IMPLICATIONS FOR ART EDUCATION OF STRATEGIES ADOPTED BY ELEMENTARY SCHOOL CHILDREN DURING MANIPULATION, RECOGNITION, AND DISCRIMINATION TASKS

by

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ABSTRACT

The purpose of this study was to discover the kinds of strategies and abilities revealed by elementary school children in response to tasks relating to visual structure and to determine whether the nature of those strategies and abilities would support or refute the assumption that perceptual learning and development are uniform, automatic, and universal.

The study was conducted with twelve elementary school children ranging in ages from 6 to 13. It consisted of the presentation of computer-generated images which involved the subjects in manipulation, recognition, and discrimination tasks. Subjects responded verbally to the images and the questions posed by the researcher. These responses were documented on video tape and later transcribed for analysis.

The nature of the subjects' responses comprised data relating to the kinds of strategies used in manipulating, recognizing, and concealing a given shape, and evidence of the ability to recognize given shapes and discriminate specific visual masking techniques.

The study showed that perceptual learning and development may not be uniform, automatic, or universal. Some children responded with different abilities and strategies to visual tasks. Children with specific strategies and the ability to base those strategies on structural knowledge were most successful in recognition and discrimination tasks.

Implications for the utilization of the findings by art educators in creating and designing art programs are discussed.

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CHAPTER I. INTRODUCTION TO THE STUDY

A. INTRODUCTION

One important factor relating to a child's development in the visual arts is the ability to impose upon and extract from the visual world as much meaning as possible. The full understanding of this ability may come about through a study of the perceptual and cognitive processes of the child. Although art educators have shown that cognition and art do not have to be considered inimical (Carter, 1983; Eisner, 1982, 1983; Engel, 1983; Olson, 1983; Pariser, 1983), it has not always been a function of traditionally-conceived art education to provide programs that address the nature of cognitive and perceptual processes in interpreting visual information. Many educators have indicated the need for structured art programs which deal with the organization and interpretation of visual information (Cowan, 1984; Eisner, 1974; MacGregor, 1972, 1975; Rowland, 1965, 1974, 1976). Most art programs today, however, are probably structured without regard for the kinds of perceptual and cognitive information underlying the interpretation of visual structure (Cowan, 1985).

The processing of visual information has traditionally been addressed within the field of perception. The concept of perception has broadened to mean more than the clinical charting of sensory input. For the purposes of this study, perception refers to the processes associated with the organization and integration of sensory data. It is concerned not only with the immediate apprehension of stimuli, but with the cognitive processes involved in forming constructs. Although art educators recognize that perception does influence artistic behavior and the actual creation of art (Lansing, 1976), the usual consideration of perceptual development has been casual. The perceptual world is basically taken for granted. Involvement in art experience usually takes place on the assumption that learning about visual structure is automatic and universal.

Vernon (1970) has stated that it is known that individual differences exist in many types of perception, but that there is little systematic work into the study of these. Various ways of explaining perception in cognitive terms have been developed (Goodenough, 1926; Gibson, 1969), and attempts have even been made to develop programs which identify and train the perceptual abilities used in classifying and structuring visual data so as to increase perceptual efficiency (MacGregor, 1977; Rowland, 1965, 1974, 1976). But there still exists a need for specific work designed to discover and explore what kinds of strategies children develop in order to make sense of what they see and how they manipulate what they see. The existence of these strategies and these individual abilities for shape recognition and manipulation among children have not yet been fully documented.

B. STATEMENT OF THE PROBLEM

Increased awareness of and reflective participation in the visual world can be thought of as a general aim of art education. But in order to fully realize this aim, the art educator should understand the nature of the processes through which visual information is sorted and organized. Through this kind of understanding, consideration can be given to how children make sense of their visual worlds, how they look at and make sense of structure. Currently, art programs are created as if perceptual development and learning were uniform, automatic, and universal. Until evidence to the contrary is produced, the epistemological and psychological bases for such an assumption will always have a problematic character.

C. PURPOSE OF THE STUDY

The purpose of this research study is to address that problem and to provide empirical evidence about the nature of perceptual abilities, learning, and development in children. The collected data will contribute to the elucidation of the kinds of cognitive processes and strategies children use in making sense of structure. It is hoped that this might in some way help clarify the assumption that perceptual learning and development are universal and automatic. Investigation which assesses the soundness of this assumption can make a contribution to the foundation upon which art education programs can be based.

D. JUSTIFICATION

Although much work has been done in the field of psychology in attempting to discover how children gain ideas about structure, this work has either been task-related, using childrens' own creations, or has used photographic and diagrammatic material that is limited in its response-generating capacity. This study used a computer to present images in sequences of gradients small enough to allow finer discriminations to be made than are possible with traditional pencil and paper methods. The establishment of patterns of recognition and discrimination led to the formation of categories of relative competency that may show how children of different ages use perceptual strategies in completing specific tasks. In determining these strategies, the groundwork has been laid for further study in this area. By understanding the nature of the strategies entailed in perception, fundamental decisions concerning image production and recognition in art education can be intelligently formulated.

E. RESEARCH QUESTIONS

This study deals with two kinds of activities: building up variations on a simple form (manipulation), and breaking down complex forms in the discovery of simple forms (recognition). Aspects of these activities are investigated in the form of six research questions.

a. Given a simple shape, what kinds of manipulations will the subject request in order to exploit its perceived properties?

b. What accounts will the subjects provide of the strategies used in the manipulation process?

c. To what extent will subjects be able to recognize a simple shape concealed within a series of similar shapes?

d. How will subjects respond to the masking of the shape by shared contour, interrupted contour, and close-color harmony, and be able to discriminate the differences between them?

e. How will subjects respond to the converse of the recognition activity in being able to select their own concealment locations for a given shape?

f. How will the subjects verbally articulate the strategies used in the recognition, concealment, and discrimination tasks?

F. DESIGN OF THE STUDY

1. Sample

Twelve children between 6 and 13 years old comprised the sample tested. These were selected to provide 4 each from the age groups 6-8 years old, 9-11 years old, and 12-13 years old.

2. Setting

An environment was selected that allowed for the monitoring of verbal responses between subject and computer-generated images. Subjects were seated in a chair about three feet from the video screen monitor.

3. Instruments

The instruments consisted of the computer and related accessories (hardware), the computer-generated program (software), and the collected field notes.

a. Computer and Accessories (Hardware)

For this study a Sony SMC-70G microcomputer (See Appendix A, p.105), with an RGB Trinitron Color Monitor (See Appendix B, p.107) was used. The screen size was 9 x 12 inches. In addition, a Summagraphics M1201 Data Tablet with stylus was used for the manipulation sequence (See Appendix C, p. 109).

b. Computer-Generated Programs (Software)

The basic program used in this study involved two phases, a manipulation sequence and a recognition sequence. The programs for both these sequences were created and generated with the Sony CP/M Disk Graphics Editor (See Appendix D, p. 111) giving a standard resolution plane of 320 x 200 in 16 basic colors. The program was stored on twelve separate micro disks (See Appendix E, p. 113).

The Manipulation sequence involved two pre-created images which were stored for use on one disk. This sequence involved the individual manipulation by the subject of two shapes, a rectangle and a circle. The researcher performed the physical manipulations in response to verbal instructions by the subjects.

The Recognition sequence involved four shapes (See Appendix F, p. 117) hidden by means of three different masking techniques (See Appendix G, p. 119). The shape was initially displayed for identification and then hidden in a display through the use of one particular masking technique. The subject attempted to recognize the shape through ten stages of decreasing complexity. This sequence consisted of 156 images stored on 11 disks.

Four shapes, a rectangle, triangle, circle, and free-form, were each masked three times using Shared Contour masking, Interrupted Contour masking, and Close-Color Harmony masking, producing twelve basic tasks. Each task was then simplified through 10 gradients.

4. Methods of Data Collection and Analysis

The entire project was recorded on video tape and the recognition task ability scores and concealment locations were recorded on specially prepared response sheets (See Appendix H, p. 123). Observer notes were also taken.

The video tapes were transcribed and content analysis was performed on the collected data.

5. Limitations

This study was limited by a number of factors. The sample was collected only from one school. It was limited to a very small and select sample, i.e., subjects selected by teachers and then by parental consent. No other tests were conducted with the subjects and results from other standardized tests were not available. Because of these limiting factors, generalizing was not attempted. The study was also limited by the artificial and contrived setting and the contraints of time.

The manipulation sequence was determined by the nature and limited versatility of the computer and its programming capabilities. Certain requests could not be processed. The recognition sequence was limited by the nature of the masking and image degradation that could be accomplished on this equipment. The kinds of images presented to the subjects were of a very specific kind, i.e., computer graphics presented on a television screen.

6. Delimitations

In designing and conducting this study a deliberate choice was made not to use subjects under 6 or over 13 years old. A choice was also made not to conduct it in a more natural setting, nor to extend the study to images presented by means other than through computer images on a television screen.

7. Definitions

Ability - Compentence at any particular point in time. Contrasted with capacity, which refers to potential (Eisner, 1983).

Close-Color Harmony - A masking technique which utilizes a background of similar shapes in closely-related colors to mask foreground shapes superimposed over the background in outline only (See Appendix G, p. 119).

Discrimination - The ability to perceive and respond to differences between stimuli (Fellows, 1968; Greene & Hicks, 1984).

Distractor - A shape or other visual element used to conceal the target shape.

Interrupted Contour - A masking technique in which contours of shapes are overlapped (See Appendix G, p. 119).

Manipulation - The physical change of the shape or its component parts.

Masking - The process of blocking one image by another (Statt, 1981).

Perception - The processes associated with the organization and integration of sensory data. It is concerned not only with the immediate apprehension of stimuli, but also with the cognitive processes involved in forming constructs.

Recognition - The act of comparing the representation of an image to one stored in memory (Glass, Hollyoak, & Santa, 1979).

Shared Contour - A masking technique in which all shapes share common contours (See Appendix G, p. 119).

Strategy - A set of mental operations used in the acquisition, retention, and utilization of information in order to achieve some objective (Bruner, Goodnow, & Austin, 1962).

Target Shape - The shape presented to the subject for study and then concealed. The shape to be found.

CHAPTER II. REVIEW OF THE LITERATURE

What evidence is there that children respond to and manipulate shapes with different strategies and abilities? This question involves exploration in the areas of perception, cognition, and developmental theory.

The study of perception is considered by some to be paramount in understanding human existence (Ittelson, 1973) and by others as a foundational area for education and especially art education (Stroh, 1983). A history of the development of perceptual theory is not germane to this study. Others have done detailed work in this respect (Boring, 1942; Hochberg, 1962; Matlin, 1983; Pastore, 1971; Wertheimer, 1974). But some knowledge of the seminal ideas and theories is necessary, if only to indicate how the foundational ideas of art education are dated.

> Many of us who teach design or drawing are not aware of much information which has been gathered by psychologists during this century, and we still teach many of the ideas about human perception which are, literally, 19th century ideas (Stroh, 1983, p. 45).

An overview of the prevalent ideas in perception may be useful, therefore, in familiarizing art educators with the theories presently provided by psychologists. This brief overview should be regarded not as an attempt to cover the field, but simply to set a frame within which the family of cognitive approaches to perception may be identified. This study takes the position that cognitive ability and perception are interactive in learning.

Although there are many different ways of classifying approaches to perception, four main ones can be identified for the purposes of this overview (Matlin, 1983). The Empiricist approach, initiated in the 17th century, emphasizes that all information comes from sensory experience and perception. All perceptual ability must come from learning. Some elements of this approach are still popular today.

The Gestalt approach came about as an objection to the Empiricist approach. It emphasizes that we perceive objects as wholes rather than as separate parts and that shape perception is innate. Perceptual learning, therefore, is relatively unimportant (Matlin, 1983).

The Gibsonian approach was developed by James Gibson (1950, 1966), and emphasizes that perception is direct and that we do not need to perform "calculations and interpretations in order to perceive" (Matlin, 1983, p. 7). Gibson's ideas have been very influential, affecting many researchers working in the field (Mace, 1977; Neisser, 1976; Turvey & Shaw, 1977).

The Information-Processing approach to perception was developed in response to computer and communication science. This approach emphasizes that information is handled in a series of individual stages and that sensation, perception, and other higher mental functions are interrelated rather than separate from each other (Matlin, 1983) and that they must be dealt with within the concept of a single system (Haber, 1974). The

Information-Processing approach is but one approach that has led to the development of a model that sees sensation, perception and all higher mental processes as interdependent and unified in the field of cognitive psychology.

Cognitive psychology has sometimes been called "information-processing psychology" (Glass, Holyoak, Santa, 1979). and many working in the field acknowledge the popularity of this model (Howard, 1983; Klahr & Wallace, 1976: Lachman, Lachman, & Butterfield, 1979; Rohwer, Ammon, & Cramer, 1974). Cognitive psychology "refers to all processes by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used" (Neisser, 1967, p. 17). It is concerned with general principles of how the mind works and deals with perception, learning, memory, and thinking (Wickelgren, 1979). Because it deals with the mind and its intellectual functions, many art educators have rejected it as being irrelevant and even inimical to the processes of art. Recently, however, many educators have put forth excellent arguments for the cognitive status of the arts (Arnheim, 1969, 1983; Eisner, 1982, 1983; Engel, 1983; MacGregor, 1983). Their claim is that the arts are cognitive in nature and cannot exist independently from thought. They make it quite clear that many cognitive processes must function in the artistic act.

An essential part of the artistic process is recognition, a cognitive function. Without the act of recognition, a sustained existence in the visual world would be impossible. One of the essential components of recognition is memory. Recognition and memory are essential to the artistic act and are vital components of the present study. The importance of memory in recognition tasks has been studied extensively. Work relating to the unreliability of memory and the fact that forgetting takes place very quickly has been conducted (Peterson & Peterson, 1959; Sternberg, 1970; Wickelgren, 1973). Studies have also been conducted as to how spatial knowledge is represented in memory (Baum, 1977; Jonides & Baum, 1978). The evidence gathered from these studies indicates that the memory stores spatial knowledge using specific visual strategies. There also exists evidence to suggest that in memory tasks, fewer errors are made when information is presented visually than when it is presented verbally (Kroll, Parks, Parkinson, Bieder, & Johnson, 1970).

In the present study, recognition of shape is a primary task. Most of the psychological work on recognition memory has been focused on visual capabilities (Glass, Holyoak, Santa, 1979). According to Glass, Holyoak, and Santa (1979), recognition consists of a process by which the representation of an input is matched against the contents of memory, followed by a decision to evaluate whether the matching process was successful (p. 57). Much research has been conducted concerning masking techniques and distractors in the recognition process. Distractors similar to the target item result in confusion, but if the distractors are dissimilar, recognition memory increases (Glass, Holyoak, Santa, 1979). The kinds of masking procedures employed and the particular individual who responds to them have also been studied (Witkin, Lewis, Hertzman, Machover, Meissner, & Wapner, 1954). If the recognition process consists of matching accompanied by an individual decision as to the success of the matching process, the nature of incorrect and successful responses must be significant. Falmagne (1972) has indicated that a subject's confidence in a hypothesis is strengthened as the number of guesses increases. Work exists to show the alternative strategies that subjects use when told that a response is incorrect (Trabasso & Bower, 1966).

Various individual research projects in the field of cognitive psychology elucidate the nature of individual recognition strategies. Subjects appear to learn rule-based strategies and these also appear to reduce recognition problems (Bourne, 1967). Subjects appear to retain the same strategy after success in recognition tasks (Levine, 1966). There exists information to indicate that a number of different strategies are used following incorrect guesses (Coltheart, 1973; Levine, 1966; Millward & Spoehr, 1973). Because organized learning about various recognition strategies is not practised, children are usually left to develop their own strategies. Some strategies are more effective than others. Some are extremely inefficient (Dunn Rankin, 1978; Matlin, 1983).

One important aspect of cognition and perception relevant to this study is shape and pattern recognition. This area has been extensively researched (Dodd & White, 1980; Juola, 1979). In harmony with the information-processing approach to perception and cognition, computer programs have been developed to recognize visual patterns (Lindsay &

Norman, 1977; Rumelhart, 1977; Selfridge, 1959; Selfridge & Neisser, 1960). Although many different theories of pattern recognition have been developed, three important ones appear in the literature. The template matching theory attempts to account for pattern recognition through the comparison of an object to a specific pattern or template (Anderson, 1980; Juola, 1979; Matlin, 1983). This theory has largely been abandoned as being too inefficient (Juola, 1979; Kaufman, 1979; Matlin, 1983).

The Distinctive Features theory accounts for pattern recognition through the distinguishing of distinctive features (Matlin, 1983). This theory was developed by Eleanor Gibson (E.J. Gibson, 1969; E.J. Gibson & Levin, 1975). The theory has many critics and has, like the template matching theory, been abandoned by many investigators (Juola, 1979; Naus & Shillman, 1976).

The Prototype matching theory proposes that we compare an object with an ideal figure or prototype to see if it matches (Matlin, 1983). The difference between this and the Template theory is that prototype patterns are abstract and not specific in shape whereas templates are specific. There are many current proponents of this particular theory (Franks & Bransford, 1971; Naus & Shillman, 1976; Posner, Goldsmith, & Welton, 1967).

There also exist many other ideas to bring the perceptual and cognitive worlds into union. Howard Gardner (1983) has developed a theory of spatial intelligence to account for the capacities used in perceiving the visual world accurately and in performing transformations and modifications upon those initial perceptions.

The present study concerns itself not only with the ways in which children might recognize and manipulate shape, but also with the differences in ability and development that might be evident. The idea of cognitive or intellectual development has been around since the 19th century (Case, 1985) and has itself undergone many developments. In 1894, James Baldwin first proposed a theory of cognitive development which involved three stages through which a child passed. Jean Piaget elaborated on Baldwin's concepts and devised a fourstage theory which covered the child's development to adulthood. Pascal-Leone (1969) attempted to devise a new theory which eliminated the weaknesses of Piaget's theories. Jerome Bruner (1964, 1968) offered a theory of cognitive development which was a "counterpoint" to Piaget's (Case, 1985, p.40). Both Piaget (Flavell, 1963) and Bruner (1973) argue that the child's thinking is at first very concrete and tied to sensory experience and then develops towards more abstraction independent of perception. Heinz Werner (1957) developed a theory which views the child's cognitive and perceptual abilities as undergoing a gradual change from general, vague, and global, to more distinct and articulated. Today, developmental psychology is alive with many competing ideas and theories.

According to Case (1985), there are three basic perspectives in regard to the application of developmental theory to education. The Piagetian perspective views the child as a rational and autonomous scientist. The Brunerian perspective sees the child as the user of cultural tools. The Information-Processing perspective sees the child as a "manipulator of symbols whose internal procedures for performing these manipulations are learned from experience" (Case, 1985). It is interesting to note that the Information-Processing model can be seen as a common linking feature between cognitive psychology, perceptual theory, and intellectual development.

Much work has been done in the field of perceptual learning (Dodwell, 1970; Gibson & Gibson, 1955; Hebb, 1949; Held & Hein, 1963; Postman, 1955; Rock, 1966; Salapateck & Kessen, 1966). The role of learning in perceptual development has been experimentally displayed (Von Senden, 1960) and many experimental studies show improved perception with learning (Fantz, 1961; Riesen, 1947, 1953, 1961; Siegel, 1953). Some art educators have investigated the relationship of perceptual training to areas of learning and behavior in art and have concluded that training strategies affect art behavior (Silverman, 1962). The systematic teaching of perceptual skills improves visual perception (Salome, 1965).

In general, there is much experimental work to support the idea that older children respond in different ways to visual stimuli than do younger children (Anglin, 1977; Flavell, 1977; Hale & Taweel, 1974; Matlin, 1983; Meyer, 1978; Neisser, 1979; Mednick & Lehtinen, 1957; Odom &

Guzman, 1972; Nelson, 1974; Riess, 1946; Vurpillot, 1968, 1976; Yonas & Gibson, 1967). However, no universal and consistent principles relating age and perceptual and cognitive development have been made. Some researchers have determined that individual differences in order of appearance in development are the rule rather than the exception (Klahr & Wallace, 1976).

Another approach to visual development has been adopted by some art educators. This approach involves the examination of childrens' drawings as an indicator of intellectual maturity (Goodenough, 1924; Harris, 1963). Viktor Lowenfeld, the most famous proponent of this approach, based his theory of development on the examination of children's drawings. According to his theory, there are five stages through which children move. These are natural aspects of human development (Lowenfeld & Brittain, 1982). Although perceptual growth is mentioned as a desirable aim of art education, it is assumed that it will occur naturally, as a consequence of involvement with art production.

Probably the greatest criticism in using drawings for determining the full extent of the child's development is summarized by Vernon (1976). Several studies reveal that young children are highly inaccurate in copying shapes. One might conclude that children have poor shape perception. However, "children can discriminate between different shapes even if they cannot copy them correctly" (Matlin, 1983, p. 321). The limitations of this approach are evident. In order "to understand a child's development, one would have to go far beyond his drawing" (McFee, 1970, p. 23).

It is in the use of the ideas, concepts, and theories offered by cognitive psychology, perceptual research, and developmental theory that the most complete evidence can be gained about children's abilities and strategies for manipulating and recognizing given shapes. The conduct of this study is based on that premise.

CHAPTER III. CONDUCT OF THE STUDY

A. SAMPLE

Twelve elementary school children ranging in ages from 6 to 13 were selected by individual classroom teachers in one elementary school as suitable for participation in the project. The final selection was made with the help of a parental consent form (See Appendix I). The subjects were selected on the basis of interest and ability to verbalize. No other criteria were stipulated. Although this study attempted to involve an equal number of male and female subjects, seven female and five male subjects only were available for participation (See Table 1). The researcher is aware of the possible bias resulting from the initial selection process and the use of a parental consent form (Kearney, 1983).

B. SETTING

The study was conducted in the Learning Assistance room at University Hill Elementary School, 5395 Chancellor Boulevard, Vancouver, B.C. during the week from Monday June 9 to Friday June 13, 1986. The subjects were seen during three different periods of the day, 8:45 to 10:15, 10:40

to 12:00, and 12:45 to 2:15 (See Table 1).

Table 1

Subjects and Setting

Subject	Age	Sex	Test Period	
Subject 1	6.6	F	Monday	12:45-2:15
Subject 2	6.8	M	Monday	8:45-10:15
Subject 3	7.3	F	Friday	10:40-12:00
Subject 4	7.4	M	Monday	10:40-12:00
Subject 5	9.1	M	Tuesday	8:45-10:15
Subject 6	9.2	F	Tuesday	10:40-12:00
Subject 7	10.8	F	Wednesday	8:45-10:15
Subject 8	10.11	F	Tuesday	12:45-2:15
Subject 9	12.5	F	Thursday	10:40-12:00
Subject 10	12.7	M	Thursday	8:45-10:15
Subject 11	12.11	M	Wednesday	10:40-12:00
Subject 12	13.3	F	Friday	8:45-10:15

C. INSTRUMENTS

The equipment was arranged in a suitable manner in the allocated room (See Appendix J, p. 126). Consideration was given to the ease of visual and physical access to the video monitor screen and the ease of administration by the researcher. The computer was situated so as to allow the best possible control by the researcher. The video monitor was made easily accessible both to the subject and the researcher. The Data Tablet and stylus were used by the researcher only in the manipulation sequence and became a surface for note-taking and documenting scores in the recognition sequence. The software, in the form of twelve micro disks, was arranged in sequential order and held in ready access for use.

D. PROCEDURE

Following a schedule issued by the school principal, the researcher called at the appointed classroom and brought the subject back to the allocated room. A brief and informal discussion was initiated by the researcher in order to put the subjects at ease The subjects were seated in the same location, about three feet from the video monitor screen. They were seen individually and only for one session each. The basic rationale for the project was explained along with the general expectations for participation. The VCR was then turned on and the actual project began. Detailed instructions were given regarding each step in the study and every attempt was made to clear up all problems in understanding.

The study began with the manipulation sequence and documentation of the kinds of changes the subject requested in order to change the appearance of the rectangle and circle (See Appendix K, p. 130). Termination of this activity was determined by the subject. After the subject terminated manipulation for the two activities, the recognition sequence was immediately presented.

Standardized instructions were then given concerning subject expectations for the twelve recognition tasks (See Appendix K, p. 130). Subjects were shown a shape and asked to remember it. They were then asked to find it while it was hidden in a complex array of similar shapes. After finding the target shape, the subject was then asked to find a suitable concealment location for the shape. After indicating the desired location, the subject was immediately presented with the next recognition task until the twelve tasks were completed.

Immediately after tasks 3 (Rectangle), 6 (Triangle), and 9 (Circle), the subject was shown an image illustrating the three different masking techniques used (Shared Contour, Interrupted Contour, and Close Color Harmony). On those occasions the subject was asked to identify the differences among these three techniques.

The entire period spent with each individual subject was approximately 90 minutes. After this period, the subject returned to the classroom while the researcher wrote any comments that might be appropriate to the study. This process was repeated for the twelve subjects involved in the study.

E. METHODS OF DATA COLLECTION

Documentation of the procedure consisted of video tape, response sheets, and observer notes. The entire procedure was recorded on video tape for later transcription and analysis. Evidence of the ability to recognize shapes and the choices for concealment locations were recorded on prepared sheets of paper (See Appendix H, p. 123). Informal notes were made by the researcher during the procedure and at the conclusion of each subject's session.

F. METHODS OF DATA ANALYSIS

The twelve video tapes comprising the twelve subjects' project participation were later transcribed into a written set of notes. Content analysis of the verbal responses and descriptions and the numerical data gathered from the response sheets was used to determine strategies and abilities employed in the areas of shape manipulation, shape recognition, recognition ability, choices and strategies for location, and discrimination ability.

G. PRELIMINARY TRIAL AND PILOT STUDY

A preliminary trial was conducted in April 1986. This trial resulted in a number of alterations in the procedural conduct of the study. It was discovered that in order to conduct the project in an efficient and effective way, consideration had to be given to the actual physical orderliness of the presentation. The physical distribution and layout of all equipment had to allow for smooth sequencing of all images and had to allow the subject both visual and physical access to the video monitor screen. It was found necessary to visually number the recognition sub-tasks in decreasing order, and the images comprising the recognition sequence held in disk storage had to be presented in a fashion other than that allowed by the "Load" computer function. This was solved by using the Slide Show function which is a feature of the Sony SMC-70G (See Appendix L, p. 145). It was also noted that a consistent and strictly ordered questioning technique by the researcher was necessary (See Appendix K, p. 130). The appropriate changes were made and observed in a subsequent pilot study.

The pilot study was conducted early in June, 1986. This study showed a vast improvement in presentation over that observed in the preliminary trial. The only caution resulting from this study was the observation to remain careful and consistent in questioning techniques.

CHAPTER IV. ANALYSIS AND INTERPRETATION OF THE RESULTS

A. INTRODUCTION

The study consisted of a manipulation sequence and a recognition sequence. All images used in these sequences were generated on the Sony microcomputer and were presented to the subjects on the video monitor. The subjects responded verbally to all questions and all computer functions were controlled by the researcher. Each subject in the study was considered individually

B. STRATEGIES USED IN MANIPULATING A GIVEN SHAPE

1. Procedure

The manipulation sequence consisted of two parts. The first part employed a rectangle as the object of manipulation and was referred to as manipulation 1, while the second part employed a circle as the object of manipulation and was referred to as manipulation 2. These two parts were presented in order and sequentially. After finishing with manipulation 1 the subject was immediately presented with the tasks involved in manipulation 2.

a. Manipulation 1

The subject was first presented with the image of a rectangle and asked to identify it (See Appendix F, p. 117). The subject was then asked to think of ways to change the shape so that it looked different. All changes were to be considered in terms of the given shape itself: rectangular additions, horizontal and vertical lines for manipulation 1, and circular additions and lines for manipulation 2. The computer had certain functional limitations which precluded carrying out certain operations (See Appendix M, p. 147). The question was repeated after each requested operation had been performed until the subject wished to stop. At this point the subject was introduced to the tasks involved in manipulation 2.

b. Manipulation 2

This part was identical in procedure and administration to the tasks of manipulation 1, except that a circle rather than a rectangle was the object of manipulation (See Appendix F, p. 117).

2. Results and Interpretation

The purpose of this sequence was to determine in part the kinds of strategies that might be employed in manipulating a given shape. For the purposes of this study, a strategy refers to a set of mental operations used to achieve an objective. A manipulation strategy, therefore, consists of the number and kinds of operations performed on a given shape and the objective towards which those operations moved. In response to the question, "What can you do to make that shape look different." the subject requested the performance of an operation (See Appendix N, p. 149). The number of operations requested by the subject was one of the constituents of the overall strategy. As table 2 indicates, the number of operations requested for both manipulation tasks ranged from 6 to 37 operations.

Table 2

Number of Operations Requested in Manipulating a Given Shape

Subject	Rectangle	Circle	Total
Subject 1	8	10	18
Subject 2	10	6	16
Subject 3	4	2	6
Subject 4	8	10	18
Subject 5	21	16	37
Subject 6	11	12	23
Subject 7	10	9	19
Subject 8	4	5	9
Subject 9	6	4	10
Subject 10	6	9	15
Subject 11	3	5	8
Subject 12	6	3	9

Roughly the same number of operations was requested for both manipulation tasks. The number of operations requested by each subject remained fairly consistent for both activities. A subject who requested a large number of operations for manipulation 1 usually requested a large number of operations for manipulation 2. The converse was generally also true. Subjects who requested very few operations for one activity also requested very few for the other activity (See Table 3).

Table 3

<u>Consistency of Operational Requests</u>

Subject	Rectangle	Circle	Total
Subject 1	M*	M	M
Subject 2	M	M	M
Subject 3	L	L	L
Subject 4	M	M	M
Subject 5	H	H	H
Subject 6	M	M	M
Subject 7	M	M	M
Subject 8	L	L	L
Subject 9	L	L	L
Subject 10	L	M	M
Subject 11	L	L	L
Subject 12	L	L	L

---

*The number of operations was classified as low medium or high.

