developmental schedule, at age three, 20 to 49 per cent of the children tested by him could draw a cross without consideration of correct angulation or rotation; while at age four, 65 to 84 per cent of those observed could draw it correctly, but again without consideration of correct angulation or rotation (28). In the present experiment, these two factors were scored, thus, making a high score more difficult to attain. Yet, the members of the experimental group were trained to perceive angle and to discriminate rotation. Why, then, did they not receive significantly higher scores on the cross than did the members of the control group?

Again, according to Gesell, at age four, only 1 to 19 per cent of the children studied drew the equilateral triangle correctly (28). Clearly this is a more difficult figure than the cross. Yet in the experiment being discussed, the control group without training drew the equilateral triangle as well as did the experimental group with training. These results are singular because on the post-posttest the experimental group perceived and drew the more difficult criterion figures significantly better than did the control group.

One possible explanation for the finding that the experimental group was not significantly superior to the control group on the training figures in any analysis except one (see Table 15, page 44) might lie in the fact that both groups of children had preschool experience in which the training figures were undoubtedly brought to the attention of the children through indirect methods, such as stories and art work and, perhaps, through direct teaching experiences, such as naming, counting, and comparing these figures. The criterion figures may not have been given such attention. Since developmental schedules indicate that the diamond is not usually drawn until between the ages of five and seven, this figure was probably not stressed in the preschool experiences. The open shapes among the criterion group--the partial X, the series of diagonal lines, the rotated H--were unusual figures and, therefore, were not likely to have been systematically presented to the children. Thus, the factor of familiarity with the training figures due to preschool experiences may have favored the control group.

It should be specified at this time that Gesell's description of the sample upon which he initially based his developmental schedule indicated that the children were "pre-school" children. They were observed in their homes or in the clinic (28); thus, it can be assumed that for the most part, the children had no organized preschool experience. Furthermore, Piaget reported that the subjects participating in the experiments upon which his schedules, in part, were based had no Montessori experience (52). Whether they had other preschool experience is unknown. The effect of preschool attendance on the children in the study under consideration, then, may have been an increased ability to perceive visually.

On the other hand, the experimental group received higher post-posttest scores on the training figures when school was entered as a variable, which indicates the possibility that there were differences among schools in the amount of exposure to, or practice with, the training figures which was provided for the children. Or some schools might have been more learning-oriented than others. The means and standard deviations for schools are presented in Appendix A-3. Before and after the experiment, the author attempted to investigate similarities and differences among schools, but since the experiment was not primarily concerned with these conditions, adequate instruments were not available to differentiate fine nuances--to differentiate the covert patterns of interaction which might be important for learning. Even the observation of basic lessons was difficult since among the preschools in the sample no uniform content seemed evident. There were, however, indications of differences in learning experiences and disciplinary procedures. Variations in physical plants, including areas conducive for the treatment sessions, were obvious.

Another possible explanation of the higher post-posttest criterion scores for the experimental group, and possibly the more cogent, is the fact that the subjects had not reached concept attainment at the time of the posttest. If the children were learning concepts as stipulated, then the process of formation and attainment and its relation to perception must be examined.

Discrimination and generalization are two important aspects of concept formation and attainment. The learner must first discriminate the relevant cues that differentiate a particular concept; he must abstract this information from sensory material (concept formation based upon perceptual processes); then he must generalize this information to other instances of the concept (concept attainment) (13, 46). Since experience with the concept is necessary to attain generalization, it seems plausible that during the training sessions the subjects were learning to discriminate the critical elements or cue properties of shape and were developing categories against which discriminations could be checked, but the subjects had within the experiment itself no opportunity to practice generalizing these elements to shapes not used in the treatment. Consequently, this lack of generalization was observed in the low scores on the criterion figures of the posttest which was designed to measure the effect of transfer to new but similar shapes. After the termination of the treatment, when the concepts themselves had become firmly acquired, the subjects may have continued to learn by relating their newly formed concepts to other instances of them; thus, generalization took place and became evident in the significantly increased post-posttest scores on the criterion figures.

If practice did not actually occur among the experimental group, however, another explanation is reasonable. The results could be explained by a delayed-action effect. In a study pertaining to attitude change and cognitive consistency, McGuire discovered, after the administration of treatment directed at specific components within attitude clusters, that these attitude clusters tended to become more consistent, to change, over a period of time because related attitudes within the clusters which did not receive treatment tended to change also in the direction of consistency. A "continued seepage" from the treatment had a delayed-action effect upon the non-treated material (49).

In the present study, the treatment may have had a similar delayed-action effect upon the perception of the related criterion figures. On the basis of "a postulate that people tend to maintain logical consistency among their cognitions (and even between cognitions and more gross behavior)" (49:345), one might conjecture that this type of behavior was reflected in the experimental group's higher scores on the criterion figures of the post-posttest. A felt-desire for perceptual-cognitive-motor consistency may have been expressed.

But without specific teaching of the perceptual elements of shape, could the children have generated relationships between the basic concepts and further examples of them? The transfer of concepts in this experiment occurred after the concepts were explored in a systematic way utilizing more than one sense modality. Without such training would such concepts have been learned, or would they have been generalized? Obviously not, since the members of the control group had school experiences with the training figures which were similar to those of the members of the experimental group, but the former did not seem to learn perceptual concepts from them to such an extent that the concepts were remembered and transferred to the criterion figures on the post-posttest. In fact, on the post-posttest criterion figures, the control group actually received a lower mean score than on the posttest criterion drawings. (See Table 12, page 42, and Table 20, page 47.) This fact raises one last question.

Can one account for the comparability of the adjusted scores of the control group on the posttest criterion figures to those of the experimental group; while on the post-posttest the former's scores on the same figures are lower than the latter's? (See Table 10, page 41, and Table 18, page 46.) Perhaps most compelling is the conjecture that the control group members learned from the pretest. Such learning may have been reflected in their posttest scores. The amount and intensity of the learning may have been low, and, since no overlearning or practice was involved, the memory traces did not resist forgetting. As a result, a drop in scores was observed on the post-posttest criterion figures. It will be recalled that Campbell and Stanley consider the interaction of the testing with the experimental variable as a weakness in the research design used in the present study (14). As stated above, there were seemingly valid reasons why it was thought that such an interaction would not occur in the present study; however, from the results of the analyses, such an interaction, indeed, may have occurred.

Another possible interpretation, of course, is the ever-present factor of contamination among treatments, even though preventive measures are taken. When large numbers of people are involved, however, one would hope that such contamination would be randomized over all groups. In the current experiment, the directors of the schools and some of the parents knew the objectives and methods of the program. (See Appendix C-4.) This fact could have covertly influenced the school program during the time of the experiment when it was clearly evident that a learning program was being conducted by an outside group and that many schools would be compared. After the treatment sessions had been concluded, the special attention (if any) afforded to the objectives of the experiment could have subsided since the experimenters were no longer present as a reminder of the study. There could also have been contamination on the part of the experimenters, even though training sessions were provided and the differences between the programs were delineated. Moreover, the control group members may have realized that they were receiving special attention and thus tried harder on the posttest (Hawthorne effect). But of these ostensible explanations for the higher scores of the control group on the posttest criterion figures as compared with their lower scores on the post-posttest criterion figures, the most convincing seems to be the one purporting learning from the pretest.

In summary, it seems reasonable to attribute the increased post-posttest criterion scores of the experimental group to the effects of the learning program and the learning processes.

Other Findings

Sex Differences

As must be obvious, there was no significant evidence of differences between the sexes. Table 29 presents the means and the standard deviations of the boys and the girls, irrespective of groups. If differences in perception do occur between boys and girls between the ages of three and one-half and four in relation to the learning of perceptual concepts--the critical elements of shape--they were not apparent in this study.

TABLE 29

MEANS AND STANDARD DEVIATIONS FOR PRETEST, POSTTEST, AND POST-POSTTEST ACCORDING TO SEX

		Training		Criterion		Combined	
		$\bar{Y}$	SD	$\bar{Y}$	SD	$\bar{Y}$	SD
Pretest	Boys	20.87	5.67	18.73	5.47	39.60	10.22
	Girls	21.93	5.70	20.11	5.52	42.04	9.94
Posttest	Boys	23.70	7.20	21.13	6.44	44.83	12.75
	Girls	23.96	8.12	21.61	5.94	45.57	13.27
Post-Posttest	Boys	25.27	7.25	21.17	5.76	46.43	11.76
	Girls	26.57	8.02	21.86	6.56	48.43	13.25

Social Class Considerations

When attempting to isolate degree of competence and social class, it was found that because of the large number of subjects who were eliminated from the study, only two children from the lower class remained in the experimental group. Their scores seemed to exert a spurious effect upon the total results, making an interpretation untenable. Appendix A-1 lists the social class of each participant in the experiment.

Motor Ability

Motor scores were significant at the .05 level only in the analyses of the posttest training scores. In every other analysis, when the usual covariates were entered, motor ability had no further effect upon the dependent variable. Since the training figures were the easiest figures to draw, the fact that those subjects with high motor ability achieved high scores on the training figures does not seem surprising, especially if familiarity with the figures from the school situation was an influencing factor. This result may also reflect the fact that according to Bender and Koppitz, perception and motor skill, while developing concomitantly, progress at uneven rates (9, 42).

IQ

This factor was significant as a covariate only in the analysis of the posttest--post-posttest gain scores on the criterion figures. Those subjects with the highest IQ scores tended to gain more points on the criterion figures of the post-posttest, the most difficult of the tests administered, perhaps, because it demanded the greatest amount of learning and the greatest number of processes in the learning procedure.

In summary, the variables of sex, IQ, and motor ability did not make a significant difference in the overall performance of the children in this study. The best predictor of scores on the Geometric Figures Test was the pretest training score, which was a significant covariate in every analysis except in the posttest--post-posttest gains scores analyses. Thus, after entering the pretest training scores, the other covariates were generally not significant in relation to the dependent variable.

Figure Analysis

An analysis of figure difficulty revealed, in general, that the figures with vertical and horizontal lines and ninety degree angles were easier to perceive and draw accurately than were the figures with oblique lines and non-ninety degree angles. The vertical cross received the highest score in each presentation of the Geometric Figures Test; while the vertical and horizontal diamonds, the series of diagonal lines, and the diagonal cross fell among the five figures receiving the lowest scores in each presentation for both the experimental and control groups. The equilateral triangle occurred among the five lowest scoring figures for both groups on the pretest, but on the posttest and the post-posttest, it occurred among the top five figures for the control group and among the bottom five figures for the experimental group, although the mean scores for each group were similar. The partial diagonal cross, containing a ninety degree angle, occurred among the upper five drawings in every presentation for both groups. Table 30 presents the means, standard deviations, and the standard errors of the means for each figure on the post-posttest.

TABLE 30

MEANS, STANDARD DEVIATIONS, AND STANDARD ERRORS OF THE MEANS FOR TEN GEOMETRIC FIGURES ON POST-POSTTEST*

	Experimental Group				Control Group		
Training Figures	$\bar{Y}$	SD	SE	Training Figures	$\bar{Y}$	SD	SE
6	7.12	2.57	.50	6	6.94	2.18	.39
4	5.62	2.02	.40	4	4.94	2.23	.39
7	4.88	2.27	.45	9	4.78	2.15	.38
9	4.65	2.23	.44	7	4.56	2.09	.37
10	4.15	2.20	.43	10	4.25	2.05	.36
Total	26.42	7.85	1.54	Total	25.47	7.47	1.32
Criterion Figures				Criterion Figures			
1	5.77	2.20	.43	2	5.00	1.80	.32
2	5.31	2.20	.43	1	4.69	2.63	.46
8	4.08	2.02	.40	5	3.78	1.72	.30
3	4.04	2.32	.45	3	3.69	1.53	.27
5	3.46	1.53	.30	8	3.41	1.24	.22
Total	22.65	6.42	1.26	Total	20.56	5.79	1.02
Grand Total	49.08	13.29	2.61	Grand Total	46.03	11.72	2.07

*Based on summed scores of two raters; highest possible score = 10

CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purposes of the present study were the determination of whether children between the approximate ages of three and one-half to four years could learn to perceive the critical elements of shape through a learning program in perceptual-motor activity; whether they would transfer such perceptual learning to similar tasks; and whether they could resist the process of forgetting.

Review of the Study

An interdisciplinary approach composed of research in early childhood development, neurology, and psychology was brought to bear upon the problem of the ability of children to learn to perceive visually. Findings from these fields were interrelated into a unified pattern from which the hypotheses and experimental treatment were germinated. The results were intended to be applied to art education.

The theory of early learning which postulates the necessity of establishing within the cortex of the brain many elementary nervous connections before more advanced associations (learning) can be generated formed the basis of the problem. In translating this theory into a learning program, the problem became one of determining the essential and elementary features of a complex task, the visual perception of shape, which could be used as the foundation for more advanced learning. Basic and applied research indicated that the elements of line, parallel lines, and angle are important features in shape perception, but that these elements are learned slowly and serially through a discrimination process involving a motor component and a great deal of practice. Tactile perception, including tactile stimulation, tracing, and manipulation, was discovered also to be an important precursor for the growth of visual perception.

A close relation between the nature of concept formation and attainment and perceptual learning was found to exist, with perceptual learning forming the foundation for the cognitive learning of concepts. This is compatible with the fact that perception, a method of knowing, is by definition subsumed under the generic term, cognition, which includes the many approaches to knowing, such as concept development. The interrelations of these ways of knowing are now recognized by psychologists and learning theorists. Hebb has stated that since percept and concept are closely related, the term conceptual development can be used to depict either (34).

Developmental studies indicated that children between three and seven years of age only gradually perfect their ability to draw geometric figures. Evidence from other fields of endeavor, however, supported the fact that perception is not only inherent but learned. Motor skill, per se, does not completely account for the observed lack of drawing ability, but an undifferentiated visual perceptual system contributes to the inability. Thus, a program in perceptual-motor learning was designed and presented to preschool children.

Procedures

Fifty-eight children from fourteen preschools in San Francisco and Daly City, California, were randomly assigned to an experimental group and a control group. Through a series of individual lessons, the experimental subjects received a perceptual learning program based on the essential elements of shape, namely, straight line, parallel lines, and angle. These were presented through the medium of perceptual-motor activity, which consisted of tactile stimulation, tactual tracing, and manipulation. The control group received indirect perceptual training, composed of puzzles and matching games, none of which contained geometric shapes similar to those used in the experimental program.

Each member of the two groups worked individually during the entire program with one of the four participating experimenters, who was assigned an equal number of subjects from each group. The fourteen lessons for each group were equal in time, ranging between ten and fifteen minutes. The learning program encompassed six weeks, with an additional twelve days devoted to testing.

Prior to the beginning of the treatment, each subject took the Marianne Frostig Eye-Motor Test, the Goodenough-Harris Draw-a-Man Test and the Geometric Figures Test (the pretest). At the end of the training, each group member took the posttest; and four weeks later, the post-posttest, both of which were distributions of the Geometric Figures Test. The standardized tests were scored according to their appropriate manuals; while the results of the Geometric Figures Test were independently rated by two trained judges. The correlations between the judges' scores on each of the ten geometric figures ranged from .85 through .97.

Analysis of the Data

The pretest, posttest, and post-posttest (the Geometric Figures Test) were identical except for order of presentation. Each test was composed of two sets of geometric figures randomly assigned within three distributions. Scores from these two sets were examined in the analyses of covariance which were performed to test three hypotheses at the .05 level of significance. *t*-tests were used to determine whether the experimental group received significantly higher scores on the posttest and post-posttest as compared with the control group. The covariates considered in the analyses were age, IQ scores, motor scores, pretest training, and pretest criterion scores. When school was used as a classification variable, sex was entered as a covariate. Those covariates which were significant at the .05 level were entered into each analysis and are indicated in the descriptions below.

Results of Hypothesis I

> Training in visual perception which emphasizes perceptual-motor activity increases the ability of preschool children to copy accurately geometric line drawings. Thus, the subjects in the experimental group (trained) will achieve higher scores than the subjects in the control group (untrained) on that part of the posttest which requires the copying of the geometric figures presented in the training program.

Two statistical tests were conducted in relation to Hypothesis I. To test whether the experimental subjects received higher scores on the posttest training figures than the control group, a two-way analysis of variance by treatment and sex was run with pretest training and motor scores entered as covariates. The *t*-test showed no difference at the required level of significance between the two groups on the training figures.

The second test, a two-by-two analysis of covariance using treatment and school as classification variables and pretest training and motor scores as covariates, produced only a .10 level of significance between groups. The null hypothesis was accepted since the experimental hypothesis was not supported.

Results of Hypothesis II

> Learning as a result of a training program in visual perception emphasizing perceptual-motor activity transfers to the criterion figures (those which are similar to, but not identical with, the figures in the training program). Thus, the subjects in the experimental group will achieve higher scores than the subjects in the control group on that part of the posttest which requires the copying of the criterion figures.

Hypothesis II did not reach the .05 level of significance when tested by a two-way analysis of variance with covariance adjustments by pretest training and pretest criterion scores. Because the research hypothesis was not supported, the null hypothesis was accepted.

Results of Hypothesis III

Learning as a result of a program in perceptual-motor activity resists the process of forgetting.

A. The subjects in the experimental group will achieve higher scores than the subjects in the control group on that part of the post-posttest which requires the copying of the training figures.

B. The subjects in the experimental group will achieve higher scores than the subjects in the control group on that part of the post-posttest which requires the copying of the criterion figures.

Part A was tested for significance by an analysis of covariance with treatment and sex as classification variables and pretest training and pretest criterion scores as covariates. A t-test did not produce a significant difference between the two groups on the post-posttest training scores. However, with treatment and school as classification variables and pretest training and pretest criterion scores as covariates, the results of an analysis of covariance indicated that t was significant at the .05 level. Thus, the subjects in the experimental group perceived and drew the training figures more accurately than did the control members only when school was entered as a variable; then the experimental group significantly surpassed the control group on the training figures.

In the analysis of Part B, with treatment and sex run as classification variables and pretest training scores as the covariate, the treatment was significant at the .05 level; thus, the experimental subjects received higher scores on the post-posttest criterion figures than did the control group members. It would appear that the first group of subjects had learned basic concepts during the treatment and had transferred them to similar situations.

When treatment and school were entered as the independent variables and pretest training scores as the covariate, school effects were significant at the .05 level; while treatment became significant at the .01 level. Thus, with the effects of schools controlled, the effect of the experimental variable became more significant.

Total gain scores on the post-posttest favored the experimental group at the .01 level of significance; while gain scores on the criterion figures were significant at the .05 level. Gain scores for the experimental group on the training figures of the post-posttest were not significant. Upon the above evidence, Hypothesis III was partially accepted.

Conclusions

The results of the present experiment tend to support the perception-delineation theory of art education in respect to the fact that preschool children can learn to perceive visually more accurately when taught the critical elements of shape through perceptual-motor activity, consisting of tactile stimulation, tactual tracing, and manipulation. The fact that the improvement in perceptual veridicality was observed on the drawings of the criterion figures, some of which are not drawn accurately on developmental schedules until between five and seven years of age, suggests the effectiveness of the treatment. The fact that these results became apparent after a period during which training had been discontinued was explained in terms of the process of concept formation and attainment and/or the process of cognitive consistency.

The evidence resulting from the experiment tends to uphold hand stimulation and activity as a variable important to visual perceptual integration. The results, furthermore, tend to concur with Piaget and Inhelder's theory that perceptual activity is a factor in the development of visual decentrations (movements of the eye from one part of the object to another), as well as Ayre's position on the role of tactile stimulation in the visual perceptual process; but the results add a further dimension--that of learning as the outcome of a directed teaching experience.

With the exception of the post-posttest analysis with school entered as a variable, the training figures were drawn with no more accuracy by the experimental group than by the control group. This result was accounted for by the fact that preschool attendance exposes children in a variety of ways to these common figures.

Differences among schools were revealed, the nature of which was not part of the present investigation; however, it may be postulated that the amount of exposure to the common geometric training figures, such as the square, rectangle, triangle, and cross may have varied from school to school. There may also have been differences among schools in relation to the emphasis placed upon cognitive explorations and learning experiences.

In terms of the overall analyses, neither motor ability, as measured by scores on the Frostig Eye-Motor Test, nor IQ, as measured by scores based upon the Goodenough-Harris Draw-a-Man Test, accounted for the differences between the experimental and control groups after the pretest scores had been entered as a covariate. Age and sex differences were found to be non-significant. The finding on the variable of sex agreed with Frostig's finding on the relationship of visual perception and sex at the kindergarten level. The figure analysis tended to concur with the developmental schedules; for both groups, the vertical cross was the easiest to perceive as measured through drawing and the diamond, the most difficult. Social class differences could not be analysed because of the few subjects remaining in the experiment from among the group of lower class experimental children.

Implications

The perceptual-motor activity of tactile stimulation, tactual tracing, and manipulation together with the factor of time which allows for practice or for the occurrence of a redundancy of stimuli can be structured at the preschool level into a meaningful and understandable program of shape perception. Consideration of this variable should be included in the formation of a curriculum incorporating visual perceptual training.

Teachers adhering to a developmental approach to learning can be assured that the direct teaching of the elements of shape perception through the perceptual-motor activity described can be profitable for children since evidence from the present study indicates that the subjects not only learned but also remembered the material presented in the training program. Furthermore, they were able to use the acquired information in related situations. As an aside, it might be interesting to note that a few parents (of children from different schools) voluntarily told the project director that their children (in the experimental group) looked forward to, or enjoyed, the lessons and even used the terminology, such as equilateral triangle at home.

When considering art education and perceptual training as described in this study, it may be convenient for teachers to think of perceptual training as a continuous part of the total art experience, yet as an independent part demanding special attention and a separate time period. It cannot be concluded from the present study that children should spend time in art laboriously drawing accurate geometric shapes. It must be emphasized, instead, that simple geometric shapes contain the elementary or critical features apparently necessary for the accurate perception of shape. Perceptual training assists the eye and brain in organizing one's immediate environment; through training the child learns the cues to which he must attend if he is to comprehend and interpret adequately the patterns or images impinging upon the retina. It follows that the results of the training procedures should be directly applicable to art production. Thus, if a child has learned that the basic cues of a shape are straight line, parallel lines, and angle, he should be able to comprehend and interpret shapes having these cue properties more veridically. He should be able to use this knowledge when delineating imaginatively, creatively, realistically, or naturalistically the mode of expression is immaterial. Whether he would transfer this knowledge to art expressions depends in part upon whether the instructor teaches specifically for transfer, since transfer occurs more readily when concepts and generalizations in one area are made directly applicable to another area (46). Whether a child would desire to transfer or use such knowledge in art expressions is a personal decision relative to the aims of the art product.

Since the analysis of figure difficulty indicated the diamond to be the most difficult, teachers at the preschool level might follow training in vertical and horizontal line perception and ninety degree angle perception with training on oblique lines and non-ninety degree angles. This sequence concurs with that observed by developmentalists, such as Arnheim (2) and Schaefer-Simmern (61) but avoids the long delay of waiting for the child to reach the stage at which he independently discovers the diagonal. It, furthermore, insures that the child will be provided with the background experiences necessary for discovery and for the understanding of his perceptual responses.

Recommendations

It was recognized during the course of the present study that a more controlled and uniform learning environment would have been desirable, yet such an environment even though centrally located would have precluded the use of a large sample. For preschool investigations of the effects of variables upon learning which do not require classroom interactions, laboratory conditions are recommended provided an adequate sample size can be procured.

It is further suggested for future studies that tactile stimulation be more adequately controlled. Because of the nature of the tactile stimulation provided for the subjects in the present experiment, it could not be determined whether each subject received equal or sufficient amounts of it. Although individual thresholds and tolerances undoubtedly exist, one might consider such devices as an electric vibrating plate with a timing unit to insure a greater amount of control.

Allowances for individual learning differences should be considered. In the present experiment, this would, of course, have necessitated a different research design and would have been, in effect, a different study, but such an approach, requiring long range commitments of personnel presenting basic material within a flexible program could, perhaps, reach children at different levels than were possible in the present study. Videotaping and reviewing of the lessons taught might provide information about individual differences which could then be incorporated into future lessons.

Another study might seek to determine whether perceptual training on the critical elements of shape aids in the remembering of shape after the stimulus has been removed. Such remembering has implications for all areas of art.

A study should investigate the utilization of the critical elements of shape in the creative and self-expressive two-dimensional products of preschool children who have participated in a perceptual-motor learning program. Questions pertaining to transfer and to degree of awareness of shape in drawings might be answered.

If simple transfer occurs in relation to visual perceptual learning of the type herein described, then more complex types of transfer might be studied, such as the transfer of perceptual concepts of shape to the making of aesthetic discriminations.

Preschool curricula might include more structured and cognitive programs based upon guidelines developed by members of the various schools. Such programs should most likely attempt to attain some uniformity of content across learning modalities.

Parents should become more informed and knowledgeable about the importance of early perceptual and cognitive learning and actively work for and support the establishment of such preschool programs. In some preschools this is already a fact, but the large drop-out rate of children in the present study indicates that much work in this area of parental education still needs to be accomplished. If the concept of early perceptual and cognitive learning is accepted, then preschool training in these areas becomes important to the total education of children.

APPENDIXES

APPENDIX A-1

AGE, IQ SCORE, MOTOR SCORE, AND SOCIAL CLASS OF EACH SUBJECT ACCORDING TO SEX AND GROUP

Subject	IQ Score	Motor Score	Age (month;year)	Social Class*
Experimental boys				
1	73	0	3;5	4
2	122	5	3;6	2
3	73	0	3;11	2
4	127	4	3;3	8
5	68	0	3;7	1
6	122	1	3;9	4
7	122	0	3;6	4
8	73	5	3;6	4
9	77	2	3;7	1
10	100	4	3;9	2
11	95	3	3;7	4
12	82	0	3;11	2
13	91	2	3;8	2
14	73	0	3;6	2
Experimental girls				
15	100	4	3;10	4
16	130	0	3;5	6
17	91	2	3;6	2
18	70	2	3;5	2
19	140	4	3;9	2
20	83	3	3;6	4
21	87	2	3;9	2
22	121	3	3;3	4
23	100	0	3;4	4
24	100	0	3;4	2
25	108	4	3;7	3
26	100	0	3;7	1

*Categories are based on Centers' Occupational Index. (See Table 1, page 22.)

APPENDIX A-1 (Continued)

Subject	IQ Score	Motor Score	Age (month;year)	Social Class*
Control boys				
27	77	0	3;5	4
28	73	0	3;8	4
29	95	0	3;7	6
30	91	2	3;5	4
31	73	3	3;4	11
32	104	3	3;6	6
33	82	0	3;11	6
34	113	2	3;10	4
35	73	5	3;11	6
36	91	2	3;10	2
37	95	4	3;4	6
38	100	0	3;10	2
39	100	3	3;10	10
40	118	0	3;8	2
41	86	2	3;3	4
42	82	2	3;5	6
Control girls				
43	96	0	3;10	2
44	108	4	3;9	4
45	70	4	3;7	6
46	121	4	3;3	6
47	108	4	3;8	4
48	70	1	3;11	11
49	100	2	3;8	9
50	91	2	3;8	4
51	100	2	3;5	3
52	87	2	3;8	2
53	83	4	3;5	10
54	66	2	3;11	4
55	70	4	3;11	4
56	134	4	3;9	4
57	96	4	3;6	2
58	66	2	3;10	2

*Categories are based on Centers' Occupational Index. (See Table 1, page 22.)

APPENDIX A-2

GEOMETRIC FIGURES TEST SUMMARY SCORES OF EACH SUBJECT ACCORDING TO SEX AND GROUP

	Pretest*			Posttest*			Post-Posttest*		
Subject	Training	Criterion	Total	Training	Criterion	Total	Training	Criterion	Total
Experimental boys									
1	10	12	22	15	11	26	23	21	44
2	23	24	47	29	26	55	34	22	56
3	15	17	32	14	17	31	22	18	40
4	30	27	57	43	31	74	39	35	74
5	14	16	30	16	16	32	14	12	26
6	22	22	44	22	24	46	35	22	57
7	27	22	49	32	29	61	34	28	62
8	10	10	20	10	10	20	10	12	22
9	20	14	34	27	25	52	31	26	57
10	28	20	48	28	28	56	28	26	54
11	19	14	33	24	21	45	25	18	43
12	14	10	24	16	10	26	16	23	39
13	21	23	44	24	26	50	32	28	60
14	15	14	29	14	14	28	12	12	24
Experimental girls									
15	24	25	49	38	28	66	37	35	72
16	29	17	46	27	24	51	28	35	63
17	19	23	42	26	23	49	27	25	52
18	19	14	33	19	21	40	18	24	42
19	32	23	55	35	20	55	28	21	49
20	22	19	41	23	23	46	35	20	55

*All scores represent the sum of the scores of the two raters.

APPENDIX A-2 (Continued)

	Pretest*			Posttest*			Post-Posttest*		
Subject	Training	Criterion	Total	Training	Criterion	Total	Training	Criterion	Total
Experimental girls (cont'd)									
21	22	19	41	21	25	46	31	23	54
22	25	27	52	25	19	44	31	24	55
23	23	21	44	27	22	49	28	24	52
24	19	16	35	16	12	28	19	14	33
25	24	21	45	26	16	42	26	21	47
26	24	27	51	16	23	39	24	20	44
Control boys									
27	21	11	32	19	10	29	16	14	30
28	14	15	29	25	24	49	20	24	44
29	20	19	39	19	22	41	23	21	44
30	28	22	50	29	24	53	32	20	52
31	22	19	41	28	22	50	24	14	38
32	30	23	53	28	27	55	28	22	50
33	18	10	28	18	10	28	20	20	40
34	24	17	41	25	16	41	28	18	46
35	20	22	42	29	26	55	26	16	42
36	26	20	46	23	23	46	28	22	50
37	16	23	39	19	25	44	25	22	47
38	19	25	44	19	27	46	24	16	40
39	24	18	42	24	18	42	22	21	43
40	22	16	38	24	23	47	25	31	56
41	25	27	52	35	29	64	25	30	55
42	29	30	59	33	20	53	37	21	58

*All scores represent the sum of the scores of the two raters.

APPENDIX A-2 (Continued)

Subject	Pretest* Training	Pretest* Criterion	Pretest* Total	Posttest* Training	Posttest* Criterion	Posttest* Total	Post-Posttest* Training	Post-Posttest* Criterion	Post-Posttest* Total
Control girls									
43	17	12	29	15	18	33	21	24	45
44	20	18	38	21	24	45	22	24	46
45	25	26	51	29	27	56	35	26	61
46	36	23	59	43	34	77	45	33	78
47	21	23	44	26	22	48	29	30	59
48	10	10	20	10	10	20	10	10	20
49	16	23	39	19	16	35	24	20	44
50	24	24	48	33	26	59	28	21	49
51	20	28	48	18	26	44	24	13	37
52	20	13	33	19	16	35	17	21	38
53	20	16	36	29	28	57	35	18	53
54	10	10	20	10	10	20	10	10	20
55	24	18	42	24	21	45	28	14	42
56	28	20	48	36	32	68	38	27	65
57	26	31	57	24	23	47	26	18	44
58	15	16	31	16	16	32	20	17	37

*All scores represent the sum of the scores of the two raters.

APPENDIX A-3

MEANS AND STANDARD DEVIATIONS OF TOTAL SCORES FOR COMBINED GROUPS ON PRETEST, POSTTEST, AND POST-POSTTEST ACCORDING TO EXPERIMENTER AND SCHOOL

Experimenter	School	Pretest		Posttest		Post-Posttest	
		Y̅	SD	Y̅	SD	Y̅	SD
I	3	45.25	12.50	60.00	14.02	63.25	15.09
	4	42.00	8.12	45.00	11.20	48.00	7.30
	7	40.25	7.50	45.25	11.50	43.25	11.76
	8	44.67	3.06	48.33	5.86	45.33	10.41
II	10	38.00	5.29	51.67	5.51	50.00	8.89
	11	42.00	3.67	47.40	5.18	52.40	5.32
	13	43.40	11.45	45.80	14.65	47.20	13.02
III	1	33.50	6.36	39.00	8.49	45.50	.71
	2	35.00	14.73	37.00	16.52	45.00	15.52
	6	44.60	11.55	48.60	18.04	54.20	14.08
	12	35.00	16.09	36.33	14.15	39.33	17.79
IV	5	30.50	14.85	35.00	21.21	29.00	12.73
	9	39.29	11.81	43.00	13.42	44.29	12.37
	14	42.33	10.26	37.67	5.13	42.67	5.13

APPENDIX B-1

SCHEDULE OF LESSON PRESENTATIONS FOR EXPERIMENTAL AND CONTROL GROUPS

(March 28--May 5, 1967)

Date	Lessons	Schools Assigned to Group I*			
		Experimental Group		Control Group	
		Boys	Girls	Boys	Girls
March 27 (M)					
28 (T)					
29 (W)	1	b**	a	d	c
30 (Th)					
31 (F)	2	c	d	a	b
April 3	3	a	b	c	d
4					
5	4	d	c	b	a
6					
7	5	b	a	d	c
10	6	c	d	a	b
11					
12					
13					
14	7	a	b	c	d
17	8	d	c	b	a
18					
19	9	b	a	d	c
20					
21	10	c	d	a	b
24	11	a	b	c	d
25					
26	12	d	c	b	a
27					
28					
May 1					
2					
3	13	b	a	d	c
4					
5	14	c	d	a	b

*Schools assigned to Group I: 1, 7, 8, 9, 10, 11, 12, 14 (Monday-Wednesday-Friday); Group II: 2, 3, 4, 5, 6, 13 (Daily).

**Letters indicate order in which each subgroup was treated.

APPENDIX B-1 (Continued)

Date	Lessons	Schools Assigned to Group II*			
		Experimental Group		Control Group	
		Boys	Girls	Boys	Girls
March 27 (M)					
28 (T)	1	b**	a	d	c
29 (W)					
30 (Th)	2	c	d	a	b
31 (F)					
April 3					
4	3	a	b	c	d
5					
6	4	d	c	b	a
7					
10					
11	5	b	a	d	c
12	6	c	d	a	b
13	7	a	b	c	d
14					
17					
18	8	d	c	b	a
19					
20	9	b	a	d	c
21					
24					
25	10	c	d	a	b
26					
27	11	a	b	c	d
28					
May 1	12	d	c	b	a
2	13	b	a	d	c
3					
4	14	c	d	a	b
5					

*Schools assigned to Group I: 1, 7, 8, 9, 10, 11, 12, 14 (Monday-Wednesday-Friday); Group II: 2, 3, 4, 5, 6, 13 (Daily).

**Letters indicate order in which each subgroup was treated.

APPENDIX B-2

PROGRAM SCHEDULE FOR CONTROL GROUP ACCORDING TO EXPERIMENTERS, SCHOOLS, AND ACTIVITIES

Experimenters	Schools	Lessons 1	2	3	4	5	6	7	8	9	10	11	12	13	14
I	3, 4 / 7, 8	KK	P	P	P	B	P	P	D / P	D	P / D	BP / L	B	B	L / BP
II	10, 11 / 13	B	P	P	P	P	KK	P	P	B	B	L / BP	D	BP / L	D
III	1, 12 / 2, 6	B	P	P	P	KK	P	P	P	B	B	L / BP	D	BP / L	D
IV	5 / 9, 14	KK	P	P	P	B	P	P	P	D	D	BP / L	B	B	L / BP

Legend:

B Blockhead
BP Bouncing putty
D Picture dominoes
KK Kiddie kards
L Lotto
P Puzzles

APPENDIX B-3

SCHEDULE FOR TEST ADMINISTRATORS

Test Administrators	Schools		
	Pretest	Posttest	Post-Posttest
I	2, 12, 13*	1, 5, 10, 11	3, 7, 14
II	4, 5, 8, 10, 11	6, 9, 14	13**
III	3, 6, 7, 9	2, 12, 13	1, 4, 5, 8, 10, 11
IV	1, 13, 14, 5*, 12*	3, 4, 7, 8	2, 6, 9, 12

*Included only those subjects who missed first session.
**Testing accomplished by a trained substitute.

APPENDIX C-1

GENERAL INSTRUCTIONS FOR TEST ADMINISTRATORS

Approaching the School Situation

1. Introduce yourself to the director of the school. Present to her a copy of the list of names of the children to be tested.

2. Be as unobtrusive as possible in the school. Try not to disrupt the program more than is absolutely necessary.

3. Remember that all information collected on the subjects is confidential. Please do not discuss it with anyone except the project director.

4. Do not discuss the tests or the experiment with the directors, teachers, or parents. Any questions by adults should be referred to the project director. If a child asks why he is being called into the testing room, say, "I want you to play some games and to draw for me." If you are in a position to discourage the children from talking among themselves about the tests, do so.

Approaching the Testing Situation

1. Because you are in a testing situation, it is imperative that conditions remain uniform; therefore, memorize the test instructions and follow the directions implicitly.

2. Administer the Geometric Figures Test first. Follow this by a rest period during which the child stands up, stretches his arms above his head, and shakes his hands. Then present the Frostig Eye-Motor Coordination Test, followed by the Goodenough-Harris Draw-a-Man Test.

3. Test in sequence, when possible, the children whose names are typewritten on your list. Replace each unavailable child with an alternate from your list of handwritten names, beginning with the first name and continuing in sequence. Place a check mark by the name of each child when he is tested.

4. When an alternate is selected, inform the director or teacher; she will assist in locating him. She should also indicate the change on her list of names.

5. Be absolutely certain that you are testing the child whose name appears on the test packet (envelope). Change the name on the test packet when an alternate replaces the original child.

6. Place every protocol in the child's envelope before he leaves the testing room. Fasten the envelope securely.

7. Have extra supplies, such as sharp pencils and crayons and paper available. Keep all supplies and test packets separate from the materials immediately being utilized with an individual child.

8. Do not use defective equipment. Return all such equipment immediately to the project director for replacement. Erase any pencil marks or smudges which get on the models.

9. Contact the project director at the end of each day.

Approaching the Subject

1. Address the child in a friendly manner. Tell him you would like him to play some games and do some drawing for you. Carry your enticement toys in a concealed place ready for use.

2. If a child is reluctant to enter the testing room, enticement may be necessary. It may involve the use of the hand-puppets or bouncing toys or any technique which will not adversely influence the administration of the tests. The aid of the teacher may be useful.

3. If a child firmly refuses to participate, temporarily skip him, but return to him later. Exhaust every possible means of allurement; however, do not force a child against his will. A child who refuses twice should not be approached a third time. He may be approached on a subsequent day. Record the child's name and any discernible reason for his refusal.

4. Escort the child to the table in the testing room. Seat him in a position facing away from any influence which might be distracting.

5. Make sure the light is plentiful, especially in the working area. If the child is seated near a window, and if it is possible, place him in such a way that the light is directed over his left shoulder. Do not seat a child directly in front of a window.

6. Praise the child and his work. Since each child will respond differently to praise and reinforcement, use your judgment in regard to timing and amount.

GOOD LUCK!

APPENDIX C-2

GENERAL INSTRUCTIONS FOR EXPERIMENTERS

Approaching the Experimental Situation

1. The experimenters will administer two programs, one to Group E (Experimental), and the other to Group C (Control). Following the exact directions for both programs is vital to the success of the experiment.

2. During a training unit, which consists of two days, each experimenter will visit approximately four schools and work with approximately 24 subjects. Before each unit begins, there will be a brief training session for experimenters to insure that uniform conditions prevail within the experimental situation.

3. Group E will receive fourteen lessons of approximately twelve minutes of individual instruction, the purpose being to improve the subject's visual perception of two-dimensional, geometric shapes. The elements of straight line, angle, and parallel lines will be taught through perceptual-motor activity, consisting of tactile stimulation, tactual tracing, and manipulation (construction). Lesson plans will be provided for each session.

4. Group C will play games requiring the matching of pictures and will work puzzles. The members of this group will receive no directed learning experiences in visual perception, *per se*. They will receive, however, the same number of individual lessons of the same time duration as will the members of Group E.

Approaching the School Situation

1. Be as unobtrusive as possible in the schools. Try not to disrupt the program more than is necessary.

2. Introduce yourself to the director, who in turn will most likely introduce you to the teachers of the children with whom you will be working.

3. Remember that all information about the subjects is confidential.

4. Refrain from discussing the experiment with directors, teachers, parents, or friends. It is important to control sources which might influence the children's responses, thus, contaminating the experimental results. Refer all questions to the project director.

5. Do not discuss the experiment with the children who are participating or with any other children in the schools. Tell the participating children only that which is pertinent to their respective programs. If a child asks why he is not being called into the treatment room, tell him, "It is __________(child's name) turn now."

6. Discourage children from talking among themselves about the learning program if you happen to hear such conversations.

7. Do not allow adults or other children to observe the treatment. Their presence in the treatment room might influence the subject's reactions. If you are teaching in an open room containing other adults and children, seat the subject facing away from the distraction and discourage onlookers.

Approaching the Teaching Situation

1. Approach the child in a friendly way. Attempt to gain his confidence. If he is in Group E tell him you would like him to do something for you. Say, "______, will you come with me? I want you to do something for me." If he asks what you want him to do, say, "I'll show you. Come with me." When in the treatment room, if he asks what he is to do, you may say, "You're going to learn about ____________ (element or shape on the agenda for the day). If the child is in Group C, he should be approached in the same way. When in the treatment room, the experimenter may say, "I want you to play some games with me," or "I want you to work some puzzles."

2. If a child is reluctant to enter the treatment room, enticement may be necessary. It may involve the use of the puppets or bouncing toys or any technique which will not directly influence the administration of the treatment. The aid of the teacher may be useful.

3. Escort the child to the table in the treatment room. Seat him in a position facing away from any influence which might be distracting.

4. If a child firmly refuses to participate, temporarily skip him, but return to him later. Exhaust every possible means of allurement; however, do not force a child against his will. A child who refuses twice in one day will not be treated on that day. He will simply miss one lesson and will resume the program with the next lesson.

5. Record the number of missed treatments on the form supplied for that purpose. Indicate, according to the directions, whether the child was absent or refused to participate.

6. Make sure the light is plentiful, especially in the working area. If the child is seated near a window, have the light come over his non-dominant shoulder if possible; if not possible, have it directed over his dominant shoulder. Avoid placing a child in front of a window so that the light shines directly into his eyes.

7. During the treatment, if the child's attention should happen to stray from the learning experience, try to redirect it immediately. Do not engage in extraneous conversation unless absolutely necessary for purposes of motivation or rapport. At the earliest possible moment, return to the lesson.

8. Reinforcement consists of such words and phrases as "good," "very good," "fine," "very fine," or "excellent." Base your reinforcement upon the quality of the performance, but don't hesitate to praise the child for his responses. Each child will respond differently to praise. Use your judgment.

9. If the child becomes discouraged or restless, say, "You did the last one so well;" or "Try;" or "You have been working (playing) so hard (well). Can you do this like you did the others?" Any similar statement which is appropriate to the situation can be used. Sometimes it might be appropriate to say, "Show me how fast you can do it."

APPENDIX C-3

MEMORANDUM

TO: Nursery School Directors and Teachers

FROM: Ruthan Kannegieter, Visual Perception Project Director

DATE: March 8, 1967

1. The test administrators will begin giving the pretest on Monday, March 13, 1967. They will come to your school on either Monday or Tuesday. If there are any participating children who cannot be seen for one reason or another, they will be seen on Wednesday, March 15, 1967.

2. The test administrator will bring you a list of the names of the children who will participate. I'm sorry that I cannot be more specific at this time about the names of the children and the day and hour during which the test administrator will arrive, but, due to factors beyond my control, this information is not yet available.

3. It would be most desirable if the children were not told in advance about the test or the learning program. The less attention directed toward the learning program, including the tests, the better. It would be most helpful if you could also advise the parents not to discuss the program with the children. If the children are observed talking about it, any form of distraction by the teacher would be recommended. The reason for this de-emphasis is the fact that we do not wish the participating children to feel that they are getting special attention. Such an attitude could influence the results of the study. The test administrators are being directed to ask each child if he will play some games and do some drawing.

4. The learning program will begin on Monday, March 27, 1967. I will be able to send you a program schedule during the week of Easter vacation.

5. The only equipment the test administrators and experimenters will need is a table and two chairs located in a separate room or quiet area. I believe I discussed with each director the working arrangements. The test administrators will be advised of these arrangements.

6. From time to time throughout the program, I will contact you. If any problems develop, or if you have any questions in the interim, please contact me at....

APPENDIX C-4

STATEMENT PREPARED FOR DIRECTORS AND PARENTS

(Many of the directors were concerned about the nature and conditions of the experiment. Because of requests for written material which could be utilized within the school and also disseminated to the parents, the following statement was prepared.)

The proposed learning program is a study in visual perception. The contention is made that preschool children between three years, three months, and four years of age can learn to perceive accurately as the result of a training program involving perceptual-motor activity. Such activity would consist of tactile stimulation, tactual tracing, and manipulation (construction) of geometric, two-dimensional shapes. The children would learn concepts about angles, straight lines, and parallel lines. A second group would receive indirect perceptual training, consisting of matching shapes and working puzzles. Each child would be seen by one experimenter fourteen times for approximately ten minutes a session. A pretest, posttest, and post-posttest would be administered in addition.

Until recently, very little attention has been accorded to visual perception by educators. Children seemed to develop perceptual techniques "on their own." It is currently believed that visual perception is a learned as well as developmental process. If indeed this is the case, then the techniques of visual perception could profitably be taught to children. If children are left to their own devices, some may never learn to perceive adequately and may become "perceptual illiterates."

The present study endeavors to determine the type of training which may be beneficial at an early age. The results will be utilized in curriculum planning.

It would be most desirable if parents and teachers did not discuss the training with the children since such discussions may influence the results of the experiment. Discussion after the termination of the experiment is perfectly acceptable. Each director will be provided with a complete report of the study.

APPENDIX D-1

HANDEDNESS TEST

Directions for Administration

1. This test accompanies the three main tests. Instruct the subject to put his pencil down after completing each item on each test; then observe the hand with which the child picks up the pencil. Keep count of hand preference on the Handedness Test card.

2. The response to each item on the Geometric Figures Test and the Frostig Test and the first response on the Goodenough-Harris Test will be recorded.

a. For the first response, an X is placed in row 1, column R if the child picks up the pencil with his right hand and completes the response with this hand.

b. An X is placed in row 1, column L if he picks up the pencil and completes the response with his left hand.

c. An arrow is drawn from right to left in the middle of row 1 if the child picks up the pencil with his right hand and then transfers it to his left hand before beginning to draw.

d. An arrow is drawn from left to right in the middle of row 1 if he picks up the pencil with his left hand and transfers it to his right hand before drawing.

e. An X is marked in row 1 under both columns R and L if the child changes hands after the drawing has been started, thus using both hands to execute the final product.

f. Categories c and e and categories d and e could be combined for some subjects.

g. The above pattern of notation is utilized for subsequent responses.

APPENDIX D-2

THE GEOMETRIC FIGURES TEST MANUAL

Directions for Administration

1. The models are presented in sequence beginning with number one and continuing through number ten. The numbers are found on the back of the model in the upper right-hand corner.

2. Directly in front of the subject, place the white, rectangular steelboard in the vertical position. Toward the upper center of the board and parallel to its edges, place the model, and directly below place a sheet of paper on the back of which has been recorded in the upper right-hand corner the number of the model.

3. Between the model and the sheet of paper, place a sharpened pencil.

4. Say to the child, "I would like you to draw a picture here (point to the sheet of paper) just like this one. (Point to the model.) Do the very best that you can. Make yours look just like this one. (Point to the model.) Put your pencil down when you have drawn the picture."

5. When the second model is presented, say, "Will you draw another picture like this one?" (Point to the model.) When the third model is presented, say, "Now another picture just like this one." (Point to the model.) Follow this procedure for the remaining models.

6. The directions may be repeated for individual items, but do not use any other words or actions.

7. If a child is hesitant, say, "I am sure you can. Make yours look just like this one. (Point to the model.) Try." Reward when the drawing has been accomplished by saying, "You did very well."

8. If a child says, "Is this right?" say, "Make yours just like this one." (Point to the model.)

9. If a child breaks his pencil while drawing, give him another one and another sheet of paper, and ask him to start the drawing over. Say, "Will you try again?" If a child wants another piece of paper because he is dissatisfied with his picture, give it to him. In each case record the second drawing as such.

10. In cases in which the child starts a drawing over on the same sheet of paper, record this fact by numbering the drawings as first, second, third, etc. This action is particularly important when drawings overlap.

11. Reward may be provided by using such terms as "good," fine," "very good," or by saying, "You did very well," or "You did fine."

DIRECTIONS FOR SCORING THE TEST

General Information

The purpose of this test is to determine whether the testee perceived the ten geometric shapes accurately as judged by his drawings.

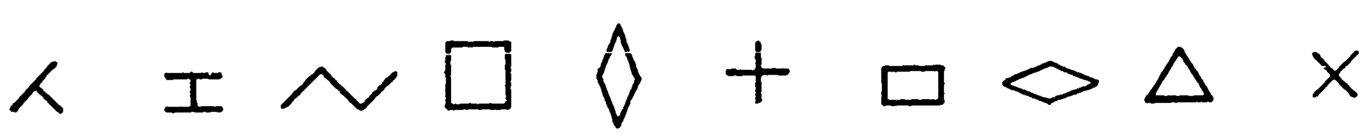
The term figure refers to the subject's drawing. The term model refers to the standard figure presented to the subject to copy. The basic structure of each figure is judged in relation to the basic structure of its specific model primarily by visual inspection. However, in borderline or uncertain cases, measurement is employed. The figures should not be rotated when being judged. They are in the correct position for judging when the model number appears in the upper right corner. If two or more figures were drawn by the subject, the best one should be chosen for scoring.

For each model there are five categories into one of which each figure is to be placed. These categories range from a scribble, valued at one point, to a correctly drawn figure, valued at five points. The appropriate model and examples of drawings for each category will accompany each of the ten groups of figures. The sequence for judging these groups will be randomly assigned. The rater will place each figure in a pile according to its appropriate category, after which the recorder will mark the score on the master scoring sheet.

Scoring Information

Basic Structure

The basic structure of a model refers to the specific arrangement of its lines, angles, spatial divisions, and proportions (excluding size). The more closely a figure resembles the model in these attributes, the more perfect is its structure, and the higher is the score assigned to it. Size, *per se*, is not scored. Figure 1 presents the ten models.



1 2 3 4 5 6 7 8 9 10

Figure 1

Scribble. A scribble is defined as a mass composed of curved and/or straight lines or as a single line or as a series of lines. Ovals with facial features are considered to be scribbles. Figure 2 illustrates some examples of scribbles.

Figure 2

Shape. A shape is described as an outline form composed of two or more related lines or of one continuous line with juxtaposed beginning and ending points. Two or more related lines compose an open shape. A continuous line with juxtaposed beginning and ending points comprises a closed shape which should possess few, if any, interior lines. (Compare a, b, and c of Figure 3.) If a figure is both open and closed, it should be judged in relation to whichever attribute comprises three-fourths of the entire figure. (Compare d and e of Figure 3.) If both attributes are equally distributed, the figure should be scored in relation to the model; thus, if the model is open, the figure should be scored as open, and vice versa. (See Figure 3f.) If a closed figure extends to the edge of the paper, but no pencil line completes the shape, it is considered either a closed or open shape according to the above

a Closed — b Open — c Closed, Borderline: interior lines — d Open

e Closed — f Scored as open for Model 2 — g Open — h Closed

Figure 3

criteria for determining such shapes. (See Figure 3g.) If a small portion of a closed shape is cut off the paper, perhaps because of poor planning, but the figure can be closed visually (as in Figure 3h), it is considered a complete figure and judged according to the appropriate model.

Line

A line is considered straight if it more or less follows a direct path between its beginning point and its ending point. In questionable cases, the line must be measured. (See Measurement of line.) A continuous line used to delineate a figure is appropriately counted as more than one line according to the number of major directional changes it contains. (See Closed angle.) Figure 4 indicates various types of lines.

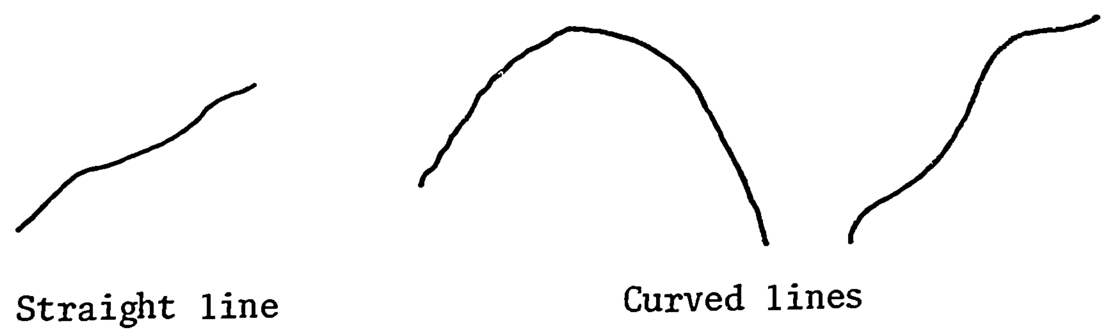


Figure 4

Interruption. An interrupted line is one which has separations within its total length or is one which does not meet another line at an angle. The spaces resulting from such separations must not be larger than two millimeters. (See Angle.) Figure 5 illustrates the concept of interruption.