Rectangle - 0-7 low; 8-14 medium; 15-21 high

Circle - 0-5 low; 6-10 medium; 11-16 high

Total - 0-12 low; 13-24 medium; 25-37 high

A convenient division of subjects into a simple age classification suggests itself by the fact that the sample consists of six subjects under the age of ten, and six subjects ten years of age and older. This classification is designated "younger" and "older" subjects and used throughout the study. In general, fewer operations were requested by the older subjects (37%) while more operations were requested by the younger subjects (63%). No significant findings were evident in an examination of the number of operations requested by sex. Research has been conducted to show that there are no real or apparent differences between sexes in visualization tasks (Linn & Petersen, 1983).

In examining the components of the strategies used in manipulation, consideration was given not only to the number of operations requested, but to the kind of operations. Although a given shape can be manipulated in an infinite variety of ways, the subjects requested certain operations which could be classified as additive, alterational, positional, and subtractive.

Additive operations consisted of those which added a shape or shape element or color to the existing image. Examples of these kinds of requests were, "Put a little square on top of it," "add a rectangle there," "add a big square around the whole thing." Color, when considered as an addition to the existing image is an additive operation.

Alterational operations were those which somehow altered the structure of the existing image. Requests which demonstrated an alterational operation were, "Shrink it down," "Expand that middle box out," "Make it higher," "Make these lines extend out." Color was considered an alterational operation when the request was made to change the existing color.

Positional operations were those which relocated or repositioned the existing image. Requests which illustrated this operation were, "Make it turn a bit," "Flop it down on its side," "Flip it right over," "Turn it around."

Subtractive operations were those which removed some or all of the existing image. Examples of these requests were, "Remove those middle lines," "Take those three edges off," "Cut this part off," "Erase the top semi-circle."

Although this broad classification is capable of refinements, it is a starting point in attempting to construct the nature of the strategies used. A general schema which depicts the kind and number of operations requested can be constructed from this classification. A summary of this can be seen in Appendix O, p. 188.

An interesting result which emerges from this classification concerns the number of times certain operations were requested (See Table 4).

Table 4

Frequency of Operations Requested

Operation	Rectangle	Circle	Total
Additive	64 (66%)	79 (87%)	143 (76%)
Alterational	11 (11%)	7 (8%)	18 (9%)
Positional	7 (7%)	0 (0%)	7 (4%)
Subtractive	15 (16%)	5 (5%)	20 (11%)
Total	97	91	188

The additive operation was the one most frequently requested (76%) while the positional operation was least frequently requested (7%). Only two subjects, both female (Subjects 7 and 9), chose to use color in their manipulations. Both these colors were requested as additions, e.g. "Add red there," and were considered additive operations. No positional operations were requested for manipulation 2 (circle), even though operational requests such as flip it over were available after some additions to the image.

Tables 5 and 6 summarize the kinds of requested operations according to individual subjects and reveal a range of different kinds of requested operations.

Table 5

Kinds of Requested Operations - Rectangle

	Operations																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Subject 1	S	P	A	A	A	A	A	A													
Subject 2	A	A	A	A	A	A	A	A	A	A											
Subject 3	A	A	A	A																	
Subject 4	A	P	S	P	P	S	S	P													
Subject 5	A	S	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Subject 6	A	A	A	A	A	A	A	A	A	A	A										
Subject 7	X	S	X	S	P	A	A	A	A	A											
Subject 8	X	S	X	S																	
Subject 9	A	A	A	A	A	A															
Subject 10	X	S	X	X	S	A															
Subject 11	X	X	S																		
Subject 12	P	S	X	S	X	S															

Table 6

Kinds of Operations Requested - Circle

Subjects	Operations																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Subject 1	A	A	A	A	A	A	A	A	A	A							
Subject 2	A	A	A	A	A	A											
Subject 3	A	A															
Subject 4	A	A	S	A	A	A	A	A	A	A							
Subject 5	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	
Subject 6	A	A	A	A	A	A	A	A	A	A	A	A					
Subject 7	X	A	A	A	A	A	A	A	A								
Subject 8	X	A	A	A	A												
Subject 9	X	A	A	A													
Subject 10	A	X	X	A	A	A	A	A	S								
Subject 11	S	A	A	A	S												
Subject 12	X	X	S														

Table 7 presents the kind of operational requests made with respect to age.

Table 7

Kinds of Requests Made According to Age of Subjects

	Rectangle		Circle		Total	
	Young	Older	Young	Older	Young	Older
Additive	52(81%)	12(19%)	55(70%)	24 (30%)	107(75%)	36 (25%)
Alterational	0	11(100%)	0	7(100%)	0	18(100%)
Positional	5(71%)	2 (29%)	0	0	5(71%)	2 (29%)
Subtractive	5(33%)	10(67%)	1(20%)	4(80%)	6(30%)	14 (70%)

The younger subjects tended to use long strings of additive operations and to be fairly consistent in the application of the same strategy for both manipulation activities. The older subjects tended to vary the operations requested and to choose different sets of operations for each manipulation activity. None of the younger subjects used an alterational operation while every one of the older subjects used at least one. The older subjects appeared to be much more experimental and varied in their choice of operations. No significant findings were discovered in an examination of the results according to sex.

Strategy has been defined in this study as a set of operations used to achieve an objective. Since the kinds of operations involved in manipulation strategy have been examined, it remains to examine the objectives which constitute the strategy. The objective of the operation was the changed visual appearance of the given image. Two factors were involved in the analysis of the extent to which the objective was met. First, at any stage during the operations and at the conclusion, the images could be examined. Second, the verbal responses from the subjects helped provide information as to the objective (See Appendix P, p. 201).

A simple way to classify the objective was to observe those behaviors most evident in the subjects' manipulations. These observations yielded two concepts, symmetrical and representational, and their opposites, asymmetrical and non-representational as categories.

It was observed that there were different ways in which a subject could arrive at images that could be classified as representational or non-representational. (See Table 8).

Table 8

<u>Methods of Arriving at Final Images</u>

	Begin	Process	End
1.	NR*	continue	NR
2.	NR	change	R
3.	NR	identify R	R
4.	NR	identify R	NR
5.	R	continue	R
6.	R	change	NR

* NR = Non-Representational

R = Representational

Subjects arrived at a final non-representational image in three ways. Some subjects began with operations that generated non-representational images and simply continued this until the task was terminated. Others began constructing a representational image and without any verbal indication, changed the process and selection of operations so that a non representational image resulted at the end. Still others began with a non-representational image, identified something representational in it, but then continued constructing a non-representational image.

There were also three ways by which subjects arrived at a representational image. Some subjects began with representational intentions and then contined these through to the end. Others began non-representationally and without any verbal indication changed the process into representational manipulation. The remainder began with a non-representational image, then verbally identified something representational in it and then continued building upon this identification.

For this study and the analysis of objectives, the final image was the one classified according to the symmetrical/representational and their opposities category. Determination of this assignment was made through analysis of the final image and any verbal clues given by the subject which helped determine intention (See Appendix P, p. 201).

The results, as seen in Table 9, show that the most frequent objective was a symmetrical, non representational image (62%).

Table 9

Objectives - Final Image

Subject	Rectangle	Circle
Subject 1	S/N	S/N
Subject 2	S/R	S/R
Subject 3	S/N	S/N
Subject 4	A/N	S/N
Subject 5	A/R	S/R
Subject 6	S/N	S/N
Subject 7	S/N	S/N
Subject 8	S/N	S/R
Subject 9	A/N	A/N
Subject 10	S/N	S/R
Subject 11	S/N	S/N
Subject 12	S/N	S/N

S/N = 15(62%)

S/R = 5(21%)

A/N = 3(13%)

A/R = 1(4%)

Only one subject arrived at an asymmetrical non representational image. Most of the final images were symmetrical (83%) and non representational (75%). Eight of the twelve subjects arrived at the same objective for both manipulation activities. Examination of the data showed no relationships between age, sex, and objectives.

Analyses of operations and objectives revealed that no subject requested any change which involved perspective, three-dimensional effects, or depth illusion. All manipulation was done on a two-dimensional surface using only two dimensional effects. Whether this was a product of the imposition of the restrictions or expectations set up by the computer, or some cognitive factor is material for further study.

3. Summary

The subjects in this study were varied in their choices of strategies for manipulating a given shape. There was some consistency shown in the number of operations a subject would request; the older subjects generally requested fewer operations. Additive operations were requested most frequently by all subjects, however, the younger subjects tended to request them more than the older ones. No subject under ten years of age used an alterational operation while all subjects ten and older requested an alterational operation. The older subjects were much more experimental in their choice of operations. Many different ways were adopted to get to the same final image. In terms of objectives, symmetrical and non representational image objectives were by far the most common. A great many varied types of operations were shown to lead to results which had common characteristics. The most variation in individual choice of operations seemed to come at the beginning of the activity. After one operation had been tried, a chain of similar ones followed.

C. STRATEGIES USED IN RECOGNIZING A GIVEN SHAPE

1. Procedure

The recognition sequence comprised twelve individual recognition tasks consisting of four different shapes masked in three different ways (See

Table 10).

Table 10

<u>Nature of the Recognition Tasks</u>

Task	Shape[1]	Masking Technique[2]
Task 1	Rectangle	Shared Contour
Task 2	Rectangle	Interrupted Contour
Task 3	Rectangle	Close-Color Harmony
Task 4	Triangle	Shared Contour
Task 5	Triangle	Interrupted Contour
Task 6	Triangle	Close-Color Harmony
Task 7	Circle	Shared Contour
Task 8	Circle	Interrupted Contour
Task 9	Circle	Close-Color Harmony
Task 10	Free-Form	Shared Contour
Task 11	Free-Form	Interrupted Contour
Task 12	Free-Form	Close-Color Harmony

[1] See Appendix G, p. 119

[2] See Appendix H, p. 123

Each subject experienced all twelve tasks sequentially. Except for the shape and masking procedure used, the structure of each task was identical and was administered in the same way.

a. The Structure and Administration of the Recognition Task

Each task consisted of ten sub-tasks. The sub-tasks were simplifications of the original image, called sub-task 10. Sub-task 10 consisted of the target shape masked within a complex structure. Each succeeding sub-task removed some of the distractors until only the target shape remained as sub-task 1. After sub-task 10, the screen was covered and the subject was asked for any ideas about how the shape was going to be found. This procedure was repeated after sub-tasks 7 and 4. When the target shape was finally recognized, the subject was asked how it was found. The verbal responses to the questions asked constitute the data for this section and are contained in detail in Appendix Q, p. 204.

2. Results and Interpretation

In using only verbal responses to document the kinds of strategies used in recognizing a given shape, regard must be paid to the inability of some subjects to verbalize intellectual activities. The research literature indicates difficulties with equating conscious awareness with verbal expression. There is support for the idea of some correspondence between verbal description and conscious awareness (Manis, 1971). But the lack of an alternative has "led researchers to rely upon verbal inquiry as a means of assessing awareness" (Manis, 1971, p. 82). In the present study, there was much evidence of inconsistency in responses and of inability to articulate the mental process. It is best to consider this section simply as an examination of the subject's reflections on the strategies they employed in the tasks.

As in the manipulation strategies, recognition strategies consisted of operations and an objective. The objective in this case was the successful recognition of the target shape. The kinds of operations which constituted the strategies, as articulated by the subjects, were extremely varied. For the purposes of this study, a four-part classification of operations was evidenced in the verbal responses.

The greatest number of responses were those reflecting structural recognition. This refers to the kinds of mental operations which seek to recognize the object with direct reference to its structure. Responses indicated that the subject was using structural properties as the basis for recognition. References to the image's size and shape and the way it was sitting were most common. It can certainly be argued that this was influenced by the initial directions of the researcher, i.e., the subject was specifically asked to remember and recognize the shape in terms of its structure (See Appendix K, p. 130). Some subjects did merely repeat the keywords and instructions given to them, while others appeared from their accounts to display a grasp of structural principles in their search. The frequency of this kind of response was fairly even across all age groups.

Second in frequency were those operations unable to be identified or articulated by the subject. This either suggests lack of awareness of the operation, inability to verbalize it properly, or unwillingness to articulate it. Examples of statements which demonstrate this operation are, "I don't know,""Just looking," or a simple "No" to the question posed by the researcher. It is difficult to determine the difference between inability and unwillingness to answer. Most of the subjects displayed great enthusiasm during the recognition sequence and were very impatient with questions asked of them. Many of the subjects became quite agitated when the screen was covered after sub-tasks 10, 7, and 4, and they were asked a question. They displayed a desire to be left alone until they had successfully found the target shape. This may account for the difference between the quality of response to the questions posed during the task and response to the question after they had found the target shape. The latter seemed much more complete and genuine than the former.

Responses indicating an unidentified operation were given more frequently the longer a subject took in recognizing the shape. Most of the responses to the question posed after sub-task 4, for example, were of this type. This type of response was given more frequently as the recognition sequence itself progressed. Some subjects used this response totally in the last few tasks. All subjects gave at least one unidentified response. The younger subjects gave approximately three times more unidentified responses than the older subjects. Generally speaking, the older the subject, the fewer of these kinds of responses were given.

The next most frequent response concerned the process of scanning. This process referred to the way subjects scanned the screen in order to locate the target shape. All subjects, of course, use some form of scanning technique. Some subjects were more conscious of what they did than others. Again, responses from the older subjects outnumbered those from the younger subjects, three to one.

Support for this may exist in the literature. Research reveals that older children scan pictures more completely and systematically than younger ones and the search time of younger children is shorter (Vurpillot, 1968, 1976). Only one subject did not talk about scanning operations (Subject 2). All of the remaining eleven subjects indicated that they did not have any particular set way of scanning. How they scanned depended on a number of variables.

One approach to scanning was the scattered method. Comments which summarized this approach were "I look all over the place,""I start just where my eyes are,""I just look in all different directions,"looking everywhere." This may be a legitimate explanation of a method that is indeed scattered, or it may be an indication that the subject is unconscious of any scanning pattern or unable to express it.

Although subjects may be unaware of a pattern to their scanning, and may indeed feel that it is scattered and without pattern, research has shown that eye movements and scanning is by no means random

(Boynton, 1960). Even with those subjects who verbalized their scanning methods as random and scattered, evidence was given that supported the case for systematic searching. Their attention was first attracted towards complex areas and their scanning patterns tended to move from one complex source of information to another (Mackworth, 1965). Many subjects, however, did make their own distinctions between a scattered approach and a planned or patterned approach. The usual method followed was to use a quick scattered approach to see if the shape could be seen readily. If this scattered approach failed to locate the target shape, the subjects began searching in a more systematic way. Many subjects also quickly assessed the recognition task in terms of its difficulty. Those tasks which appeared easy merited the scattered, followed by the structured approach. Those that were perceived immediately to be difficult merited a structured approach right away. Some of the responses which indicate this behavior were, "I'm using a plan because it looks harder" (Subject 7), "I used a pattern because it's a lot harder if you look at it generally" (Subject 10), "I used a pattern again because it's hard" (Subject 10), "I don't do it [structured scanning] always, just for this" (Subject 11), "It's easier [structured scanning] when there's a lot" (Subject 12). These statements appear to confirm the proposition that children learn rule-based strategies and that these types of strategies reduce problems (Bourne, 1967).

When the subject decided to use a structured scanning approach, that structure was not set or rigid. Most subjects used a different kind of approach each time, varying their scanning strategy from spirals starting at the middle to spirals starting at the outside, from horizontal to vertical and diagonal. It is difficult to classify these approaches since they were so individual. The most common starting place, however, seemed to be the top left, leading to a progression which duplicated the left to right horizontal reading pattern. All the subjects, however, used a different pattern each time.

Some subjects gave responses to the researcher's question which revealed a logical approach to scanning. Some subjects used, or at least articulated a logical operation referring to spatial location. Their responses reveal the kinds of logical processes involved in the recognition tasks. Some subjects deduced the location pattern used by the researcher in concealing the target shape and only looked in those areas. Others used the information that they developed in the concealment (Appendix K, Discrimination Sequence 12, p. 130) to help them in the recognition tasks. e.g., "I said that people wouldn't look on the bottom, so I thought it might be hidden on the bottom," (Subject 1), "I remember where I was going to hide it," (Subject 2), "I'm going to look around the corners because that's where I hide them a lot." (Subject 5). Even if the employment of this kind of operation did not necessarily result in a better chance of recognition, it did reveal a logical operation within the recognition strategy and provided evidence of the interesting way various components of the study influenced each other.

Most of these kinds of logical-locational responses were made by the older children (71%). Many of the older subjects gave examples of how they eliminated shapes that did not correspond to the target shape. Some gave logical reasons that supported their choice of search pattern, e.g., "Because the screen changes vertically, I use a vertical search pattern." The most common reason for the adoption of a structured approach to scanning was that it was prompted by the difficulty of locating the image. Some subjects observed that the fewer distractors in the image, the easier it gets. "That's why I take so long," (Subject 3) "I could wait until they are all erased, then I could find it," Probably many or even most of the operations involved in a recognition strategy spring from a logical base, but evidence for saying so is confined to the responses offered by the subjects. The older subjects responded more readily with responses indicating logical operations (86%).

Probably the most commonly used recognition operation was the incorrect guess. Much work has been done on incorrect responses in recognition tasks (Trabasso & Bower, 1966, 1968). There exists information to show that a number of various strategies are involved in using an incorrect guess (Coltheart, 1973; Levine, 1966; Millward & Spoehr, 1973). Some of the subjects obviously used the incorrect guess as an elimination device. This was difficult to detect unless the subject verbalized it. The number of incorrect guesses was tabulated from the video tape transcriptions (See

Table 11).

Table 11

Number of Incorrect Guesses in Recognizing a Given Shape

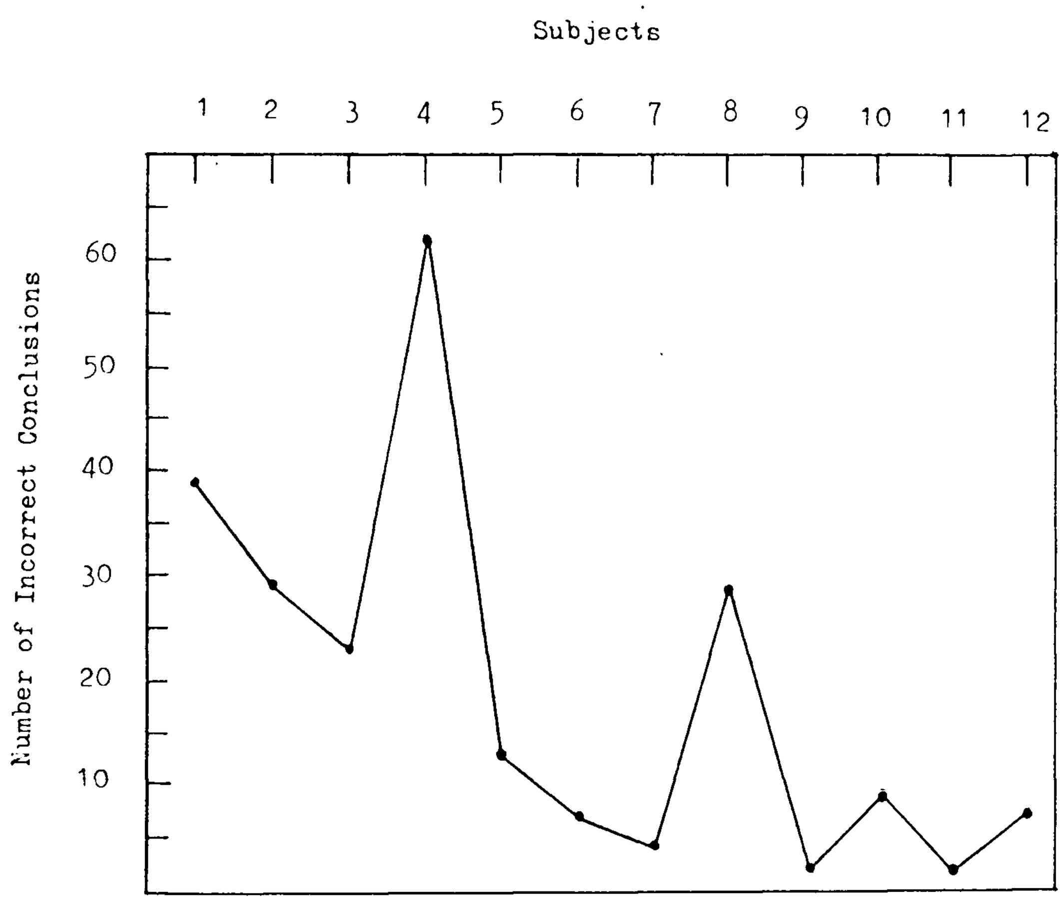
Subject	Task 1	2	3	4	5	6	7	8	9	10	11	12	
Subject 1	0	2	1	5	4	16	5	0	5	1	0	0	39
Subject 2	4	2	0	0	4	8	0	1	6	0	3	1	29
Subject 3	5	4	0	0	3	2	5	1	0	0	3	0	23
Subject 4	8	2	1	11	8	1	10	8	2	1	2	8	62
Subject 5	4	0	0	1	0	1	0	0	0	3	3	1	13
Subject 6	3	1	0	0	0	0	0	0	0	0	1	2	7
Subject 7	0	0	0	0	1	1	2	0	0	0	0	0	4
Subject 8	5	1	7	0	2	9	3	0	1	1	0	0	29
Subject 9	0	0	0	0	1	0	0	0	0	0	0	0	1
Subject 10	6	0	0	1	0	3	0	0	0	0	0	0	10
Subject 11	0	0	0	0	0	0	0	0	0	1	0	0	1
Subject 12	1	0	0	1	0	2	1	0	0	0	0	2	7
	36	12	9	19	23	43	26	10	14	7	12	14	225

The mean number of incorrect guesses was 18. It is interesting to note that the older subjects made fewer incorrect guesses. This is consistent with research studies that show younger children tend to give a higher percentage of incorrect responses than do older children (Mednick & Lehtinen, 1957; Riess, 1946). Evidence in this study may be seen as confirming research that shows that the search times of younger children are shorter than those of older children (Vurpillot, 1968, 1979). Two very significant exceptions to this are noticed with subjects 4 and 8 (See

Figure 1).

Figure 1

<u>Number of Incorrect Guesses by Subject</u>



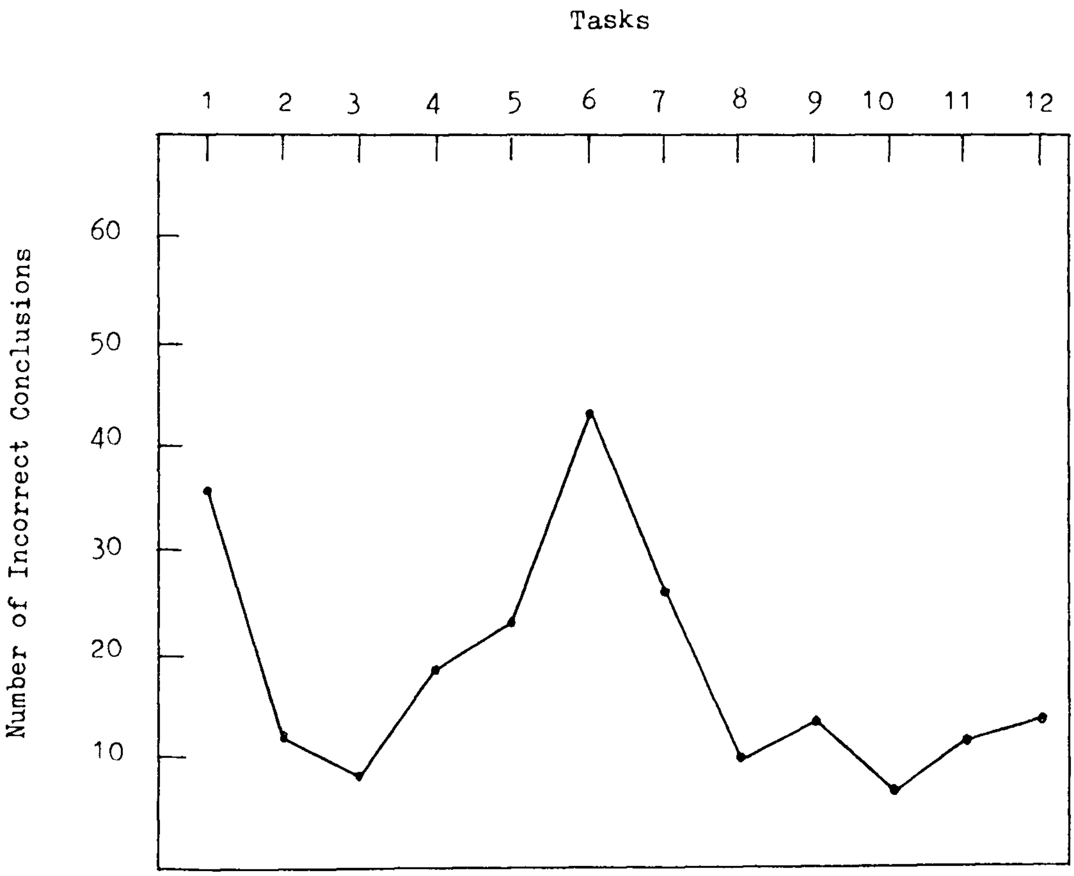
In the collected verbal responses, only three subjects indicate that guessing is an operation they use for recognition strategy. Subjects 4 and 8 are two of these. Both mention several times that guessing is a part of their strategy. This may account for the high number of incorrect guesses

Subjects 4 and 8 made in relation to others of their age. It should not be assumed, however, that just because a subject did not verbalize guessing as a technique, it wasn't used.

In order to determine whether some tasks prompted more incorrect guesses than others, Figure 2 was prepared.

Figure 2

Number of Incorrect Guesses by Task



Task 6, Close-Color Harmony circle, generated the most incorrect guesses, while task 10, Shared Contour free-form, generated the least. The triangle, as a shape, elicited the most incorrect guesses, while the free-form elicited the least (See Table 12).

Table 12

Incorrect Guesses by Shape

Shape	Incorrect Guesses
Rectangle	57 (25%)
Triangle	85 (38%)
Circle	50 (22%)
Free-Form	33 (15%)

In terms of masking technique, shared contour received the most incorrect responses while interrupted contour received the least (See Table 13).

Table 13

Incorrect Guesses by Masking Technique

Masking Technique	Incorrect Guesses
Shared Contour	88 (39%)
Interrupted Contour	57 (25%)
Close-Color Harmony	80 (36%)

3. Summary

As in the strategies used in manipulating a given shape, strategies used in recognizing a given shape were individual and varied. A strategy consisted of a number of operations and an objective. In this case, the objective was predetermined and fixed, i.e., the recognition of a given shape. Responses illustrating the operations constituting the recognition strategy were extremely varied and resulted in the identification of individual strategies. The most common response was that indicating unwillingness or inability to articulate the operation used. Next in frequency were those operations which described scanning operations. All responding subjects used a variety of operations. The most common feature seemed to be a scattered approach followed by a more focused and structured search pattern. If the task was perceived as difficult, the scattered approach was abandoned and the structured scan pattern immediately adopted. Older subjects were able to articulate some of the logical processes used in location and elimination operations. A frequently employed operation was the incorrect guess. Younger subjects made more incorrect guesses than older subjects. The two exceptions to this trend, subjects who used an exceptionally high number of guesses in relation to others of their age, were both subjects who stated that they used guessing as a strategy in image recognition.

D. EVIDENCE OF THE ABILITY TO RECOGNIZE A GIVEN SHAPE

1. Procedure

Each recognition task consisted of ten sub-tasks. Sub-tasks, numbered in decreasing order from 10 to 1, were progressive simplifications of the original masked image. The subject was shown sub-task 10 of the particular recognition task for 15 seconds before sub-task 9 appeared on the screen. Each subsequent sub-task was presented for 15 seconds before the next simplified image appeared. This progression from a complex to a more simplified image continued until the subject correctly identified the target shape. The number of the sub-task at which the shape was correctly recognized was recorded on a data sheet (See Appendix H, p.

123). Analysis of these documented results provides evidence of the subjects' ability to recognize the given shapes.

2. Results and Interpretation

Individual recognition scores were recorded and reported according to subject and task (See Table 14).