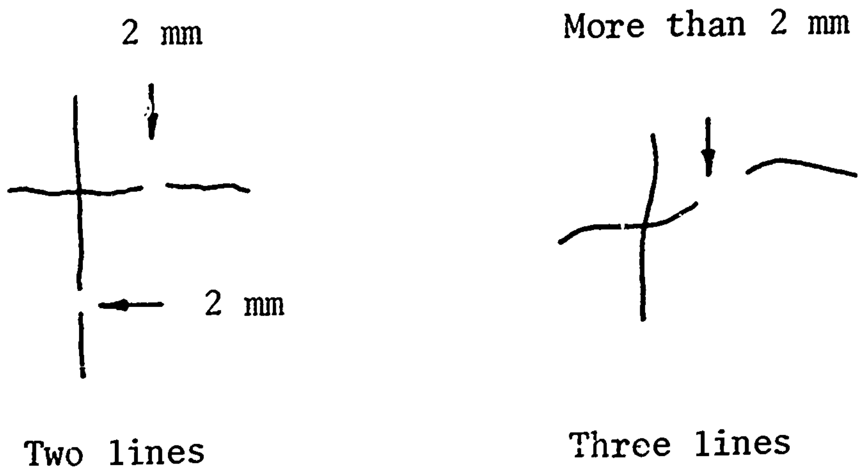


Figure 5

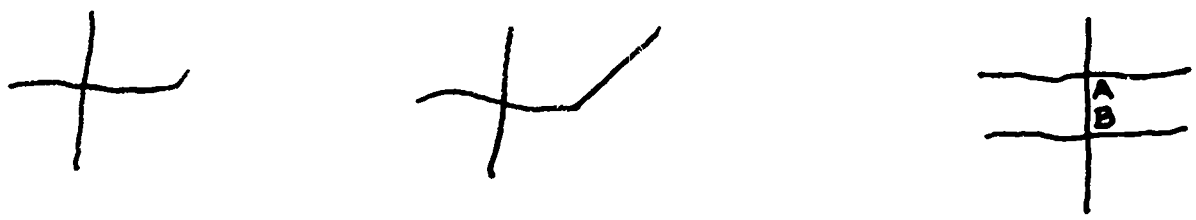
Overlapping. The overlapping of two or more lines should not interfere with the structure of the figure. If overlapping lines appear to be a unit, and they are within two millimeters of each other, they are counted as one line (See Figure 6a.) If a single line in the model is drawn with two lines in the figure, these two lines must adjoin within two millimeters; otherwise, the "line" is counted as two lines. (Compare b and c of Figure 6.) Solid masses must not interfere with the basic structure of the figure. (See Figure 6d.)

a b c d

Acceptable Not acceptable Acceptable

Figure 6

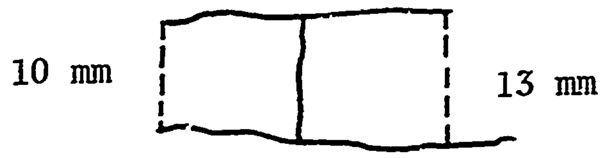
Extension. A line extension is the continuation of a line beyond the point of intersection with another line unless such extensions are part of the basic structure of the figure, as in the diagonal cross (X) or in the vertical cross (+). "Tails" are defined as pencil markings left on the paper when the pencil was being raised by the subject. They are usually finer in texture, tapered, and lighter in color. Unless otherwise stated on the rating scales, line extensions, including "tails", will be disregarded until such extensions reach the point at which they change the basic structure of the figure. One-third of the interior length of the line involved can be used to determine an acceptable length for a line extension if measurement is necessary. Figure 7 delineates acceptable and unacceptable examples of line extension.



"Tail" does not affect basic structure. "Tail" changes basic structure. Extensions are longer than 1/3 of AB. Basic structure is changed.

Figure 7

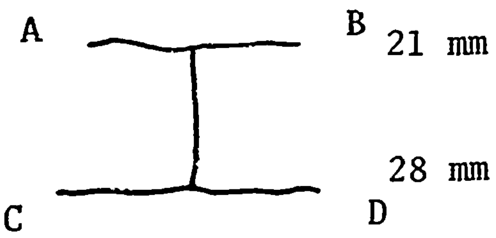
Parallel lines. Lines should be parallel within approximately one and one-third of the shorter line as measured through the parallel end-points. Figure 8 depicts the method of determining whether two lines are parallel. Reconstructed lines may be used. (See *Measurement of line.*)



Parallel lines

Figure 8

Lines equal in length. Such lines should be equal within one and one-third of the shorter line. Figure 9 illustrates two lines which are considered equal in length. Reconstructed lines may be used. (See *Measurement of line.*)



Line CD is within 1-1/3 of line AB.

Figure 9

Angle

All angles are 90 degrees with the exception of those of the equilateral triangle which are 60 degrees and those of the diamonds which are 40 and 140 degrees. Unless otherwise indicated on the rating scales, each

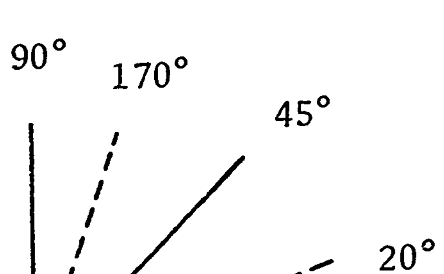


Figure 10

angle should be accurate within plus or minus 20 degrees (slightly less than one-half of a 45 degree angle as judged visually). Angles may be measured with a protractor if they cannot be adequately judged by visual inspection. (See Measurement of angles.) Figure 10 provides a guide for visual judgments.

Closed angle. A closed angle is one whose lines intersect or whose lines form a major change in direction. When two lines intersect, they must do so within two millimeters. (See Figure 11, a and b.) When the angle is formed by a continuous line delineating a major change in direction, the change of direction must be sharper than the gradual change formed by a curved line. To determine whether such a change in direction is an angle, the lines involved are extended to an apex. If the apex extends beyond two millimeters from the center of the base of the curve, the part is counted as a curved line (non-angle) rather than as an angle. If the part is considered an angle, it must be connected with straight lines and must resemble the figure. (Compare c, d, and e of Figure 11.) Exceptions for particular categories are indicated on the rating scales.

Open angle. An open angle is one whose lines do not intersect within two millimeters. This type of angle must be judged in relation to the basic structure of the figure. It is acceptable in only a few categories, which are indicated on the scoring sheets. Open angles are illustrated in Figure 11, f, g, and h.

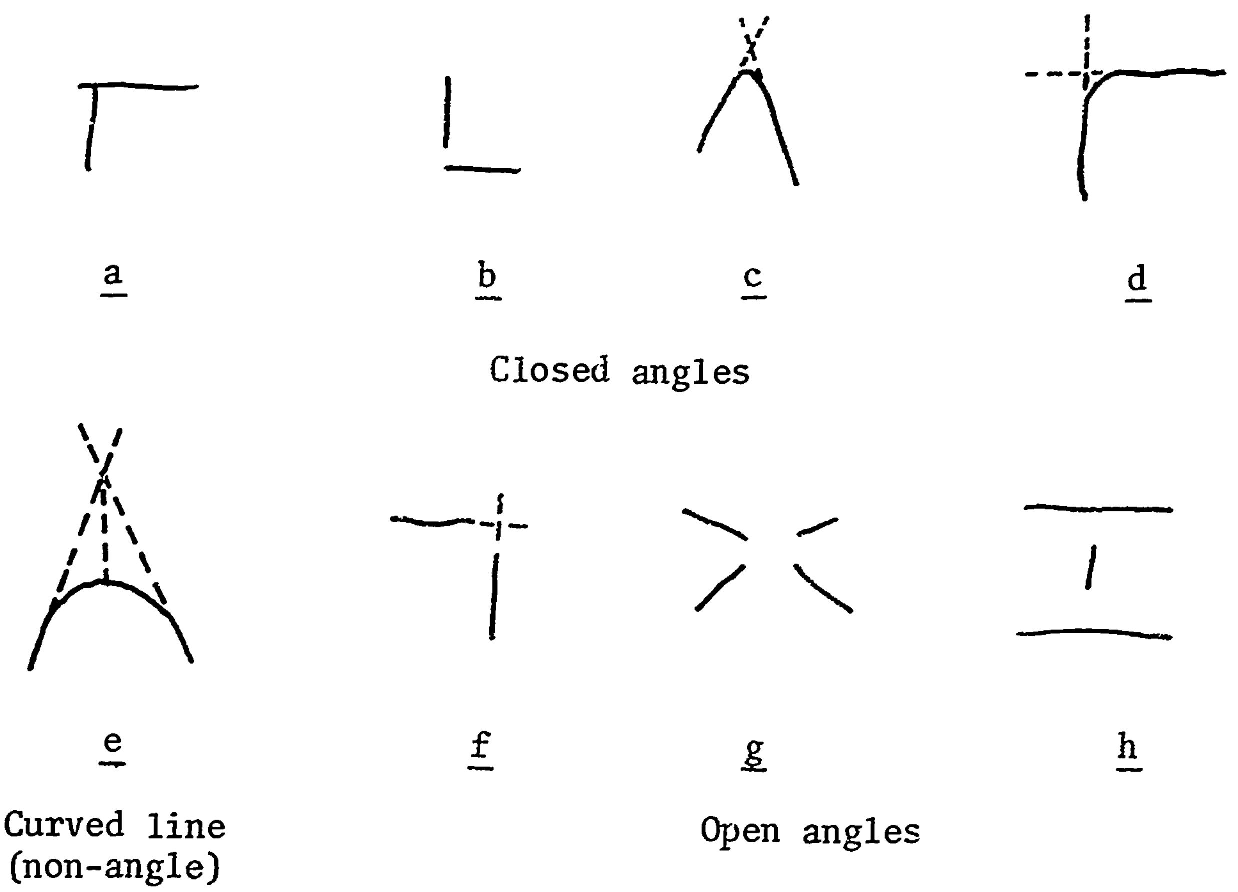
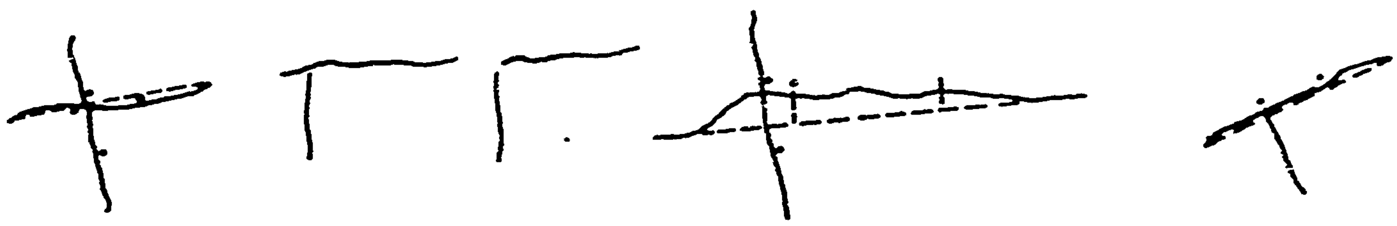


Figure 11

Bisection or intersection. These attributes should occur within the middle third of the line(s) involved. Borderline cases should be measured. When the bisection or intersection occurs at an extreme end of the middle one-third, credit should be given. The transparent overlay for line and intersection may be used. (See Measurement for bisection or intersection.) Figure 12 shows acceptable and unacceptable bisections and intersections.



Acceptable   Not acceptable   Acceptable

Figure 12

Rotation

This attribute refers to the correct placement of the figure on the page in relation to the vertical and horizontal dimensions. The center axis should fall within 20 degrees (slightly less than one-half of a 45 degree angle as judged visually) of the vertical dimensions of the paper. If necessary, measurement may be utilized. (See Measurement for rotation.) Exceptions or stipulations regarding rotation are specified on the rating sheets. Figure 13 illustrates acceptable and unacceptable examples of rotation.

Acceptable for Model 10   Not acceptable   Acceptable

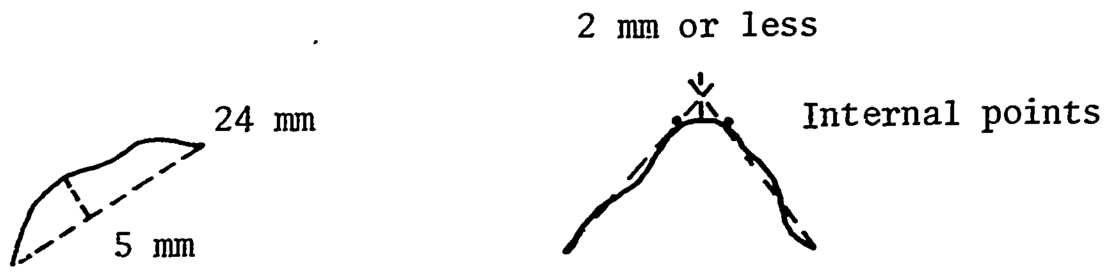
Figure 13

Measurement

For purposes of measurement, tracing paper is placed over the figure and measurements are made with a metric ruler and/or a protractor on this paper. A colored pencil is used. All such measurement sheets should be identified at the top with the number found in the corresponding position on the back of the figure and with the rater's initial. These sheets should be placed underneath the figure when it is placed in the appropriate category.

Measurement of line. Measurement for straightness of line involves the reconstruction of line by drawing a straight line between the end-points of the line of the figure. A perpendicular line is then drawn from the reconstructed straight line to the farthermost point on the line of the figure. If the perpendicular line is not longer than ten per cent of the reconstructed straight line, the line of the figure is considered to be straight. End-points for closed figures are the internal points of intersection, provided that any line extension or tail present does not interfere with the basic structure of the figure. Figure 14 indicates the method for measuring a line for straightness.

A quick method for determining straightness of line is obtained by the use of the transparent overlay for line and intersection. By matching the length of the line of the figure (as determined by the end-points) with the corresponding line of the overlay and reading from the top of the scale, the straightness can easily be determined. If the line of the figure curves or extends beyond the upper line on the scale, it is not a straight line. (See Overlays.)

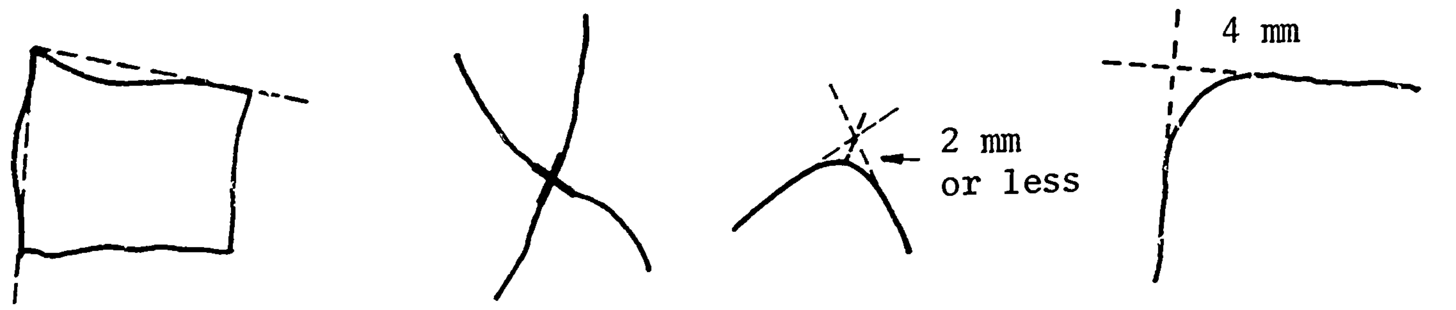


Curved line

Straight lines connected by an angle

Figure 14

Measurement of angles. Closed angles are measured directly or with reconstructed straight lines. Whichever method provides more credit for the drawing should be used. Reconstructed straight lines can be utilized for the measurement of an angle only when the lines of the figure are themselves considered straight.



Measurement of reconstructed lines

Direct measurement

Angle

Curved line

Figure 15

Direct measurement of an angle involves the measuring of the angle itself, including approximately five millimeters of each line involved.

If an angle is rounded but connected with straight lines, the straight lines are extended, often by tangents, to form a sharp angle; then a straight line is drawn from the extended apex to the center point of the curved. If this line is two millimeters or less, the angle is considered a closed angle. If it is more than two millimeters, it is considered a curved line. Figure 15 shows the various methods for measuring angles.

Measurement for bisection or intersection. Each line is divided into thirds. Reconstructed lines can be used with a grid extension. (See Figure 12.) A quick method for measurement of intersection is provided by the transparent overlay for line and intersection. The green markings on each line of the scale divide the line into thirds. The line of the figure is matched with a line on the scale, and the measurement is read directly.

Measurement for rotation. The lines of the figure are reconstructed if necessary; the central axis is bisected, and the resulting angle is measured in relation to the vertical dimension of the paper. Unless otherwise specified on the rating sheets, a deviation of 20 degrees is allowed. Figure 16 illustrates the method of measurement for the various models.

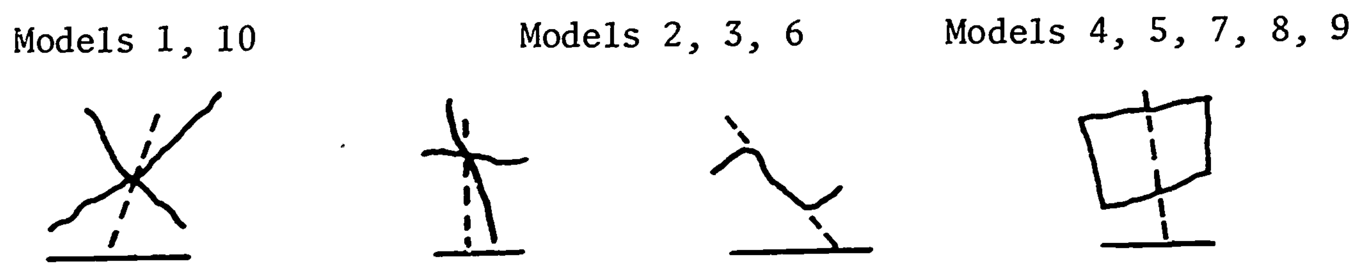


Figure 16

Overlays. In order to facilitate measuring, the translucent colored overlays may be used. The overlay for line and intersection is a scale composed of horizontal gradated line lengths and vertical spaces based on ten per cent of each line length. Thus, length of line can be estimated and its straightness can be measured by matching the line of the figure with the corresponding line of the overlay scale and reading from the top of the scale.

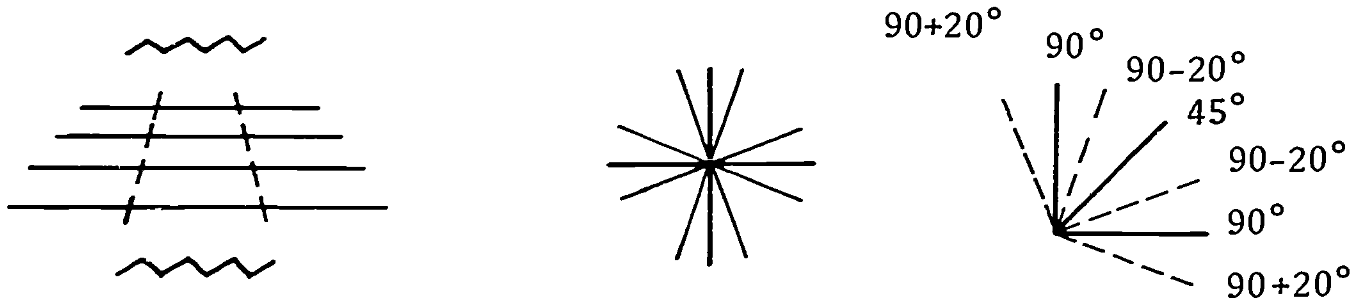
Each line is divided horizontally into one-third sections, as well as into halves; thus intersection and bisection can be easily measured.

For each model an overlay for rotation is provided. It has markings in color of three positions within which rotation for the particular figure would be considered correct. Another overlay is provided which indicates the range within which an angle would be judged correct. Examples of the overlays are shown in Figure 17.

Specific Instructions for Using the Rating Scales

Each category should contain figures better than those in the next lower category. Begin judging at category 1 and progress until the figure does not meet the qualifications for the category; then place the figure in the lower category.

The word line refers to any type of line, curved as well as straight. Lines which are required to be straight are designated as straight lines. The unmodified term angle means a closed or open angle. Closed angles are designated as closed angles. Dimension refers to the length or width of the figure. An internal point refers to a point of intersection within the figure itself (not to a point of intersection of two reconstructed lines) or to a point at which a straight line begins to form a curved line at a directional change.



Line and intersection overlay

Rotation overlay for Model 6

Angle overlay

Figure 17

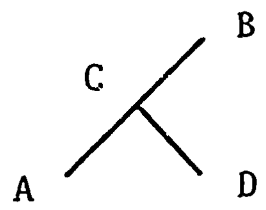
Additional figures for each category for each model will be displayed for visual inspection during the scoring sessions.

A Note About the Examples

With very few exceptions which occur mainly in categories four and five, all of the examples depicted in the following section were taken from actual protocols. The score for the category under which each drawing is shown would be the score assigned to that figure.

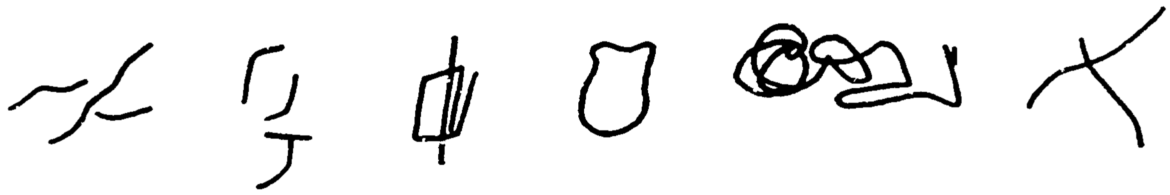
Rating Scale for Model 1

Proportions: CD = 1/2 AB
Angles = 90°



0 No markings on paper. (Since there will be very few drawings in this category, it will not be part of future scales. Place this type of test in a separate pile.)

1 Scribbles
Closed shapes
Open shapes not resembling Model 1; figures resembling Models 2, 3, 6, and 10; and figures with extensions of CD by more than 10% beyond AB



2 Open shapes resembling Model 1
Permitted:
More than two lines
Curved lines
Open angles

3 Two straight lines
Two closed angles

4 Two straight lines
Closed angles of 90°
Intersection

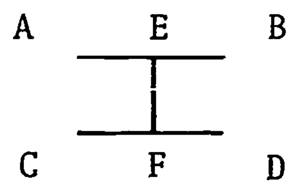
Straight line

5 Two straight lines
Closed angles of 90°
Intersection
CD = 1/2 AB
Correct rotation

20° rotation

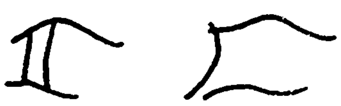
Rating Scale for Model 2

Proportions: AB = CD
EF = 1/2 AB
Angles = 90°

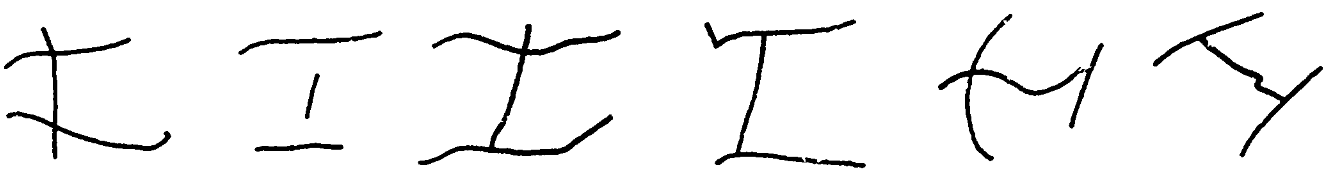


1 Scribbles
Closed shapes
Open shapes not resembling Model 2; figures resembling Models 1, 3, 6, and 10

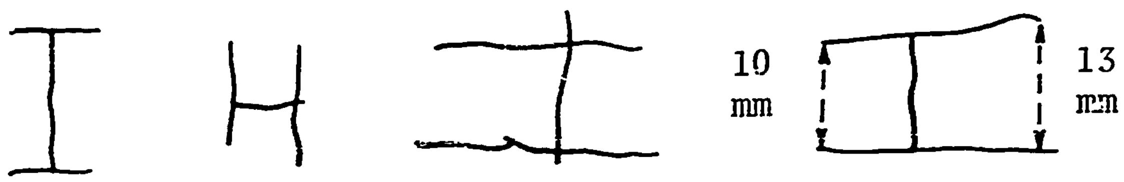
2 Shapes resembling Model 2
Permitted:
More than 3 lines



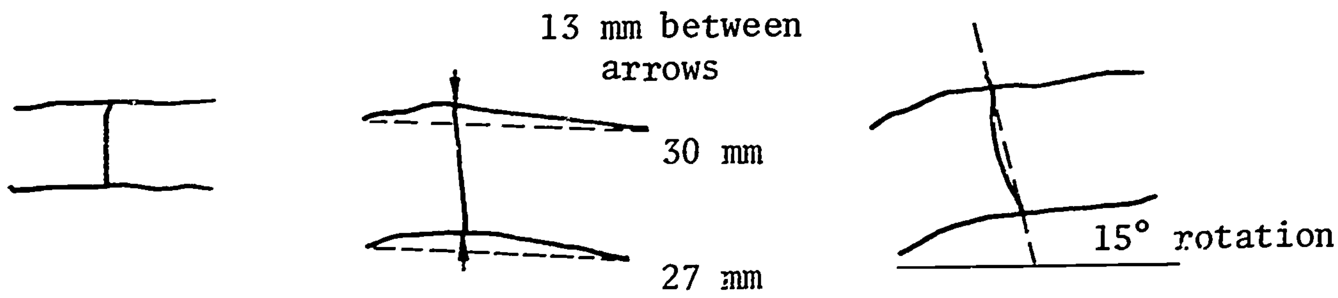
3 Three lines
Permitted:
Two open angles



4 Three straight lines
Two closed 90° angles
Intersection
AB = CD within 1/5
AB is parallel to CD



5 Three straight lines
Two closed 90° angles
Intersection
AB = CD within 1/5
AB is parallel to CD
EF = 1/4(AB + CD) within 1/5 of this obtained figure
Correct rotation



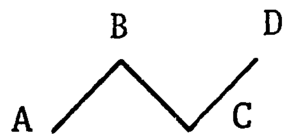
30
27
4/57
14

14 x 1/5 = 3

Range of EF = 14 + 3 = 17
14 - 3 = 11

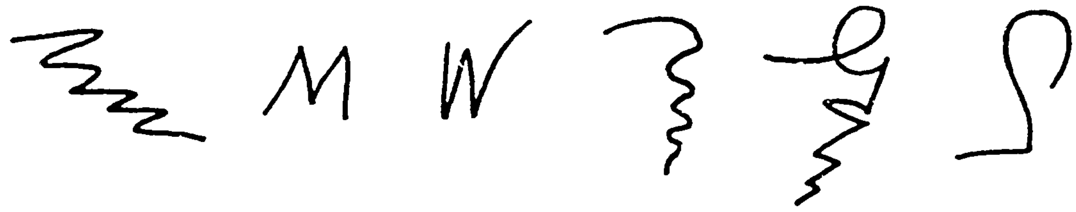
Rating Scale for Model 3

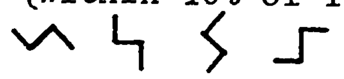
Proportions: AB = BC = CD
Angles = 90°

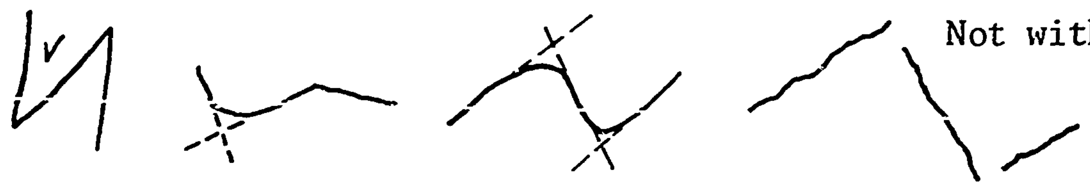


1 Scribbles
Closed shapes
Open shapes not resembling Model 3; figures resembling Models 1, 2, 6, and 10

2 Open figures resembling Model 3
Permitted:
Perseveration



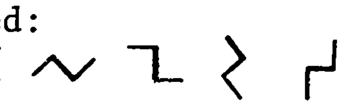
3 Three straight lines
Permitted:
Open angles (within 10% of length of line involved)
Reversal ( are acceptable positions.)

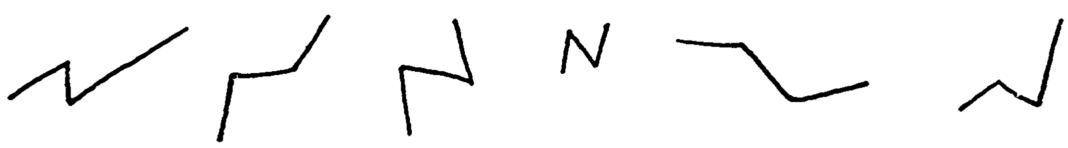


Not within 10% of BC

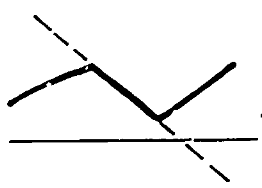
Not within 10% of CD

Angle   Angles   Open angles

4 Three straight lines
Two closed angles
NOT permitted:
Reversal ( are acceptable positions.)



5 Three straight lines equal in length
AB and CD are parallel
Two closed 90° angles (±10° secondary to parallelness of AB and CD)
Correct rotation
NOT permitted:
Reversal

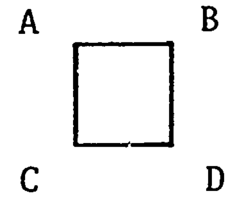


40°

5° rotation

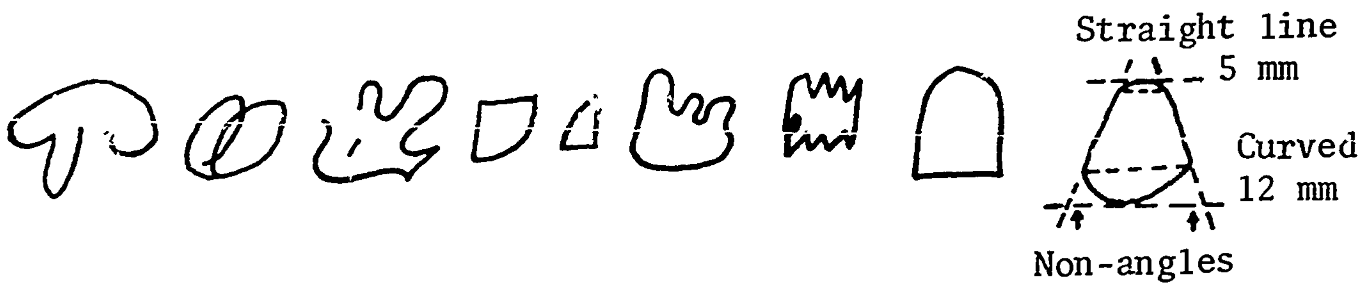
Rating Scale for Model 4

Proportions: AB = BD = CD = AC
Angles = 90°

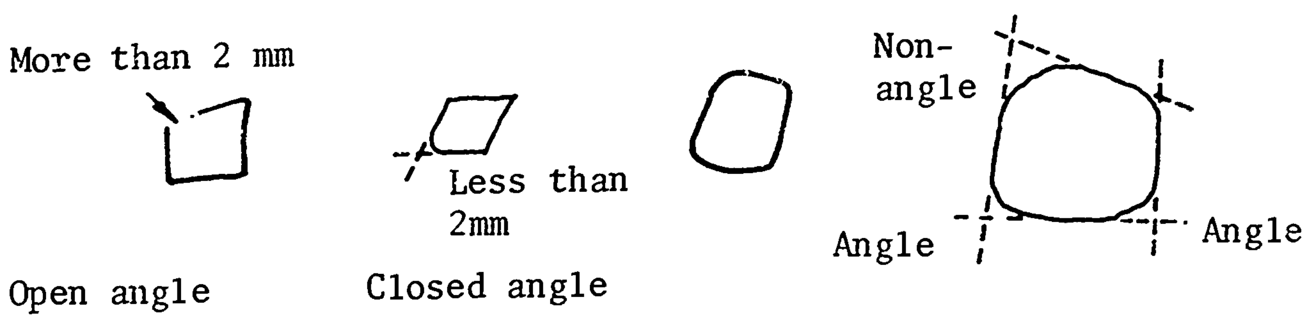


1 Scribbles
Open shapes

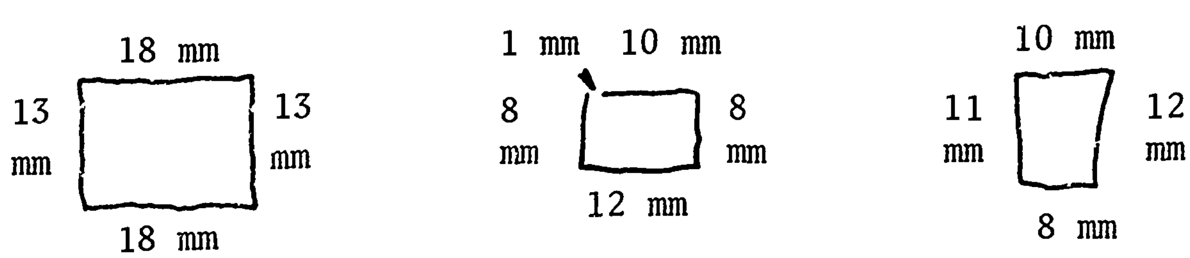
2 Closed shapes, including ovals (loops), circles, and triangles



3 Four straight lines
Four closed angles
Permitted:
One angle may be an open angle or a non-angle, provided the non-angle is connected with straight lines.



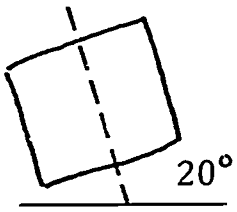
4 Four Straight lines
Four closed 90° angles
Permitted:
One angle may be a 90° angle open within 10% of the line involved.
Longer line of one dimension (width or length) is equal to or less than 1-1/2 of shorter line of other dimension.



13 x 1-1/2 = 19-1/2
Longest line must be 19-1/2 or less.

8 x 1-1/2 = 12
Longest line must be 12 mm or less.

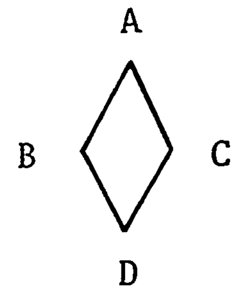
5 Four straight, equal lines
Four 90° angles (within ±10°)
Correct rotation



20° rotation

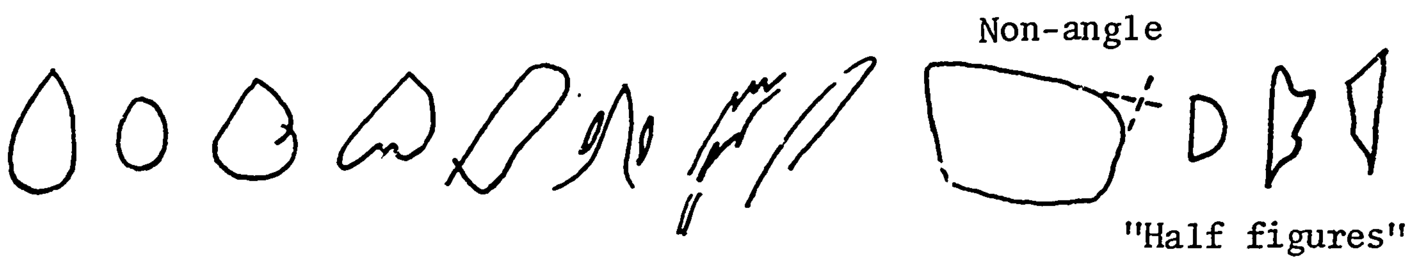
Rating Scale for Model 5

Proportions: AB = BD = CD = AC
Angles A and D = 40°
Angles B and C = 140°

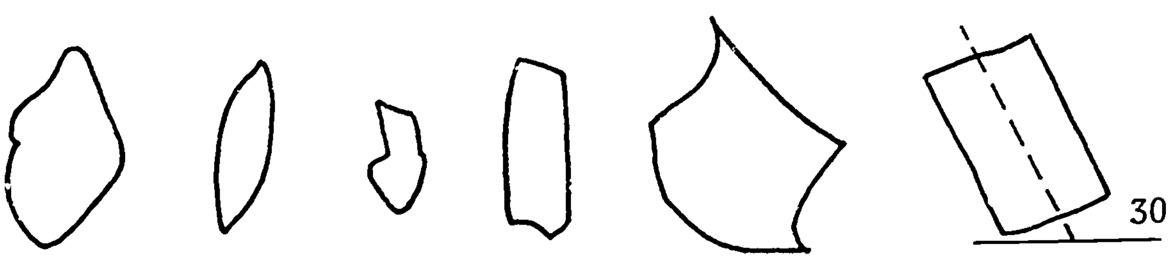


1 Scribbles
Open shapes

2 Closed shapes, including ovals, circles, triangles
Squares and rectangles rotated less than 20°
"Half" figures

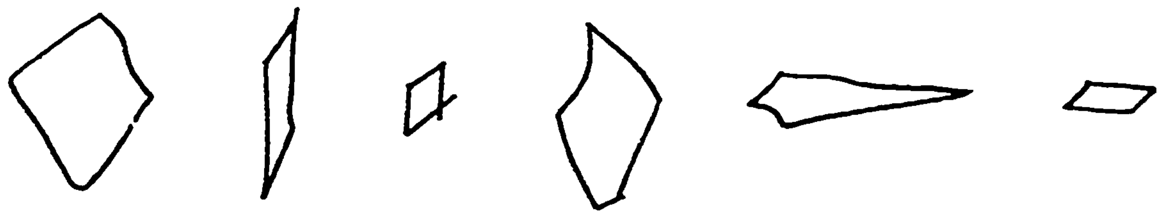


3 Closed, elongated figures containing:
At least two closed angles
One dimension approximately 2 times other dimension
Permitted:
Five lines
Two elongated curved lines joining at two points
Rectangles or squares with 90° angles rotated more than 20°

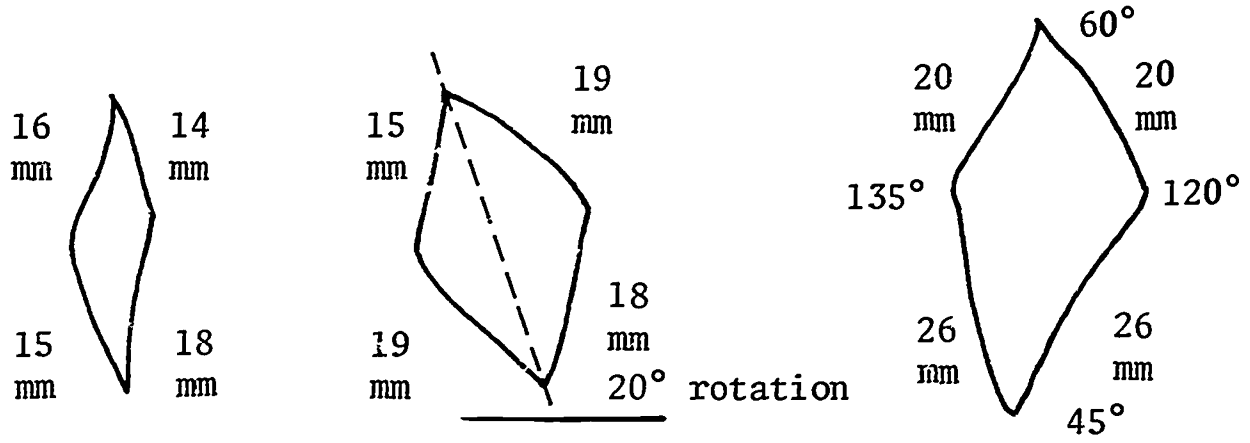


30° rotation

4 Four straight lines
Four closed, oblique angles
Permitted:
Rhombuses or parallelograms with angles equal to or greater than 60° and 120°

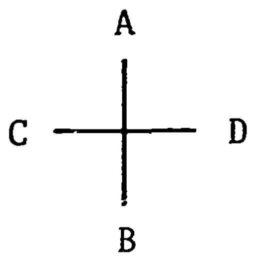


5 Four straight, equal lines
Two closed, opposite angles of 40°
Two closed, opposite angles of 140°
Correct rotation

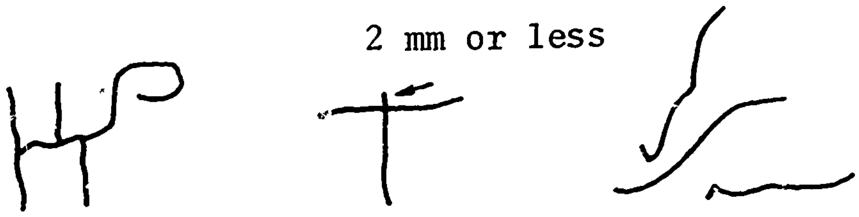


Rating Scale for Model 6

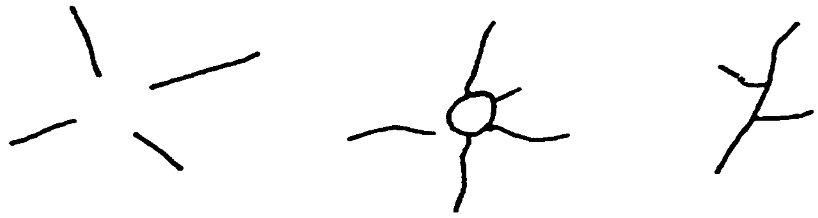
Proportions: AB = CD
Angles = 90°



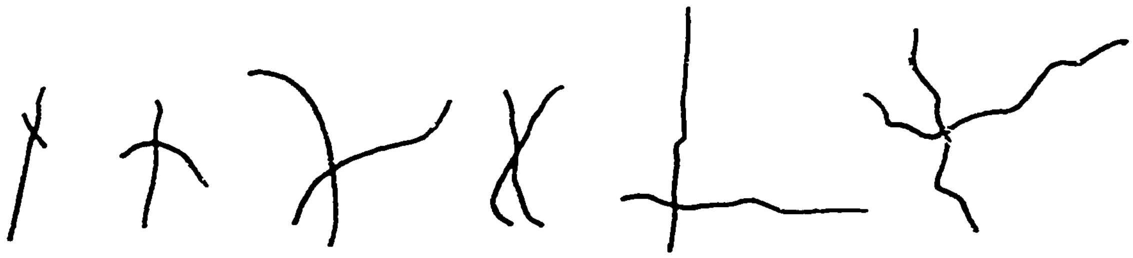
1 Scribbles
Closed figures
Open figures, including those resembling Models 1, 2, and 3

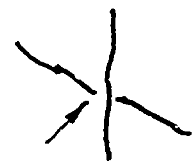


2 Open figures resembling Model 6
Permitted:
More than two lines



3 Two crossed lines
Closed angles



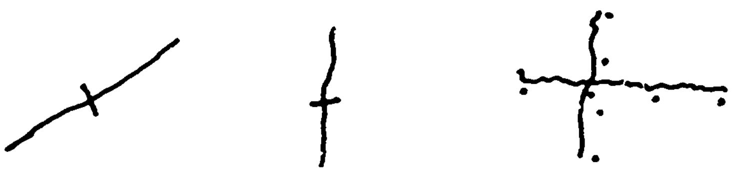


2 mm or less

Acceptable

4 Two straight, crossed lines
Two closed 90° angles
Intersection

15 mm

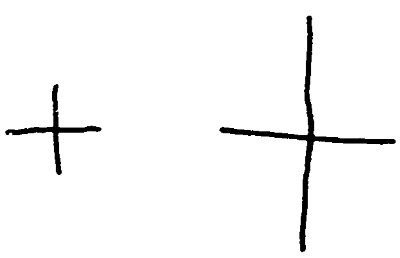


21 mm

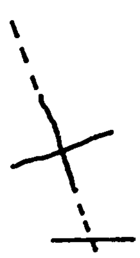
Acceptable

5 Two straight, crossed, equal lines
Two closed 90° angles (within ±10)
Intersection
Correct rotation

24 mm



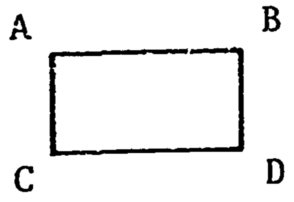
18 mm



Acceptable
Lines are within 1/3.

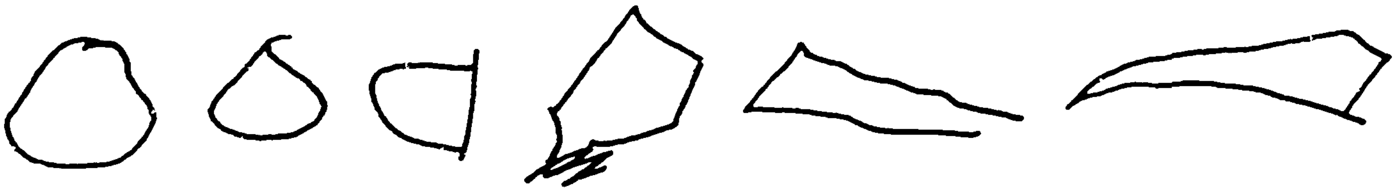
Rating Scale for Model 7

Proportions: AB = CD, AC = BD, AC = 1/2 AB, BD = 1/2 AB
Angles = 90°



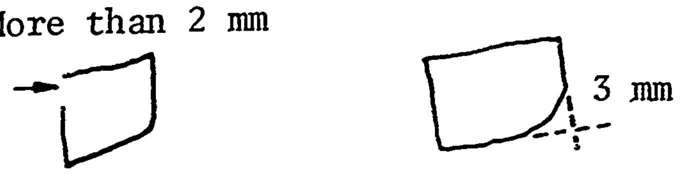
1 Scribbles
Open shapes

2 Closed shapes, including ovals, circles, triangles, diamonds



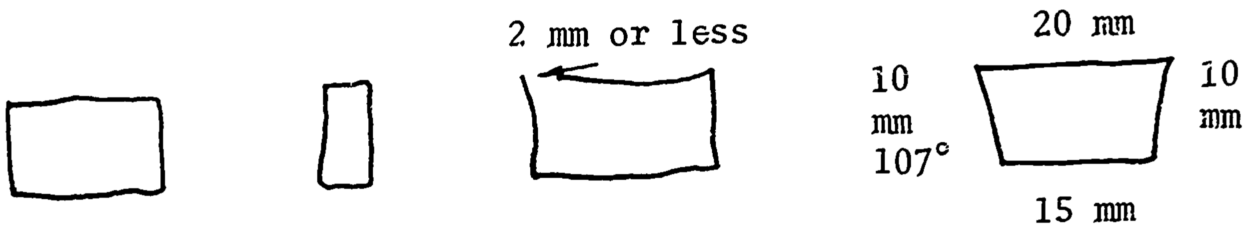
3 Four straight lines
Four closed angles
Permitted:
One angle may be an open angle or a non-angle, provided the non-angle is connected with straight lines.

More than 2 mm

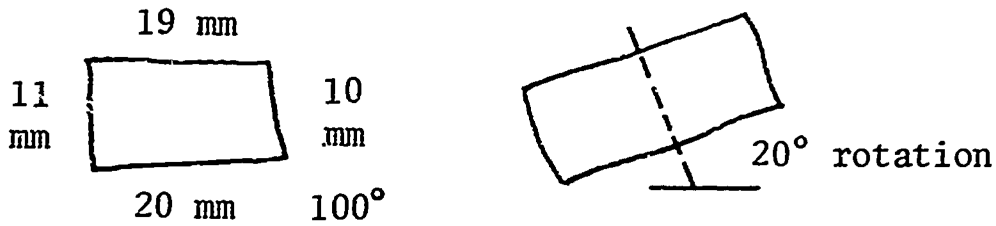


Open angle Non-angle

4 Four straight lines
Four closed 90° angles
Permitted:
One angle may be a 90° angle opened within 10% of the line involved.
AB = CD (longer dimensions; disregard rotation.)
AB and CD are at least 1-1/2 times longer than AC and BD. (Longer line of one dimension is equal to or greater than 1-1/2 of shorter line of other dimension.)

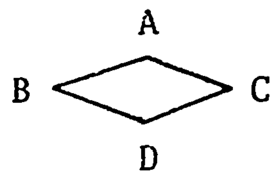


5 Four straight lines
AB = CD; each is twice as long as AC and BD. (AC + BD = 1/2 AB ÷ CD, within 1/3 AC + BD)
Four 90° angles (within ±10°)
Correct rotation



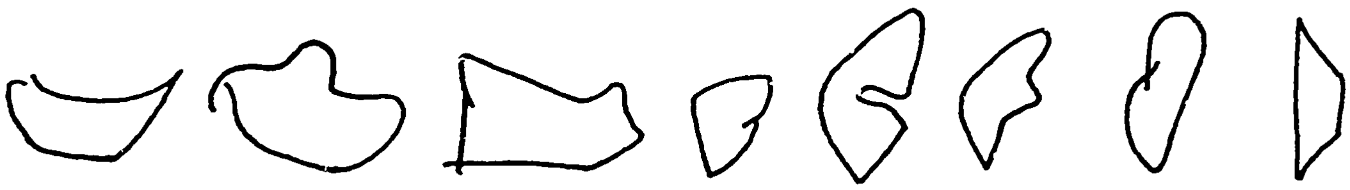
Rating Scale for Model 8

Proportions: AB = BD = CD = AC
Angles A and D = 140°
Angles B and C = 40°



1 Scribbles
Open shapes

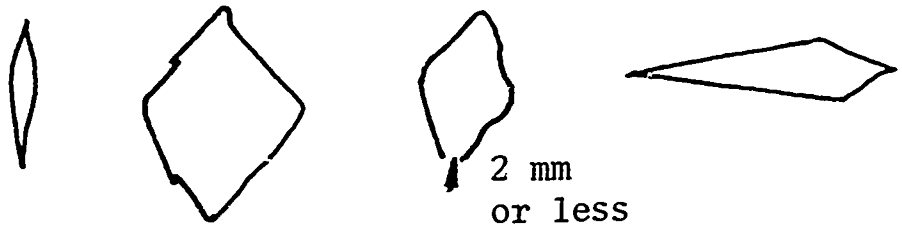
2 Closed shapes, including ovals, circles, triangles
Squares and rectangles rotated less than 20°
"Half" figures



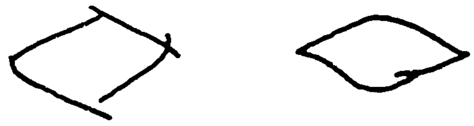
"Half figures"

3 Closed, elongated figures containing:
At least two closed angles
One dimension approximately 2 times other dimension
Permitted:
Five lines
Two elongated curved lines joining at two points
Rectangles or squares with 90° angles rotated more than 20°

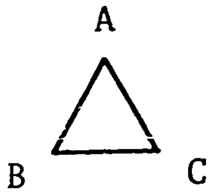
4 Four straight lines
Four closed, oblique angles
Permitted:
Rhombuses or parallelograms with angles equal to or greater than 60° and 120°



5 Four straight, equal lines
Two closed, opposite angles of 140°
Two closed, opposite angles of 40°
Correct rotation



Rating Scale for Model 9



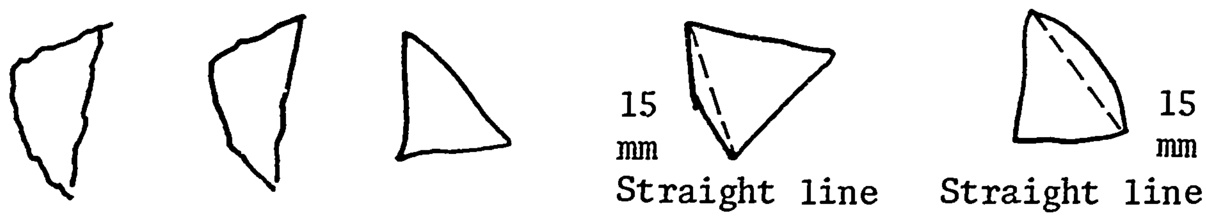
Proportions: AB = BC = AC
Angles = 60°

1 Scribbles
Open figures

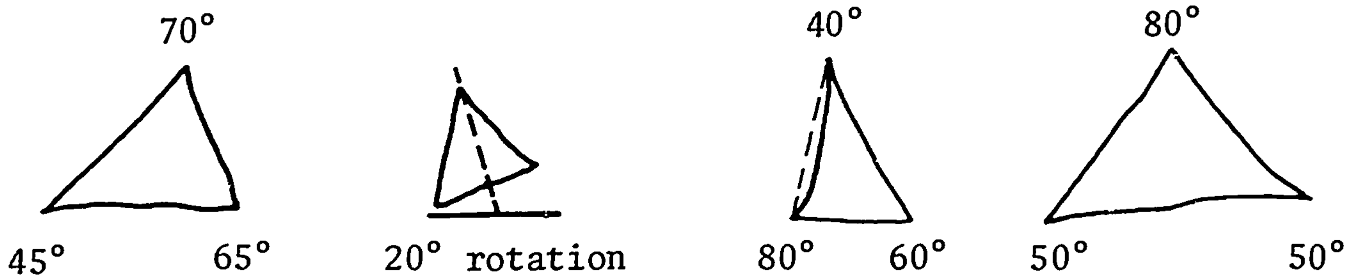
2 Closed figures, including ovals, circles, squares, rectangles

3 Three lines
Permitted:
Three non-angles (formed by curved lines), provided the figure looks like a triangle

4 Three straight lines
Three closed angles
Permitted:
One angle of 90°

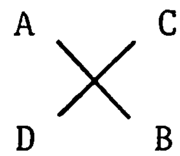


5 Three straight lines
Three closed angles of 60°
Correct rotation



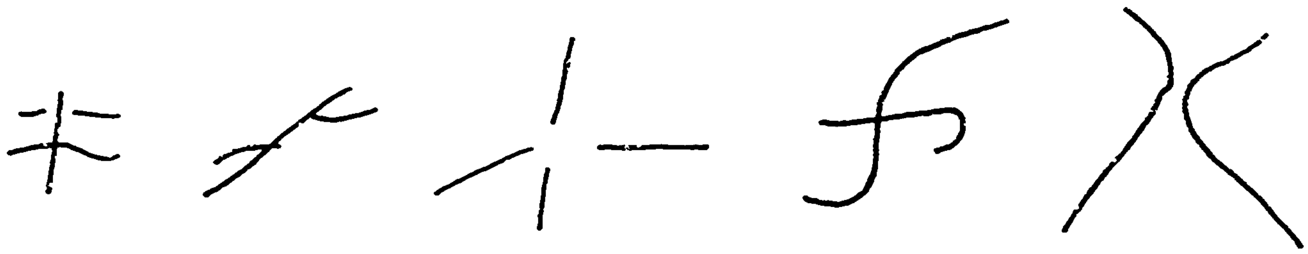
Rating Scale for Model 10

Proportions: AB = CD
Angles = 90°

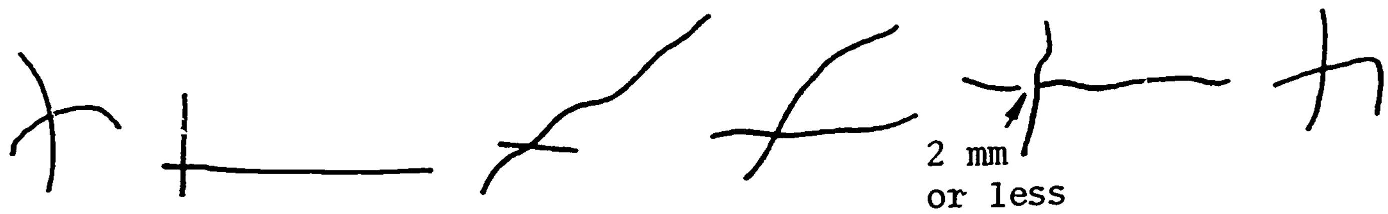


1 Scribbles
Closed figures
Open figures not closely resembling Model 10; figures resembling Models 1, 2, and 3

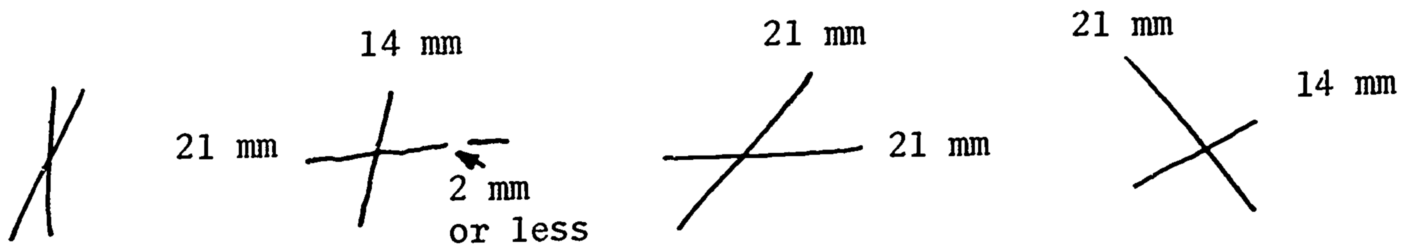
2 Open shapes resembling Model 10
Two lines crossed by less than 2 mm
Permitted:
More than 2 lines



3 Two lines crossed by 2 mm or more
(Changes in direction at ends of lines must not be more than 10% of line measured from one end-point to the point of change in direction.)
Permitted:
Rotation of 45°

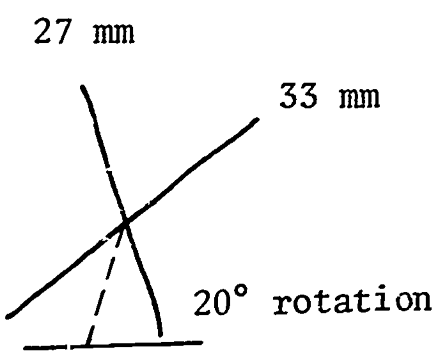


4 Two straight, crossed, equal lines, at least one of which is an oblique line of 20° or more
Intersection



All intersections are within middle 1/3.