Table 14

<u>The Ability to Recognize a Given Shape</u>

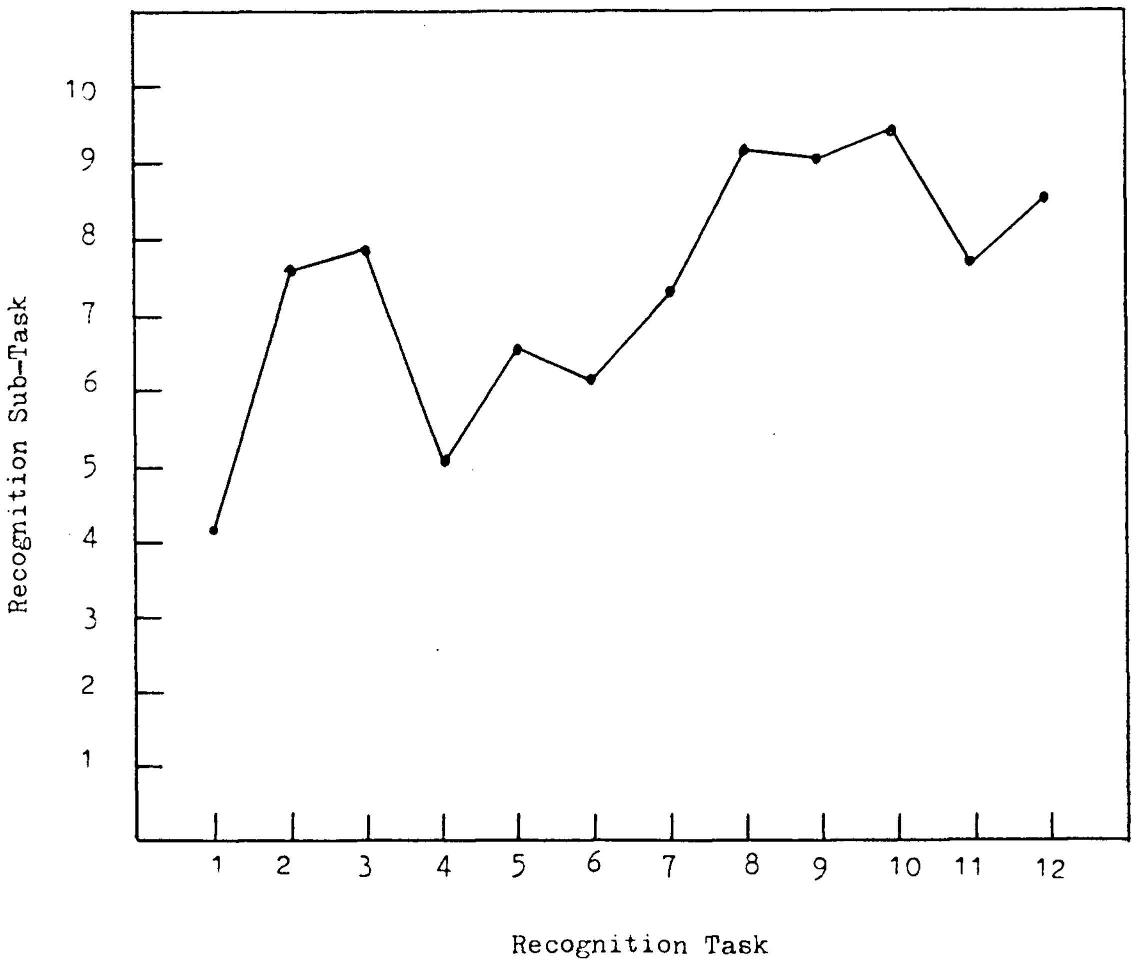
Subject	Task													
	1	2	3	4	5	6	7	8	9	10	11	12	T	M
Subject 1	9	6	5	1	3	2	6	10	8	10	8	9	77	6.42
Subject 2	2	5	9	8	4	5	9	8	6	10	7	10	83	6.92
Subject 3	4	7	10	9	3	9	6	8	10	10	6	10	92	7.67
Subject 4	5	9	8	3	5	9	6	6	10	10	9	7	87	7.25
Subject 5	1	9	9	4	8	10	5	10	10	9	7	10	92	7.67
Subject 6	3	7	9	7	8	10	10	10	10	10	8	5	97	8.08
Subject 7	8	8	10	8	9	1	5	10	9	10	7	10	95	7.92
Subject 8	2	9	1	1	8	2	7	9	9	10	10	10	78	6.50
Subject 9	1	8	8	7	5	8	8	10	9	8	6	8	86	7.17
Subject 10	4	9	9	4	9	6	10	10	9	7	10	9	96	8.00
Subject 11	9	8	10	3	9	8	9	10	10	10	9	9	104	8.67
Subject 12	2	8	7	6	9	3	7	10	10	9	6	4	81	6.75
Total	50	93	95	61	80	73	88	111	110	113	93	101	1068	
Mean	4.17	7.75	7.92	5.08	6.67	6.08	7.33	9.25	9.17	9.42	7.75	8.42		

The recognition task sequence is a direct reflection of reaction time, a "concrete and quantitative measure of very covert and unobservable cognitive processes of thought" (Leahey, 1985, p. 136). A longer reaction time reflects either a more complex process or more processes than a shorter reaction time indicates (Donders, 1868; Leahey, 1985). Analysis of the results obtained in this study reveals that the subjects showed increasing ability in recognition as the study progressed. In examining the subjects' individual profiles (See Appendix R, p. 237). a clear pattern emerges. Generally speaking, the subjects individually displayed an increase in their ability to recognize the given shapes, Although a wide variety of abilities is displayed, this seems to settle into a rising pattern after task 6. This is better illustrated when the ability mean is displayed as in

Figure 3.

Figure 3

The Ability to Recognize a Given Shape by Task



It is interesting to note that the lowest score (4.17) is for the first task in the recognition sequence. The second lowest score is for task 4, which is the beginning of a new shape. There was evidence of ability to recognize a given shape more readily as the study progressed. This trend is represented in Table 15.

Table 15

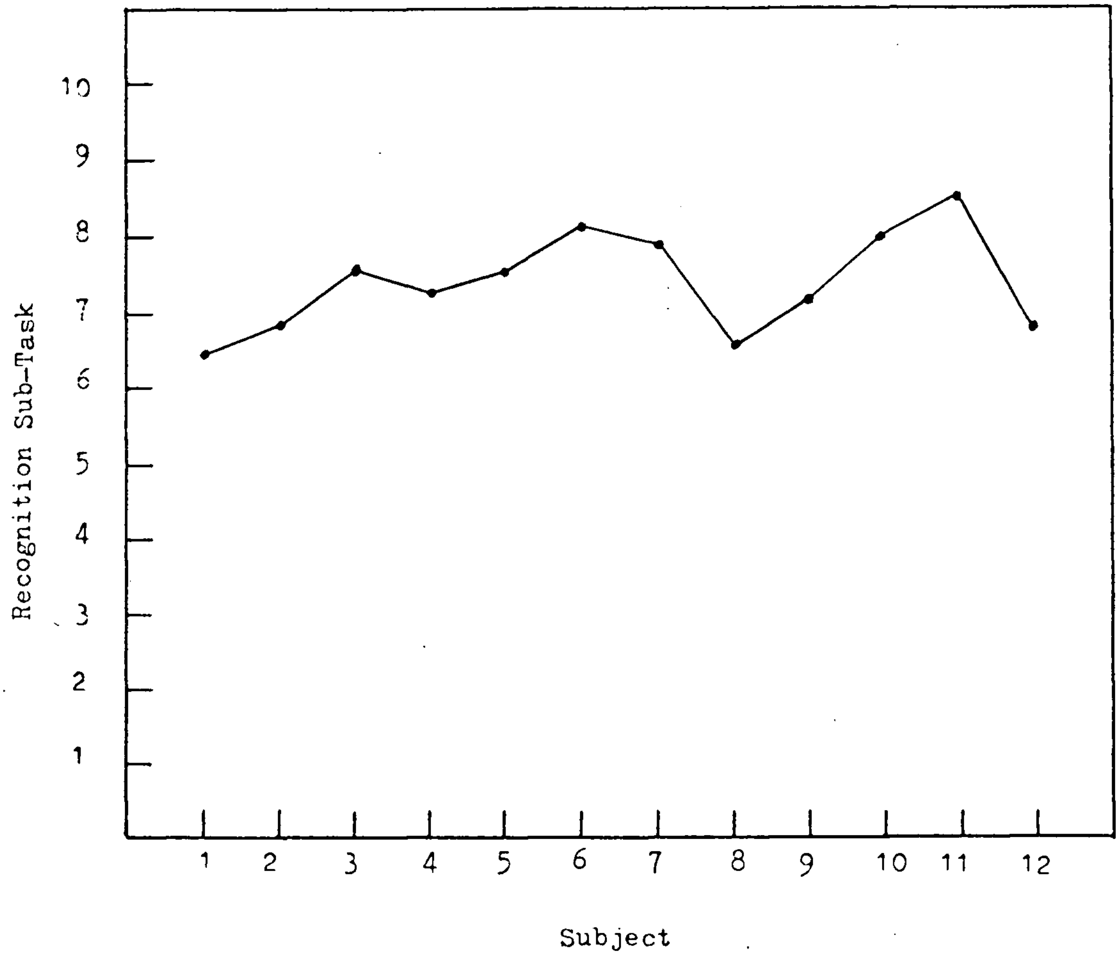
Ability by Shape

Shape	Mean
Rectangle	6.61
Triangle	5.94
Circle	8.58
Free-Form	8.53

There does not appear to be a significant increase in ability according to the ages of the subjects. (See Figure 4). This is in direct contrast to some of the research which indicates that reaction time in recognition studies decreases with age (Yonas & Gibson, 1967), and that younger children have more difficulty in recognition tasks than older ones (Vernon, 1976). Other research studies, however, state that individual variations and order of appearance in recognition and cognitive development is the rule rather than the exception (Klahr & Wallace, 1976) and that the ability to make accurate spatial judgments is not a general trait in children (Smith and Smith, 1966).

Figure 4

Ability to Recognize a Given Shape (Subject Mean)



The mean ability level of the younger subjects was 7.33. The mean ability level of the older subjects was 7.50. Generally, the higher scores were achieved by older subjects, but some of the lower scores were also achieved by them. Most of the subjects who achieved low scores in ability were also those who made the greatest number of incorrect guesses. Subjects 1, 4 and 8, who articulated that they were using guessing as a means of recognition, gave the most incorrect guesses and also achieved the lowest ability scores (See Table 16).

Table 16

Low Scorers (Under 7.25)

Subject	Ability Mean	Guesses
Subject 1	6.42	39
Subject 2	6.92	29
Subject 4	7.25	62
Subject 8	6.50	29
Subject 9	7.17	1
Subject 12	6.75	7

There appeared to be no significant links between the manipulation and recognition strategies employed by subjects.

The results were examined to see what relationship existed between those who made very few incorrect guesses and their ability scores (See Table

17).

Table 17

Subjects Making Few Incorrect Guesses (12 or fewer)

Subject	Guesses	Ability Mean
Subject 6	7	8.08
Subject 7	4	7.92
Subject 9	1	7.17
Subject 10	10	8.00
Subject 11	1	8.67
Subject 12	7	6.75

Of the six subjects who made 12 or fewer incorrect guesses, 4 were high ability scorers.

3. Summary

Examination of ability to recognize a given shape provides yet more evidence of individuality and diversity. Among the subjects studied, there does not appear to be any real progression in ability according to age. There does appear to be direct evidence of an increase in individual ability as each subject progressed through the recognition tasks. It was shown that the subjects who used guessing as a recognition strategy and who also made the highest number of incorrect guesses, achieved among the lowest recognition scores. Generally those subjects who made the least number of incorrect guesses achieved the highest scores.

E. STRATEGIES USED IN SELECTING A LOCATION FOR CONCEALING A GIVEN SHAPE

1. Procedure

At the completion of each recognition task, i.e., after the subject had correctly recognized the shape and had responded to the researcher's questions, the image constituting sub-task 10 was re-presented on the screen. The subject was then asked to find a place to hide the target shape so that it would be difficult to find. After selecting a location, the subject was asked to provide a reason for the choice. The location was registered on an 8 x 8 transparent grid and recorded on a specifically prepared sheet (See Appendix H, p. 123).

2. Results and Interpretation

This activity, in a sense, is the converse of the recognition sequence. Instead of asking subjects to recognize a shape hidden within a field of distractors, the subjects were asked to find a location within the field of distractors in which to hide a target shape. The data consisted of the selected locations and the verbal responses rationalizing the choice. Again, as table 18 reveals, diversity of selection and rationalization characterized this part of the study.

Table 18

Selected Locations For Concealing a Given Shape*

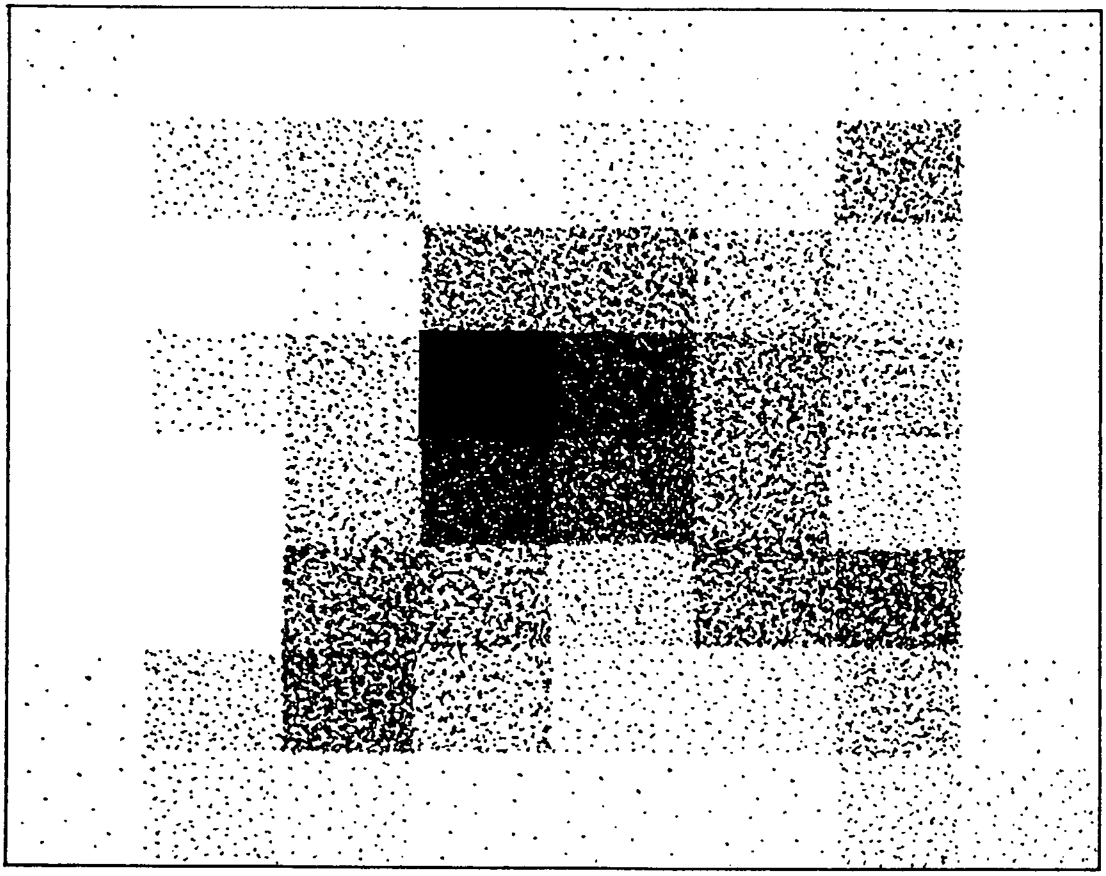
	Subjects											
	1	2	3	4	5	6	7	8	9	10	11	12
Task 1	B/8	B/7	E/4,5	G/3,4	G/2	C/6,7	C/7	D/6	D/7	D/6	C/7	D/4,5
Task 2	B/4	G	D/5	C/2,3	D/3	D,E/3,4	D/5	C/5	F/3	D/3	E,F/5	B/7
Task 3	D/4,5	E/4	E/3,4	E/6	F/3	G/3,4	D/4	D/5	C/5	C/2	D/6	C/6
Task 4	D,E/3	7,8	D/4,5	E/2	E/4	F/6	G/2	E/1,2	F/3,4	F/6	D/4	D,E/4,5
Task 5	B/2	F,G/5,6	D/5	E/7	F/7	B/2	B/2	G/7	C/6	D/2	G/4	B/4
Task 6	C/2	C/8	D/4,5	F,G/2	E/5	F/4,5	C/6	E/5	E/4	C/4	D/4	C,D/5,6
Task 7	G/6	G/6	E/4	E/6	D/5	C/2,3	D/4	F/4,5	E/3	F/6	G/6	C/6,7
Task 8	E/7	D/7	D,E/3,4	A/1	E/5	F,G/7	F/6	D/4,5	B,C/4,5	D/5	G/6	G/6
Task 9	C/4	C/4	E/4,5	C/4	E/2	D/5	F/6	D/4,5	-	F/4	E/3,4	D,E/4,5
Task 10	F/2,3	C,D/7	D,E/4,5	C/4	B/6	E/3,4	D/3	E/6	C/2	F/3	G/3	C,D/6
Task 11	C/5	D/6	E,F/5	H/8	F/5	E,F/4	D/4	E/4	D/3	C/7	G/4,5	C/3
Task 12	B/7,8	G/6,7	D,E/4	D/7	F/6	G/8	C/7	E/6	D/4	F/4	G/5	G/2

* Explanation of symbols appears as Appendix H, p. 123.

There were, however, some common elements which allowed classification. In general, the center areas were chosen more often, and the outside edges least often as good concealment locations. The frequency of selected locations can best be seen in Figure 5.

Figure 5

Frequency of Selection in Location



Video Screen

Here the most frequently selected locations appear as the darkest areas with a tonal gradation to light indicating decreasing frequency of selection.

One factor in the determination of choice is certainly the model location provided by the target shape hidden in the recognition task just undergone by the subject. This model location may have influenced the subjects' choices. In order to determine whether the target shape and location provided a model which influenced the subject's choice, the results were analyzed according to whether the chosen location was spatially proximate to the model location. Criteria for what constituted close spatial proximity were established (See Appendix S, p. 244) and the results reported in

Table 19.

Table 19

Close Spatial Proximity to Model Location

	Tasks												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
Subject 1			X		X						X	X	4(33%)
Subject 2		X	X			X							3(25%)
Subject 3		X		X	X	X		X	X	X			7(58%)
Subject 4			X				X	X				X	4(33%)
Subject 5				X		X	X	X					4(33%)
Subject 6				X	X				X				3(25%)
Subject 7		X	X		X	X		X	X		X	X	8(67%)
Subject 8			X			X		X	X	X	X	X	7(58%)
Subject 9			X	X	X	X		X			X		6(50%)
Subject 10				X	X	X		X	X				5(42%)
Subject 11		X	X	X		X							4(33%)
Subject 12	X		X	X	X	X	X		X		X		8(67%)
Total	1	4	8	7	7	9	3	7	6	2	5	4	63

*X - indicates a close proximity location

Most of the chosen locations were not close to the model location (56%). The choices, however, as Table 19 shows, are fairly evenly divided between those near and those distant from the model location. The older subjects selected more locations (60%) near the model location than did the younger subjects. Only one subject chose a location near the model on Task 1. Shared Contour masking elicited the fewest close proximity locations (21%). Interrupted Contour masking received the next (36%), while the most close proximity location selections were made for Close-Color Harmony (43%). This hierarchy from Shared contour to Close-color harmony manifests itself in various ways throughout the study. The shape that was most frequently located near the model was the triangle (37%), followed by the circle (25%). The shape least frequently located near the model was the free-form (17%).

The task that elicited the greatest number of close proximity responses was Task 6. Nine subjects (75%) chose a close location for this task. Task 6 also received the greatest number of incorrect guesses during the recognition sequence.

The shape was chosen for concealment in exactly the same place as the model on only six occasions. Five of those six exact locations were generated by only two subjects (subjects 4 and 7) who also gave the majority of their selections as close (67%). All the subjects who chose the exact location were female.

An analysis of the subjects' verbal responses indicating the reasons for their choice of location revealed a number of different explanations. Subjects in this task, more than in any other, tended to get very impatient with the question posed by the researcher as to why that particular location was chosen. The general tendency of most subjects was to give some detailed answers for the first few tasks and then respond with the same answer for the remaining tasks, or respond with statements such as, "Same reason as before," "I don't know," or "Same as I said before."

By far the most common sets of operations governing the concealment strategy derived from notions of quantity. It was evident that subjects chose locations that were structurally complex, and they were aware of this. The areas that were most filled with shapes and lines seemed to be the best place to hide the shape. The response that best characterized this reason stated "That is where the most shapes are." This type of reason was given frequently by both age groups. An extention of this reason was provided by some subjects, usually the older subjects, who stated that they hid the shape in the most structurally complex area for some particular reason. The most common reason was that overlapping occurred in this area. A shape that was overlapped was considered to be more difficult to find than one that wasn't. Half of the twelve subjects gave responses that used overlap as an explanation. Another explanation for concealment was that putting the shapes beside others that looked like it would make it difficult to find.

Some of the subjects employed a locational explanation. They put the shape in a place they thought would be hidden because "nobody would look there." They explained this choice in various ways. "I try to hide it around the corners because people look in the middle" (Subject 5). "I usually look in the middle" (Subject 7). Some identified their own search strategies and then applied them to the concealment tasks. "I don't usually look down on the bottoms. I usually look in the middle"(Subject 7). "I always find it in the middle. Putting it on the edges would be hard to find." This locational operation was used by five subjects, three of whom were older. One subject (Subject 4) employed a peculiar strategy. After noticing that the chosen location was recorded by the use of a transparent grid marked with letters and numbers, he began using the numbers and letters as devices for locating concealment locations. After choosing a location which he determined would be area E7 on the grid, he explained his choice. "Because it stands for my name and my age" (E7 = Evon, age 7). Again, after selecting A1, he explained, "it's A and it's 1 and it's my secret code. A is 1 and 1 is A." He seemed serious in answering that this would indeed be the best place for hiding the shape. He then started selecting letters distant from certain numbers. To him, H and 1 would be a difficult place "because H is not very close to 1."

3. Summary

Diversity of reasons characterized the strategies used in concealing the given shape. The middle areas of the visual screen were chosen most often for concealment locations. Choices were fairly evenly divided between those that were close and those that were distant from the model location. The older subjects chose more locations near the model than did the younger ones. Subjects who chose locations identical to those of the model were also those with the highest number of near locations.

The responses describing reasons for selections were varied. Subjects gave statements that employed locational, structural, and logical considerations for their choices. The most widely given response indicated that the most structurally complex area was the best choice for a concealment location.

F. EVIDENCE OF THE ABILITY TO DISCRIMINATE THE TECHNIQUES USED IN MASKING A GIVEN SHAPE

1. Procedure

At the completion of tasks 3, 6, and 9, a further task was undertaken by the subjects. After the subject had indicated reasons for concealing the shape in a chosen location, an image showing the three different masking procedures used in the previous three tasks was presented on the screen (See Appendix T, p. 246). The subject was introduced to them by being told that these were the different ways in which the shape had been hidden, and then asked to explain what the differences between them were.

2. Results and Interpretation

Verbal responses given in answer to the question "Can you tell me the differences between them," constitute the data for analysis (See Appendix U, p. 249).

The responses were basically of three types that explained the differences in terms of difficulty, quantity, or structure. The ability to correctly discriminate the masking techniques had been determined as involving structural discrimination and was the criterion for successful performance. As the administration of this task was terminated when the subject gave what was considered to be a correct explanation, not all subjects gave an equal number of responses.

As Table 20 shows, the least used response was that which discriminated the difference in terms of difficulty (17%).

Table 20

Discrimination Responses

Task	Difficulty 3	6	9	Quantity 3	6	9	Structure 3	6	9
Subject 1	0	1	0	0	2	0	3	2	0
Subject 2	0	0	0	2	3	3	1	0	0
Subject 3	0	0	0	1	3	1	3	0	3
Subject 4	3	0	0	0	2	2	1	1	1
Subject 5	0	0	0	1	0	0	3	3	3
Subject 6	3	0	3	0	3	0	0	0	0
Subject 7	0	0	0	0	0	0	3	3	3
Subject 8	0	0	0	0	0	0	0	3	3
Subject 9	3	2	0	0	1	0	3	2	0
Subject 10	0	0	0	0	0	0	3	0	0
Subject 11	0	0	0	0	0	0	3	0	0
Subject 12	3	0	0	0	2	0	3	1	3
Total	12	3	3	4	16	6	26	1	16

The most common form of this response was a statement explaining that one particular technique was harder or easier than the other two. Those who employed this response used it most frequently (71%) on their first exposure to this discrimination activity (at task 3). Only two of the five subjects who used this response continued to use it after the first time. Subjects who used it were unanimous in indicating that there was a hierarchy of difficulty in the masking techniques. They perceived Shared Contour to be the easiest, Interrupted Contour to be the next hardest, and Close-Color Harmony to be the most difficult.

This perceived order of difficulty was also voiced by other subjects throughout the study. The most common reaction to the tasks involving Close-Color Harmony as a masking technique was shock. The majority of subjects expressed agreement that Close-Color Harmony was the most difficult of the three techniques yet this perceived general difficulty was not reflected in the actual difficulty and performance as revealed in the subject's ability scores. The order of actual difficulty is the reverse of the perceived difficulty. According to the recognition ability scores, shapes employing Close Color Harmony were the most easily recognized (7.90) followed by Interrupted Contour (7.85), and Shared Contour was the most difficult (6.50). It may well be that shapes employing Close-Color Harmony masking were the most difficult. The reason they were so readily recognized may have been provided by the subjects when they explained the strategies they used in recognition. Many of the subjects stated that their scan and search patterns became much more structured and disciplined when the task was perceived to be more difficult. The more organized strategy may indeed produce better results.

The second most used response discriminated differences in the observed masking techniques on the basis of the quantity of shapes present (26%). The usual response indicated that Shared Contour had fewer shapes than Interrupted Contour, and that Close-Color Harmony had more than both of them. This certainly corresponds with the perceived hierarchy of difficulty. Younger subjects seemed to use this response more (88%) than did older subjects. It was also used more for the tasks involving triangles (62%) than for any of the other shapes. It seems that in this section of the study, the younger children concentrated on number while the older children concentrated on structure. This is in contrast to some other research studies which show that younger children ignore the number of items and concentrate on shape and color, while older children ignore shape and color and concentrate on the number of items (Odom & Guzman, 1972).

a. Discriminating Shared Contour

The response used most frequently (57%) was that dealing with structure or quality of the masking technique employed. In various ways, discrimination of difference was perceived as residing in the visual structure of the shapes themselves. The criterion established for evidence of the successful ability to discriminate the masking technique was basically structural. The criterion for discriminating shared contour was simply understanding that the shapes shared their contours. None of the younger subjects gave a response that indicated their understanding of this. The usual type of structural response from the younger subjects dealt with the size of the shapes and their plainness or complexity. All but one of the older subjects gave responses which displayed ability to discriminate the masking technique. Their responses ranged from a simple observation like, "It is simple with nothing overlapping" (Subject 11), to some very intricate explanations. Subject 7 explained shared contour in terms of wholeness. "It's whole. There's not just outlines. Like we could color each one in. There's not one sitting behind it. Whole is when there's no lines underneath interfering with the whole shape." Subject 10 gave another kind of explanation. Shared contour "is straight blocks all grouped together with no spacing, no color, and they don't overlap each other." Subject 8 echoed Subject 7's idea about being able to color the blocks in. "There is no space in the background. Everything is the shape." Subject 12 was the only older subject not to successfully discriminate this masking technique.

b. Discriminating Interrupted Contour

The criterion for discriminating the second masking technique, Interrupted Contour, was understanding that the shapes overlapped. Most of the subjects (67%) were able to correctly discriminate this technique. Half of the younger subjects were also successful. Most of the responses used the word "overlapping," however some responses implied other concepts like "tied together." All but one of the older subjects displayed their understanding of this technique. Some of the older subjects expanded on the word "overlapping." Subject 7 stated that "there is just the outline.

There are boxes behind it that you can see...the lines are interfering." Subject 8 said that "there is more space in the background and the shapes are ringed around each other." Again, Subject 12 was the only older subject not to provide a structure-based explanation.

c. Discriminating Close-Color Harmony

Establishing a criterion for the correct discrimination of Close-Color Harmony masking was more difficult. The technique employs a background of similar shapes in closely-related solid colors to mask the foreground shapes which are superimposed, in outline only, over the background. The subjects responded with a variety of answers explaining their perceptions. All the subjects gave color as the primary difference. The younger subjects gave color alone as the difference, whereas the older subjects tended to name color along with other explanations of difference. Subjects 9 and 12 were the only older subjects to give only color as the perceived difference. Subject 7 stated that the colors were different and that there were "outlines and whole boxes. It's a mixture of one and two. There are pink outlines with lots of colors in them." Subject 10 stated that they were "all spaced out with none of them touching and there was color added in the back and shapes in some of the shapes." This was perhaps the fullest explanation received from any of the older subjects. The other older subjects explained the differences as being combinations of all three masking techniques.

3. Summary

The subjects displayed evidence of their ability to discriminate the masking technique through responses that were classified as dealing with difference related to difficulty, quantity, or structure. Difference in terms of difficulty was the least given response while difference in structural terms was given most. Subjects generally perceived Shared Contour to be the easiest and Close-Color Harmony to be the most difficult. Examination of their recognition ability scores showed the reverse to be case. Perceived degree of difficulty of the three masking techniques was similar for younger and older subjects.

Responses differentiating the technique in terms of the number of shapes present were made more often by the younger subjects. Responses concerning structural differences were made fairly evenly by both younger and older subjects. The older subjects, however, displayed a much better understanding of the technique used. Almost invariably they correctly discriminated the structural properties of the masking technique.

CHAPTER V. SUMMARY AND CONCLUSIONS

This study was conducted in order to determine whether the strategies and abilities revealed by elementary school children to tasks related to visual structure would support or refute the assumption that perceptual learning is automatic and universal. The study was conducted with twelve elementary school children over the period of one week. It consisted of the presentation and completion of a computer-generated program which involved subjects in manipulation, recognition, concealment, and discrimination tasks. The results of the study comprised several distinct yet interrelated areas.

When asked to think of ways to make a specific shape look different, subjects showed consistency in the number of operations they chose to do over two tasks. Younger subjects seemed to request more operations than older subjects. Additive operations were the most frequently requested by all subjects. Younger subjects, however, generally requested more additive operations than older subjects. Positional operations were least frequently requested. No alterational operations were requested by the younger subjects while all the older subjects requested at least one. Younger subjects seemed to request long strings of additive operations for both manipulation tasks, while the older subjects were much more experimental and varied in their choice of operations, while those choices differed for both tasks. The manipulation objectives tended towards non-representation and symmetry. No attempt was made by any subject to generate image changes which employed depth illusion.

When asked to perform tasks involving the recognition of a specific shape, subjects revealed increasing ability to perform more successfully as the study progressed. There was very little evidence, however, of significant difference in ability according to age. The subjects employed a variety of personal strategies in the recognition tasks. Most subjects based their strategy on structural knowledge. The method of scanning or searching played a large role in the strategies. Older subjects talked about their scanning strategies much more than younger subjects. Scanning operations seemed to follow a standard routine. Subjects used a rather casual and scattered approach when the task appeared easy. If the task appeared to be difficult, or if the subject encountered some difficulty in a previously perceived easy task, a change was immediately made to a more structured and patterned scanning approach. Subjects who did this were unanimous in their belief that a structured approach was more effective in successful performance. These structured approaches were unique to each subject. Some subjects admitted to using guessing as a strategy for recognition. Subjects who admitted this, and who also had very high incorrect guess scores, also achieved very low recognition ability scores. In general, older subjects gave fewer incorrect guesses than younger subjects.