5 Two straight, crossed, equal lines
Closed 90° angles
Intersection
Correct rotation



APPENDIX E-1

LEARNING PROGRAM FOR EXPERIMENTAL GROUP

Directions for Experimenters

1. Language should be kept at a minimum. Avoid using words which the child may not understand. The words corner and drawing will be used instead of angle and tracing.

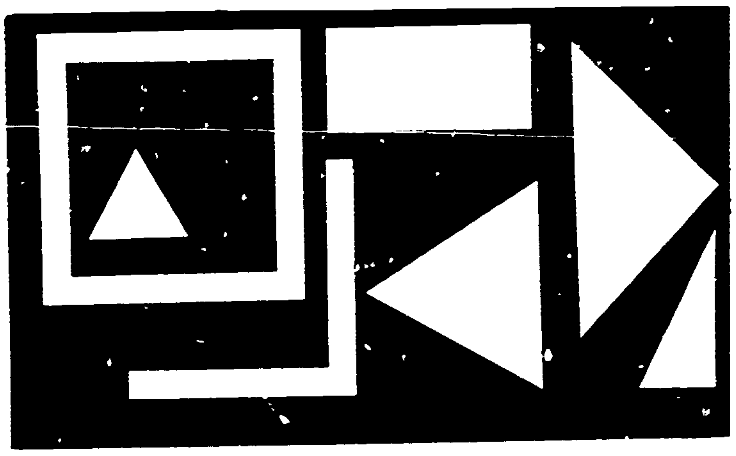
2. Demonstrate the complete action or tracing pattern for the subject in a slow and deliberate manner. Be sure your arm does not obstruct the child's view of your fingers. When pointing, place your finger at the side of the object, not on the object.

3. If the child does not follow your action correctly after the first demonstration, show him again. If his response is inappropriate or incorrect, break down the pattern into two simple patterns. If the child still is unable to perform correctly, guide his hands through the motions; then ask him to perform the action unassisted. If he is unable to do so, go on to the next item. Some children may require a longer period of simplified learning in the early stages of the program. As they respond more readily, attempt to present the total pattern for their copying as soon as possible.

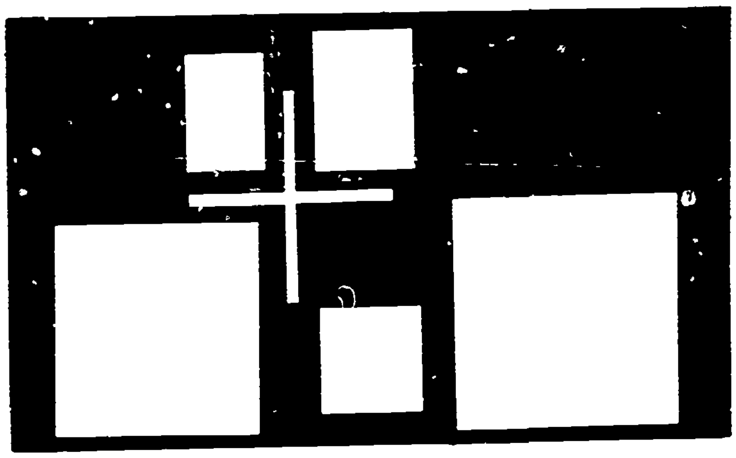
4. Be sure you and the child trace very deliberately. Do not cut corners.

5. Do not use defective equipment because this may adversely influence the results. Return all defective equipment immediately to the project director for replacement. Be particularly concerned about the corners of the cardboard shapes, which may bend or fray.

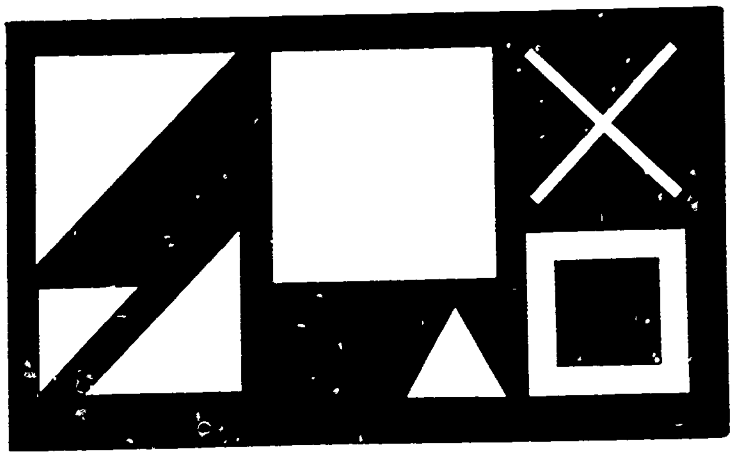
Examples of Equipment Used in the Experiment



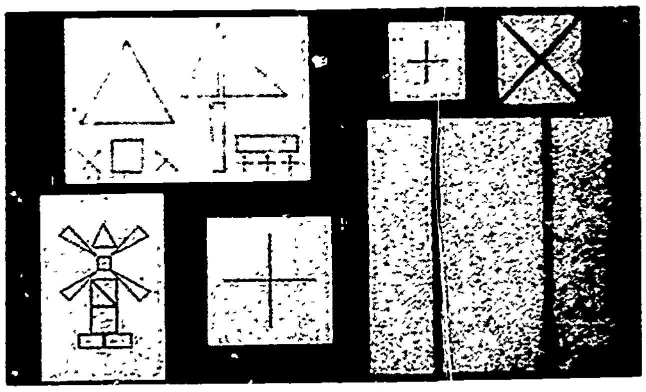
Templates and Solid Figures



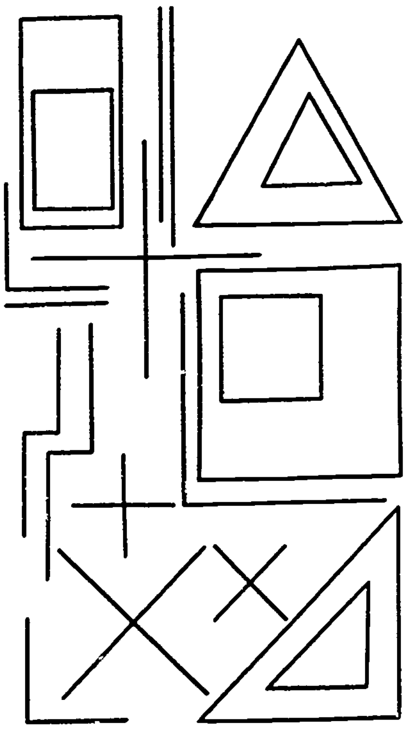
Template and Solid Figures



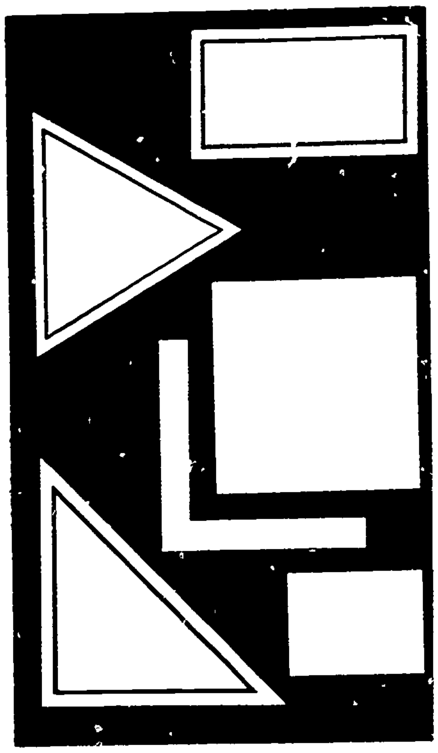
Templates and Solid Figures



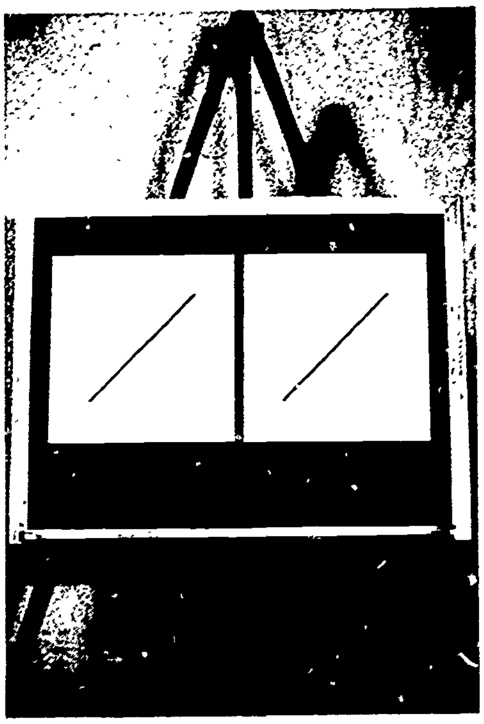
Pictures 1 through 6



Wire Figures



Templates and
Solid Figures



Templates on Chalkboard

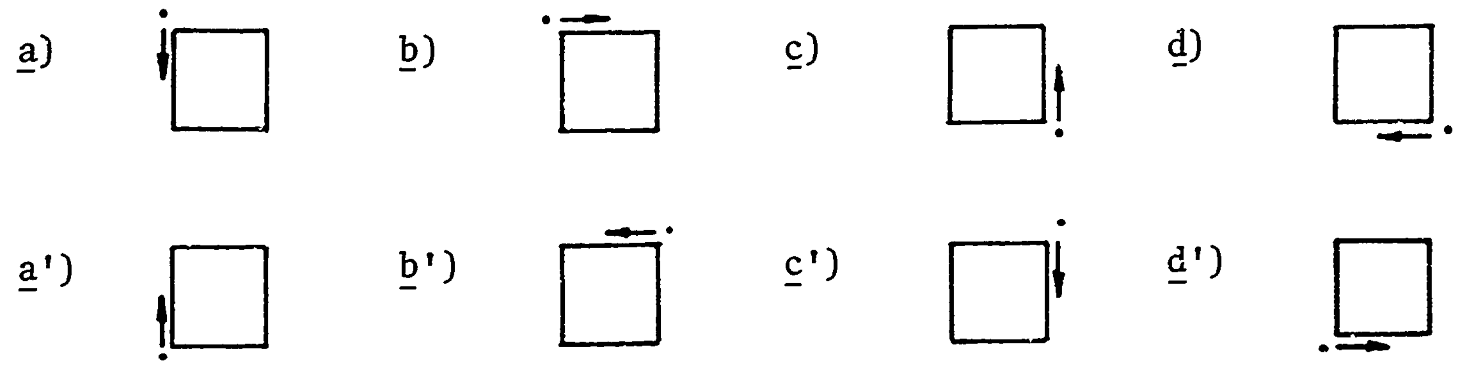
Symbols and Terms Used in the Experimental Treatment

A	= arm(s)	I	= index
cb	= chalkboard	L	= left
cm	= centimeter(s)	M	= middle
ccw	= counterclockwise	mb	= magnetic board
cw	= clockwise	mm	= millimeter(s)
D	= dominant	ND	= non-dominant
E	= experimenter	P	= pattern(s); preceded by 1 or 2
F	= finger(s)	R	= right
FF	= four fingers	S	= subject
H	= hand(s), handed	sb	= steel board
		T	= thumb

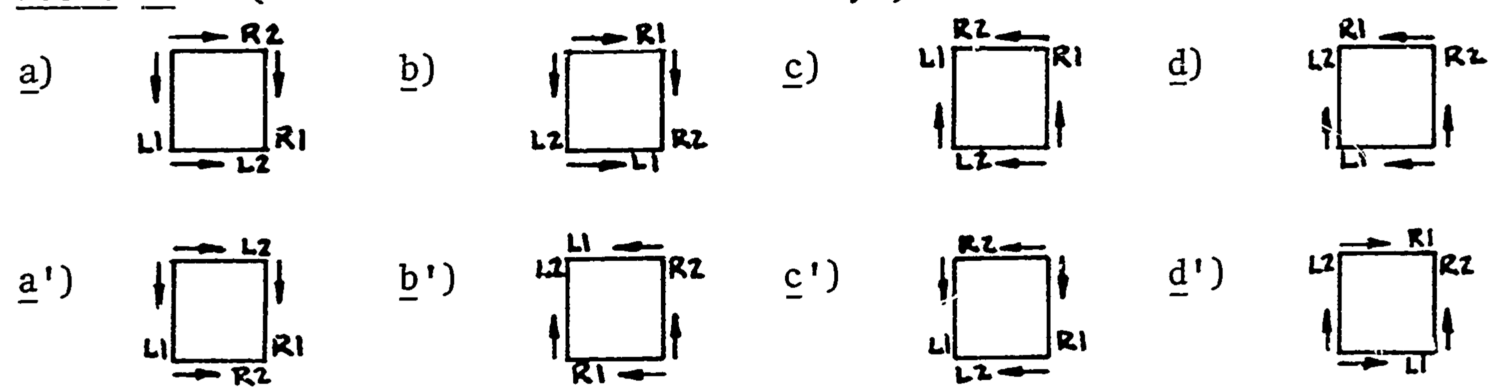
Arrow: indicates direction of tracing.
Basic: specifies pattern to be traced; followed by Roman numeral.
Continuous tracing: begins at (·) and continues around entire outline of shape.
Discontinuous tracing: consists of single lines or angles of a shape consecutively drawn according to a basic pattern.
Fine tracing: is accomplished with finger(s).
Gross tracing: is performed at chalkboard with arms outstretched from shoulder joint and elbow joints straight.
Magic board: is a board covered by an acetate sheet. Markings made by a stylus on covering sheet can be "erased" by lifting sheet from board.
Numbers: indicate consecutive order of tracing.
One-A tracing: is performed in front of chalkboard with arms outstretched from shoulder joint, elbows straight, and index, middle, and ring finger tips touching shape. In some instances, a specific finger or another combination of fingers is required.
One-H tracing: is performed in front of chalkboard with arms outstretched from shoulder joint, elbows straight, and hands flat against shape.
Palmar tracing: is performed with palm flat against shape.
Pinching: is accomplished with thumb and finger tracing wire shape which is firmly adhere to background.
Point (·): denotes starting position for tracing.
Return: signifies that S retraces object to original starting point.
Rotate: denotes for E that object is turned in same plane; for S that object is held upright in line of vision and is turned one full revolution against cupped palm.
Rotating with pinch: indicates that object is held at eye level and rotated by S with two hands, one of which is pinching object on front and back surfaces.
Two-A tracing: is the same as One-A tracing except that two arms are used.
Two-H tracing: is the same as One-H tracing except that two hands are used.

Basic Patterns for Experimental Treatment

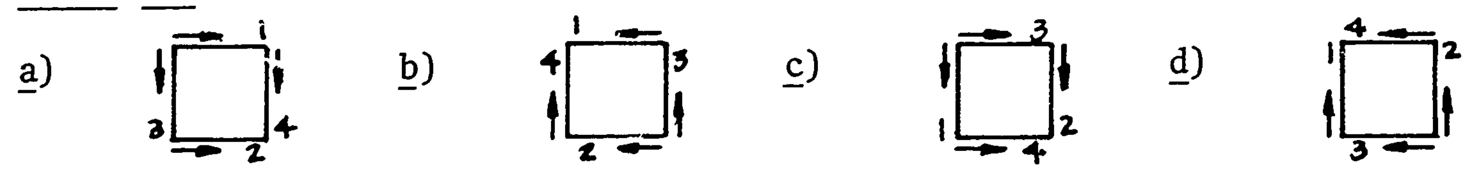
Basic I



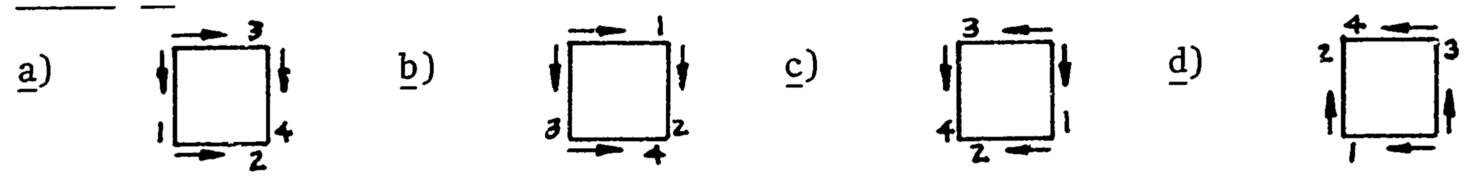
Basic II (RH and LH trace simultaneously.)



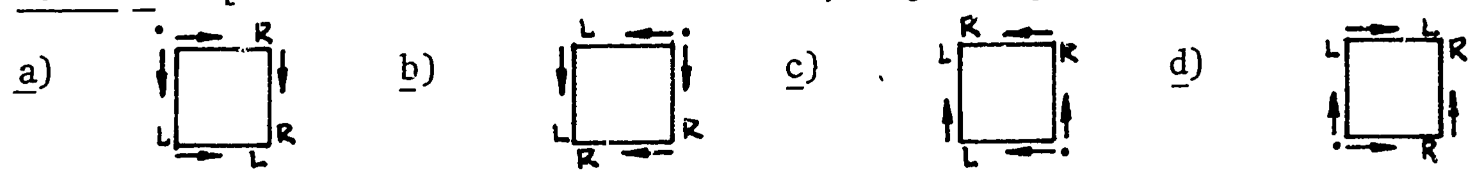
Basic III



Basic IV



Basic V [RH and LH trace simultaneously beginning at (.).]



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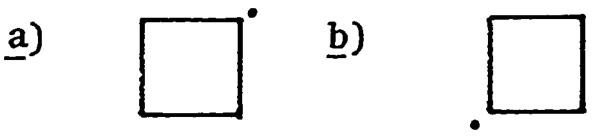

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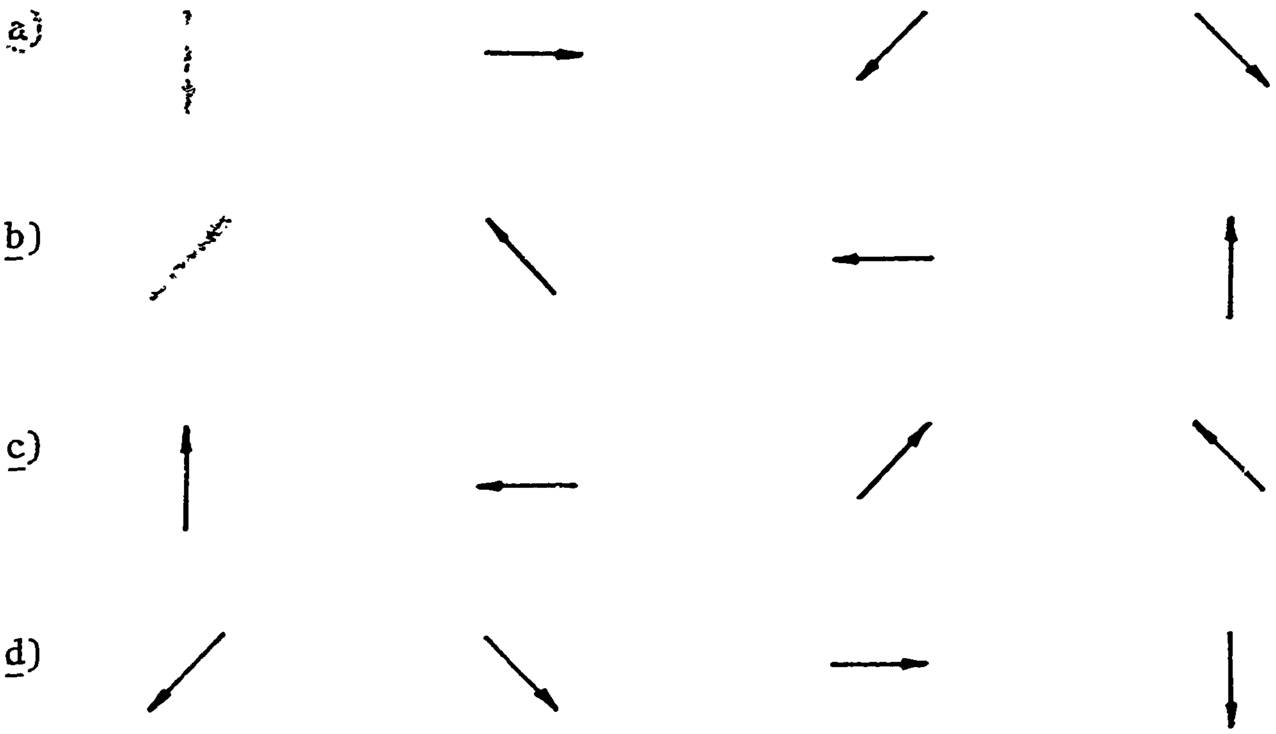

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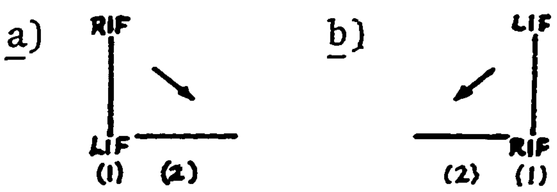
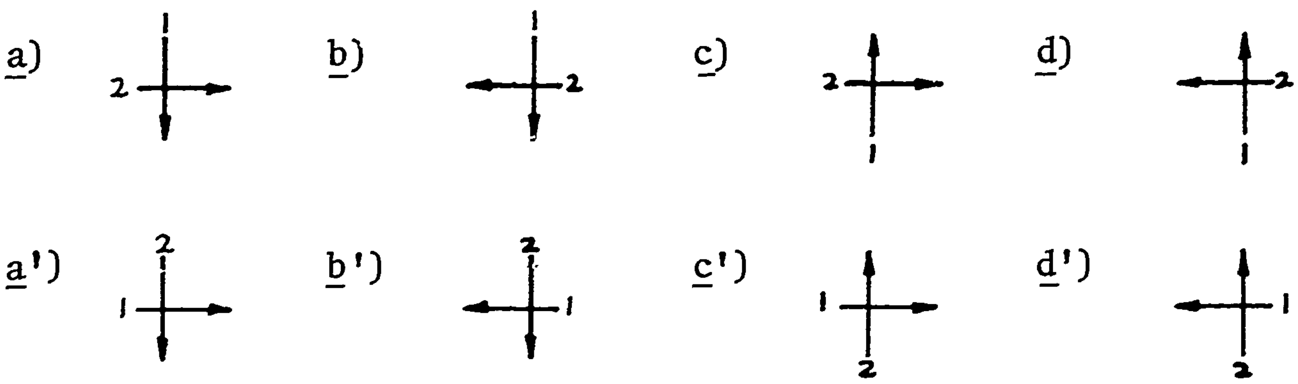
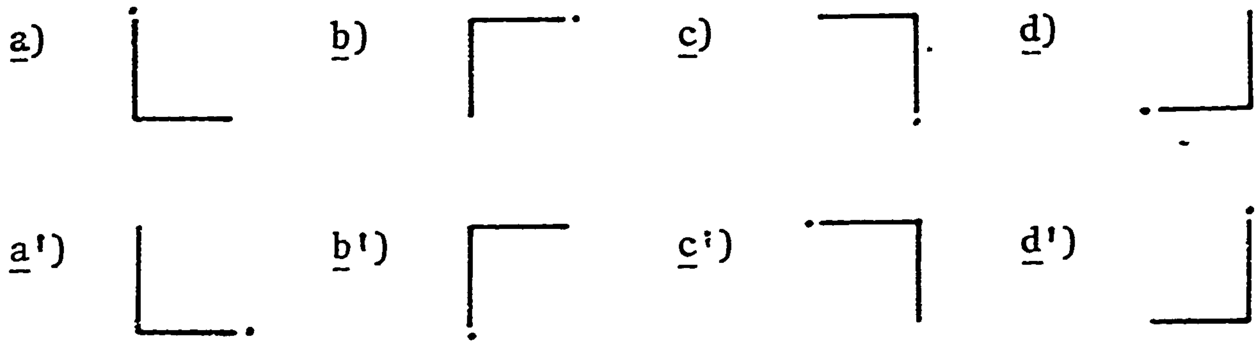