Subjects were asked to select a location amongst a complex arrangement of shapes in which to hide a given shape. The greatest number of selected locations were positioned in the center of the viewing screen. There did not seem to be any real influence generated from the location of the model shape. Subjects generally stated a strategy for concealment which used the most visually complex area as the best hiding place.

Finally, subjects were asked to discriminate the difference between the masking techniques used in the recognition sequence. Older subjects were able to verbalize much more lucidly about this activity than younger ones. The older subjects were almost always correct in their explanations for discriminations. Many subjects perceived a hierarchy of difficulty in the three masking techniques and most agreed that Shared Contour was the easiest while Close-Color Harmony was the most difficult. This perceived difficulty was exactly opposite to the ability scores, which showed that Close-Color Harmony was the most easily recognized while Shared Contour was the most difficult.

1. Implications for Art Education

The results reported from the conduct of this study raise interesting questions for art education. If we can accept that art is a cognitive activity, then we must realize the "need for deliberate structuring of experiences within a visual arts program so as to make explicit the characteristics and methods of organizing visual phenomena" (Cowan, 1984, p. 30). In order to structure those experiences properly, attention must be paid to certain cognitive functions, i.e., strategies relating to manipulation, recognition, and discrimination.

This study shows that some children respond with different abilities and strategies to specific visual tasks. Children with definite perceptual strategies and the ability to base those strategies on structural knowledge were better able to recognize and discriminate visual shapes than children who used ineffective strategies. Perceptual learning does take place. Indications of increasing competency in recognition ability as the study progressed were revealed.

How much more effective could children's perceptual abilities be if the art program consciously helped them develop strategies for coping with complex visual structure. Some art educators may find it important to redevelop art programs based on the awareness that perceptual learning may not occur naturally, and that children do possess different and varyingly effective strategies for dealing with visual structure. These programs should take into account the fact that perception of the visual world takes place in degrees of success dependent on the kind of mental strategy employed. Without guided instruction in devising perceptual strategies, children are left on their own to develop both effective and ineffective ones. This is a problem that has been recognized through research (Dunn-Rankin, 1978; Matlin, 1983). Art educators should be aware of this and construct programs which help children make sense of their visual worlds in the most effective way possible. Only by mastering such skills and acquiring the ability to control them, can a child "begin to deal efficiently with an increasingly complex environment" (Brown, 1975, p. 146).

To further these ideas, it would be profitable to continue work based on the results of this study. More detailed and specific knowledge is needed about the kinds of perceptual strategies used by children. What kinds of operational changes in the structure of a shape are children of certain ages able to perform? What would be the effect of an educational program which gave children opportunities to learn about structure and gave them viable and effective strategies for perception, manipulation, and discrimination of visual form? Since the perception of structure in the visual world is an essential part of the art program, should it not be taught in a systematic way, based on the latest research in the field? In order to do this with intelligence, more must be learned about what constitutes effective and ineffective perceptual strategies and the mechanisms for teaching the effective ones. This would involve some sort of alliance of art education with other disciplines now working in this area. In order to construct a program as independent of fortuitous circumstance as possible, controlled observation is necessary. Research studies into children's perceptual abilities might employ, as did this study, the computer as a means of presenting material in ways that are more efficient and economical than are afforded by graphic media. A computer bank of collected information would allow greater sharing, access, and uniformity for future replication.

Concentrated and competent work in this area will provide a solid data source of information about how children make sense of their visual worlds. The understanding that results may provide an empirically sound basis for the development and administration of art programs that may ultimately lead to a more universal form of visual literacy than exists at present.

REFERENCES

Anderson, J.K. (1980). Cognitive psychology and its implications. San Francisco: W.H. Freeman & Co.

Anglin, J.M. (1977). Word, object, and conceptual development. New York: W.W. Norton.

Arnheim, R. (1969). Visual thinking. Berkeley: University of California Press.

Arnheim, R. (1983). Perceiving, thinking, forming. Art Education.36(2), 9-11.

Baum, D.R. (1977). Cognitive maps: The mental representation of geographic distance. Unpublished Ph.D dissertation, University of Michigan.

Beilin, H. (1971). Developmental stages and developmental processes. In D.R. Green, M.P. Ford, & G.B. Flamer (Eds.), Measurement and Piaget (pp. 172-196). New York: McGraw-Hill.

Booth, D. (1982). Art education and young children's spontaneous pattern painting. Journal of the Institute of Art Education,6(3), 1-15.

Boring, E.G. (1942). Sensation and perception in the history of psychology. New York: Appleton-Century-Crofts.

Bourne, L.E. Jr. (1967). Learning and utilization of conceptual rules. In B. Kleinmuntz (Ed.), Concepts and the structure of memory. New York:

Wiley.

Boynton, R.M. (1960). Visual search techniques. National Academy of Science. National Research Council Publication, 712, 232.

Brown, A.L. (1974). The role of strategic behavior in retardate memory. In N.R. Ellis (Ed.). International review of research in mental retardation. (pp. 37-68). Academic Press, 7.

Brown, A.L. (1975). The development of memory: Knowing, knowing about knowing, and knowing how to know. In W.R. Reese (Ed.). Advances in child development and behavior, (pp. 236-275). New York: Academic Press

Bruner, J. (1964). The course of cognitive growth. American Psychologist, 19, 1-15.

Bruner, J. (1968). Processes of cognitive growth: Infancy. Worcester: Clark University Press.

Bruner, J. (1973). Beyond the information given . New York: W.W. Norton & Company Inc.

Bruner, J.S., Goodnow, J.J., & Austin, G.A. (1962). A Study of thinking. New York: Science Editions Inc.

Carter, C.L. (1983). Arts and cognition: Performance, criticism, and aesthetics. Art Education, March, 1983, 61-67.

Case, R. (1977). Responsiveness to conservation training as a function of induced subjective uncertainty, m-space, and cognitive style. Canadian Journal of Behavioral Science, 9, 12-26.

Case R. (1978). Piaget and beyond: Toward a developmentally based theory and technology of instruction. In R. Glaser (Ed.). Advances in instructional psychology (pp. 167-228). Hillside, N.J.: Erlbaum.

Case, R. (1985). Intellectual development. New York: Academic Press Inc.

Coltheart, V. (1973). Confidence ratings as a response index in concept identification. Journal of Experimental Psychology, 87, 46-50.

Cowan, D.A. (1984). Educating vision. Art Education , September, 1984, 30-31.

Dodd, D.H., & White, R.M. (1980). Cognition: Mental structures and processes. Boston: Allyn & Bacon Inc.

Dodwell, P.C. (1970). Visual pattern recognition . New York: Holt, Rinehart, & Winston, Inc.

Dunn-Rankin, P. (1978). The visual characteristics of words. Scientific American, 238, 122-130.

Eisner, E.W. (1972). Educating artistic vision. New York: MacMillan Publishing Co.

Eisner, E.W. (1974). The mythology of art education. Curriculum Theory Network, 4, 89-100.

Eisner, E.W. (1982). Cognition and curriculum. New York: Longman.

Eisner, E.W. (1983). On the relationship of conception to representation. Art Education, 36(2), 22-27.

Engel, M. (1983). Art and the Mind. Art Education. 36(2), 6-8.

Eriksen, C.W. (1958). Unconscious processes. In M.R. Jones (Ed.). Nebraska symposium on motivation. Lincoln: University of Nebraska Press, 169-227.

Falmagne, R. (1972). Memory processes in concept identification. Journal of Experimental Psychology, 92, 33-42.

Fantz, R.L. (1961). The origin of form perception. Scientific American, 204, 66-72.

Flavell, J.H. (1963). The Developmental psychology of Jean Piaget. Princeton: Van Nostrand.

Flavell, J.H. (1970). Developmental studies of mediated memory. In H.W. Reese, & L.P. Lipsitt (Eds.). Advances in child development and behavior.Volume 5. New York: Academic Press, pp. 181-211.

Flavell, J.H. (1977). Cognitive development. Englewood Cliffs, N.J.: Prentice-Hall.

Franks, J.J., & Bransford, J.D. (1971). Abstraction of visual patterns. Jornal of Experimental Psychology, 90, 65-74.

Gardner, H. (1983). Frames of mind. New York: Basic Books, Inc.

Gibson, E.J. (1969). Principles of perceptual development. New York: Appleton-Century-Crofts.

Gibson, E.J. (1969b). Principles of perceptual learning and development. New York: Meredith Corporation.

Gibson, J.J. (1950). The Perception of the visual world. Boston: Houghton Mifflin.

Gibson, J.J. (1966). The senses considered as perceptual systems. Boston: Houghton Mifflin.

Gibson, J.J., & Gibson, E.J. (1955). Perceptual learning: Differentiation or enrichment? Psychological Review, 62, 1-32.

Glass, A.L., Holyoak, K.J., & Santa, J.L. (1979). Cognition. Reading: Addison-Wesley Publishing Co.

Goodenough, F. (1924). The intellectual factor in children's drawings. Doctoral Dissertation, Stanford University.

Goodenough, F.L. (1926). Measurement of intelligence by drawings. New York: Harcourt, Brace, & World.

Greene, J., & Hicks, C. (1984). Basic cognitive processes. Oxford: Open University Press.

Groen, G.J. (1978). The theoretical ideas of Piaget and educational practise. In P. Suppes (Ed.). Impact of research on education: Some case studies (pp. 267-318). Washington: National Academy of Education.

Haber, R.N. (1974). Information Processing. In E.C. Carterette, & M.P. Friedman (Eds.). Handbook of perception vol. 1 (pp. 335-364). New York: Academic Press.

Hale, G.A., & Taweel, S.S. (1974). Age differences in children's performance on measures of component selection and incidental learning. Journal of Experimental Child Psychology, 18, 107-116.

Harris, D. (1963). Children's drawings as measures of intellectual maturity. New York: Brace & World.

Hebb, D.O. (1949). The organization of behavior. New York: John Wiley & Sons.

Held, R., & Hein, A. (1963). Movement-produced stimulation in the development of visually guided behavior. Journal of Comparative and Physiological Psychology, 56, 872-876.

Helson, H. (1926). The psychology of gestalt. American Journal of Psychology, 37, 25-62.

Hochberg, J. (1962). Nativism and empiricism in perception. In L. Postman (Ed.). Psychology in the making, New York: Alfred A. Knopf Inc.

Hochberg, J. (1966). In the mind's eye. In R.N. Haber (Ed.). Contemporary theory and research. (pp. 309-332). New York: Holt, Rinehart, & Winston, Inc.

Hooper, F., & Sheehan, N. (1977). Logical concept attainment during the aging years: Issues in the neo-Piagetian research literature. In W. Overton, & J. Gallagher (Eds.). Knowledge and development. (pp. 205-255). New York: Plenum.

Howard, D.V. (1983). Cognitive psychology: Memory, language, and thought. New York: MacMillan Publishing Co. Inc.

Ittleson, W.H. (1973). Environment and cognition. New York: Seminar Press.

Jackson, S. (1965). The growth of logical thinking in normal and subnormal children. British Journal of Educational Psychology, 35, 255-258.

Jonides, J., & Baum, D.R. (1978). Cognitive maps as revealed by distance estimates. Paper presented at the meeting of the Midwestern Psychological Association, Chicago.

Juola, J.F. (1979). Pattern recognition. In R. Lachman, J.L. Lachman, & E.C. Butterfield (Eds.). Cognitive psychology and information processing: An introduction. (pp. 489-523). New Jersey: Erlbaum Associates.

Kearney, J. (1983). Sample bias resulting from parental consent forms.

Public Opinion Quarterly, 47 (1), 97-111.

Keating, D. (1979). Adolescent thinking. In J. Adleson (Ed.). Handbook of adolescence. (pp. 77-134). N.Y: Wiley.

Kerpelman, L.C., & Pollack, R.H. (1964). Developmental changes in the location of form discrimination cues. In R.N. Haber(Ed.). Contemporary theory and research. (pp. 547-553). New York: Rineholt & Winston, Inc.

Klahr, D., & Wallace, J.G. (1976). Cognitive development: An information processing view. Hillsdale, N.J.: Erlbaum.

Kroll, N.E.A., Parks, T., Parkinson, S.R., Bieber, S.L., & Johnson, A.L. (1970). Short-term memory while shadowing: Recall of visually and aurally presented letters. Journal of Experimental Psychology, 85, 220-224.

Lachman, R., Lachman, J., & Butterfield, E.C. (1979). Cognitive psychology and information processing. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Lansing, K.M. (1976). Art, artists, and art education. Iowa: Hendall Hunt Publishing Company.

Lashley, K.S., Chow, L.K., & Semmes, J. (1951). An examination of the electrical field theory of cerebral integration. Psychological Review, 58, 123-136.

Leahey, T.H. (1985). Human learning. Englewood Cliffs,N.J.: Prentice-Hall Inc.

Levine, M. (1966). Hypothesis behavior by humans during discrimination learning. Journal of Experimental Psychology, 71, 331-338.

Lindsay, P.H., & Norman, D.A. (1977). Human information processing. New York: Academic Press.

Lovell, K., & Shields, J.B. (1967). Some aspects of the study of the gifted child. British Journal of Educational Psychology, 37, 201-208.

Lowenfeld, V., & Brittain, L. (1982). Creative and mental growth.

Lunzer, E.A. (1965). Problems of formal reasoning in test situations. Monographs of the society for research in child development, 30, (entire issue).

Lunzer, E.A. (1968). Formal reasoning. In E.A. Lunzer, & J.F. Morris (Eds.). Development in human learning. London: Staples Press.

McFee, J.K. (1970). Preparation for art. Belmont, California: Wadsworth Publishing Company Inc.

MacGregor, R.N. (1972). The development and validation of a perceptual index for utilization in the teaching of art, Studies in Art Education, 13(2), 11-18.

MacGregor, R.N. (1975). Response strategies adopted by elementary school children to items in a perceptual index. Studies in Art Education, 78(3), 54-61.

MacGregor, R.N. (1977). Art plus. Toronto: McGraw-Hill Ryerson Limited.

MacGregor, R.N. (1983). Brain, mind, and the art curriculum. Art Education, 36(2), 84-86.

Mace, W.M. (1977). James J. Gibson's strategy for perceiving: Ask not what's inside your head, but what your head's inside of. In R. Shaw & J. Bransford (Eds.). Perceiving, acting, and knowing: Toward an ecological psychology. (pp. 43-66). N.J.: Erlbaum Associates. .

Mackworth, N.H. (1965). Visual noise causes tunnel vision. In R.N. Haber (Ed.). Contemporary theory and research. (pp.433-437). New York: Rinehart & Winston, Inc.

Manis, M. (1971). An introduction to cognitive psychology. Belmont, California: Brooks/Cole.

Matlin, M.W. (1983). Perception. Boston: Allyn & Bacon, Inc.

Mednick, S.A., & Lehtinen, L.E. (1957). Stimulus generalization as a function of age in children. Journal of Experimental Psychology, 53, 180-183.

Meyer, J.S. (1978). Visual and verbal processes involved in the development of picture recognition skills. Child Development, 49, 178-187.

Millward, R.B., & Spoehr, K.T. (1973). A direct measurement of hypothesis-sampling strategies. Cognitive Psychology, 4, 1-38.

Nagel, E. (1963). Wholes, sums, and organic unities. In D. Lerner (Ed.). Parts and wholes. New York: Free Press of Glencoe.

Naus, M.J., & Shillman, R.J. (1976). Why a Y is not a V: A new look at the distinctive features of letters. Journal of Experimental Psychology: Human Perception and Performance, 2, 394-400.

Neimark, E. (1975). Intellectual development during adolescence. In F. Horowitz (Ed.). Review of child development research, Volume 4. Chicago: Chicago University Press.

Neisser, U. (1967). Cognitive psychology. New York: Appleton-Century-Crofts.

Neisser, U. (1979). The control of information pickup in selective looking. In A.D. Pick (Ed.). Perception and its development: A tribute to Eleanor J. Gibson. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Nelson K. (1974). Concept, word, and sentence: Interrelations in acquisition and development. Psychological Review, 81, 267-285.

Odom, R.D., & Guzman, R.D. (1972). Development of hierarchies of dimensional salience. Developmental Psychology, 6, 271-287.

Olson, D.R. (1983). The role of the arts in cognition. Art Education, 36(2), 36-83.

Pariser, D. (1983). The arts, cognition, and craft. Implications for teaching and research. Art Education, 36(2), 50-57.

Pascual-Leone, J. (1969). Cognitive development and cognitive style. Unpublished Doctoral dissertation, University of Geneva.

Pastore, N. (1971). Selective history of theories of visual perception. Oxford University Press.

Peterson, L.R., & Peterson, M.J. (1959). Short-term retention of individual verbal items. Journal of Experimental Psychology, 58, 193-198.

Piaget, J. (1952). The origins of intelligence in children. New York: International Universities.

Pinard, J., & Laurendeau, H. (1969). Stage in Piaget's developmental theory: Exegesis of a concept. In D. Elkind, & J.H. Flavell (Eds.). Studies in cognitive development. (pp. 121-170). London: Oxford University Press.

Posner, M.I., Goldsmith, R., & Welton, K.E. Jr. (1967). Perceived distance and the classification of distorted patterns. Journal of Experimental Psychology, 73, 28-38.

Postman, L. (1955). Association theory and Perceptual Learning. Psychological Review, 62, 438-446.

Riesen, A.H. (1947). The development of visual perception in man and chimpanzee. Science, 106, 107-108.

Riesen, A.H. (1953). Interocular transfer of habits learned monocularly in visually naive and visually experienced cats. Journal of Comparative and Physiological Psychology , 46, 166-172.

Riesen, A.H. (1961). Stimulation as a requirement for growth and function in behavioral development. In D.W. Fiske, & S.R. Maddi (Eds.). Functions of varied experience (pp. 57-80). Homewood, Illinois: Dorsey Press.

Riess, B.F. (1946). Genetic changes in semantic conditioning. Journal of Experimental Psychology, 36, 143-152.

Rock, I. (1966). The Nature of perceptual adaptation . New York: Basic Books.

Rock, I. (1975). An Introduction to perception. New York: MacMillan Publishing Co.

Rohwer, W.D. Jr. (1974). Understanding intellectual development. Hinsdale, Illinois: The Dryden Press.

Rowland, K. (1965). Looking and seeing. London: Ginn & Company.

Rowland, K. (1974). Sight and insight. Van Nostrand Reinhold.

Rowland, K. (1976). Visual education and beyond. London: Ginn & Company.

Rumelhart, D.E. (1977). An Introduction to human information processing. New York: Wiley.

Salapateck, P., & Kessen, W. (1966). Visual Scanning of triangles by the human newborn. Journal of Experimental Child Psychology, 3, 155-167.

Salome, R.A. (1965). The effects of perceptual training upon two-dimensional drawing of children. Studies in Art Education, 7(1), 18-33.

Selfridge, O.G. (1959). Pandemonium: A paradigm for learning. In Symposium on the mechanization of thought processes. (pp.26-37). London: HM Stationery Office.

Selfridge, O.G., & Neisser, U. (1960). Pattern recognition by machine. Scientific American, 203, 60-68.

Senden, M. von, (1960). Space and sight. New York: Free Press.

Siegel, A.I. (1953). Deprivation of visual form definition in the ring dove. 1. Discriminating learning. Journal of Comparative and Physiological Psychology, 46, 115-119.

Silverman, R. (1962). Comparing the effects of two versus three-dimensional art activity upon spatial visualization, aesthetic judgment, and art interest. Unpublished Ed.D. dissertation, Stanford University.

Smith, O.W., & Smith, P. (1966). Developmental studies of spatial judgments by children and adults. Perceptual and Motor Skills, 22, 62-72.

Sony Corporation. (1983). Sony micro computer "genlocker" operating instructions. Japan: Sony Corporation.

Sony Corporation. (1984). Sony trinitron color video monitor PVM-127Q/1371QM - operating manual. Japan: Sony Corporation.

Sony Corporation. (1985). Sony graphics editor. Japan: Sony Corporation.

Statt, D. (1981). Dictionary of psychology. New York: Barnes & Noble Books.

Sternberg, S. (1970). Memory scanning: Mental processes revealed by reaction-time experiments. In J.S. Antrobus (Ed.). Cognition and affect. Boston: Little & Brown.

Stroh, C. (1983). A brief primer on vision and human perception. Art Education, July, 44-45.

Summagraphics. (1984). MM1201 and MM961 data tablets technical reference. Connecticut: Summagraphics Corporation.

Trabasso, T., & Bower, G. (1966). Presolutional dimensional shifts in concept identification: A test of the sampling with replacement axiom in all-or-none models. Journal of Mathematical Psychology, 3, 163-173.

Trabasso, T., & Bower, G. (1968). Attention in learning: Theory and research. New York: Wiley.

Turvey, M.T., & Shaw, R.E. (1977). Memory (or knowing) as a matter of specification not representation: notes towards a different class of machines. Paper presented at the conference on levels of processing, Rockport, Massachusetts.

Vernon, M.D. (1970). Perception through experience. London: Methuen & Co., Ltd.

Vernon, M.D. (1976). A further study of visual perception . Conn: Hafner Publishing Company.

Vurpillot, E. (1968). The development of scanning strategies and their relation to visual differentiation. Journal of Experimental Child Psychology, 6, 632-650.

Vurpillot, E. (1976). The visual world of the child. New York: International Universities Press.

Werner, H. (1957). The conception of development from a comparative and organismic point of view. In D. Harris (Ed.). The Concept of development. (pp. 218-255). Minneapolis: University of Minnesota Press.

Wertheimer, M. (1974). The problem of perceptual structure. In E.C. Carterette, & M.P. Friedman (Eds.). Handbook of perception, volume 1. (pp. 75-92). N.Y.: Academic Press.

Wickelgren, W.A. (1973). The long and short of memory. Psychological Bulletin, 80, 425-438.

Wickelgren, W.A. (1979). Cognitive psychology. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

Yonas, A., & Gibson, E.J. (1967, April). A developmental study of feature processing strategies in letter discrimination. Paper presented at Einstein Psychological Association Meeting, Boston.

Young, F.M. (1985) Visual studies. Englewood Cliffs, N.J: Prentice-Hall Inc.

APPENDIX A

Sony SMC-70G "Genlocker" Microcomputer

Sony SMC-70G "Genlocker" Microcomputer

The Sony SMC-70G "GENLOCKER" microcomputer has all the basic functions of a microcomputer. Its hardware has the flexibility to facilitate general applications, and is designed so that it can be operated by a variety of software. It utilizes a circuit that enables GENLOCK synchronization of the computer output to a video signal. The SMC-70G supports the disk operating system CP/M which permits many kinds of application programs.

The SMC-70G incorporates a Z-80A central processing unit (CPU). The Z-80A has 158 basic instructions including block transfer and block search, bit operation, and other functions.

The SMC-70G is an 8-bit general purpose computer. The entire 64K byte memory consists of RAM and is open to the user. The video RAM is mapped in the I/O area. The System Monitor and Sony BASIC interpreter are written in shadow ROM format.

A general-purpose Disk Operating System CP/M is available as the standard system of the SMC-70G (Sony, 1983).

APPENDIX B

Sony Trinitron Color Video Monitor

Sony Trinitron Color Video Monitor - PVM-1271QM

The Sony Trinitron Color Video Monitor picture tube has a grill aperture of 0.25 mm and gives a high resolution picture (composite: 550 lines, RGB: 600 lines. When used as a character display, up to 2000 characters (80 characters/line x 25 lines) can be displayed with clarity.

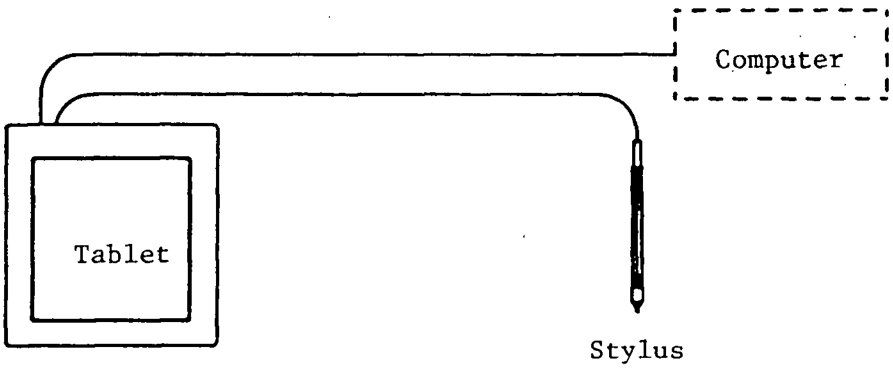
Analog RGB and digital (TTL level) RGB input signals can be fed to the RGB input connectors (BNC type and 25-pin multi connectors), which allows a microcomputer, such as the Sony SMC-70G "GENLOCKER" microcomputer to be connected to this monitor. (Sony, 1984).

APPENDIX C

Summagraphics MM1201 Data Tablet with Stylus

Summagraphics MM1201 Data Tablet with Stylus

A data tablet is an input device allowing the translation of graphic information into digital information suitable for a digital device such as a computer or computer terminal.



The MM1201 tablet has a nominal active area of 11.7" x 11.7". The stylus, a hand held-device, is used with the tablet to locate points. The MM translates the position of the stylus on the tablet into digital information and communicates the digital information to the computer. (Summagraphics, 1984).

APPENDIX D

Sony Graphics Editor

Sony Graphics Editor

The Sony Graphics Editor program allows a full range of graphic functions, such as full color pictures, graphs, charts, and drawing functions. Two components of the program were used in this study.

Edit Mode

Edit mode allows the coloring of individual pixels that comprise the display screen. In this mode the picture can also be maginified by a factor of two, four, or eight in order to do editing of fine details.

Command Mode

The command mode allows a variety of functions such as drawing simple complex shapes, coloring, clearing and erasing, and mixing and superimposing pictures on a disk. (Sony, 1985).

APPENDIX E

Micro Floppy Disks

Micro Floppy Disks

Specially designed, 3½ inch Micro Floppy disks were used for the project. The disks are designed by Sony for use in the Sony SMC-70 and SMC-70G computer systems (Sony, 1983).

The programs and images used in the study were stored on twelve disks (See Table E1).

Table E 1

Contents of Disks

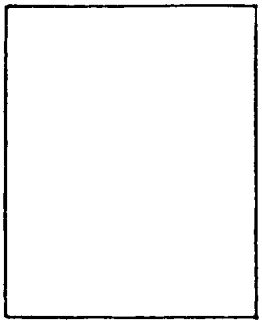
Disk	Sequence	Contents
Disk 1	Recognition	Task 1 - Rectangle - Shared Contour
		Task 2 - Rectangle - Interrupted Contour.
Disk 2		Task 3 - Rectangle - Close Color Harmony.
Disk 3		Task 4 - Triangle - Shared Contour
		Task 5 - Triangle - Interrupted Contour.
Disk 4		Task 6 - Triangle - Close Color Harmony.
Disk 5		Task 7 - Circle - Shared Contour
Disk 6		Task 8 - Circle - Interrupted Contour.
Disk 7		Task 9 - Circle - Close Color Harmony.
Disk 8		Task 10 - Free Form - Shared Contour
Disk 9		Task 11 - Free Form - Interrupted Contour
Disk 10		Task 12 - Free Form - Close Color Harmony.