Basic IX



Basic X



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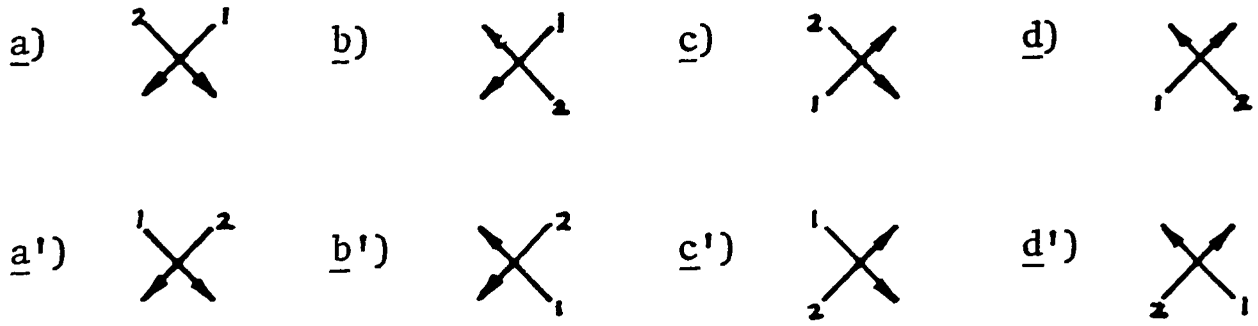

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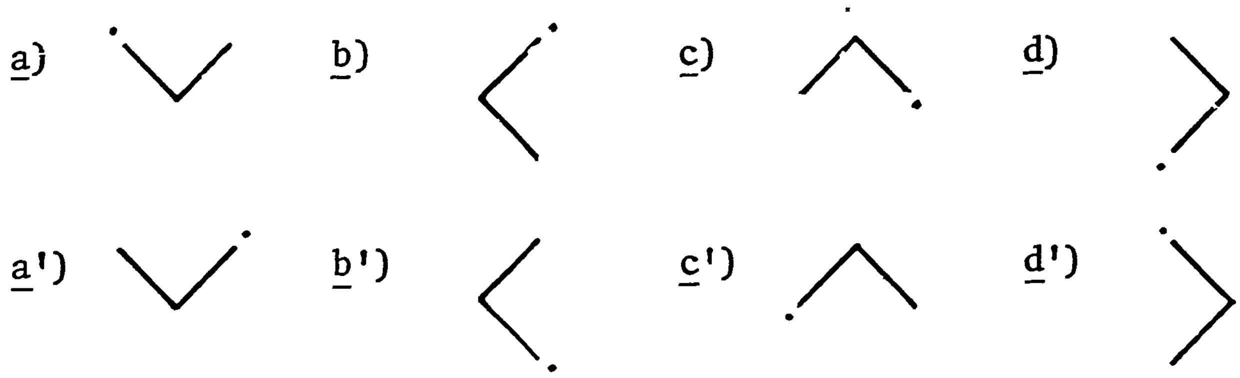
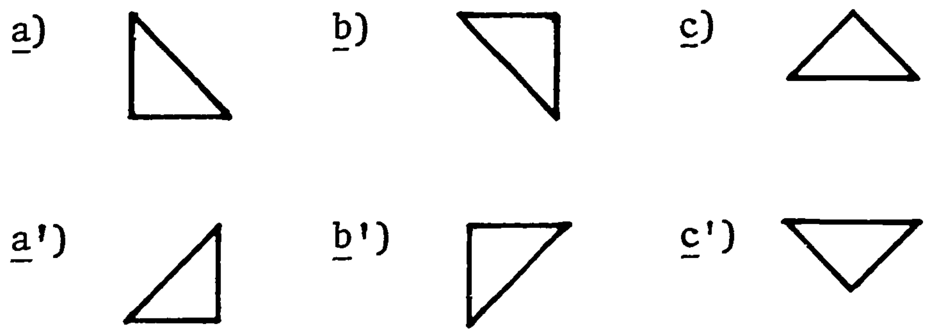
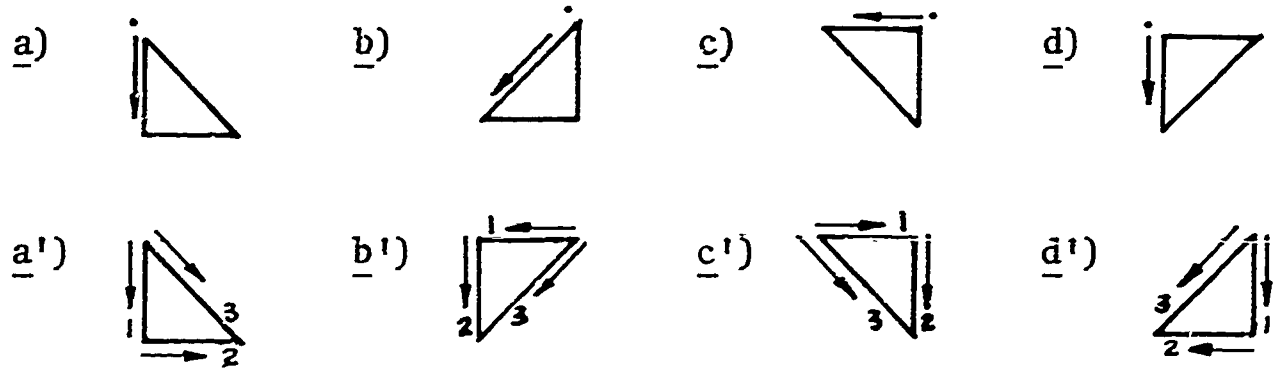


Basic XIII



Basic XIV



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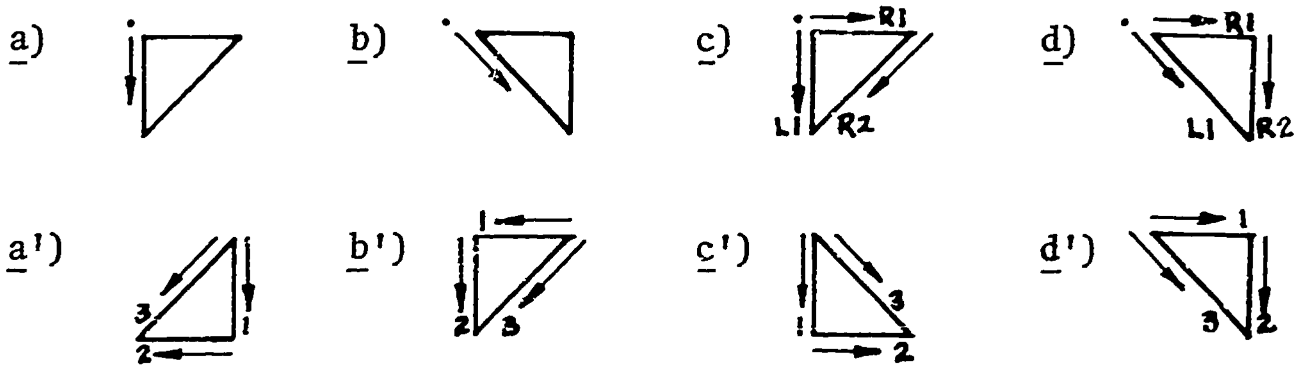

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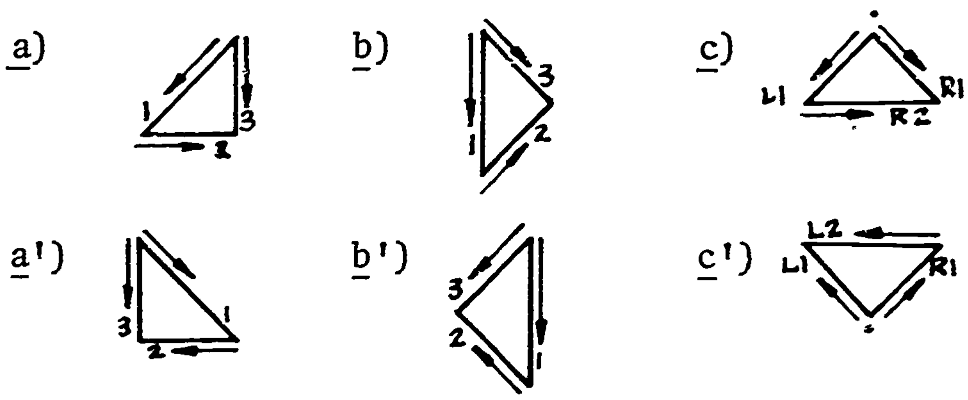
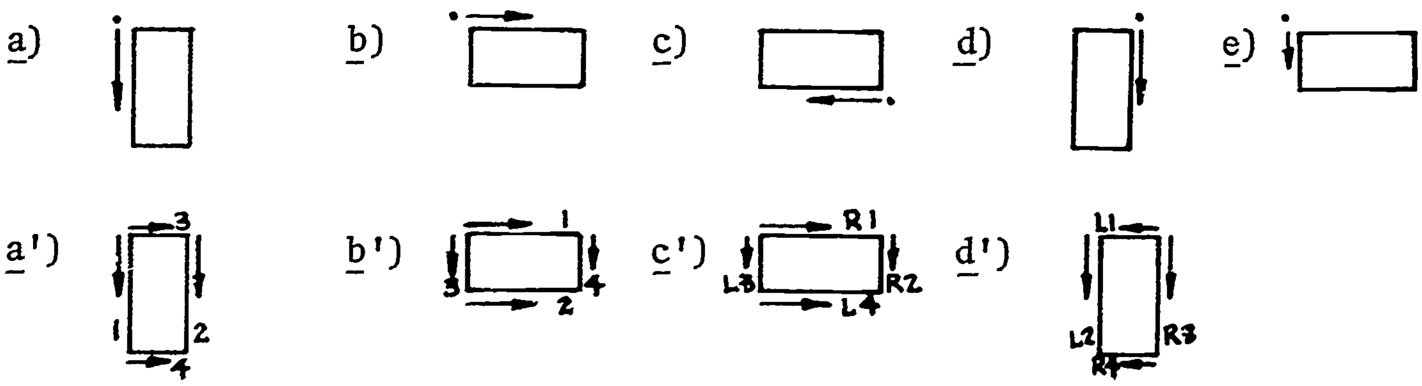


Basic XVII

Basic XVIII



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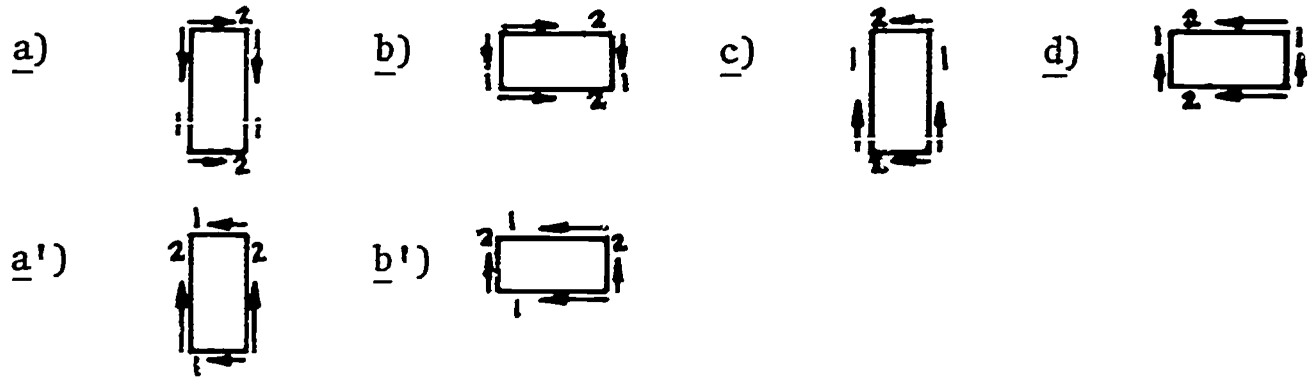
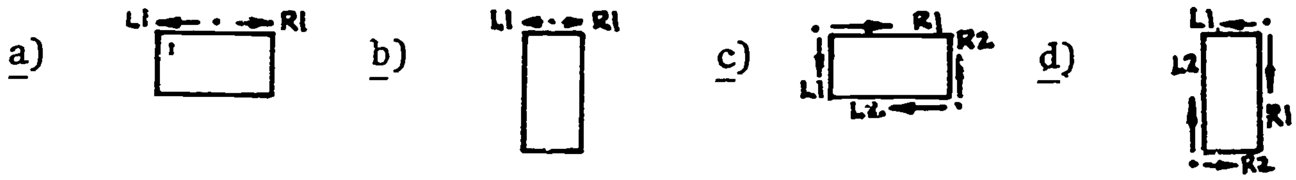
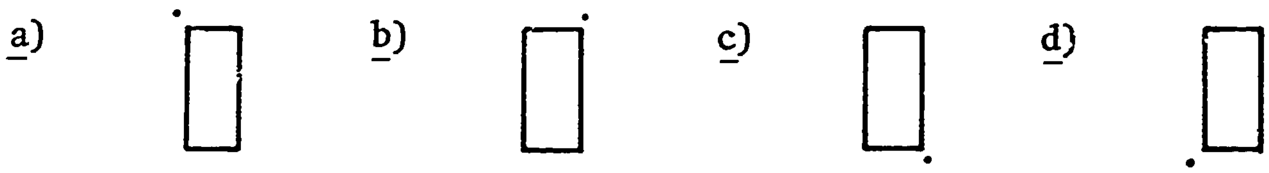


Basic XX



Basic XXI



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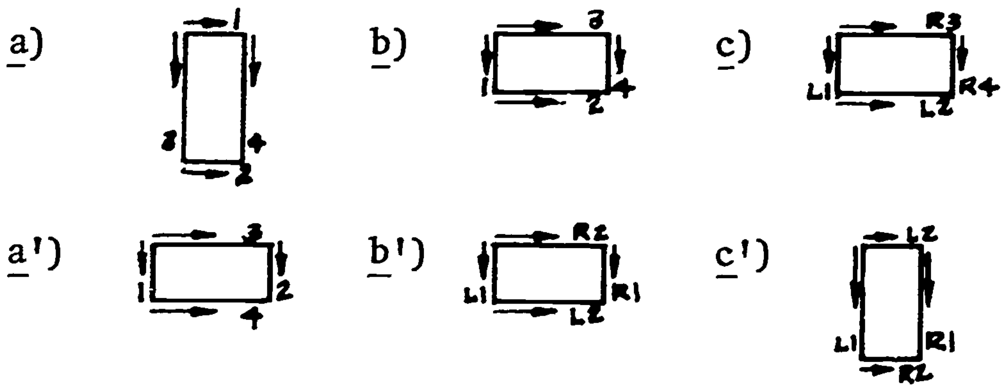

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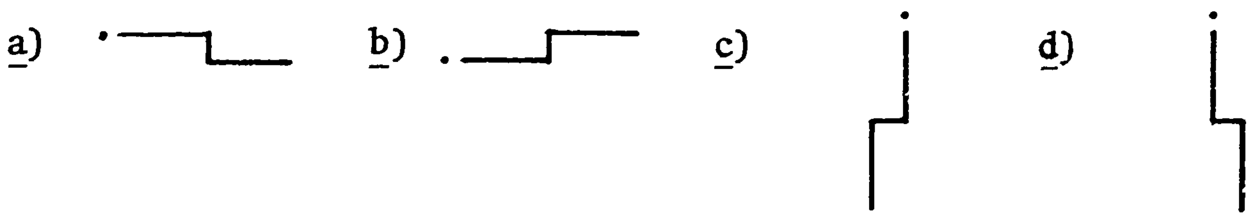
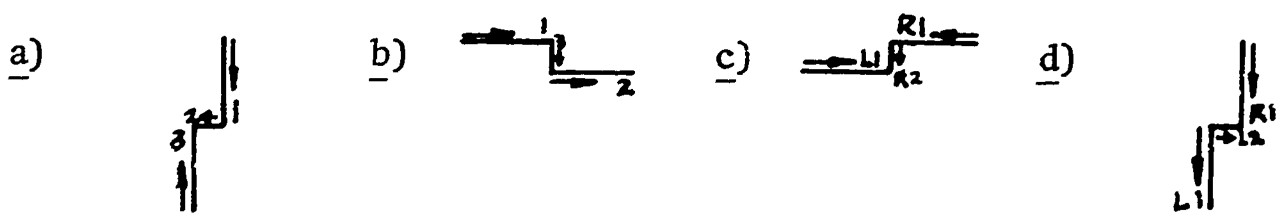
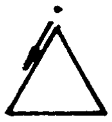
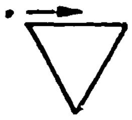


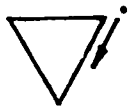
Basic XXIV

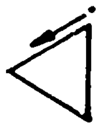


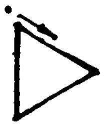
Basic XXV

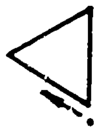
a) 

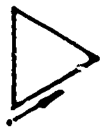
b) 

c) 

a') 

b') 

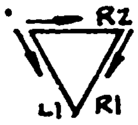
c') 

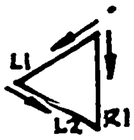
d') 

Basic XXVI

a) 

b) 

c) 

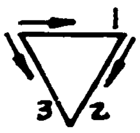
d) 

a') 

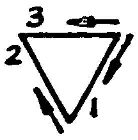
b') 

Basic XXVII

a) 

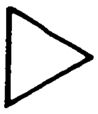
b) 

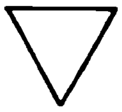
c) 

d) 

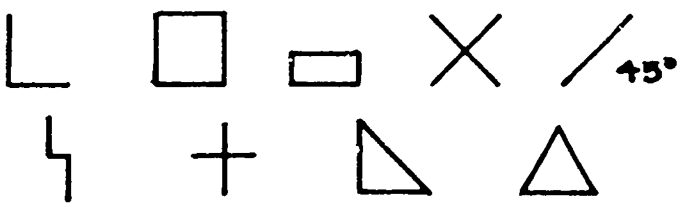
Basic XXVIII

a) 

b) 

c) 

Basic XXIX



Basic XXX

a) 

b) 

c) 

d) 

Lesson One

Square

A. Introduction

1. E: Good morning, _______. I'm _______. Come in and sit down. I'm going to teach you something new, something about seeing. You'll be looking carefully with your eyes and working with your fingers and hands. I'll tell you or show you what to do; then you will do it.

2. E: Let's look at this picture (Picture 1). It is made of many different lines and shapes. We're going to learn about these lines and shapes.

3. E: First, let's look very carefully at this shape. (E traces around a square in the picture.) This shape is called a square. Here is another square. [E draws a 7 cm (approximately 3") square on cb in the upper left-hand corner.] This shape is also a square. (E places a 9 cm solid square on cb.) Can you tell me what this is? (E places on cb an 18 cm square template and, after S has answered, indicates both the negative and positive shapes by tracing around them with his finger.) There are two squares here. Today we are learning about squares. (E removes squares from cb.)

B. Tactile stimulation, beige rugging

1. E: Before we begin, let's rub our hands on this square until they feel tingly (10 seconds). (E demonstrates by rubbing both hands on textured square.)

C. Solid square, continuous gross tracing, 2P, 20 cm, cb

1. E: I'm going to put these squares on the board like this. [E places two solid squares on cb about 10 cm (approximately 4") apart and parallel to each other.] I'll show you what you will do. Then you will do it. Stand in front of the chalkboard here (between the two squares) and put your arms out straight like this. Then start here (upper left corners) and draw the squares with these two fingers (IF and MF) like this. (E traces the patterns, returning to starting position.) Each time I'll show you how to do it. Look very carefully.

2. Two-A, IMF, Basic I, a, return

3. Two-H, Basic I, b, return

4. Two-H, Basic I, c, return

5. Two-A, IMF, Basic I, d, return

D. Recall

1. E: What were you drawing? (If subject cannot answer, E tell him.)

E. Solid square, gross tracing, 1P, 20 cm, cb

1. Two-A, IMF, parallel, Basic II, a, b. (E rotates cw.)

2. Two-H, parallel, Basic II, c, d. (E rotates cw.)

3. One-H, D, discontinuous, Basic III, a, b. (E rotates cw.)

4. One-H, ND, discontinuous, Basic III, c, d. (E rotates cw.)

F. Recognition, cb

1. E: I'm going to draw some shapes on the chalkboard. You look very carefully. Wait until I've drawn them all, then point to the square. (E draws a triangle, a rectangle, an X with 90 degree angles, and a square--all with dimensions of about 9 cm. If S points to an incorrect figure, E says, "No, point to the square.")

G. Square template, 18 cm, table, sb

1. Continuous fine tracing

a. DIF, Basic I, b, return; NDIF, a. (E rotates cw.)

b. DMF, Basic I, c', return; NDMF, b'. (E rotates cw.)

c. NDFF, Basic I, d, return; DFF, c. (E rotates cw.)

d. NDIF, Basic I, a', return; DIF, d'. (E rotates cw.)

2. Rotating, 18 cm

a. Ccw against D-palm. (D-palm is lightly cupped around edge of template. S turns ccw with NDH one full square. Square is held upright in line of vision. Unless otherwise indicated, this pattern will be followed in subsequent rotation exercises.)

b. Cw against ND-palm

3. Fine tracing, 9 cm and 18 cm

a. NDMF, Basic IV, a, 9 cm

b. DMF, Basic IV, b, 9 cm

c. DFF, Basic IV, c, 18 cm

d. NDFF, Basic IV, d, 18 cm

e. DIF, Basic IV, a, b, 9 cm

f. NDIF, Basic IV, c, d, 9 cm

H. Drawing, table, magic board

1. E: Will you draw this square on the magic board? (E presents to S a magic board and a 9 cm solid square.) E: What have you drawn?...(S "erases" drawing.)

I. Review, table, sb

1. E: Will you draw with this finger (DIF) a square in this picture (Picture 1). (If S fails, E asks him to look again; if he fails a second time, E draws around a square and names it.)

2. E: _______, you did very well. Will you come back in a few days to work with more shapes?...Good. I'll see you then; good-by. (This is a general statement. Reinforcement should be appropriate to the responses given by S.)

Lesson Two

I. Square (Continued)

A. Tactile stimulation, rubber matting. (Vertical rubbing, 5 seconds; horizontal rubbing, 5 seconds. Unless otherwise indicated, the pattern of vertical and horizontal rubbing will be followed in subsequent periods of tactile stimulation.)

B. Review, table, sb

1. E: Can you find a square in this picture (Picture 1) and draw it with your finger?

C. Solid square, gross tracing, 1P, 20 cm, cb

1. Two-A, parallel line tracing

a. IF, Basic II, c'

b. MF, Basic II, a'

c. FF, Basic II, a

d. IF, Basic II, c

2. One-H, continuous tracing

a. D, Basic I, a'

b. ND, Basic I, c', b

c. D, Basic I, d

3. Two-A tracing

a. IF, Basic V, a, c

b. MF, Basic V, b, d

D. Square template, fine parallel line tracing, 1P, 18 cm, table, sb

1. MF, Basic II, b'

2. IF, Basic II, b

3. FF, Basic II, d'

4. IF, Basic II, d

E. Wire square, 18 cm, table, mb

1. Rotating

a. Ccw against D-palm, Basic VI, a, return

b. Cw against ND-palm, Basic VI, b, return

2. Rotating with pinch

a. Cw against DT and DIF, Basic VI, a, return. [Rotation starts and ends at (·) position. Pinch is on front and back surfaces of triangle as it is held upright by S directly in line of vision. Unless otherwise stipulated, this procedure will be used for all instances of rotation with pinch.]

b. Ccw against NDT and NDIF, Basic VI, b, return

F. Drawing, table, magic board

1. E: Will you draw this square (9 cm solid) on the magic board?

II. Corner

A. Tactile stimulation, rough burlap

B. Introduction, table, sb

1. E: This is a corner. (E traces with his finger an 18 cm template of a corner.) This is a corner. (E places a 9 cm wire corner on a corner of a 20 cm solid square. He repeats this procedure for each of the remaining corners of the square.)

C. Template of corner, continuous tracing, 2P, 20 cm, cb

1. Two-A, Basic X, a, return (E rotates cw); b, return. (E rotates cw.)

2. Two-H, Basic X, c, return (E rotates cw); d, return. (E rotates cw.)

D. Solid square, fine tracing, 20 cm, table, sb

1. DMF, Basic X, b. (E directs S to draw the entire length of each line forming the corner of the square; after which he asks, "What have you drawn?") S: A corner of a square.

2. DMF, Basic X, c', d', a. (The above procedure is followed.)

3. E: See how many corners a square has. (E points to each corner with his finger.) Now you point to the corners of the square.

Lesson Three

Straight Line

A. Tactile stimulation, sandpaper

B. Introduction, table, mb, cb

1. E: Do you remember what this is? (E draws a 7 cm freehand square on cb.) I made this square with straight lines. This is a straight line. (E indicates side of drawn square.) This is a straight line. (E indicates another side.)

2. E: Here is a straight line. (E presents the 9 cm wire line in the vertical position.) Here is another straight line. (E places the 18 cm wire line in the horizontal position.) Here is a straight line. (E presents the 20 cm wire line in a position diagonal from upper left to lower right.)

3. (E draws some straight lines of various lengths and directions on cb.) E: What are these called?

4. E: Look at our picture (Picture 1). Here is one straight line. (E traces along the left side of the equilateral triangle in upper left of picture.) Can you draw another line?

C. Tactile stimulation, towelling

D. Straight line template, gross tracing, 1P, 2P, 20 cm, cb

1. One-H, D, 1P, Basic VII, a

2. Two-H, parallel, 2P, Basic VII, d

E. Wire lines, 20 cm, table, mb

1. Rolling. (Wire line is placed at heel of NDH and rolled with a reciprocal action by DH to finger tips of NDH and heel of DH. Wire is returned to starting position. Action is continued for 10 seconds.)

2. Fisting, non-stationary line

a. DH, vertical, top to bottom, return. (NDH holds lower end of wire in vertical position. DH grasps wire in web of hand, then moves from position at top of wire to one at bottom, while NDH grasps wire at opposite end.)

b. NDH, horizontal, end to end, return. (DH holds far end of wire on D-side in horizontal position. NDH grasps wire in web of hand on ND-side and moves to opposite end of wire.)

F. Straight line template, gross tracing, 1P, 2P, 20 cm, cb

1. One-H, ND, 1P, Basic VII, b

2. Two-H, parallel, 2P, Basic VII, c

G. Wire lines, 20 cm, table, mb

1. Pinching

a. DT and DIF, horizontal position, right to left, return

b. NDT and NDIF, horizontal position, left to right, return

c. NDT and NDIF, vertical position, top to bottom, return

d. DT and DIF, vertical position, bottom to top, return

2. Vertical and horizontal rotating

a. Basic VIII, a, return. (Wire is held in place by pressure from RIF and LIF.)

b. Basic VIII, b, return

H. Tactile stimulation, beige rugging

I. Straight line template, fine tracing, 1P, 2P, 20 cm, table, sb

1. LRIF, parallel, 2P, Basic VII, a

2. DMF, 1P, Basic VII, b

J. Textured parallel lines (Picture 2), table, sb

1. LRH, palmar tracing

a. Vertical position, bottom to top, return

b. Horizontal position, right to left, return

K. Straight line template, fine tracing, 1P, 2P, 20 cm, table, sb

1. LRFF, parallel, 2P, Basic VII, c

2. NDIF, 1P, Basic VII, d

L. Drawing, table, sb

1. E: Will you draw this square? (E demonstrates by drawing around inside of 18 cm square template with finger of his choice. Template is lined up with edge of sb directly in front of S.)

M. Construction, table, mb

1. E: Can you make a square here (E draws around the outside of 18 cm solid square) with these straight lines? (S puts four wire lines around solid square. E removes the square and wire lines.)