Disk	Sequence	Contents
Disk 11		Task 12 - continued.
Disk 12	Manipulation	Manipulation 1 - Rectangle
		Manipulation 2 - Circle

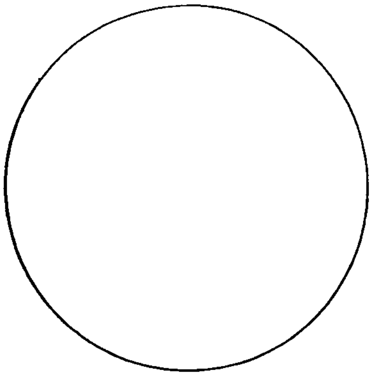
APPENDIX F

The Shapes Used in the Study

MANIPULATION

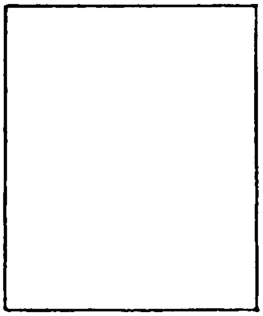


Rectangle

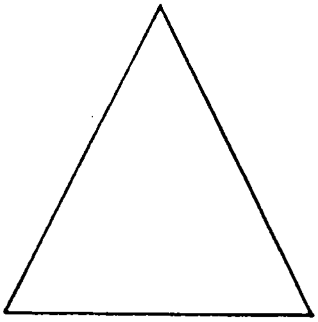


Circle

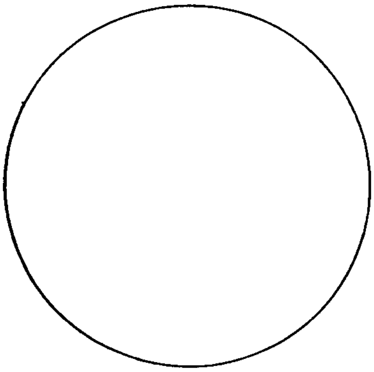
RECOGNITION



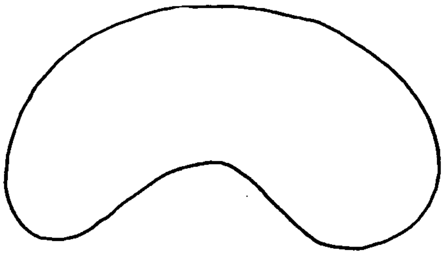
Rectangle



Triangle



Circle



Free-Form

APPENDIX G

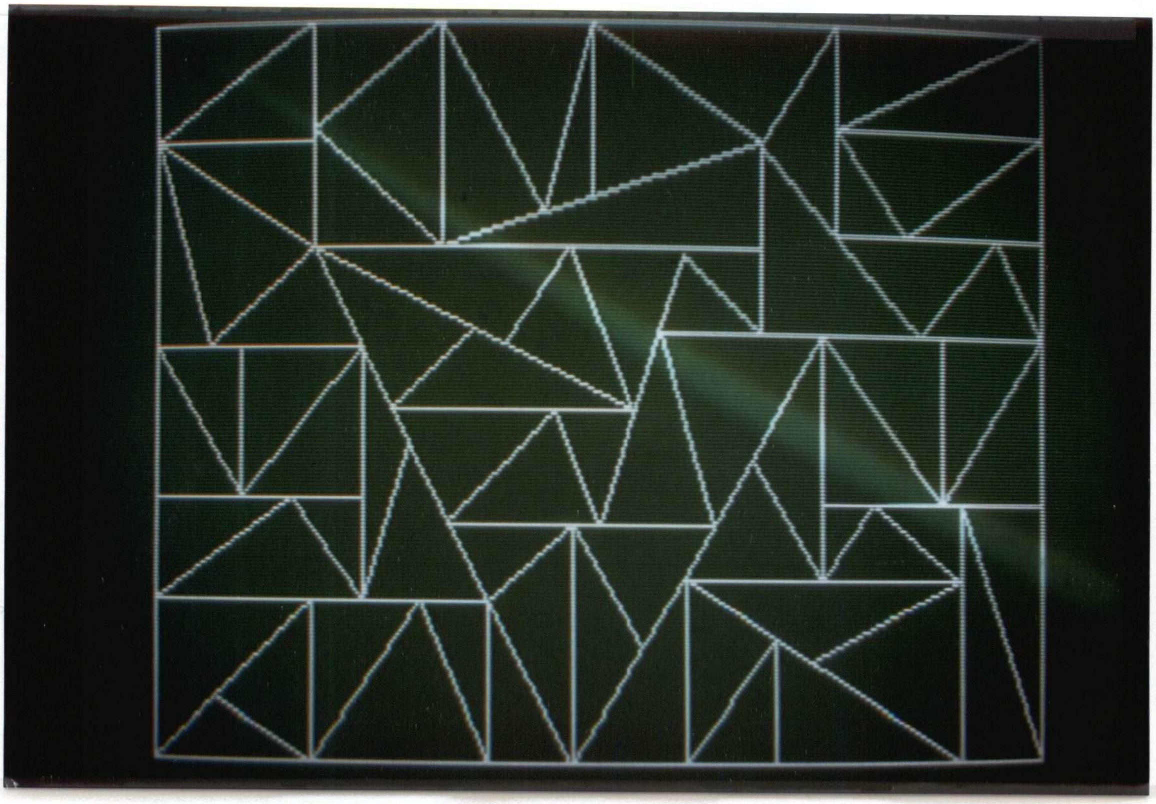
Masking Techniques

Masking Techniques

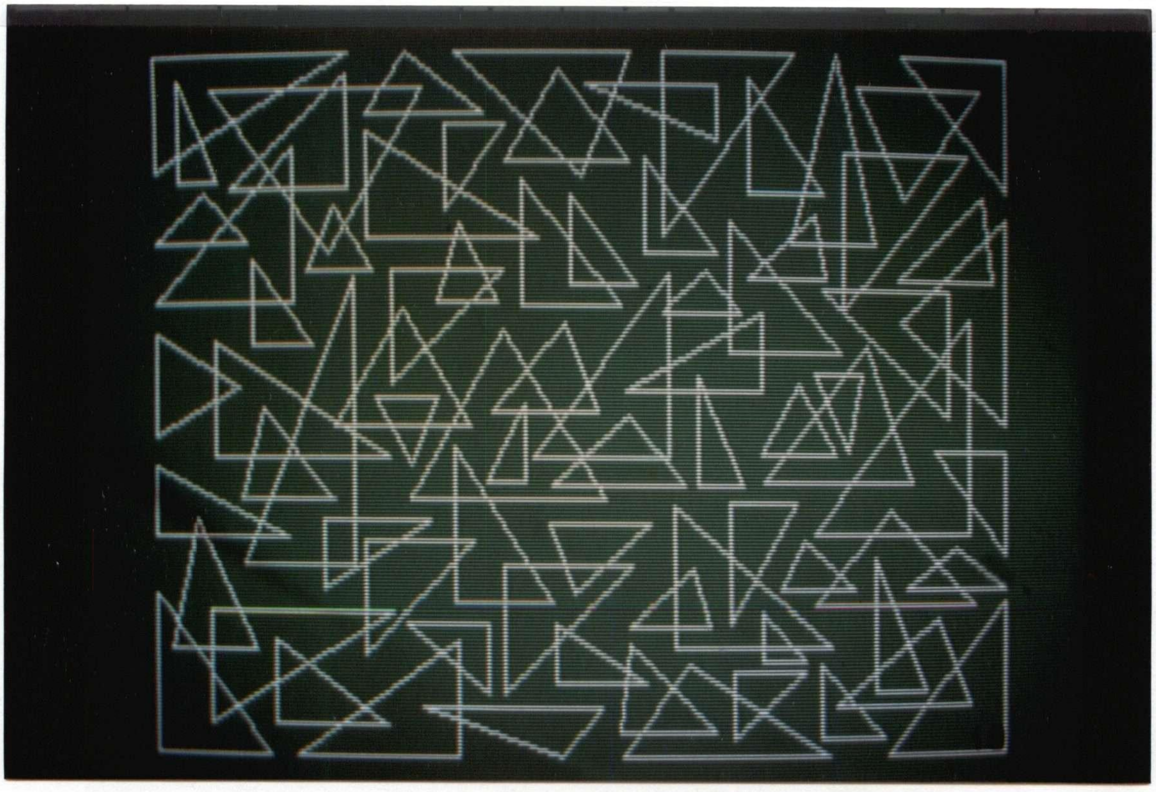
A rectangle, triangle, circle, and free-form were each masked three different ways:

1. Shared Contour - All shapes share common contours.
2. Interrupted Contour - Contours of shapes are overlapped.
3. Close-Color Harmony - A background of similar shapes in closely-related colors is used to mask foreground shapes superimposed over the background in outline only.

See the example on the next page.



Shared Contour - Triangle (Task 4)



Interrupted Contour - Triangle (Task 5)

Close-Color Harmony - Triangle (Task 6)

APPENDIX H

Recognition and Concealment Recording Sheets

Recognition Task Score Sheet

NAME ____________ AGE ____________ BIRTH DATE ____________

RSC		RIC		RCH		TSC		TIC		TCH		CSC		CIC		CCH		FSC		FIC		FCH	
10		10		10		10		10		10		10		0		10		10		10		10	
9		9		9		9		9		9		9		9		9		9		9		9	
8		8		8		8		8		8		8		8		8		8		8		8	
7		7		7		7		7		7		7		7		7		7		7		7	
6		6		6		6		6		6		6		6		6		6		6		6	
5		5		5		5		5		5		5		5		5		5		5		5	
4		4		4		4		4		4		4		4		4		4		4		4	
3		3		3		3		3		3		3		3		3		3		3		3	
2		2		2		2		2		2		2		2		2		2		2		2	
1		1		1		1		1		1		1		1		1		1		1		1	

Concealment Location Sheet

SUBJECT______________________________ AGE______________________

____

____

____

____

TASK 1__________ TASK 2__________ TASK 3__________

TASK 4__________ TASK 5__________ TASK 6__________

TASK 7__________ TASK 8__________ TASK 9__________

TASK 10__________ TASK 11__________ TASK 12__________

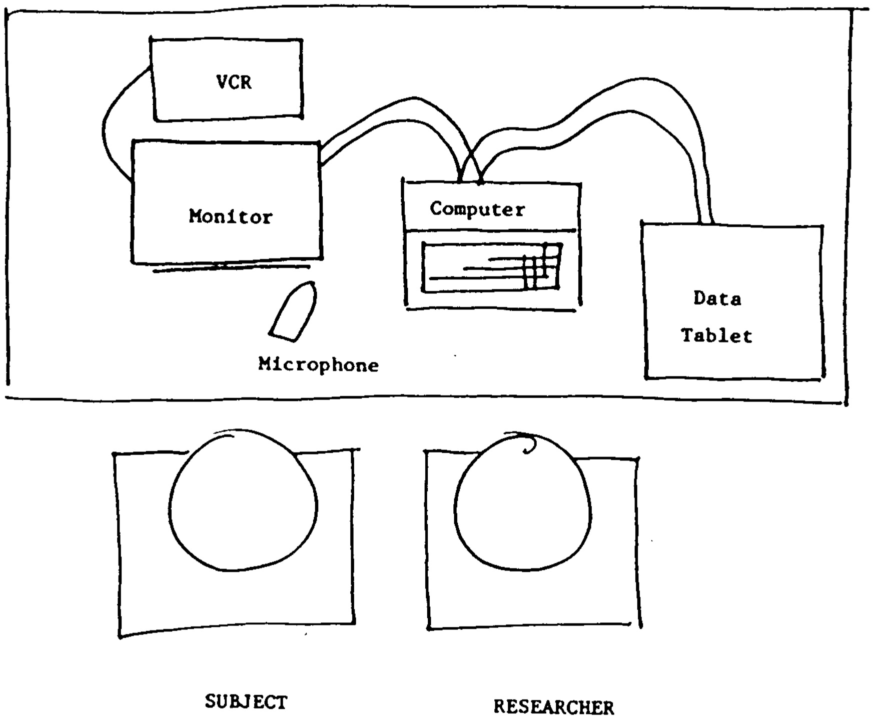
APPENDIX I

Parental Consent Form

APPENDIX J

Layout of Instruments

LAYOUT OF INSTRUMENTS, SUBJECT, AND RESEARCHER



APPENDIX K

Questions Posed by Researcher

MANIPULATION SEQUENCE

DISK 12

1. A Rectangle
2. B Circle

INSTRUCTIONS

IDENTIFICATION - Do you know what this is?
We're going to call this a rectangle.

MANIPULATION - We're going to play a little game with this rectangle.
Let's see how we can change it so that it looks different.

1. Can you think of one way you can change this rectangle so that it looks different?
2. What made you think of that?
3. Is there anything else?

DISCRIMINATION SEQUENCE

RECTANGLE - SHARED CONTOUR | DISK 1

COMPUTER IMAGE			VERBAL INSTRUCTIONS
1.	A	Identification	We are going to call this a RECTANGLE. I want you to look at it and see if you can remember its size and shape. I'm going to hide it among some other rectangles and I want you to see if you can find this exact one. It's going to be the same size and shape and sitting the same way, but hidden in a different place. It's going to be on for a short time and then some things in the picture will change a bit, but I want you to keep looking for it.
2.	B	Rect. S.C. 10	AFTER 10, COVER - It's really well hidden isn't it? Do you have any idea how you are going to find this yet?
3.	C	Rect. S.C. 9	
4.	D	Rect. S.C. 8	
5.	E	Rect. S.C. 7	AFTER 7, COVER - Repeat Cover question above.
6.	F	Rect. S.C. 6	
7.	G	Rect. S.C. 5	
8.	H	Rect. S.C. 4	AFTER 4, COVER - Repeat cover question above
9.	I	Rect. S.C. 3	
10.	J	Rect. S.C. 2	
11.	K	Rect. S.C. 1	

AFTER SHAPE HAS BEEN FOUND

12.	L	Rect. S.C. 10	1. If you were hiding this rectangle, where would you put it so it would be hard to find? 2. Why would you put it there?

DISCRIMINATION SEQUENCE

RECTANGLE - INTERRUPTED CONTOUR — DISK 1

COMPUTER IMAGE			VERBAL INSTRUCTIONS
13.	M	Identification	This is our rectangle again. I want you to look at it and see if you can remember its size and shape. I'm going to hide it among some other rectangles and I want you to see if you can find <u>this exact one</u>. It's going to be the same size and shape and sitting the same way, but hidden in a different place. It's going to be on for a short time and then some things in the picture will change a bit, but I want you to keep looking for it.
14.	N	Rect. I.C. 10	<u>AFTER 10, COVER</u> - It's really well hidden isn't it? Do you have any idea how you are going to find it yet?
15.	O	Rect. I.C. 9	
16.	P	Rect. I.C. 8	
17.	Q	Rect. I.C. 7	<u>AFTER 7, COVER</u> - Repeat Cover question above.
18.	R	Rect. I.C. 6	
19.	S	Rect. I.C. 5	
20.	T	Rect. I.C. 4	<u>AFTER 4, COVER</u> - Repeat cover question above.
21.	U	Rect. I.C. 3	
22.	V	Rect. I.C. 2	
23.	W	Rect. I.C. 1	
AFTER SHAPE HAS BEEN FOUND			
24.	X	Rect. I.C. 10	1. If you were hiding this rectangle, where would you put it so it would be hard to find? 2. Why would you put it there?

DISCRIMINATION SEQUENCE

RECTANGLE - CLOSE-COLOUR HARMONY — DISK 2

COMPUTER IMAGE			VERBAL INSTRUCTIONS
1.	A	Identification	This is our rectangle again. Notice that it is a different color with a different color background. Look at it and see if you can remember its size shape and color. I'm going to hide it among some other rectangles and I want you to see if you can find this exact one. It's going to be the same size, shape, and color, and sitting the same way, but hidden in a different place. It's going to be on for a short time and then some things in the picture will change a bit, but I want you to keep looking for it.
2.	B	Rect. C.C.H. 10	AFTER 10, COVER - It's really well hidden isn't it? Do you have any idea how you are going to find it yet?
3.	C	Rect. C.C.H. 9	
4.	D	Rect. C.C.H. 8	
5.	E	Rect. C.C.H. 7	AFTER 7, COVER - Repeat cover question above.
6.	F	Rect. C.C.H. 6	
7.	G	Rect. C.C.H. 5	
8.	H	Rect. C.C.H. 4	AFTER 4, COVER -Repeat cover question above.
9.	I	Rect. C.C.H. 3	
10.	J	Rect. C.C.H. 2	
11.	K	Rect. C.C.H. 1	
AFTER SHAPE HAS BEEN FOUND			
12.	L	Rect. C.C.H. 10	1. If you were hiding this rectangle, where would you put it so it would be hard to find? 2. Why would you put it there?
13.	M	Rect. (Masks)	This shows the different ways we've been hiding the shapes. Can you tell me the difference?

DISCRIMINATION SEQUENCE

TRIANGLE - SHARED CONTOUR | DISK 3

COMPUTER IMAGE			VERBAL INSTRUCTIONS
1.	A	Identification	We are going to call this a TRIANGLE. I want you to look at it and see if you can remember its size and shape. I'm going to hide it among some other rectangles and I want you to see if you can find this exact one. It's going to be the same size and shape and sitting the same way, but hidden in a different place. It's going to be on for a short time and then some things in the picture will change a bit, but I want you to keep looking for it.
2.	B	Tri. S.C. 10	AFTER 10, COVER - It's really well hidden isn't it? Do you have any idea how you are going to find it yet?
3.	C	Tri. S.C. 9	
4.	D	Tri. S.C. 8	
5.	E	Tri. S.C. 7	AFTER 7, COVER - Repeat Cover question above?
6.	F	Tri. S.C. 6	
7.	G	Tri. S.C. 5	
8.	H	Tri. S.C. 4	AFTER 4, COVER - Repeat cover question above.
9.	I	Tri. S.C. 3	
10.	J	Tri. S.C. 2	
11.	K	Tri. S.C. 1	

AFTER SHAPE HAS BEEN FOUND

12.	L	Tri. S.C. 10	1. If you were hiding this triangle, where would you put it so that it would be hard to find? 2. Why would you put it there?

DISCRIMINATION SEQUENCE

TRIANGLE - INTERRUPTED CONTOUR — DISK 3

COMPUTER IMAGE			VERBAL INSTRUCTIONS
13.	M	Identification	This is our triangle again. I want you to look at it and see if you can remember its size and shape. I'm going to hide it among some other triangles and I want you to see if you can find this exact one. It's going to be the same size and shape and sitting the same way, but hidden in a different place. It's going to be on for a short time and then some things in the picture will change a bit, but I want you to keep looking for it.
14.	N	Tri. I.C. 10	AFTER 10, COVER - It's really well hidden isn't it? Do you have any idea how you are going to find it yet?
15.	O	Tri. I.C. 9	
16.	P	Tri. I.C. 8	
17.	Q	Tri. I.C. 7	AFTER 7, COVER - Repeat cover question above.
18.	R	Tri. I.C. 6	
19.	S	Tri. I.C. 5	
20.	T	Tri. I.C. 4	AFTER 4, COVER - Repeat cover question above
21.	U	Tri. I.C. 3	
22.	V	Tri. I.C. 2	
23.	W	Tri. I.C. 1	

AFTER SHAPE HAS BEEN FOUND

24.	X	Tri. I.C. 10	1. If you were hiding this rectangle, where would you put it so it would be hard to find? 2. Why would you put it there?

DISCRIMINATION SEQUENCE

TRIANGLE - CLOSE COLOUR HARMONY   DISK 4

	COMPUTER IMAGE		VERBAL INSTRUCTIONS
1.	A	Identification	This is our triangle again. Notice that it is a different color with a different color background. Look at it and see if you can remember its size, shape, and color. I'm going to hide it among some other triangles and I want you to see if you can find this exact one. It's going to be the same size, and color, and sitting the same way, but hidden in a different place. It's going to be on for a short time and then some things in the picture will change a bit, but I want you to keep looking for it.
2.	B	Tri. C.C.H. 10	AFTER 10, COVER - It's really well hidden isn't it? Do you have any idea how you are going to find it yet?
3.	C	Tri. C.C.H. 9	
4.	D	Tri. C.C.H. 8	
5.	E	Tri. C.C.H. 7	AFTER 7, COVER - Repeat cover question above.
6.	F	Tri. C.C.H. 6	
7.	G	Tri. C.C.H. 5	
8.	H	Tri. C.C.H. 4	AFTER 4, COVER - Repeat cover question above.
9.	I	Tri. C.C.H. 3	
10.	J	Tri. C.C.H. 2	
11.	K	Tri. C.C.H. 1	
AFTER SHAPE HAS BEEN FOUND			
12.	L	Tri. C.C.H. 10	1. If you were hiding this triangle, where would you put it so it would be hard to find? 2. Why would you put it there?
13.	M	Tri. (Masks)	This shows the different ways we've been hiding the shapes. Can you tell me the difference?

DISCRIMINATION SEQUENCE

CIRCLE - SHARED CONTOUR

DISK 5

COMPUTER IMAGE			VERBAL INSTRUCTIONS
1.	A	Identification	1. We are going to call this a CIRCLE. I want you to look at it and see if you can remember its size and shape. I'm going to hide it among some other rectangles and I want you to see if you can find this exact one. It's going to be the same size and shape, but hidden in a different place. It's going to be on for a short time and then some things in the picture will change a bit. 2. IMAGE CHANGE - When we show the shape hidden among other shapes, the picture changes after a while. Can you tell me how it changes?
2.	B	Cir. S.C. 10	AFTER 10, COVER - It's really well hidden isn't it? Do you have any idea how you are going to find it yet?
3.	C	Cir. S.C. 9	
4.	D	Cir. S.C. 8	
5.	E	Cir. S.C. 7	AFTER 7, COVER - Repeat cover question above.
6.	F	Cir. S.C. 6	
7.	G	Cir. S.C. 5	
8.	H	Cir. S.C. 4	AFTER 4, COVER - Repeat cover question above.
9.	I	Cir. S.C. 3	
10.	J	Cir. S.C. 2	
11.	K	Cir. S.C. 1	

AFTER SHAPE HAS BEEN FOUND

12.	L	Cir. S.C. 10	1. If you were hiding this circle, where would you put it so it would be hard to find? 2. Why would you put it there?

DISCRIMINATION SEQUENCE

CIRCLE - INTERRUPTED CONTOUR — **DISK 6**

		COMPUTER IMAGE	VERBAL INSTRUCTIONS
1.	A	Identification	1. This is our circle again. I want you to look at it and see if you can remember its size and shape. I'm going to hide it among some other triangles and I want you to see if you can find <u>this exact one</u>. It's going to be the same size and shape, but hidden in a different place. It's going to be on for a short time and then the picture will change a bit. 2. <u>IMAGE CHANGE</u> - (Ask if S could not answer in Task 7). When we show the shape hidden among other shapes, the picture changes after a while. Can you tell me how it changes?
2.	B	Cir. I.C. 10	<u>AFTER 10, COVER</u> - It's really well hidden isn't it? Do you have any idea how you are going to find it yet?
3.	C	Cir. I.C. 9	
4.	D	Cir. I.C. 8	
5.	E	Cir. I.C. 7	<u>AFTER 7, COVER</u> - Repeat cover question above.
6.	F	Cir. I.C. 6	
7.	G	Cir. I.C. 5	
8.	H	Cir. I.C. 4	<u>AFTER 4, COVER</u> - Repeat cover question above.
9.	I	Cir. I.C. 3	
10.	J	Cir. I.C. 2	
11.	K	Cir. I.C. 1	

AFTER SHAPE HAS BEEN FOUND

12.	L	Cir. I.C. 10	1. If you were hiding this circle, where would you put it so it would be hard to find? 2. Why would you put it there?

DISCRIMINATION SEQUENCE

CIRCLE - CLOSE COLOUR HARMONY — DISK 7

COMPUTER IMAGE			VERBAL INSTRUCTIONS
1.	A	Identification	This is our circle again.Notice that it is a different color with a different color background. Look at it and see if you can remember its size, shape, and color. I'm going to hide it among some other circles and I want you to see if you can find this exact one. It's going to be the same size and color, but hidden in a different place. It's going to be on for a short time and then some things in the picture will change a bit, but I want you to keep looking for it.
2.	B	Cir. C.C.H. 10	AFTER 10, COVER - It's really well hidden isn't it? Do you have any idea how you are going to find it yet?
3.	C	Cir. C.C.H. 9	
4.	D	Cir. C.C.H. 8	
5.	E	Cir. C.C.H. 7	AFTER 7, COVER - Repeat cover question above.
6.	F	Cir. C.C.H. 6	
7.	G	Cir. C.C.H. 5	
8.	H	Cir. C.C.H. 4	AFTER 4, COVER - Repeat cover question above.
9.	I	Cir. C.C.H. 3	
10.	J	Cir. C.C.H. 2	
11.	K	Cir. C.C.H. 1	

AFTER SHAPE HAS BEEN FOUND

12.	L	Cir. C.C.H. 10	1. If you were hiding this circle, where would you put it so it would be hard to find? 2. Why would you put it there?
13.	M	Cir. (Masks)	This shows the different ways we've been hiding the shapes. Can you tell me the difference?

Task 10

DISCRIMINATION SEQUENCE

FREE FORM – SHARED CONTOUR — DISK 8

COMPUTER IMAGE			VERBAL INSTRUCTIONS
1.	A	Identification	1. We are going to call this a FREE FORM. I want you to look at it and see if you can remember its size and shape. I'm going to hide it among some other free forms and I want you to see if you can find this exact one. It's going to be the same size and shape and sitting the same way, but hidden in a different place. It's going to be on for a short time and then some things in the picture will change. 2. IMAGE CHANGE – (Ask if S could not answer in task 8). When we show the shape hidden among other shapes, the picture changes after a while. Can you tell me how it changes?
2.	B	F.F. S.C. 10	AFTER 10, COVER – It's really well hidden isn't it? Do you have any idea how you are going to find it yet?
3.	C	F.F. S.C. 9	
4.	D	F.F. S.C. 8	
5.	E	F.F. S.C. 7	AFTER 7, COVER – Repeat cover question above.
6.	F	F.F. S.C. 6	
7.	G	F.F. S.C. 5	
8.	H	F.F. S.C. 4	AFTER 4, COVER – Repeat cover question above
9.	I	F.F. S.C. 3	
10.	J	F.F. S.C. 2	
11.	K	F.F. S.C. 1	

AFTER SHAPE HAS BEEN FOUND

12.	L	F.F. S.C. 10	1. If you were hiding this free form, where would you put it so it would be hard to find? 2. Why would you put it there?

DISCRIMINATION SEQUENCE

FREE FORM - INTERRUPTED CONTOUR DISK 9

COMPUTER IMAGE			VERBAL INSTRUCTIONS
1.	A	Identification	1. This is our free form again. I want you to look at it and see if you can remember its size and shape. I'm going to hide it among some other free forms and I want you to see if you can find this exact one. It's going to be the same size and shape and sitting the same way, but hidden in a different place. It's going to be on for a short time and then some things in the picture will change a bit, but I want you to keep looking for it. 2. IMAGE CHANGE - (Ask if S could not answer in task 9). When we show the shape hidden among other shapes, the picture changes after a while. Can you tell me how it changes?
2.	B	F.F. I.C. 10	AFTER 10, COVER - It's really well hidden, isn't it? Do you have any idea how you are going to find it yet?
3.	C	F.F. I.C. 9	
4.	D	F.F. I.C. 8	
5.	E	F.F. I.C. 7	AFTER 7, COVER - Repeat cover question above.
6.	F	F.F. I.C. 6	
7.	G	F.F. I.C. 5	
8.	H	F.F. I.C. 4	AFTER 4, COVER - Repeat cover question above.
9.	I	F.F. I.C. 3	
10.	J	F.F. I.C. 2	
11.	K	F.F. I.C. 1	

AFTER SHAPE HAS BEEN FOUND

12.	L	F.F. I.C. 10	1. If you were hiding this circle, where would you put it so it would be hard to find? 2. Why would you put it there?

DISCRIMINATION SEQUENCE

FREE FORM - CLOSE COLOUR HARMONY — DISK 10

COMPUTER IMAGE			VERBAL INSTRUCTIONS
1.	A	Identification	This is our free form again. Notice that it is a different color with a different color background. Look at it and see if you can remember its size, shape, and color. I'm going to hide it among some other free forms and I want you to see if you can find this exact one. It's going to be the same size and color, and sitting the same way, but hidden in a different place. It's going to be on for a short time and then some things are going to change a bit, but I want you to keep looking for it.
2.	B	F.F. C.C.H. 10	AFTER 10, COVER - It's really well hidden isn't it? Do you have any idea how you are going to find it yet?
3.	C	F.F. C.C.H. 9	
4.	D	F.F. C.C.H. 8	
5.	E	F.F. C.C.H. 7	AFTER 7, COVER - Repeat cover question above.
6.	F	F.F. C.C.H. 6	
7.	G	F.F. C.C.H. 5	
8.	H	F.F. C.C.H. 4	AFTER 4, COVER - Repeat cover question above.
9.	I	F.F. C.C.H. 3	
10.	J	F.F. C.C.H. 2	
11.	K	F.F. C.C.H. 1	

AFTER SHAPE HAS BEEN FOUND

12.	L	F.F. C.C.H. 10	1. If you were hiding this free form, where would you put it so it would be hard to find? 2. Why would you put it there?

13.	M	F.F. (Masks)	This shows the different ways we've been hiding the shapes. Can you tell me the difference?

APPENDIX L

Slide Show Function

The Slide Show Feature

The Slide Show feature displays the files stored on disk in the order they stored. Duration is controlled by programmed instructions. It allows one stored image to be shown immediately after another, instead of calling up computer functions to load and present a subsequent file.

The SMC-70 will automatically run the sequencing, as in a slide show (Sony, 1985).

APPENDIX M

Computer Limitations

Appendix

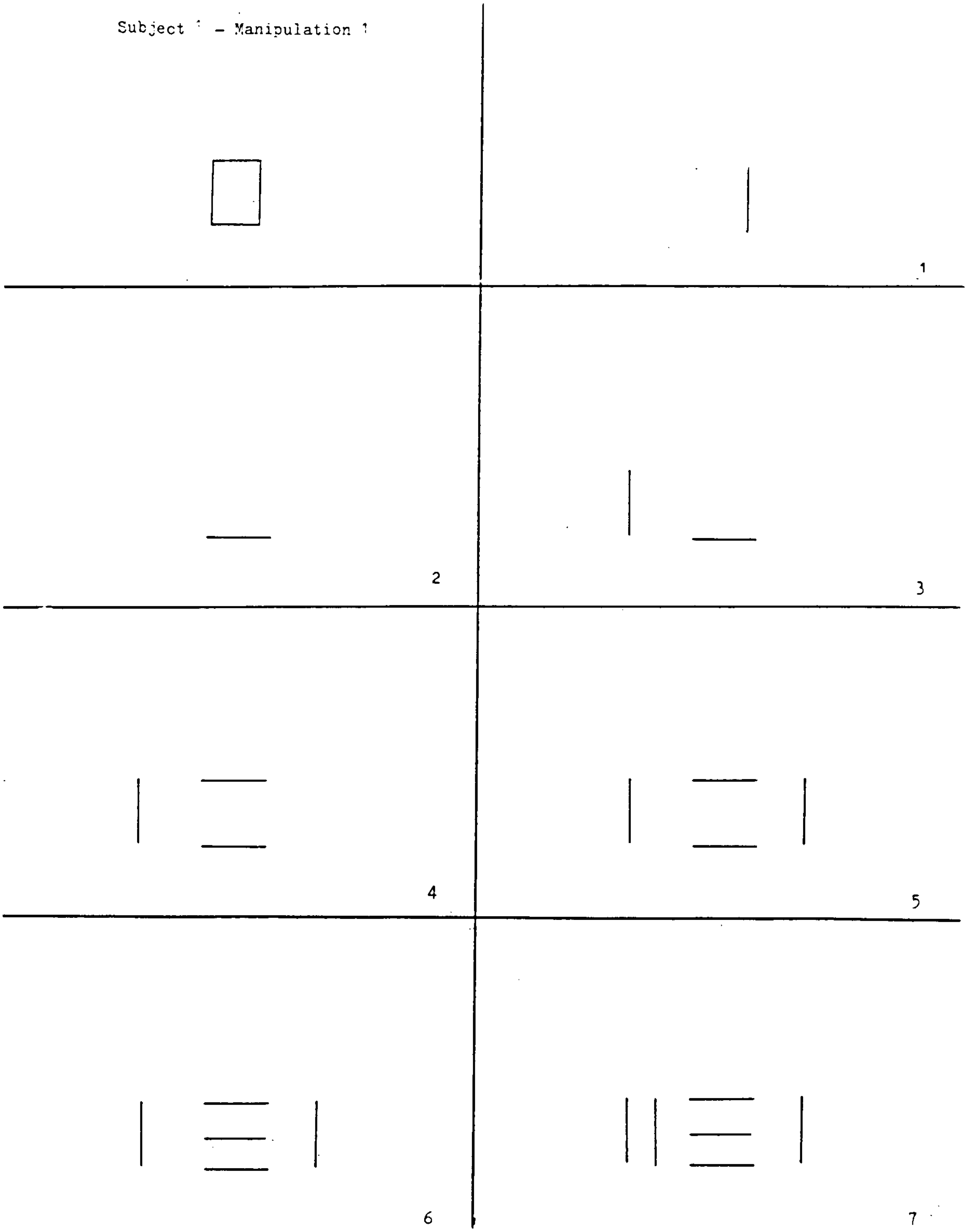
Operational Requests by Subjects Which Violated Experimental Criteria or Computer Capacity

Subject	Activity	Operation	Request
Subject 2	1	1	Put a roof on it.
	2	1	Put a straight line on top.
Subject 4	1	1	Flop it down like this (obliquely).
		5	You could cut off the corners and make a circle with it.
Subject 5	1	2	Cut it down into two triangles (a diagonal).
	2	1	Squish it down into an oval.
Subject 6	1	1	Put a diagonal through it.
	2	1	Can we do straight lines?
Subject 9	1	1	Add a triangle.