2. E: Now let's see if you can make a square like this square with these straight lines. Make it like this square. (E places 18 cm square template in front of S and then draws around inside of it, after which template is placed above the construction area and parallel to the edges of mb.)

3. [When S has completed his square, E says, "Let's see what a good square you made. Is your square like this square" (18 cm wire square)? E places wire square over constructed square but parallel to the edge of the table.] E: Is your square like my square? (If it is not, E says "Can you make your square just like this one?" E places wire square on top of template; S tries again. And again his square is checked for accuracy with the wire square.)

Lesson Four

Cross

A. Tactile stimulation, towelling

B. Review, table, mb, cb

1. E: Will you make a square with these four straight lines around this square? (E places 18 cm solid square directly in front of S on mb and traces around it with his DIF starting in upper left corner.)

2. E: Will you point to all of the corners? (If S has difficulty, E asks, "Is there another corner?" If necessary, E takes S's DIF and points with it to each corner, saying, "This is a corner."

3. E: Now put the lines of the square together like this. (E demonstrates by drawing four straight lines parallel to each other on cb.) Put the straight lines of the square here. (E points to a location on the dominant side of S adjacent to solid square.)...Look carefully; the straight lines are all the same. A square has corners (E points to each of the four corners of solid square) and straight lines. (E points to each of the four lines.)

C. Introduction, table, mb, cb

1. E: This is a cross. (E places 20 cm wire cross in front of S. After S has observed it, E moves it toward the top of mb on S's dominant side.) E: This is a cross. (E places Picture 3 in front of S on mb.) E: This is a cross. (E places template of 18 cm cross on cb and draws the cross with his DIF from top to bottom and from left to right.)

D. Tactile stimulation, hand-rubbing (fingers extended, palms together, sliding motion, 5 seconds); hand-wringing (palms crossed, fingers flexed around dorsal side of hands, positions reversed with rotary action, 5 seconds)

E. Template of cross, gross tracing, 18 cm, cb

1. One-A, D, Basic IX, a, b

2. One-H, D, Basic IX, c, d

F. Wire cross, 18 cm, table, mb

1. Pinching corners of cross. (E chooses appropriate pattern below.)

a. DRT and DRIF, Basic X, a, b, c, d

b. DLT and DLIF, Basic X, d', c', b', a'

2. Pinching cross. (E chooses appropriate pattern below.)

a. DRT and DRIF, Basic IX, a, a'

b. DLT and DLIF, Basic IX, d, d'

G. Template of cross, fine tracing, 18 cm, table, sb

1. DIF, Basic IX, d, a. (E rotates ccw.)

2. DMF, Basic IX, c, b. (E rotates ccw.)

H. Swimming game, table, sb

1. E: Make-believe this (18 cm solid square) is a swimming pool filled with water. You want to swim in a straight line from here (middle of top of solid square) to here (middle of bottom of solid square). Show me with this straight line (18 cm paper line) how you would go. (Line remains in place.)

2. E: Now make-believe you want to swim from here (middle of left side of solid square) to here (middle of right side of solid square). Show me with a straight line (18 cm paper line) how you would go.

3. E: What have you made?

I. Template of cross, fine tracing, 18 cm, table, sb

1. NDFF, Basic IX, a', d'. (E rotates cw.)

2. NDIF, Basic IX, b', c'. (E rotates cw.)

J. Tactile stimulation, sandpaper

K. Template of cross, fine tracing, 18 cm, table, sb

1. DFF, Basic IX, a. (E rotates cw.)

2. MF, alternating D-ND (1=DMF; 2=NDMF), Basic IX, b. (E rotates cw.)

L. Tactile stimulation, rough burlap

M. Template of cross, fine tracing, 18 cm, table, sb

1. DIF, Basic IX, c. (E rotates ccw.)

2. FF, alternating ND-D (1=NDFF; 2=DFF), Basic IX, d. (E rotates ccw.)

N. Construction, table, mb

1. E: Can you make a cross here (E traces Picture 4 with his finger) with these straight lines (two 9 cm, black paper strips)? (S places strips over line drawing of Picture 4. E removes strips.)

2. E: Now will you draw with this finger (DMF) each straight line of the cross....What have you drawn?

Lesson Five

I. Corner and Cross (Continued)

A. Tactile stimulation, rubber matting

B. Recall, table, mb

1. E: Do you remember what the name of this is? (E presents on mb a 9 cm wire corner.)

C. Wire cross, fine tracing of corners, 18 cm cross, 9 cm corner, table, mb

1. For DRH subjects;

a. [E places 9 cm wire corner (model) directly above working space on mb in position a of Basic X. E then places 18 cm wire cross on mb in front of S.]

b. E: Can you find the corner in the cross which looks like this corner? (E points to model.) Now draw the corner with these fingers (DT and DIF) from here to here (position a of Basic X). (E rotates 9 cm wire corner to position b of Basic X.)

c. (E repeats procedure 1b above making appropriate changes in the model and in the drawing instructions according to Basic X, b, c, d.

2. For DLH subjects:

a. [E places 9 cm wire corner (model) directly above working space on mb in d' position of Basic X. E then places 18 cm wire cross on mb in front of S.]

b. (E repeats procedures 1b above, utilizing d', c', b', and a' of Basic X in that order.)

D. Comparison and construction, table, mb

1. (Wire cross, 18 cm, is placed by E on mb in front of S.) E: Put this corner (9 cm wire) in each corner of the cross (18 cm wire). (S uses any sequence.)

2. (E places 18 cm solid square in front of S on mb.) E: What is this?

3. E: Can you find the corners of the square? Put this corner (9 cm wire) around each corner of the square (18 cm solid).

4. (E places 18 cm template of cross in front of S on mb.) E: Make a cross on this cross with these lines (two 18 cm paper lines).

II. X (Diagonal Cross)

A. Review and introduction, table, mb

1. (E places 18 cm wire cross on mb.) E: What is the name of this?...(E rotates cross to X position.) This is another kind of cross. We will call it an X.

2. (E places 18 cm X template on mb directly in front of S.) E: This is an X. (E removes template and places 9 cm wire X in front of S.) This is an X.

B. Tactile stimulation, sandpaper

C. X template

1. Parallel gross tracing, 2P, 18 cm, cb

a. Two-A, Basic XI, b

b. Two-H, Basic XI, d

2. Fine tracing, 1P, 18 cm, table, sb

a. DMF, Basic XI, a, a'. (E rotates cw.)

b. DIF, Basic XI, c, c'. (E rotates cw.)

3. Parallel gross tracing, 2P, 18 cm, cb

a. Two-H, Basic XI, a

b. Two-A, Basic XI, c

D. Game, table, sb

1. E: Make-believe you are playing ball with your friend (name may be mentioned). You are in this corner (upper left of 18 cm solid square), and your friend is in this corner (lower right of square). Show me with a line (25.5 cm, black paper strip) how straight you would throw the ball so that your friend could catch it. (Paper line remains in place.)

2. E: Now make-believe you want to kick the ball to another friend. (E may mention the name of a friend of S's.) You are in this corner (upper right), and your friend is in this corner (lower left). Show me with a line how straight you would kick the ball so that your friend _______ could catch it.

3. E: What have you made?

E. X template, fine tracing, 18 cm, table, sb

1. IF, alternating ND-D, Basic XI, b'

2. MF, alternating D-ND, Basic XI, c'

F. Games, table, mb

1. E: Give me (E uses finger puppet) an X (9 cm wire). (S chooses from among an 18 cm wire line, a 9 cm solid square, and a 9 cm wire X.)

2. (E removes all items except 9 cm wire X which is placed in front of S.) E: Can you make the X into a cross?

Lesson Six

X (Continued)

A. Tactile stimulation, rubber matting

B. Review, table, mb

1. E: Can you find and draw an X in this picture (Picture 1)?

2. (E places 18 cm wire cross on mb directly in front of S.) E: What is the name of this? (E rotates the cross cw to the X position.) E: What is the name of this?

3. (E puts 18 cm template of X on mb directly in front of S.) E: Can you put this corner (9 cm wire) in a corner of the X (template)?... In another corner?...Now draw with this finger (DIF) another corner of the X....Another....

C. Tactile stimulation, fine burlap

D. X template, parallel gross tracing, Two-A, 2P, 18 cm, cb

1. Basic XI, a, d

2. Basic XII, a', b', c', d'

3. Basic XI, d', a'

E. Wire X, pinching, 18 cm, table, mb

1. DT and DIF, Basic XI, b

2. NDT and NDIF, Basic XI, c

F. Construction, table, mb

1. (E places 18 cm template of X in front of S and two 18 cm paper strips at his D-side.) E: Will you make an X here (on top of template) with these lines (black paper strips)?

2. E: Now put each line here [D-side, 5 mm (about 1/4") apart]. Look carefully. They are the same. (E must be sure the strips are lined up evenly so that S can see that they are of equal length. E indicates top and bottom evenness by pointing with a sweeping motion.)

G. Wire corner, pinching, 9 cm, table, mb

1. NDT and NDIF, Basic XII, b

2. DT and DIF, Basic XII, d

H. X template, fine tracing, 18 cm, table, sb

1. DIF, Basic XI, c'

2. DMF, Basic XI, a'

I. Wire corner, pinching, 18 cm, table, mb

1. DT and DIF, Basic XII, c

2. NDT and NDIF, Basic XII, a

J. X template, fine tracing, 18 cm, table, sb

1. NDMF, Basic XI, b'

2. DIF, Basic XI, d'

K. Construction, table, mb

1. E: Will you make an X with these two lines (25.5 cm, black paper lines) here (on 18 cm solid square)?

Lesson Seven

I. X (Continued)

A. Tactile stimulation, cardboard. (S holds cardboard in one hand and rubs fingers and palm of other hand against it for 5 seconds. Process is reversed, 5 seconds.)

B. Review, table, mb, sb, cb

1. (E presents directly in front of S on mb an 18 cm wire X and asks S to name it. E then places sb in the vertical position in front of S and puts wire X toward upper end, center.) E: Can you make an X with these lines? (E places two 18 cm, white magnetic lines on D-side of S.)

2. E: Will you put this X (wire) on yours and see if they are alike? (E directs S to make corrections if necessary.)

3. E: Now will you make the lines of your X look like these lines. (E draws two vertical parallel lines on cb about 5 mm apart. If S's lines are not parallel and even at the top and bottom, E asks S if his lines look like the one's on the chalkboard. If, after several attempts, S is unable to make the lines parallel and even, E completes the task while S observes.

4. E: Draw your lines (magnetic) from here to here (top to bottom) with these two fingers (DIF on one line and DMF on the other line).

5. E: What can you say about these lines? (E elicits response, "They are alike." If S is unable to answer correctly after some time, E may ask, "Are they alike?" E reinforces the final response by saying, "They are alike; an X is made with two straight lines.")

C. Tactile stimulation, rubber matting

D. X Template

1. Parallel gross tracing, 2P, 18 cm, cb

a. Two-A, Basic XI, a

b. Two-H, Basic XI, b

2. E: Point to the corners of an X. (S should point to all four corners of one X in any sequence with any finger.)

3. Parallel gross tracing, 2P, 18 cm, cb

a. Two-H, Basic XI, c

b. Two-A, Basic XI, d

E. Wire corner, pinching, 18 cm, table, mb

1. DT and DIF, Basic XII, a

2. DT and DMF, Basic XII, c

F. X template, fine tracing, 2P, 18 cm, table, sb

1. IF, Basic XI, c'

2. FF, Basic XI, d'

G. Construction, table, mb

1. E: Can you make a square around this X (Picture 5) with these corners? (E presents two 9 cm wire corners to S on his D-side.)

2. E: Look where the lines of the X come--to the corners of the square. Will you point to the corners of the square which you made?

II. Right Triangle

A. Introduction, table, sb in vertical position, cb

1. (E presents a solid right triangle, 14 cm, in position a of Basic XIII directly in front of S.) E: This is a right triangle. (E moves triangle to upper part of sb.)

2. (E presents a wire right triangle, 18 cm, in same position as above on a sheet of 8-1/2 x 11" white paper directly in front of S on sb.) E: This is a right triangle.

3. [E draws on cb a 25 cm right triangle (vertical and horizontal sides approximately 10") in the same position as above.] E: This is a right triangle.

B. Tactile stimulation, towelling

C. Solid right triangle, continuous gross tracing, 2P, 18 cm, cb

1. Two-A, Basic XIV, a, return. (E rotates ccw.)

2. Two-H, Basic XIV, b, return

D. Wire right triangle, rotating, 18 cm, cb

1. Ccw against NDH

E. Solid right triangle, continuous gross tracing, 2P, 18 cm, cb

1. Two-A, Basic XIV, c, return. (E rotates ccw.)

2. Two-H, Basic XIV, d, return

F. Wire right triangle, rotating, 18 cm, table, mb

1. Cw against DH

G. Solid right triangle, fine tracing, 9 cm, table, sb

1. DMF, Basic XIV, a' (E rotates cw); NDMF, b'

2. DFF, Basic XIV, c' (E rotates cw); NDFF, d'

H. Construction, table, sb

1. E: Can you make a square from these right triangles? (E places two 18 cm solid right triangles directly in front of S but above working area in the positions of a' and a of Basic XIII. Square is checked with 18 cm wire square placed parallel to edges of sb.)

Lesson Eight

Right Triangle (Continued)

A. Review, table, sb

1. E: Do you remember what this is? (E places an 18 cm solid right triangle on sb in position a, Basic XIII, directly in front of S.)

2. E: What is the name of this? (E presents a 14 cm solid right triangle in position b, Basic XIII, directly in front of S; then E rotates the right triangle to the position of c, Basic XIII, and repeats the question.)

B. Tactile stimulation, sandpaper block

C. Solid right triangle, fine tracing, 9 cm and 18 cm, table, sb

1. DIF, continuous, Basic XV, a, 18 cm

2. IF, Basic XV, c, 18 cm

3. DMF, continuous, Basic XV, b, 9 cm

4. MF, Basic XV, d, 9 cm

D. Solid right triangle, fine tracing, 18 cm, sb

1. DT and DIF, Basic XIII, a. (S holds right triangle upright with NDH. Lower edge is supported on sb. DT and DIF spread out from apex of angle along edges of triangle as far as hand will allow. E rotates cw.)

2. DT and DIF, Basic XIII, c, a'. (Above procedure is repeated for each position.)

E. Wire right triangle, rotating with pinch, 18 cm, table, mb. (E chooses the appropriate pattern below.)

1. Ccw against DRT and DRIF, Basic XIII, a

2. Cw against DLT and DLIF, Basic XIII, a'

F. Template of right triangle, fine tracing, 18 cm, table, sb. (E chooses the appropriate pattern below.)

1. DRMF, Basic XVI, a, b

2. MF, Basic XVI, c

3. DLMF, Basic XVI, a', b'

4. MF, Basic XVI, c'

G. Solid right triangle, fine tracing, 18 cm, mb

1. NDT and NDIF, Basic XIII, a, c, a'. (See D1, above.)

H. Wire right triangle, fine tracing, 18 cm, mb

1. RT and RIF, Basic XVII, a. [Right triangle is adhered to mb. T and IF start movement together at (·) and proceed along edges as far as hand will extend.]

2. LT and LIF, Basic XVII, b

3. RT and RIF, Basic XVII, c

I. Game, table, sb

1. (E places directly in front of S an 18 cm solid square and on his D-side one 25.5 cm, black paper line.) E: Can you make two triangles with this square and line? (E makes certain paper line lies flat.)

a. E: Will you point to a right triangle?

b. E: Will you point to another right triangle? (E leaves completed work in front of S.)

2. (E places another 25.5 cm, black paper line on D-side of S.) E: Can you now make an X on this square? (S adds a line to the one on the square.)

J. Right triangular template, fine tracing, 18 cm, table, sb

1. DIF, Basic XV, a'

2. NDIF, Basic XV, c'

3. DMF, Basic XV, b'

4. NDMF, Basic XV, d'

K. Comparison and measurement of triangle and square, table, mb

1. E: Listen very closely and look very carefully. I'm going to see how well you can play this game. You will have to listen very closely and look very closely if you want to play the game.

2. (E places a 9 cm solid square and a 9 cm solid right triangle in front of S, the square to the right side and the right triangle to the left side in the position of a, Basic XIII.) E: Will you put this corner (9 cm wire) around this corner? (E points to upper left of square.)...Are the corners alike?...Will you put the corner (9 cm wire) around this corner? (E points to upper right corner of square.)...Are the corners alike?...Now around this corner. (E points to lower right corner of square.) Look very closely. Do the corners look alike?...Now put the corner (9 cm wire) around this corner of the square. (E points to lower left corner of square.)...Are the corners alike? (Corrections are made if necessary.)

3. E: Tell me, are all of the corners of the square like this corner? (E points to the 9 cm wire corner which is silhouetted against mb.) S: Yes. E: Yes, all of the corners of the square are like this corner. (E points to the 9 cm wire corner.)

4. E: Now put this corner (9 cm wire) around this corner of the right triangle (90° corner). Are the corners alike?...Put this corner (9 cm wire) around this corner (lower right) of the right triangle. Are the corners alike? Look carefully. S: No. E: Good, this corner of the right triangle (E points to lower right corner) is not like this corner (9 cm wire corner). (When measuring corners of triangle, E places wire corner along vertical or horizontal edge of triangle.)

5. E: Put the corner (9 cm wire) around this corner (apex) of the right triangle. Are the corners alike? S: No. E: Very good. The corners are not alike.

6. E: Can you point to all of the corners of the square that are alike?...E: All of the corners of a square are alike. One corner of a right triangle is like the corners of the square. Can you draw (with any finger) the corner of the right triangle which is like the corner of the square?...The other corners of the right triangle are not like the corners of the square; can you draw these corners? (When drawing the corners, S should draw the entire length of each side which forms the corner.)

7. E: You have played the game very well.

L. Construction, table, mb

1. E: Now we're going to play a puzzle-game. Can you make a right triangle with this corner and these lines? (E puts in front of S one 25.5 cm, black magnetic line in the vertical position on the left side of an 18 cm right corner (wire) placed in position a, Basic X. (When S completes the figure, E removes the parts.)

2. E: Can you make a right triangle from these lines? [One 12.5 cm and two 9 cm, black magnetic lines are presented horizontally with one short line on top, the long line in the middle, and the other short line on the bottom. The left-hand margin is even, and the lines are about 1 cm (about 1/2") apart. S and E check the triangle made by S with the 9 cm wire right triangle. Corrections are made if necessary.]

Lesson Nine

Rectangle

A. Introduction, table, sb, cb

1. E: Here are two squares (9 cm solid). Will you put them together here. (E points to a place directly in front of S on sb.)... You have made a rectangle. Here is a rectangle (10 x 20 cm solid, vertical position). This is another rectangle (7 x 10 cm solid, horizontal position). Here is a rectangle. E draws a freehand, 25 x 3 cm (approximately 10 x 1-1/4") rectangle on cb in horizontal position.

B. Tactile stimulation, rough burlap

C. Solid rectangle, gross tracing, 2P, 1P, 18 x 9 cm, cb

1. Continuous tracing

a. Two-A, 2Γ, Basic XVIII, a

b. Contiguous arm-palm-fingers, 1P, Basic XVIII, b. (Palms are held together; fingers and arms are outstretched. Lines are drawn with finger tips.)

2. Parallel tracing, 1P

a. Two-A, Basic XIX, a, b

b. Two-H, Basic XIX, c, d

D. Recall

1. E: What have you been drawing?

E. Tactile stimulation, towelling

F. Rectangular template, continuous fine tracing, 18 x 9 cm, table, sb

1. NDIF, Basic XVIII, c

2. NDMF, Basic XVIII, d

G. Rectangular solid, rotating, 10 x 20 cm

1. Ccw against DH (starting position: vertical)

H. Rectangular template, discontinuous fine tracing, 7 x 10 cm, table, sb

1. DMF, Basic XVIII, a'

2. DIF, Basic XVIII, b'

I. Construction, felt board placed on sb

1. E: Can you make a rectangle with these squares? (E puts two yellow, 9 cm felt squares on D-side of S, who puts them together either horizontally or vertically so that the sides touch each other. Corrections are made by placing the 18 x 9 cm felt rectangle on top of the constructed shape and parallel to the edges of sb. If yellow rectangle is seen, it should be straightened by S.)

J. Tactile stimulation, beige rugging

K. Solid rectangle, 18 x 9 cm, 10 x 7 cm, table, sb

1. Fine tracing, 18 x 9 cm

a. FF, Basic XX, a, b

b. IF, parallel, Basic XXII, c', b'

2. Rotating, 18 x 9 cm

1. Cw against NDH (starting position: horizontal)

3. Fine tracing, 18 x 9 cm

a. NDIF, discontinuous, Basic XXII, a

b. IF, Basic XX, c

c. DMF, discontinuous, Basic XVIII, b'

d. MF, Basic XX, d

4. Fine tracing, 10 x 7 cm

a. LT and LIF, Basic XXI, a. [Rectangle is adhered to sb. T and IF start together at corner (·) and proceed along edges as far as hand will extend.]

b. RT and RIF, Basic XXI, b, c

c. LT and LIF, Basic XXI, d

d. IMF, Basic XVIII, d'

e. IF, Basic XVIII, c'

L. Construction, table, felt board

1. (E places 18 x 9 cm greenfelt rectangle in center of felt board.) E: What is this?...Can you make a rectangle on top of this rectangle (E points to green rectangle) with these shapes? (E places one 9 cm, yellow square and two 4.5 x 9 cm, light green rectangles on D-side of S. Upon correct completion, small shapes are removed.)

2. E: Will you make a rectangle with these shapes here (on top of green rectangle)? (E puts one 9 cm, yellow square and four 4.5 cm, red squares on D-side of S.)

3. E: What have you made? S: A rectangle.

Lesson Ten

Rectangle (Continued)

A. Review, table, cb, mb

1. E: What is the name of this? (E places 7 x 10 solid rectangle on cb in horizontal position.) What is this called? (E places 18 x 9 cm wire rectangle on mb in vertical position.) What is this? (E puts 9 x 12 solid rectangle on cb in vertical position. If S says, "A square," E places a 9 cm square next to the rectangle and asks, "What is this?...Are these shapes alike?"...E then holds square on top of rectangle with one finger so that the figure is not obscured from S's view and says, "Do you see that they are not alike?...Which one is the rectangle?"...E removes square and asks S to name the shape remaining on cb.)

B. Tactile stimulation, cardboard

C. Solid rectangle, gross tracing, 18 x 9 cm, cb

1. Contiguous arm-palm-fingers, discontinuous, Basic XVIII, a'

2. Contiguous arm-palm-fingers, Basic XXII, b

E. Tactile stimulation, towelling

F. Wire rectangle, 18 x 9 cm, table, mb

1. Pinching, discontinuous

a. DT and DIF, Basic XVIII, a'

b. NDT and NDIF, Basic XXII, a'

2. Rotating

a. Ccw against DH

G. Drawing, table, magic board

1. Solid rectangle, 10 x 7 cm

H. Wire rectangle, 18 x 9 cm, 7 x 10 cm, table, mb

1. Fine palmar tracing, 7 x 10 cm, Basic XXII, c

2. Fine palmar tracing, 7 x 10 cm, Basic XVIII, d'

3. Rotating, 18 x 9 cm

a. Cw against NDH

I. Simultaneous comparison tracing, table, sb

1. [E places a 9 cm solid square slightly to the left of center on sb before S and to the right, a 9 x 12 solid rectangle. The shapes are 4 cm (about 1-1/2") apart.] E: Point to the rectangle....Point to the square....When I say, "Go," you draw the rectangle with this finger (RIF) starting here (upper left corner) and draw the square with this finger (LIF) starting here (upper left corner). Draw both shapes together like this. (E demonstrates, using Basic I, a, and Basic XVIII, e.) E: Draw very carefully. Are you ready? Go.

J. Construction, table, mb

1. E: Will you make a rectangle here (E points to left of center) with these lines (two 18 cm and two 9 cm wire lines placed on right side of S)? (Constructed rectangle may be in either the horizontal or vertical position, but it must be parallel to sides of mb. E checks for accuracy with 18 x 9 cm wire rectangle. If S makes an error, E places wire rectangle directly above working area and asks S to make his rectangle "like this one." Constructed rectangle remains in place.)

2. E: Will you make a square here (right of center) with these lines (four 9 cm wire lines)? (E checks with 9 cm wire square; S makes corrections if necessary as follows: S is shown wire square, then given another opportunity to make it correctly. If he is unable to remember the shape, E

places the square above the working area, and S tries again. The constructed shape is checked, and the wire model is removed from mb.)

3. E: Let's take these two lines (horizontals of rectangle) and put them here (in vertical position on left side of mb). Now take these two lines (verticals of rectangle) and put them here (in vertical position next to first set of lines). (All four lines are close together and even at base.)

4. E: Will you draw these lines like this? (E demonstrates by simultaneously drawing the two left lines with his LIMF and the two right lines with his RIMF.) E: In a rectangle we have some lines which are alike and some lines which are different--not alike.

5. (E repeats above process for the square, but disassembled lines are put on the right side of mb.) E: In a square all of the lines are alike; all of the lines are the same.

Lesson Eleven

I. Zigzag

A. Introduction, table, mb, cb

1. E: This is a new shape. Let's call it a zigzag. (E places on mb the 9 x 3 cm wire zigzag in the position of Basic XXIII, d.) Here is a zigzag. (E places 11 x 4 cm template on cb in position of a, Basic XXIII.) Here is another zigzag. [E draws a 5 x 2-1/2 x 5 cm (approximately 2 x 1 x 2") zigzag on cb in the position of Basic XXIII, c.]

B. Tactile stimulation, rubbing hands (5 seconds), wringing hands (5 seconds)

C. Zigzag template

1. Gross tracing, 11 x 4 cm, cb

a. Contiguous arm-palm-fingers, continuous, Basic XXIII, d, b

b. One-H, D, Basic XXIV, a

c. One-H, ND, discontinuous, Basic XXIV, b

2. Fine tracing, 11 x 4 cm, table, mb

a. NDMF, continuous, Basic XXIII, b

b. NDIF, continuous, Basic XXIII, d

D. Drawing, table, magic board

1. Wire zigzag, 9 x 3. (S draws one side only of wire shape.) E: What is the name of the shape you have drawn?...Will you draw this shape (E points to shape on magic board) with this finger (DIF)?

E. Zigzag template, continuous fine tracing, 11 x 4 cm, table, sb

1. DFF, Basic XXIII, a

2. DIF, Basic XXIII, c

F. Recall

1. E: What have you been drawing? (Zigzag remains in front of S on mb.)

II. Equilateral Triangle

A. Introduction, table, sb, cb

1. E: When we learned about triangles, we used this kind. (E puts 18 cm solid right triangle on sb.) There are many kinds of triangles. Here is another kind. It is an equilateral triangle. (E places solid 18 cm equilateral triangle beside 18 cm right triangle on sb.) Here is another equilateral triangle. [E draws a 13 cm (approximately 5") equilateral triangle on cb.] Here is an equilateral triangle. (E centers a 9 cm wire equilateral triangle on top of 18 cm solid equilateral triangle on sb.)

2. (E places 18 cm wire equilateral triangle on mb in front of S. Triangle is to be used as a model.) E: Look at our picture (Picture I). Can you find an equilateral triangle in it? (If S chooses wrong shape, E asks him if the shape he chose looks like the wire model on mb. He is given another opportunity to choose. If he chooses incorrectly again, E points out the correct triangle.)

B. Tactile stimulation, fine burlap

C. Solid equilateral triangle, gross tracing, 1P, 18 cm, cb

1. Contiguous arm-palm-fingers, continuous, Basic XXV, a, b

2. Continuous tracing. Choice of:

a. One-H, DL, Basic XXV, a'

b. One-H, DR, Basic XXV, b'

3. Two-A, Basic XXVI, a, b

D. Recall

1. E: What have you been drawing?

III. Zigzag (Continued)

A. Tactile stimulation, beige rugging

B. Recall

1. E: What is the name of this shape? (E places a zigzag in front of S.)

C. Wire zigzag, 11 x 4 cm, 9 x 3 cm, table, mb

1. IF, discontinuous, 11 x 4 cm, Basic XXIV, c, d

2. Pinching, continuous, 9 x 3 cm

a. NDT and NDIF, Basic XXIII, a

b. DT and DMF, XXIII, d

D. Game: Windmill puzzle, table, felt board

1. (E places Picture 6 and plastic shapes on felt board. Plastic shapes are randomly arranged, but no piece should touch another piece, and the squares should NOT be in the diamond position. (E should make these adjustments unobtrusively when shapes are spread out on felt board.)

2. E: Let's work a puzzle. Put one of these shapes (E points to the colored plastic shapes) here. (E points to Picture 6.) Put it on the shape that is like it--the shape that is the same. Look carefully.

Lesson Twelve

Equilateral Triangle and Zigzag (Continued)

A. Review, table, sb

1. E: What is the name of this shape? (E presents an 18 cm solid equilateral triangle on sb in the position of Basic XXVIII, a. If S answers, "A triangle," E asks him what kind of triangle; if he cannot respond, E tells him.)

2. E: Do you remember the name of this shape? (E presents the 11 x 4 cm zigzag template in the position of Basic XXIII, b, on sb beside the equilateral triangle.)

B. Tactile stimulation, cardboard

C. Solid equilateral triangle, gross tracing, 18 cm, cb

1. Contiguous arm-palm-fingers, Basic XXVII, a

D. Zigzag template, continuous gross tracing, 11 x 4 cm, cb

1. One-A, L, Basic XXIII, a. (Top edge is traced.)

2. One-A, R, Basic XXIII, d. (Right side is drawn.)

E. Solid equilateral triangle, gross tracing, 18 cm, cb

1. Contiguous arm-palm-fingers, Basic XXVII, b

F. Equilateral triangular template, fine tracing, 9 cm, 18 cm, table, mb

1. Continuous tracing, 9 cm. Choice of:

a. DLMF, Basic XXV, c'

b. DRMF, Basic XXV, d'

2. IF, Basic XXVI, a', 18 cm

G. Tactile stimulation, fine burlap

H. Solid equilateral triangle, 18 cm, 9 cm, table, sb

1. Fine tracing, 18 cm

a. DIF, Basic XXVII, c

b. NDIF, Basic XXVII, d

2. Rotating, 18 cm

a. Cw against NDH

3. Fine tracing, 9 cm

a. DT and DIF, Basic XXVIII. (S holds equilateral triangle upright with NDH. Lower edge is supported on sb. DT and DIF start at apex and proceed along edges as far as hand will extend. Process is repeated from each apex as triangle is rotated ccw.)

I. Tactile stimulation, beige rugging

J. Construction and comparison, table, mb

1. (E places 18 cm solid equilateral triangle in the position of Basic XXVIII, a, on mb above and slightly to the right side of the working area.) E: Will you make an equilateral triangle here (E points to area slightly to right side of S) like this one (E points to model) with these lines? (E places three 18 cm lines in vertical position about 5 mm apart on the right side of S. The constructed equilateral triangle is checked for accuracy with the wire equilateral triangle and for a base parallel to the edge of mb.)

2. (E places the 9 cm solid equilateral triangle in the position of Basic XXVIII, b, above and slightly to left side of working area. E puts three 9 cm wire lines on left side of S in vertical position about 5 mm apart.) E: Will you make an equilateral triangle here (E points to left side of 18 cm constructed equilateral triangle) like this one (E points to 9 cm model) with these lines (9 cm). (Equilateral triangle is checked for accuracy with 9 cm wire equilateral triangle by S and E.

3. E: Will you put the lines of this equilateral triangle (18 cm) here (on right side). Make them look like the lines I draw on the chalkboard. (E draws three 18 cm vertical lines about 5 mm apart.)

4. E: What can you tell me about these lines? (E elicits, then makes explicit, "They are alike; they are the same.")

5. E: The lines in every equilateral triangle are alike. In every equilateral triangle the lines are the same.

6. E: Draw these lines with these fingers (RIF-MF-RingF).

7. (The same procedure is repeated for the 9 cm constructed equilateral triangle, but the lines are put on the left side and drawn with LIF-MF-RingF.)

8. E: What can you tell me about these lines?...E: The lines in every equilateral triangle are alike. In every equilateral triangle the lines are the same.

K. Solid equilateral triangle, fine tracing, 9 cm, 18 cm, table, sb

1. DIF, continuous, Basic XXV, a, 18 cm

2. DFF, continuous, Basic XXV, a', 18 cm

3. MF, Basic XXVI, b', 9 cm

Lesson Thirteen

Equilateral Triangle (Continued)

A. Review

1. (E places on mb before S in the following order and positions: 9 cm wire right triangle, Basic XIII, a; 9 cm wire equilateral triangle, Basic XXVIII, a; 9 cm solid right triangle, Basic XIII, a'.)

2. E: Give me the equilateral triangle. (If S chooses the wrong shape, E says, "Look carefully; how can you tell if a triangle is an equilateral triangle?" S: In an equilateral triangle, all of the lines are alike, or all of the lines are the same. If S answers incorrectly, E says, "All of the lines in an equilateral triangle are alike.")

3. (S is given another opportunity to select the equilateral triangle. If he chooses the wrong shape again, E gives him a 9 cm straight line and says, "Put this line by each line of this shape (9 cm wire right triangle) like this." E demonstrates the first line placement by matching the 9 cm line to a 9 cm line in right triangle. After S completes the procedure, E says, "Are all of the lines the same as your line?" Process is repeated with the other shapes in sequence until S discovers the equilateral triangle. When S makes correct choice, E says, "That is an equilateral triangle; it has three lines which are the same. It has three lines which look alike.")

4. (If above procedures are unsuccessful, E places three 9 cm wire lines on D-side of S, who then places the lines around one shape at a time. S determines which triangle has three lines that are the same. E reinforces S's correct choice as in A3, above.)

B. Tactile stimulation, sandpaper

C. Wire equilateral triangle, table, mb

1. Fine palmar tracing, 18 cm, table, mb

a. Basic XXVI, c, d

2. Pinching, continuous, 18 cm, table, mb

a. LT and LIF, Basic XXV, a

b. RT and RMF, Basic XXV, c

3. Rotating with pinch

a. Ccw against DT and DIF.

D. Tactile stimulation, rough burlap

E. Comparison of equilateral and right triangles, table, mb

1. (E puts a 9 cm solid equilateral triangle slightly to the left of center of mb in the position of Basic XXVIII, a; then he places a 9 cm solid right triangle slightly to the right of center in position a, Basic XIII.)

2. (E asks S to draw each shape and to name it.)

3. [E places a 9 cm right corner--comparison corner 1 (cc-1)--in the position of Basic X, a, slightly above center and between the two triangles already positioned on mb.]

4. [E places 9 cm wire corner--comparison corner 2 (cc-2)--around cc-1.] E: Are these the same?

5. E: Will you put this corner (cc-2) around the corner of the triangle which looks like it?...What is the name of the triangle?...A right triangle has this kind of corner. (E draws with finger the 90° corner of the triangle, starting at apex and drawing both complete lines which form the corner. E keeps arms and hands out of line of vision of S.)

F. Comparison of right corner and square, table, mb

1. (E moves the 9 cm solid equilateral triangle and the 9 cm right triangle to left and adds a 9 cm solid square. Cc-1 is placed in the center above the three shapes in the position of Basic X, a.

2. E: What is the name of this shape? (E points to the square.)

3. E: Do you see a corner like this one (E points to cc-1) in the square? Put your corner (cc-2) around a corner of the square which looks like this one. (E rotates cc-1 three times, repeating same procedure.)

4. E: All of the corners of a square look like this corner. (E points to cc-1 and rotates it to represent the four corners of a square.)

G. Review

1. E: Point to the triangle that has this kind of corner. (E points to cc-1 in position of Basic X, a.

2. E: Draw the corner of the triangle which looks like this corner (cc-1) with your finger.

Lesson Fourteen

Review

A. Tactile stimulation, rough burlap

B. Comparison of the corners of an equilateral and right triangle and of a rectangle and square, table, mb

1. (E places 9 cm wire right triangle in the position of Basic XIII, b', on the far left of mb; the 9 cm wire rectangle at left of center on mb in the vertical position; the 9 cm wire equilateral triangle in the position of Basic XXVIII, c, to the right of center; and the 9 cm wire square to the far right on mb. The 9 cm wire comparison corner (cc-1) is placed above center in the position of Basic X, a.

2. E: Will you point to the equilateral triangle?...The right triangle?...The rectangle?...The square? (If S does not know the shapes, E points to them and states their names.)

3. E: Look very carefully. Are these two corners the same? (E places cc-2 around cc-1.)

4. E: Will you put this corner (cc-2) around the corner which looks like it in the right triangle?...A right triangle has a corner which looks like this one. (E points to cc-1.) It has corners which do not look like this corner (cc-1). (E points to the two corners which are not right angles.)

5. E: Will you put your corner (cc-2) around one of the corners of the rectangle which looks like it?...All of the corners of a rectangle look like this corner (cc-1). (E points to each corner after rotating cc-1 into matching position for appropriate corners of rectangle.)

6. (E repeats B5, above, substituting the square for the rectangle.)

7. E: Look very closely, now. Will you put your corner around a corner in the equilateral triangle which looks like it?...An equilateral triangle has corners (E points to each of them), but they do not look like this one (cc-1). (E rotates cc-1 into the position of Basic X, b, c, d.)

C. Tactile stimulation, cardboard

D. General instructions for final review

1. (In the following section, all of the shapes are 9 cm wire figures which are presented on mb. All of the drawing will be accomplished with DIF. E presents the shapes on mb in the positions of Basic XXIX.)

2. E: Let's see how fast you can find and draw the shapes I name. Look and draw very carefully. See if you can get them all right. Use this finger (DIF).

3. E: Can you find and draw an X?...An equilateral triangle?

4. E: Can you draw the straight line?...Can you find and draw the zigzag? (E removes shapes.)

E. Tactile stimulation, hand rubbing (5 seconds), hand wringing (5 seconds)

F. Comparison of the corners of a cross and an X, table, mb

1. E: Here is a cross (18 cm wire). Can you find a corner which looks like this one (cc-1 in the position of Basic X, a, which has been placed above center of working area). Put this corner (cc-2) next to a corner of the cross which looks like this one. (E places cc-2 around cc-1.)

2. E: Are there more corners which look like this one?...(E rotates corner to form positions of Basic X, d, c, b. S matches appropriate corner of cross with cc-2.) All of the corners of a cross look like this one (cc-1).

3. (E changes position of cc-1 to that of Basic XXX, a. S compares his corner by placing it around cc-1.)

4. E: Here is an X (18 cm wire). Can you find a corner which looks like this corner (cc-1 in position a of Basic XXX)?...Put your corner next to it....Are there more corners which look like this corner (cc-1)? (E rotates cc-1 to positions of Basic XXX, b, c, d for appropriate matching on X by S.) All of the corners of an X are the same. They all are like your corner.

G. Review (continued)

1. (E arranges shapes on mb in the position of Basic XXIX.)

2. E: Where is the cross?...Will you draw it with your finger?... Can you find and draw the square?

3. E: Can you draw the corner?...Can you draw the rectangle?

H. Farewell

1. Appropriate remarks

APPENDIX E-2

PROGRAM FOR CONTROL GROUP

Directions for Experimenters

1. The experimenter will present the material to each subject; instruct him in the rules; observe his play, or in some cases, play with him; point out errors; and reinforce for correct responses.

2. If a child makes an error which interferes with his progress and which he cannot or does not correct, the experimenter points to it and asks the subject to observe it. If, after two suggestions, the subject does not respond, the experimenter removes the error, and the activity proceeds. Do not explain the nature of the error or its correction because such explanations may inadvertently provide training in perceptual discrimination--a situation which must be avoided under the conditions of the experiment.

3. Directions will be provided for each activity.

Initial Lesson for Puzzles

1. E: Let's work some puzzles today. This is the picture you are going to make. (E shows the completed puzzle to S.) I'm going to put the pieces here. See if you can make the picture. (E places the pieces picture-side down in front of S.)

2. If S puts a piece in the wrong position and is unable to correct his error after attempting to do so, E points to the incorrectly placed piece and says, "Look carefully here."

3. As the program progresses, E may ask S to see how fast he can complete a puzzle, or E may present two puzzles at a time with the pieces mixed. E should use his judgment.

Kiddie Kards

Group I	Group II	Group III	Group IV
mouse	rabbit	squirrel	camel
elephant	turtle	lion	Noah
panda	giraffe	seal	fawn
cat	hippo	donkey	bear
dog	pig	buffalo	kangaroo
monkey	zebra	tiger	lamb

1. E: Hello, _______. Today we're going to play a card game. Let me show you. (E sits opposite S.)

2. E: Here is a picture of the head of a mouse. (E holds up the card with right hand and points to it with left hand.)

3. E: Here is a picture of the feet of the mouse.

4. E: When we put the head (E points to it) and the feet (E points to it) together like this, we make a picture of a mouse.

5. The cards are placed in two piles, one containing the pictures of the heads and the other, the pictures of the feet. The pile of feet is placed farther away from E, facing S. The pile of heads is placed closer to E, also facing S. Thus, the top cards of each pile form the completed animal as viewed by S.

6. Procedures 1, 2, and 3, above, are repeated using the remainder of the cards in Group I.

7. E: Now, if I mix these cards like this and put them on the table like this (three rows of four single cards), can you make a picture of a monkey? (If S does not know what a monkey or some other animal looks like, E points to the head card as he again says the name.)

8. E: Put your picture here. (E points to a spot in front of S, who subsequently places all of the pictures in close proximity.)

9. E: Very good. Now you know how to play the game. Let's make some more pictures.

10. E: Can you make a picture of a panda? (Upon completion, S is asked to make a picture of a mouse, a cat, a dog, and an elephant in that order.)

11. For each remaining group of cards, the above procedures are repeated beginning with either statement 2 or statement 7, depending upon how difficult the game is for S.

Lotto

1. E: Good morning, _______. Today we're going to play a game called lotto. Let me show you.

2. The barn card is used for demonstration. This is the card with the picture of the barn in the upper left corner. E selects the following corresponding small cards: barn, cat, duck, feather, hammer, jug, key, and lemon, plus the egg, kettle, and ax cards; then, he places the large card in front of S and one in front of himself.

3. E: I will take a card from here (pool of small cards in the center of the playing area) and hold it up like this. If you have the picture which is like it on your card (E points to large card), you point to it with your finger and say, "Here." I will then give you the picture, and you will put it on your card. I will play the game, too. If I have the picture on my card (E points to large card), I will point to it and say, "Here." Then I will put the picture on my card. When all of the pictures on your card are covered, you say, "Lotto." When all of the pictures on my card are covered, I will say, "Lotto." The first person to say, "Lotto," wins the game.

4. E holds up the small cards in the following order: barn, key, cat, kettle, ax, feather, duck, lemon, egg, hammer, jug.

5. Unmatched cards are placed in a pile to the side of the playing area.

6. After the demonstration, S may choose a large card from a number of them presented picture side down. E also chooses a card.

7. S may become the leader who chooses and shows the small cards.

8. If S makes a mistake, E places the small card beside the corresponding picture on the large card and asks, "Are these alike?" If S realizes his error, E reinforces him for his corrected response. If S persists in stating that the dissimilar pictures are the same, E says "Look carefully." If S still insists that they are the same, E says, "No, they are not alike." E then places the card in the pile of unmatched cards.

9. If the game proceeds easily, S may choose more than one card. A larger number may increase motivation, but E should use discretion in this matter. E may also choose additional cards for himself but should not have more cards than S.

Picture Dominoes

The directions which accompanied this picture-matching game were followed but were placed in a format similar to those described above. The game was played with the experimenter.

Blockhead

The directions which accompanied this building-block game were followed but were placed in a format similar to those described above. The game could be played alone or with the experimenter.

Bouncing Putty

S was encouraged to make animals with the plastic material, but he was free to play with the material in any way that he chose.

REFERENCES

REFERENCES

1. Ames, L. B. 1966. "Individuality of Motor Development," Normal Growth and Development with Deviations in the Perceptual Motor and Emotional Areas. Edited by M. J. Fehr. St. Louis, Missouri: Washington University School of Medicine, Department of Occupational Therapy.

2. Arnheim, R. 1954. Art and Visual Perception. Berkeley: University of California Press, 1965.

3. Attneave, F. 1954. "Some Informational Aspects of Visual Perception," Psychological Review, 61:183-193.

4. Atwater, S. K. 1953. "Proactive Inhibition and Associate Facilitation as Affected by Degree of Prior Learning," Journal of Experimental Psychology, 46:400-404.

5. Ayres, A. J. 1964. "Tactile Functions, Their Relation to Hyperactive and Perceptual Motor Behavior," American Journal of Occupational Therapy, Vol. 18, No. 1, pp. 6-11.

6. ______. 1963. "The Development of Perceptual-Motor Abilities: A Theoretical Basis for Treatment of Dysfunction," American Journal of Occupational Therapy, Vol. 17, No. 6, pp. 221-225.

7. Banta, T. J. 1967. Personal communication.

8. Belo, J. 1955. "Balinese Children's Drawings," Childhood in Contemporary Cultures. Edited by M. Mead and M. Wolfenstein. Chicago: University of Chicago Press, pp. 52-69.

9. Bender, L. 1938. "A Visual Motor Gestalt Test and its Clinical Use," American Orthopsychiatric Association Research Monograph, No. 3, 176 pp.

10. Bloom, B. S., A. Davis, and R. Hess. 1965. Compensatory Education for Cultural Deprivation. New York: Holt, Rinehart and Winston.

11. Bruner, J. S. 1957. "On Perceptual Readiness," Psychological Review, 64:123-152.

12. ______. 1962. The Process of Education. Cambridge: Harvard University Press.

13. ______, J. J. Goodnow, G. A. Austin. 1956. A Study of Thinking. New York: Science Editions, Inc., 1962.

14. Campbell, D. T. and J. C. Stanley. 1963. "Experimental and Quasi-Experimental Designs for Research on Teaching," Handbook of Research on Teaching. Edited by N. L. Gage. Chicago: Rand McNally and Company, pp. 171-246.

15. Centers, R. 1949. The Psychology of Social Classes. Princeton: Princeton University Press.

16. Deutsch, M. P. 1963. "The Disadvantaged Child and the Learning Process," Education in Depressed Areas. Edited by A. H. Passow. New York: Teachers College, Columbia University, pp. 163-179.

17. Ditchburn, R. W. and D. H. Fender. 1955. "The Stabilized Retinal Image," Optical Acta, Vol. 2, No. 3, October, pp. 128-133.

18. Dubin, E. R. 1946. "The Effect of Training on the Tempo of Development of Graphic Presentation in Preschool Children," Journal of Experimental Education, Vol. 15, December, pp. 166-173.

19. Efland, A. D. 1965. "The Effect of Perceptual Training Upon the Differentiation of Form in Children's Drawings." Unpublished dissertation, Stanford University.

20. Fowler, W. 1962. "Cognitive Learning in Infancy and Early Childhood," Psychological Bulletin, 59:116-152.

21. Frank, L. K. 1957. "Tactile Communication," Genetic Psychology Monograph, 56:209-255.

22. Frostig, M. and D. Horne. 1964. The Frostig Program for the Development of Visual Perception. Chicago: Follett Publishing Company.

23. _______, W. Lefever, and J. R. B. Whittlesey. 1966. Administration and Scoring Manual for the Marianne Frostig Developmental Test of Visual Perception. Revised edition. Palo Alto, California: Consulting Psychologists Press.

24. _______, et al. 1963. "Visual Perceptual Development and School Adjustment and Progress," American Journal of Orthopsychiatry, Vol. 33, No. 2, March, pp. 367-368.

25. _______, et al. 1964. "The Marianne Frostig Developmental Test of Visual Perception, 1963 Standardization," Perceptual and Motor Skills, 19:463-499.

26. Gellermann, L. W. 1933. "Form Discrimination in Chimpanzees and Two-Year-Old Children: I. Form (Triangularity) Per Se," Journal of Genetic Psychology, 42:3-27.

27. _______. 1933. "Form Discrimination in Chimpanzees and Two-Year-Old Children: II. Form Versus Background," Journal of Genetic Psychology, 42:28-50.

28. Gesell, A. 1925. The Mental Growth of the Pre-School Child. New York: The Macmillan Company.

29. _______ and L. B. Ames. 1946. "The Development of Directionality in Drawing," Journal of Genetic Psychology, 68:45-61.

30. Gibson, E. J. 1953. "Improvement in Perceptual Judgments as a Function of Controlled Practice or Training," Psychological Bulletin, 50:401-431.

31. _______, et al. 1962. "The Role of Grapheme-phoneme Correspondence in the Perception of Words," American Journal of Psychology, 75:554-570.

32. Gibson, J. J. and E. J. Gibson. 1955. "Perceptual Learning: Differentiation or Enrichment?" Psychological Review, 62:32-41.

33. Graham, F., P. Berman, and C. Ernhart. 1960. "Development in Preschool Children of the Ability to Copy Forms," Child Development, 31:339-359.

34. Harris, D. B. 1963. Children's Drawings and Measures of Intellectual Maturity. New York: Harcourt, Brace and World, Inc.

35. Hebb, D. O. 1949. Organization of Behavior. New York: Science Editions, Inc., 1961.

36. Hunton, V. D. 1955. "The Recognition of Inverted Pictures by Children," Journal of Genetic Psychology, 86:281-288.

37. Jefferson, Blanche. 1963. Teaching Art to Children. Second edition. Boston: Allyn and Bacon, Inc.

38. Jensen, A. R. 1963. "Learning in the Preschool Years," Journal of Nursery Education, Vol. 18, No. 2, pp. 133-138.

39. Kellogg, R. 1959. What Children Scribble and Why. Palo Alto, California: National Press Books.

40. Kensler, G. L. 1964. "The Effects of Perceptual Training and Modes of Perceiving Upon Individual Differences in Ability to Learn Perspective Drawing." Unpublished dissertation, Stanford University.

41. Kephart, N. C. 1960. The Slow Learner in the Classroom. Columbus, Ohio: Charles E. Merrill Books, Inc.

42. Koppitz, E. M. 1964. The Bender Gestalt Test for Young Children. New York: Grune and Stratton, Inc.

43. Levin, H. 1963. "The Effects of Motor Pretraining on Children's Association and Recognition Learning," A Basic Research Program on Reading. Cornell University: Cooperative Research Project Number 639, 10 pp.

44. Lowenfeld, V. and W. L. Brittain. 1964. Fourth edition. Creative and Mental Growth. The Macmillan Company.

45. McBeath, P. M. 1965. "The Effectiveness of Three Reading Preparedness Programs for Perceptually Handicapped Kindergarteners." Unpublished dissertation, Stanford University.

46. McDonald, F. J. 1965. Educational Psychology. Second edition. Belmont, California: Wadsworth Publishing Company, Inc.

47. McFee, J. K. 1962. "Implications for Change in Art Education." Paper read at the Spring Regional Conference, Western Arts Association.

48. ______. 1961. Preparation for Art. San Francisco: Wadsworth Publishing Company, Inc.

49. McGuire, W. J. 1960. "Cognitive Consistency and Attitude Change," Journal of Abnormal and Social Psychology, 60:345-353.

50. Montessori, M. 1912. The Montessori Method. New York: Schocken Books, 1964.

51. ______. 1914. Dr. Montessori's Own Handbook. New York: Schocken Books, Inc., 1965.

52. Piaget, J. and B. Inhelder. 1956. The Child's Conception of Space. Translated from the French by F. J. Langdon and J. L. Lunzer. London: Routledge and Kegan Paul.

53. Pick, A. D. 1963. "Improvement in Visual Discrimination of Letter-Like Forms," A Basic Research Program on Reading. Cornell University: Cooperative Research Project Number 639, 11 pp.

54. Pritchard, R. M., W. Heron, and D. O. Hebb. 1960. "Visual Perception Approached by the Method of Stabilized Images," Canadian Journal of Psychology, 14:67-77.

55. Quenouille, M. H. 1948. "The Analysis of Covariance and Non-Orthogonal Comparisons," Biometrics, 4:240-246.

56. Read, H. [n.d.] Education Through Art. New York: Pantheon Books.

57. Rice, C. 1930. "Excellence of Production and Types of Movement in Drawing," Child Development, Vol. 1, No. 1, pp 1-14.

58. ______. 1930. "The Orientation of Plane Figures as a Factor in Their Perception by Children," Child Development, Vol. 1, No. 2, pp. 111-143.

59. Riesen, A. H. 1947. "The Development of Visual Perception in Man and Chimpanzee," Science, 106:107-108.

60. Salome, R. A. 1965. "The Effects of Perceptual Training Upon the Two-Dimensional Drawings of Children," Studies in Art Education, Vol. 7, No. 1, pp. 18-33.

61. Schaefer-Simmern, H. 1948. The Unfolding of Artistic Activity. Berkeley: University of California Press.

62. Sears, P. S. and E. M. Dowley. 1963. "Research on Teaching in the Nursery School," Handbook of Research on Teaching. Edited by N. L. Gage. Chicago: Rand McNally and Company, pp. 814-864.

63. Slochower, M. Z. 1946. "Experiments on Dimensional and Figural Problems in the Clay and Pencil Reproductions of Line Figures by Young Children: II. Shape," Journal of Genetic Psychology, 69:77-95

64. Solley, C. M. and G. Murphy. 1960. Development of the Perceptual World. New York: Basic Books, Inc.

65. Townsend, E. A. 1951. "A Study of Copying Ability in Children," Genetic Psychology Monograph, 43:3-51.

66. Travers, R. M. W. 1967. Essentials of Learning. Second edition. New York: The Macmillan Company.

67. Underwood, B. J. 1951. "Associative Transfer in Verbal Learning as a Function of Response Similarity and Degree of First-List Learning," Journal of Experimental Psychology, 42:44-53.

68. ______ and R. W. Schulz. 1960. Meaningfulness and Verbal Learning. New York: J. B. Lippincott Company.

69. Vernon, M. D. 1952. A Further Study of Visual Perception. Cambridge [England]: At the University Press.

70. _______. 1955. "The Functions of Schemata in Perceiving," Psychological Review, 62:180-192.

71. Walker, H. M. and J. Lev. 1953. Statistical Inference. New York: Henry Holt and Company, Inc.

72. Weinberg, G. H. and J. A. Schumaker. 1962. Statistics, an Intuitive Approach. Belmont, California: Wadsworth Publishing Company, Inc.

73. Wohlwill, J. F. 1960. "Developmental Studies of Perception," Psychological Bulletin, 57:249-288.