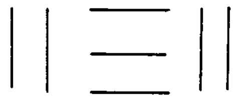
APPENDIX N

The Manipulation Sequence: Operations

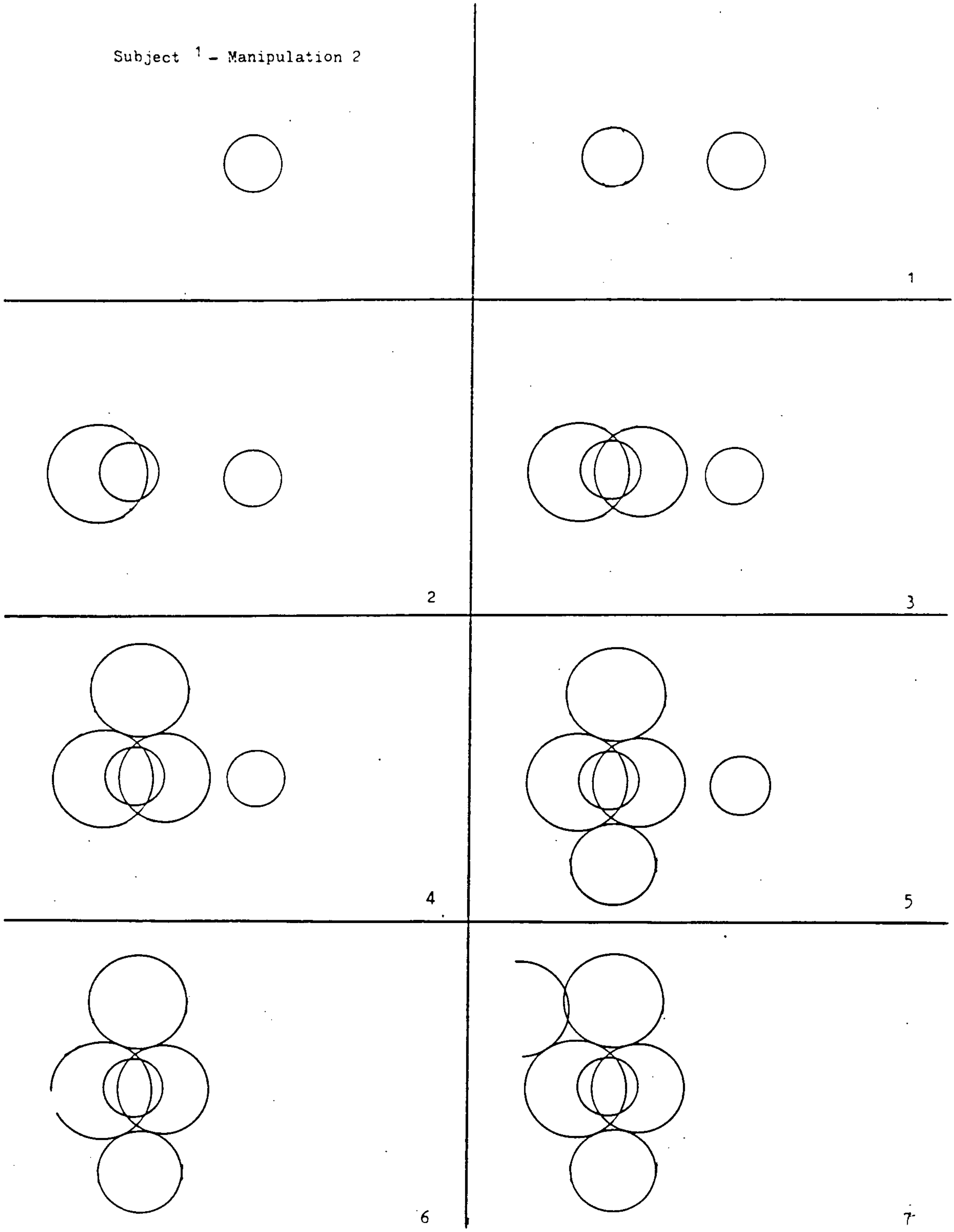
Subject [illegible] - Manipulation 1



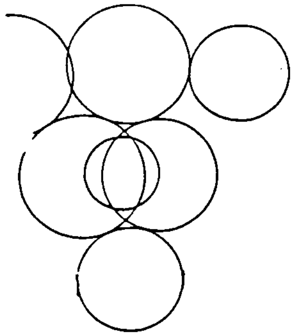
1 – 1



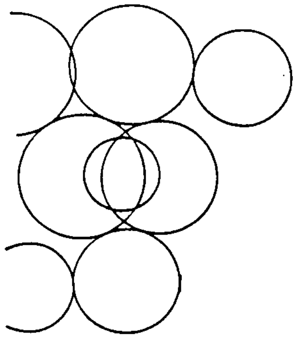
8


Subject 1 - Manipulation 2
1
2
3
4
5
6
7

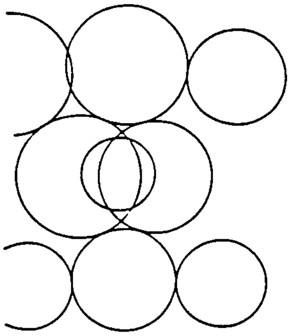
1 – 2



8

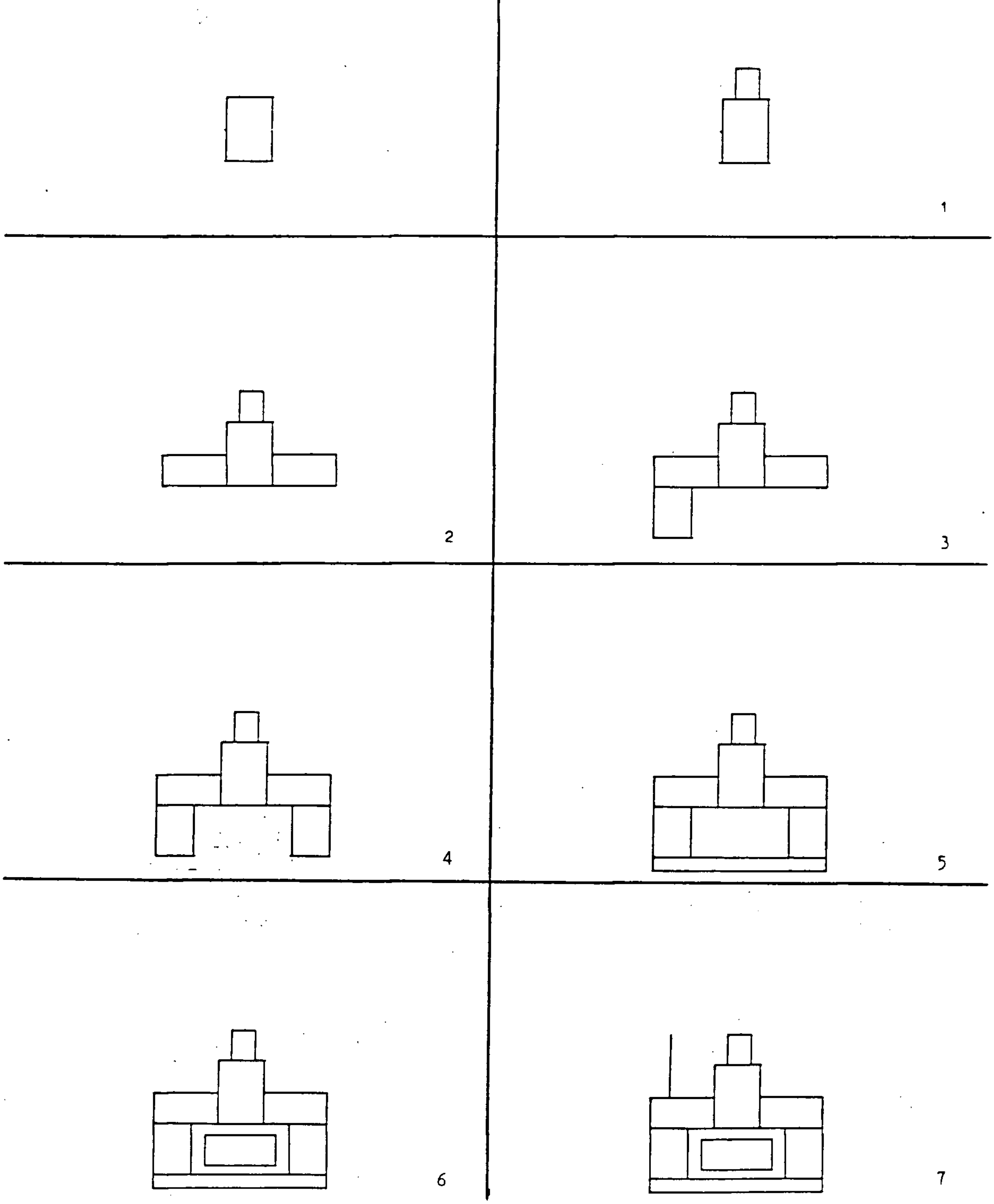


9

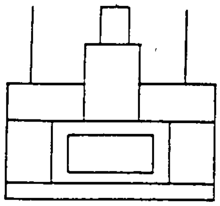


10

Subject 2 - Manipulation 1



2 – 1



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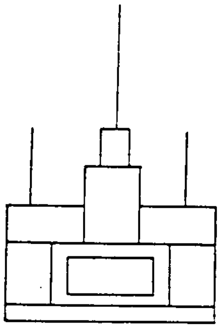
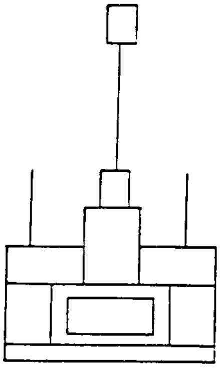
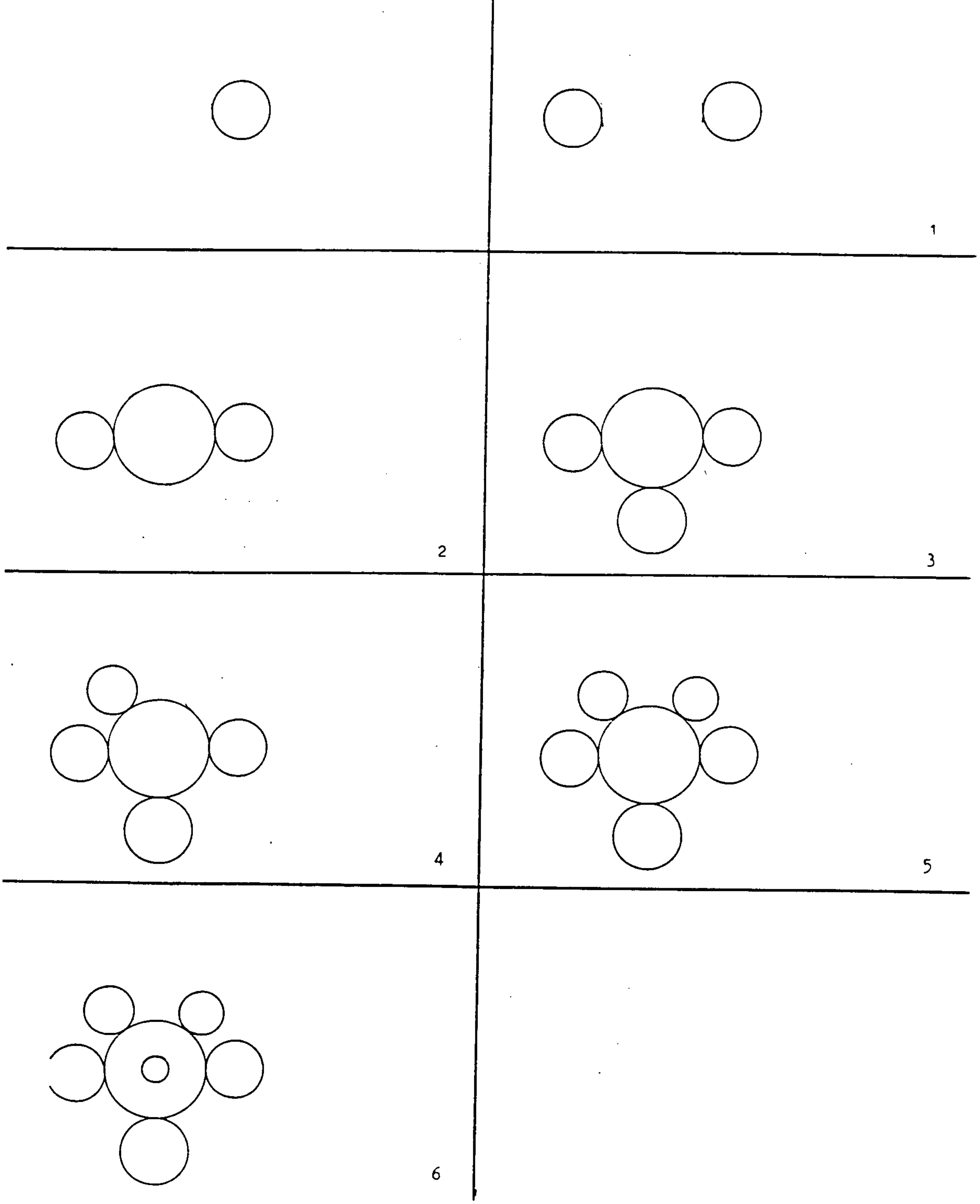


9

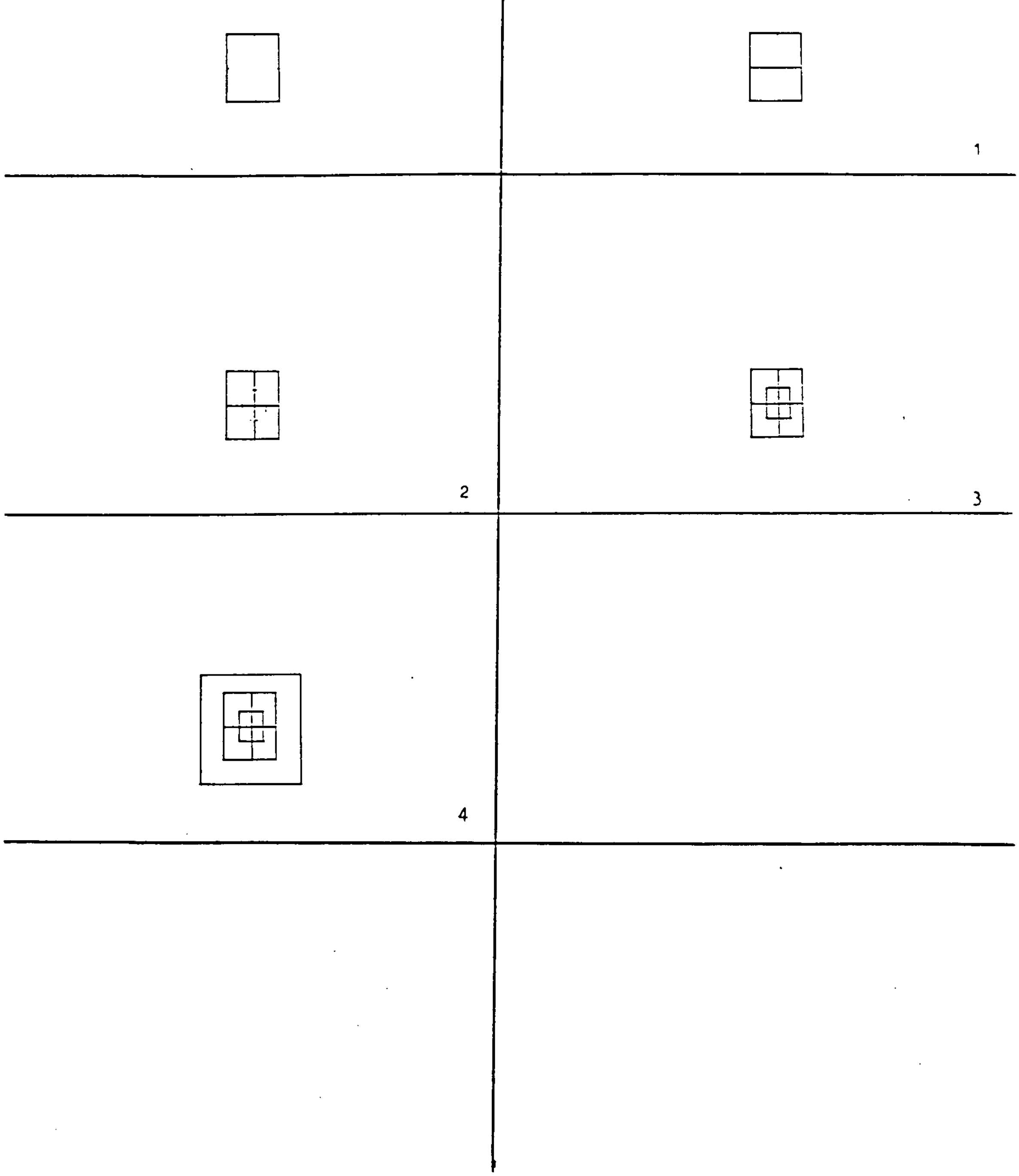


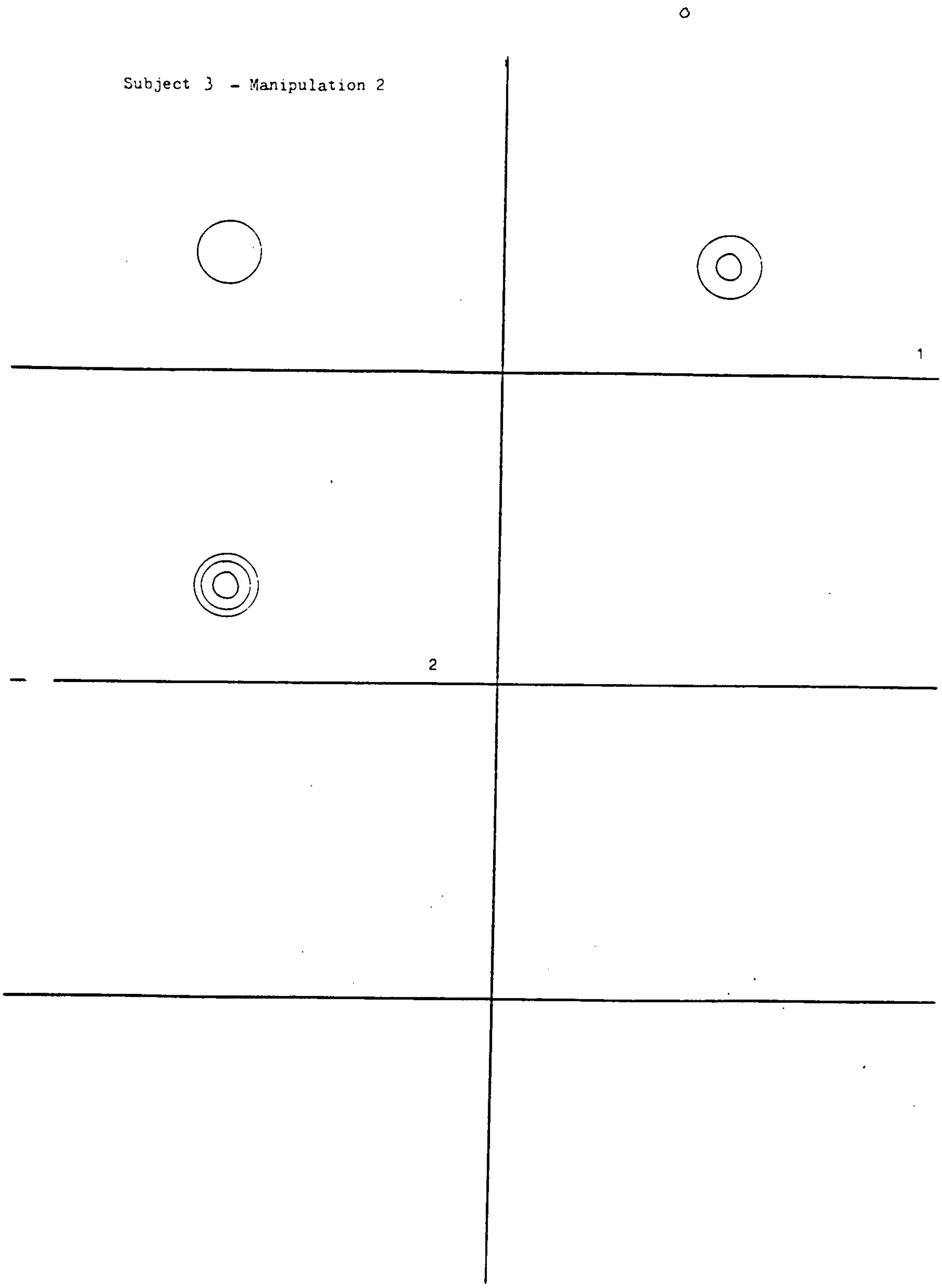
10

Subject 2 - Manipulation 2



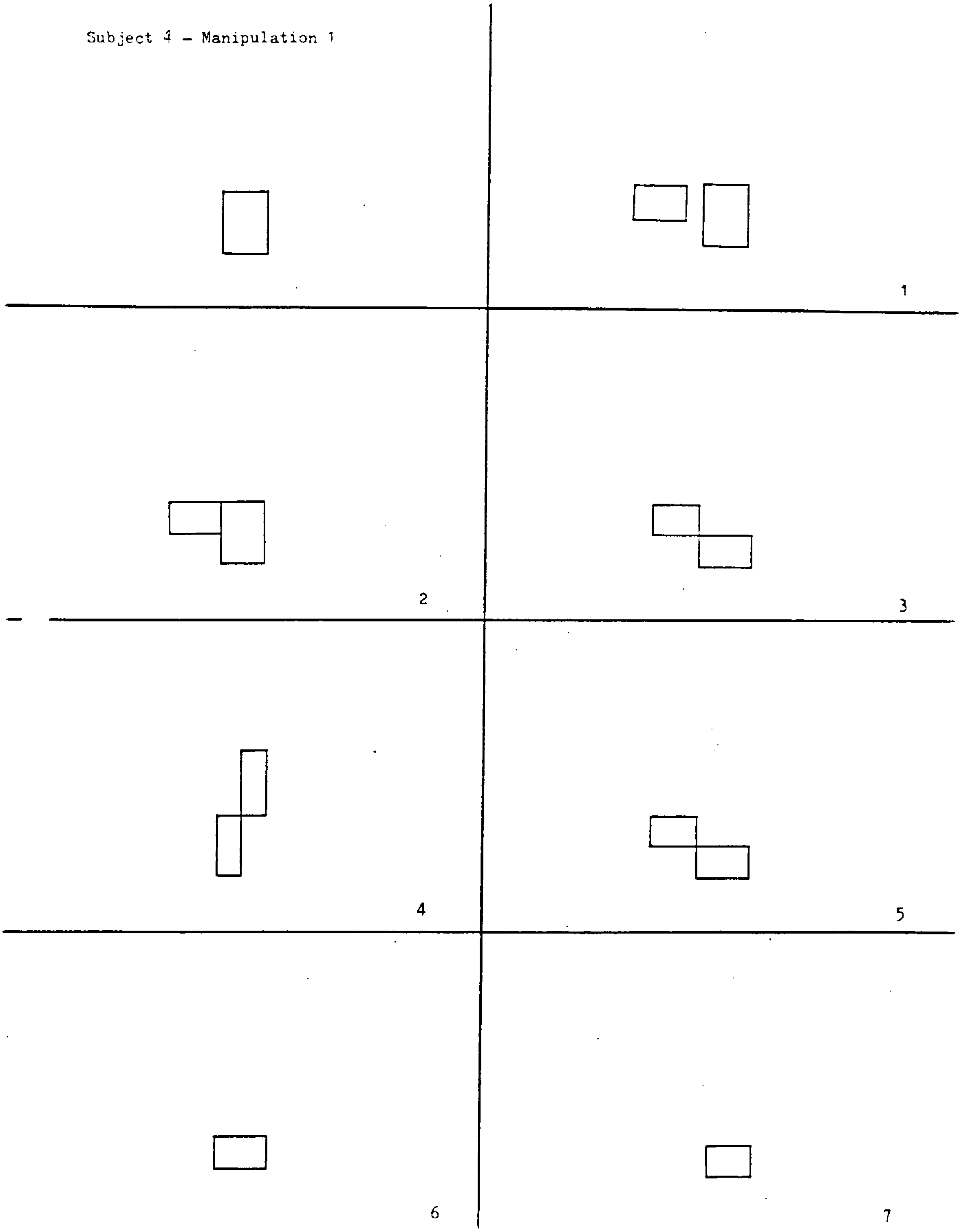
Subject 3 - Manipulation 1

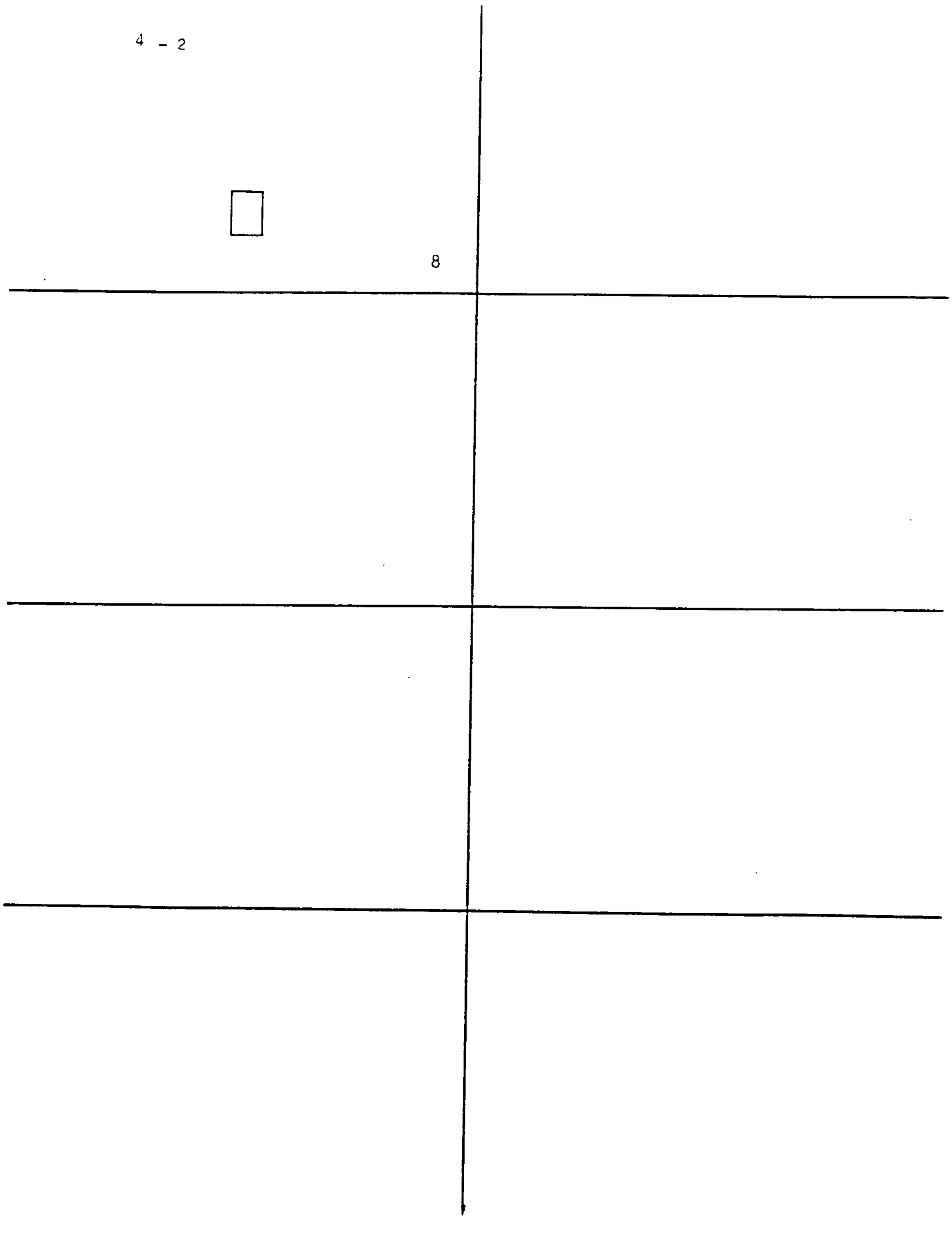




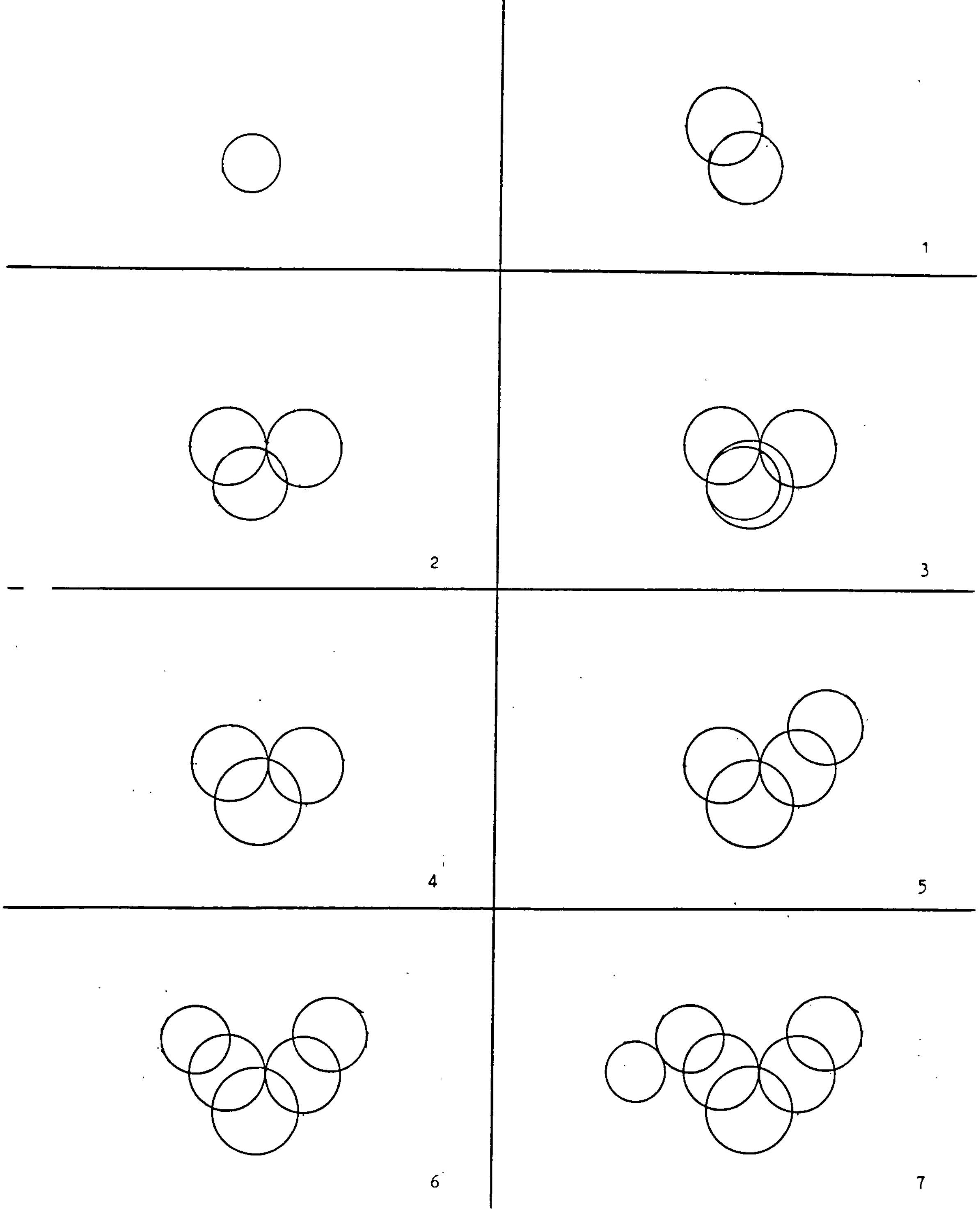
Subject 3 - Manipulation 2
1
2

Subject 4 - Manipulation 1

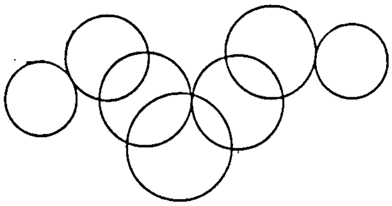



4 - 2
8

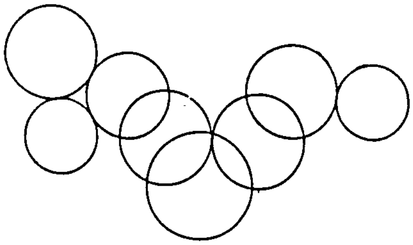
Subject 4 - Manipulation 2



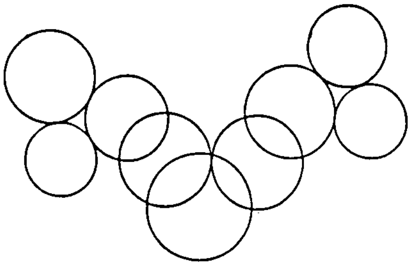
4 - 2



8

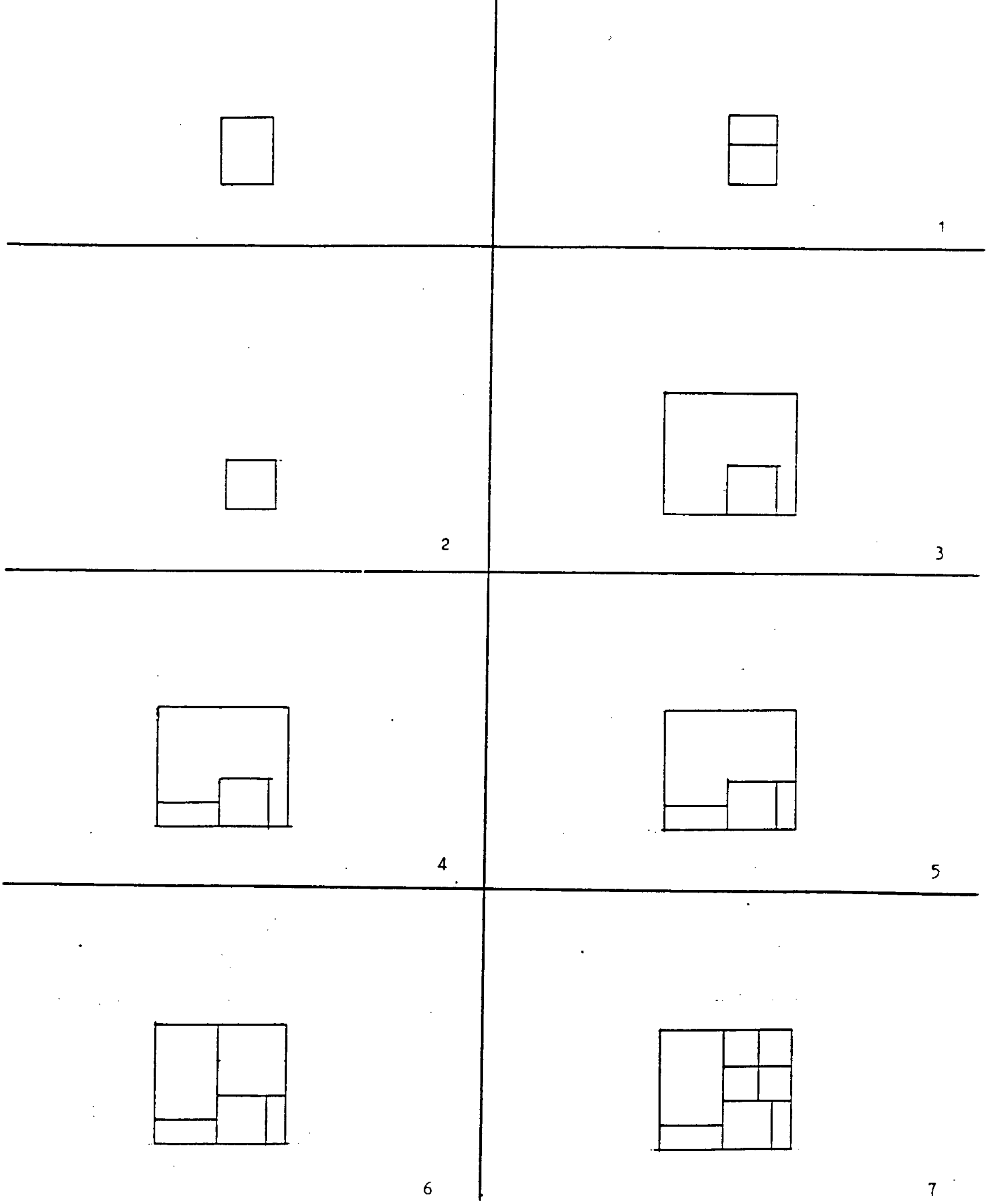


9

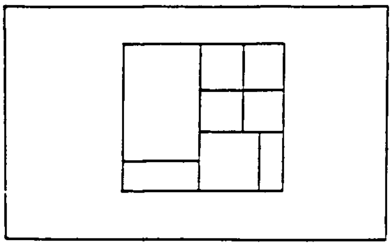


10

Subject 5 - Manipulation 1



5 - 1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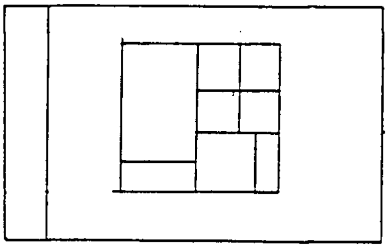
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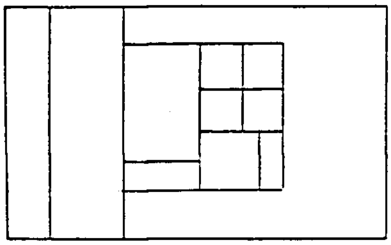
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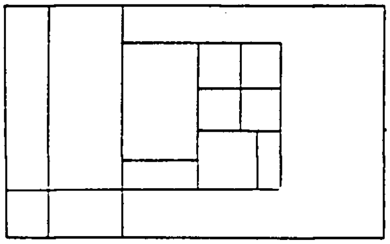
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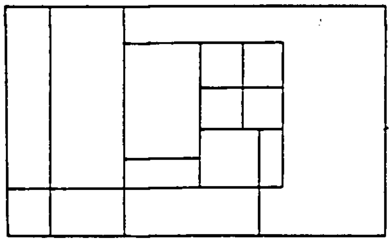
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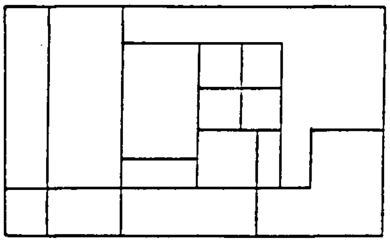
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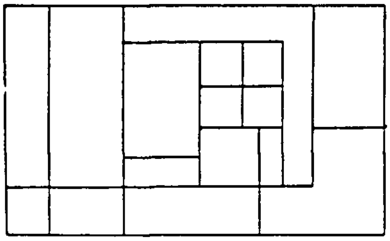
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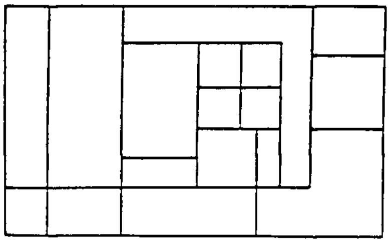
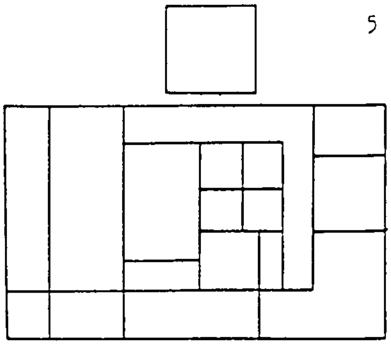
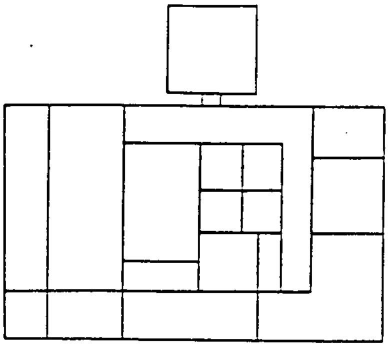

15

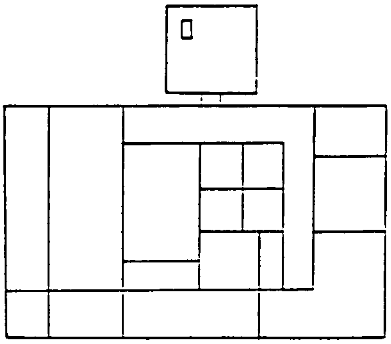
5 - 1



16



17



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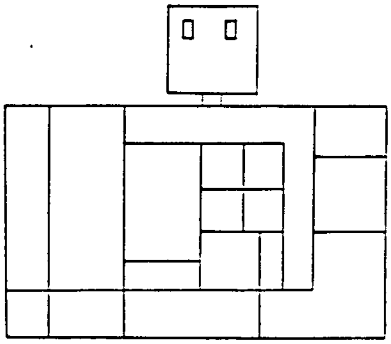

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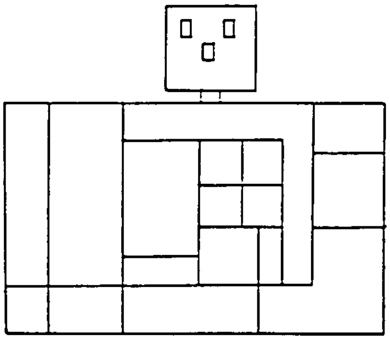

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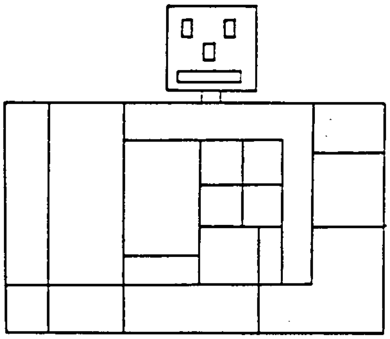
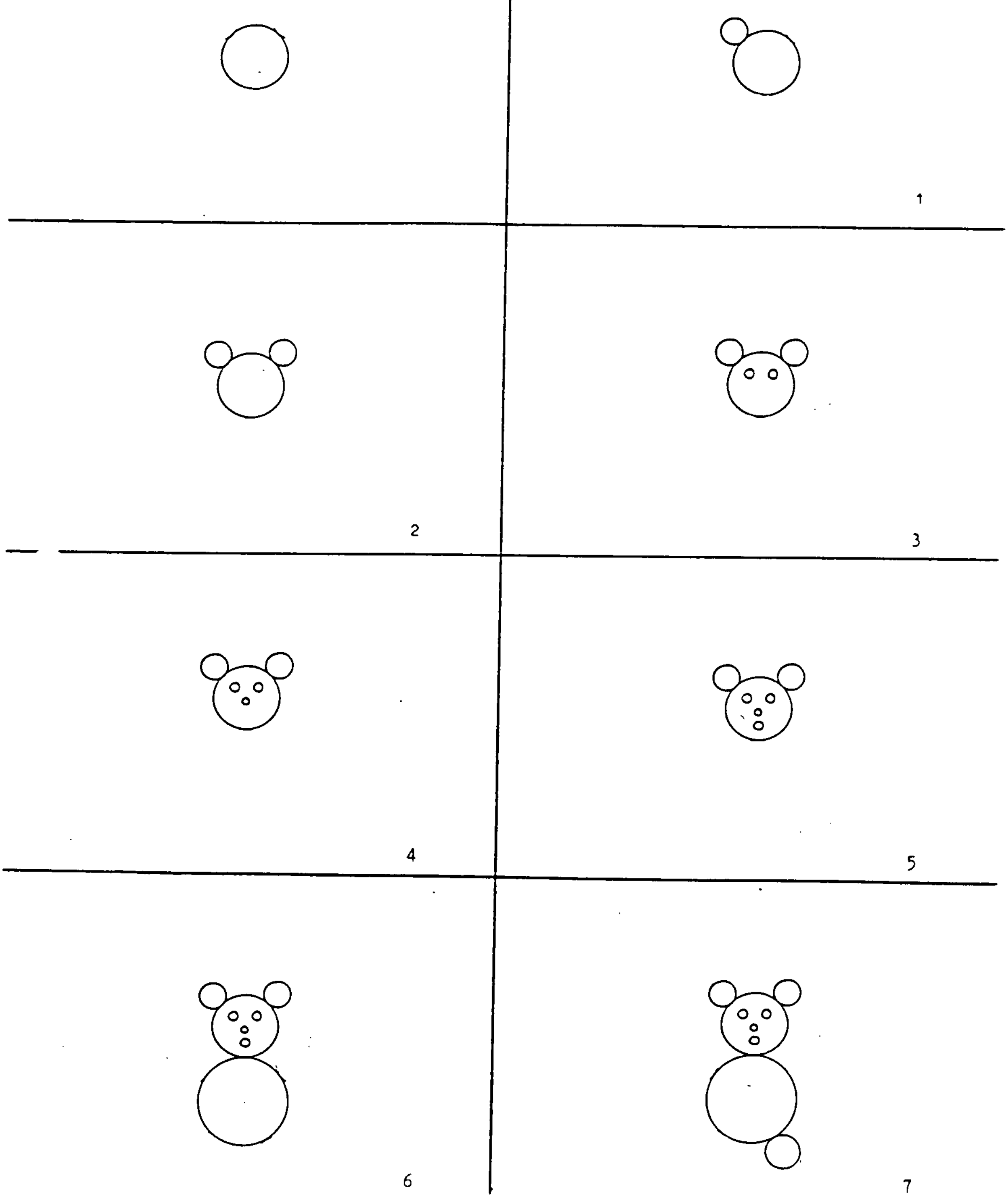
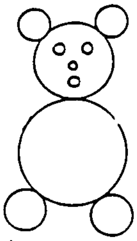


21

Subject 5 - Manipulation 2



5 - 2



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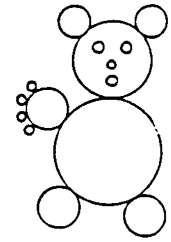

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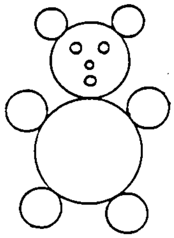

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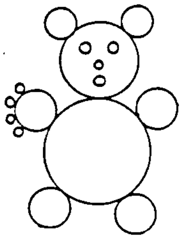
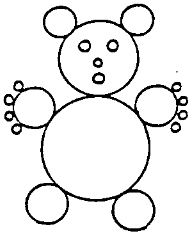
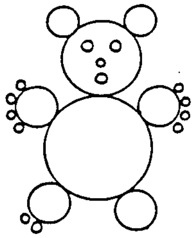


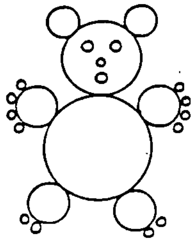
11



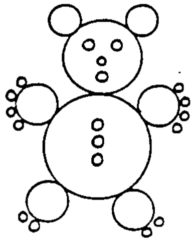
12



13

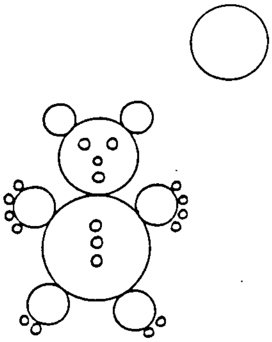


14



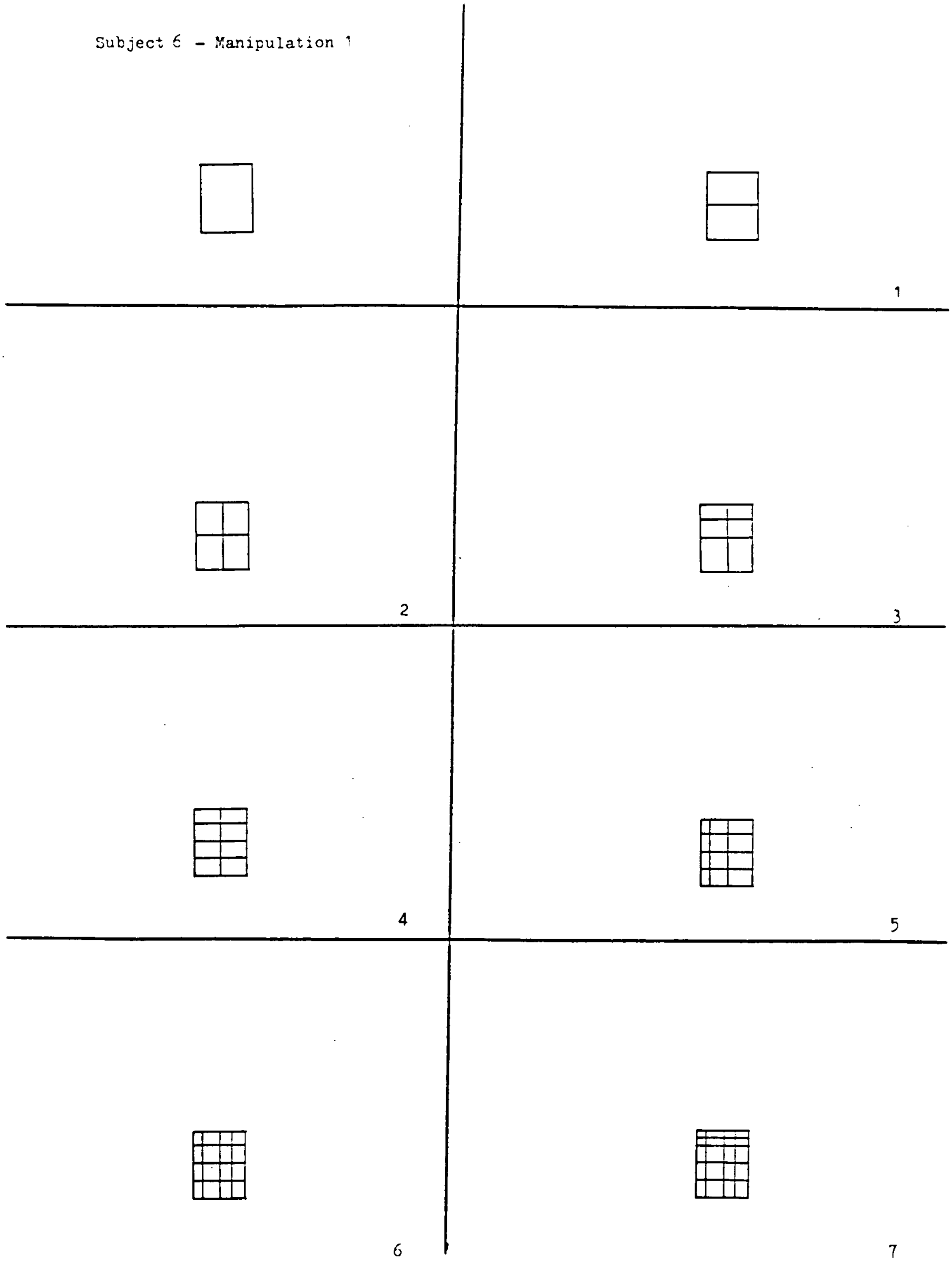
15

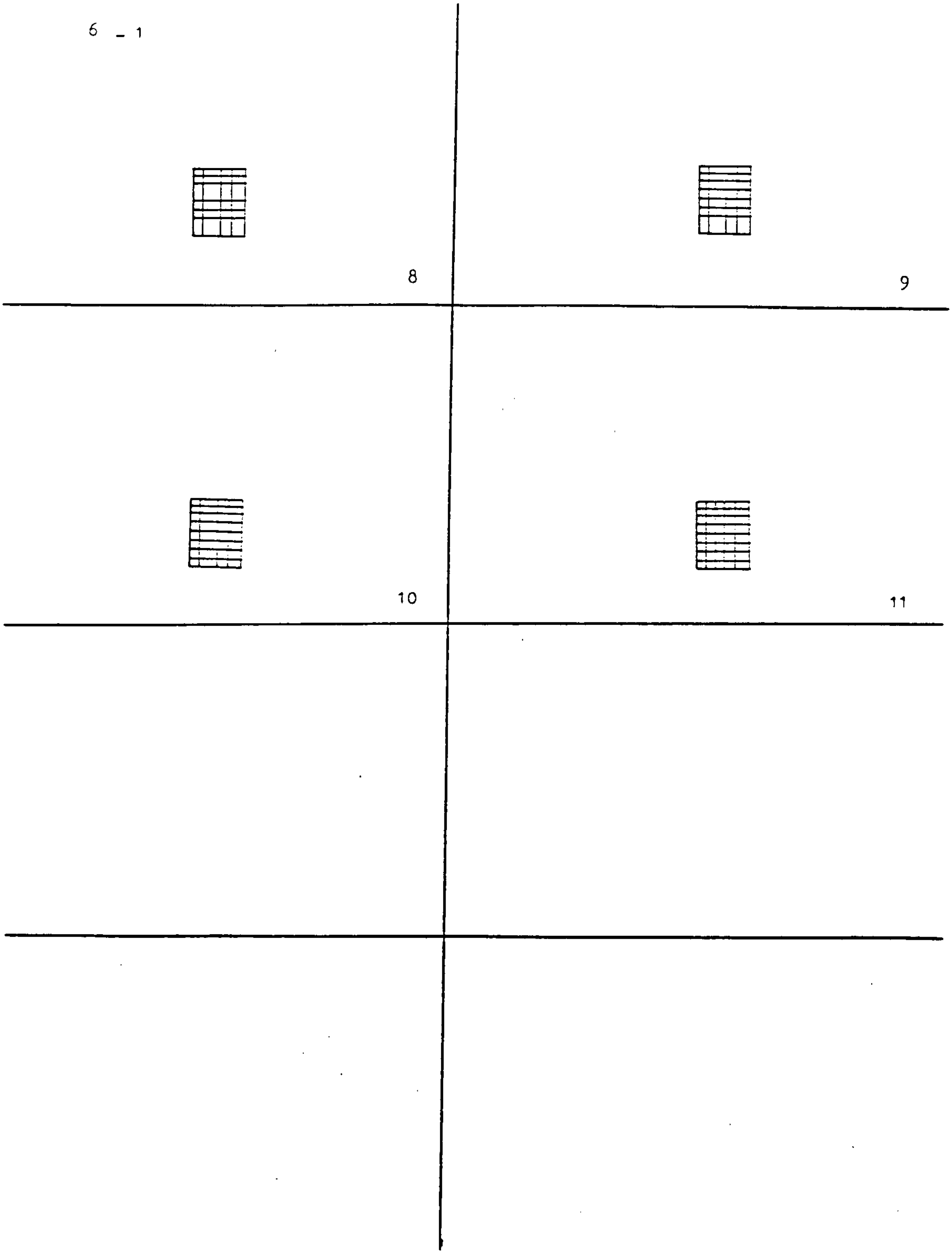
5 - 2



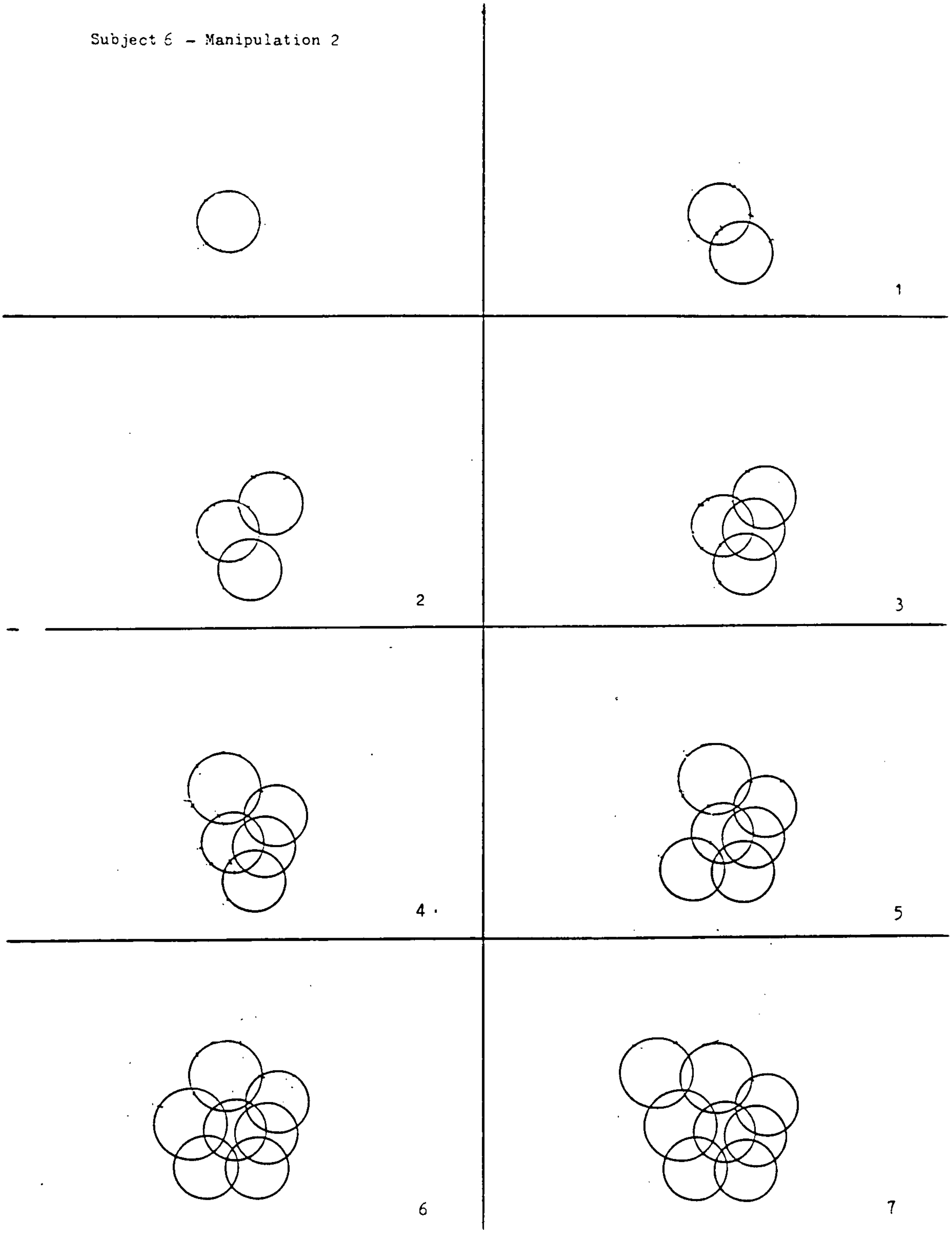
16

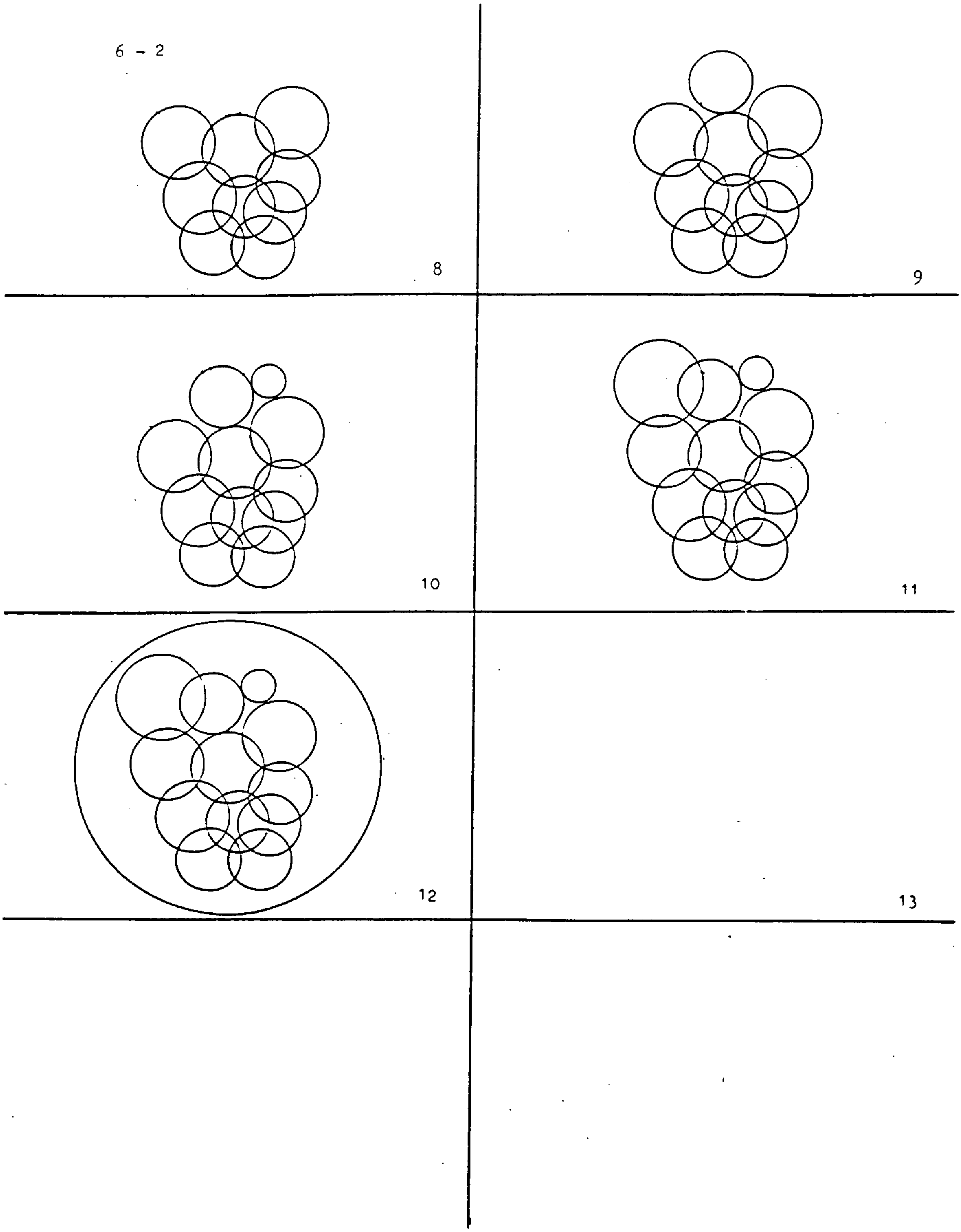
Subject 6 - Manipulation 1

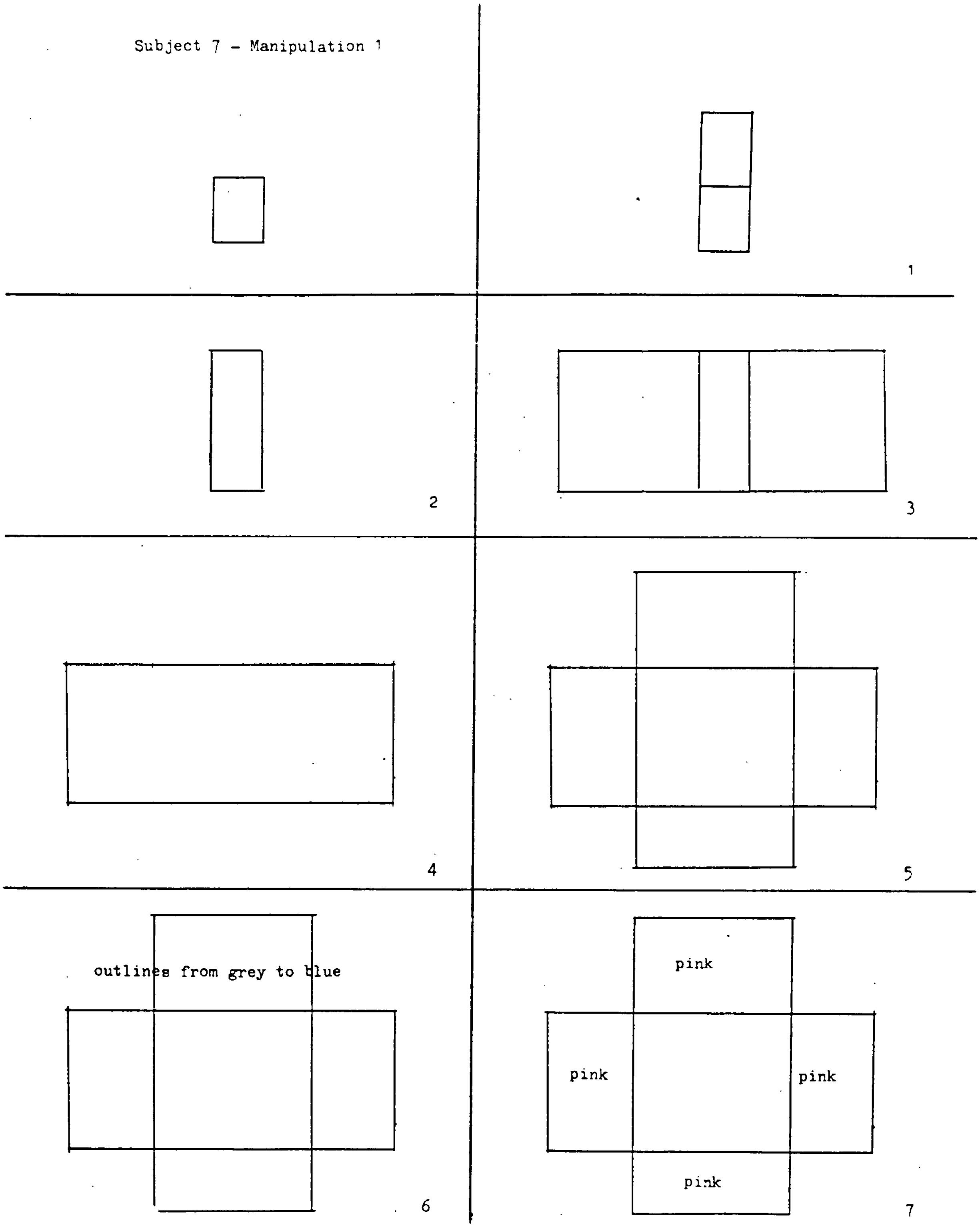



6 - 1
8
9
10
11

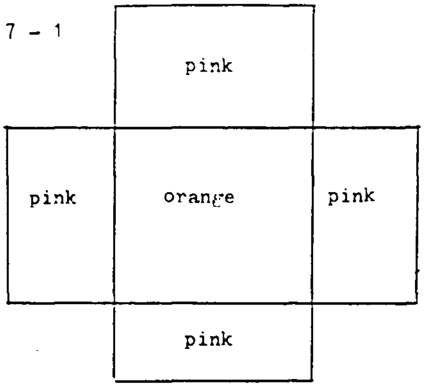
Subject 6 - Manipulation 2



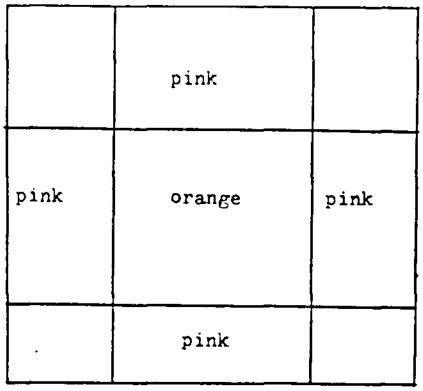

6 - 2
8
9
10
11
12
13


Subject 7 - Manipulation 1
1
2
3
4
5
outlines from grey to blue
6
pink
pink
pink
pink
7

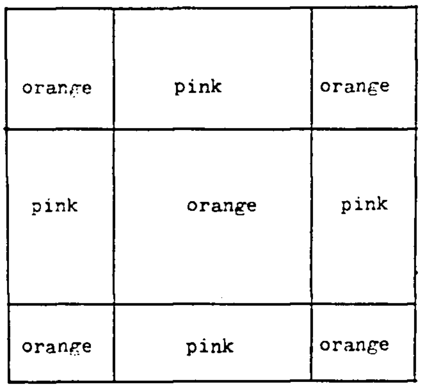
7 - 1


pink
pink
orange
pink
pink

8

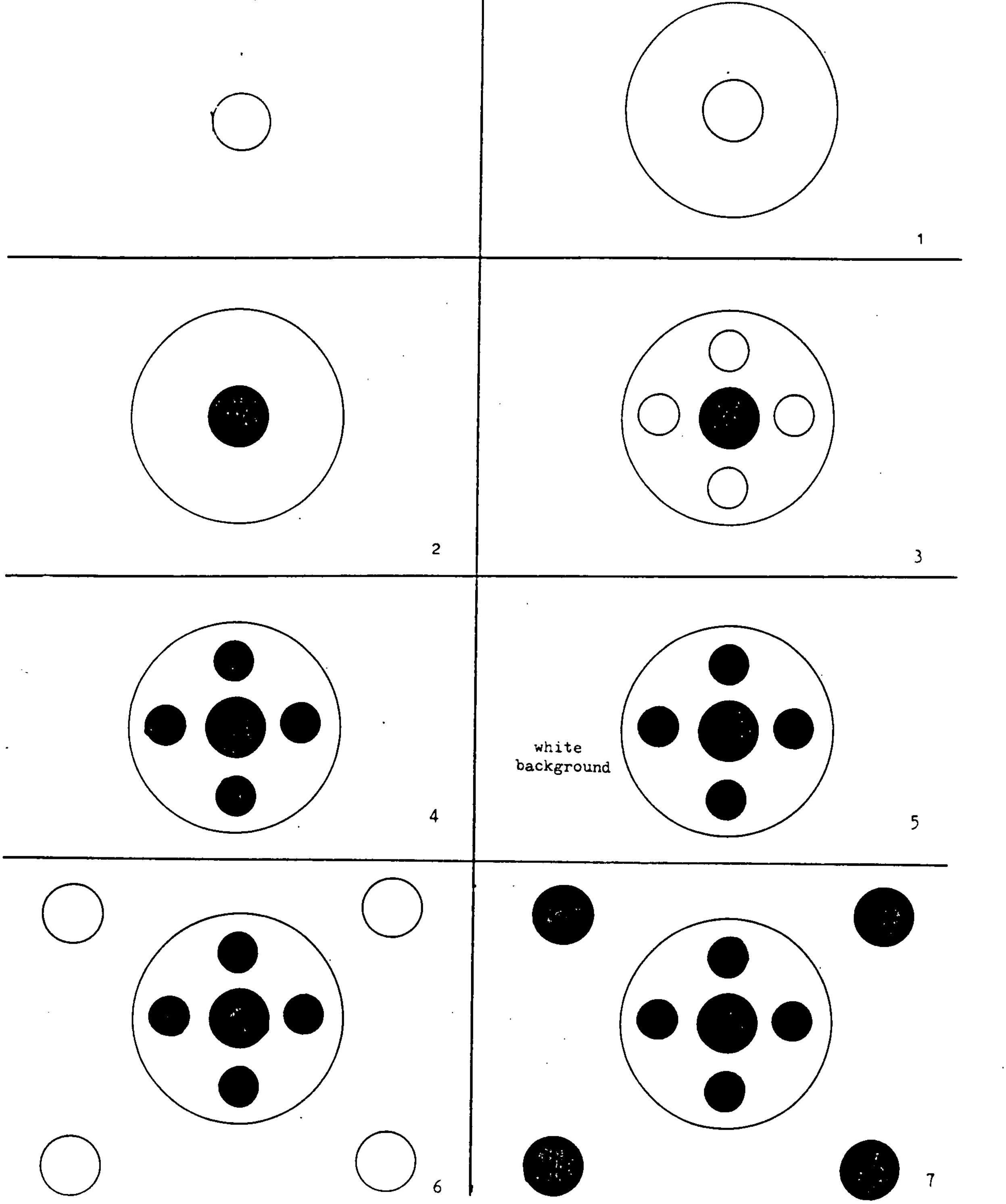

pink
pink
orange
pink
pink

9

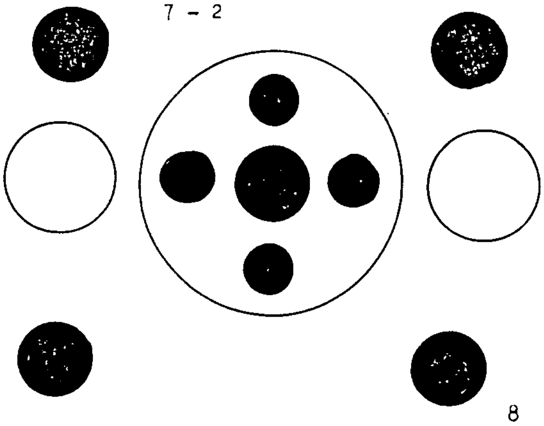

orange
pink
orange
pink
orange
pink
orange
pink
orange

10

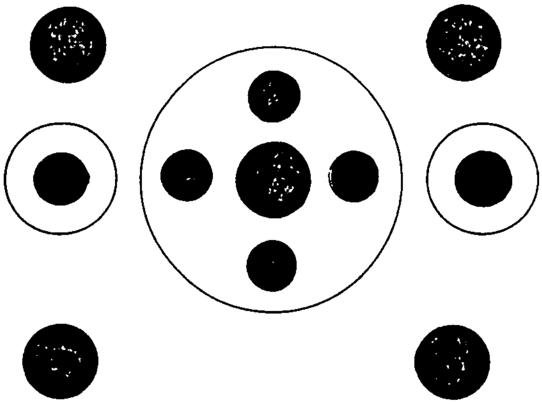
Subject 7 - Manipulation 2



7 - 2

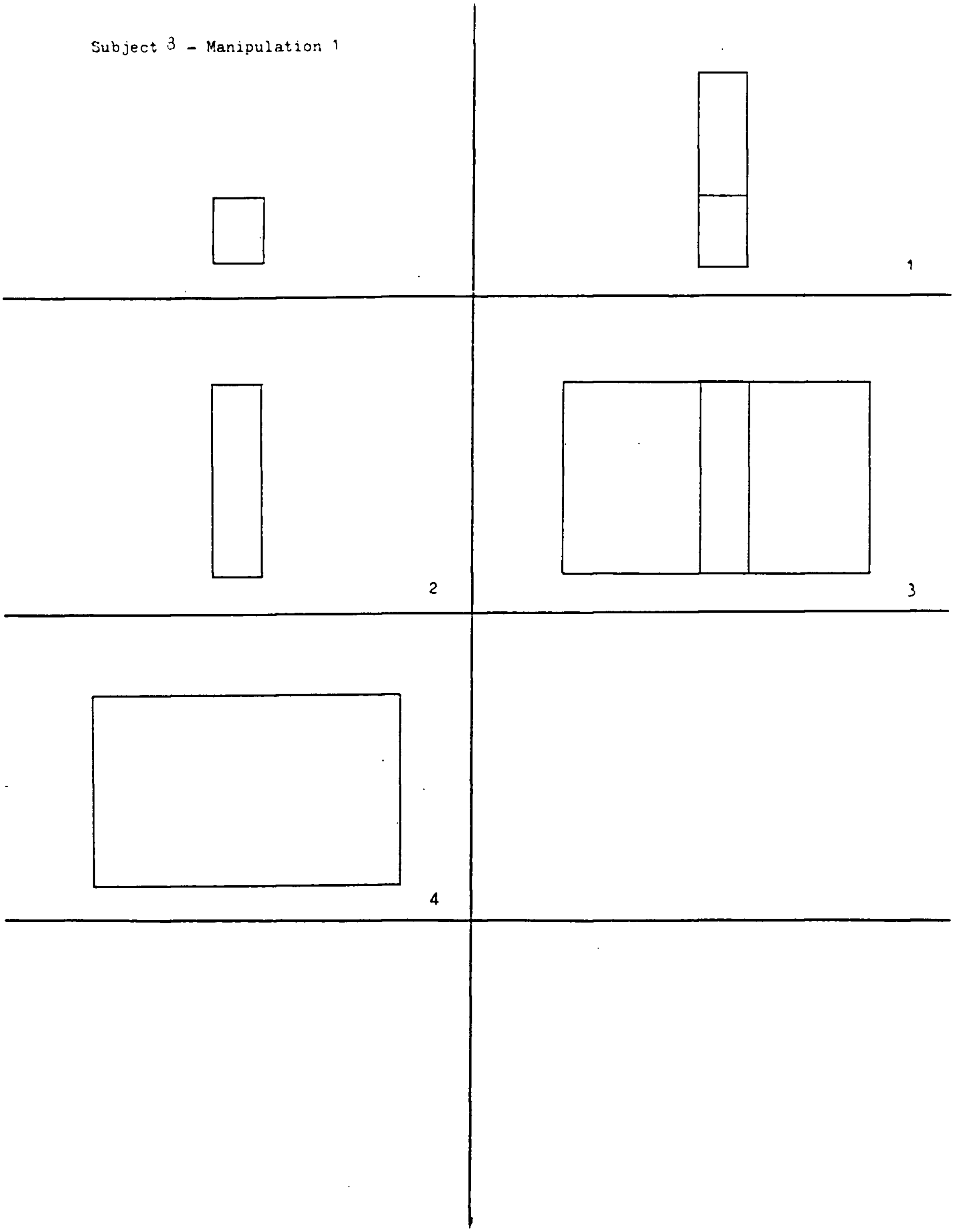


8

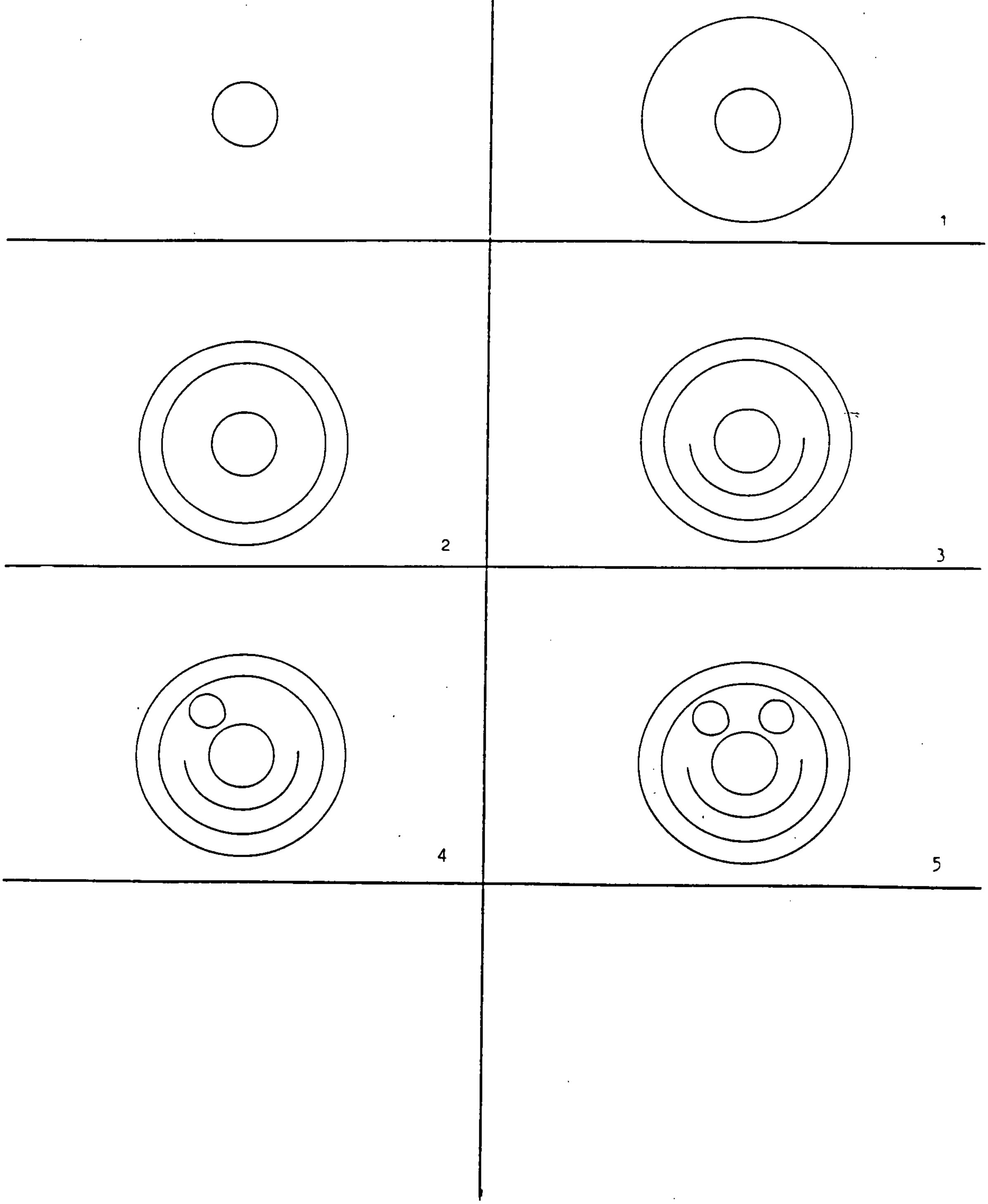


9

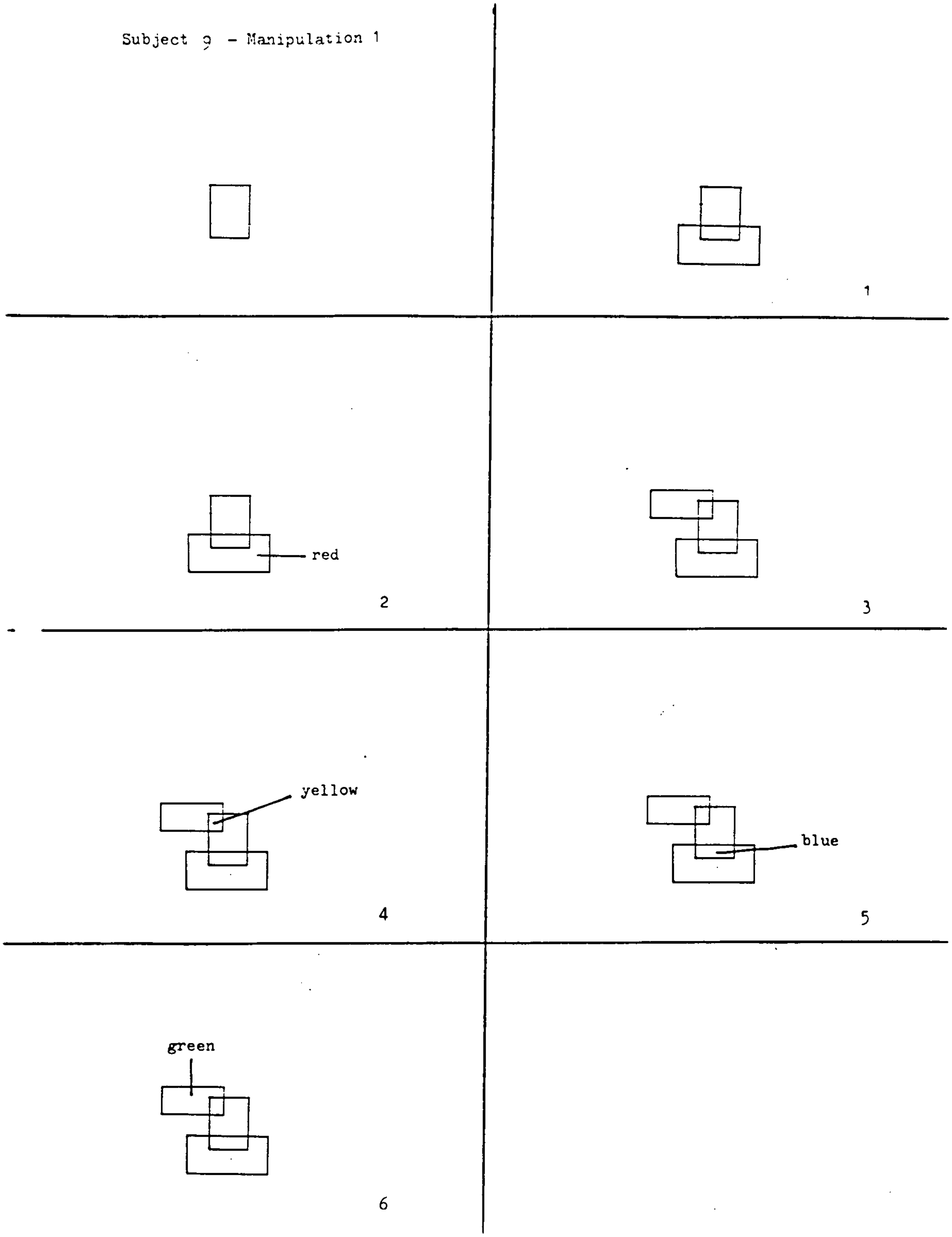
Subject 3 – Manipulation 1

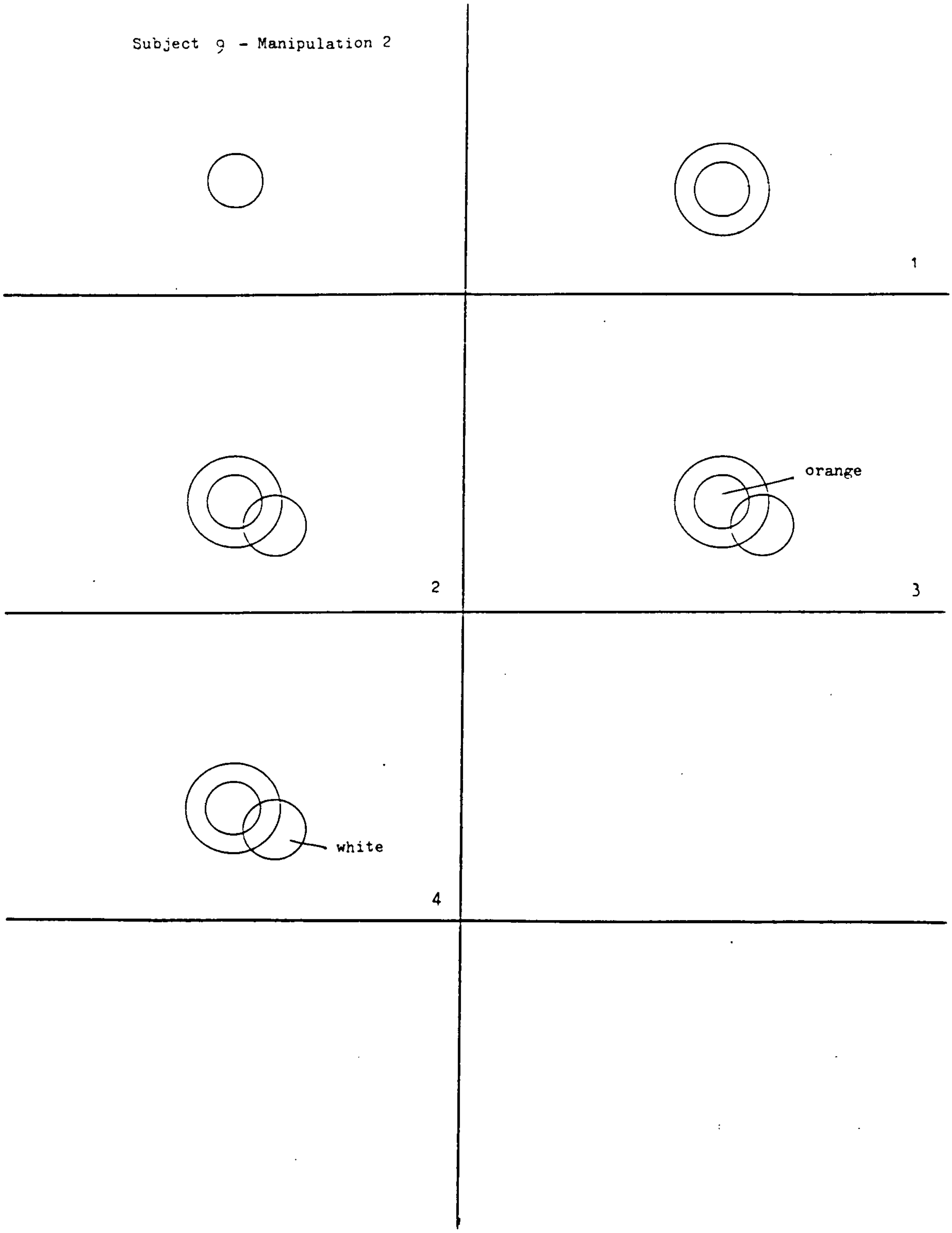


Subject 8 - Manipulation 2

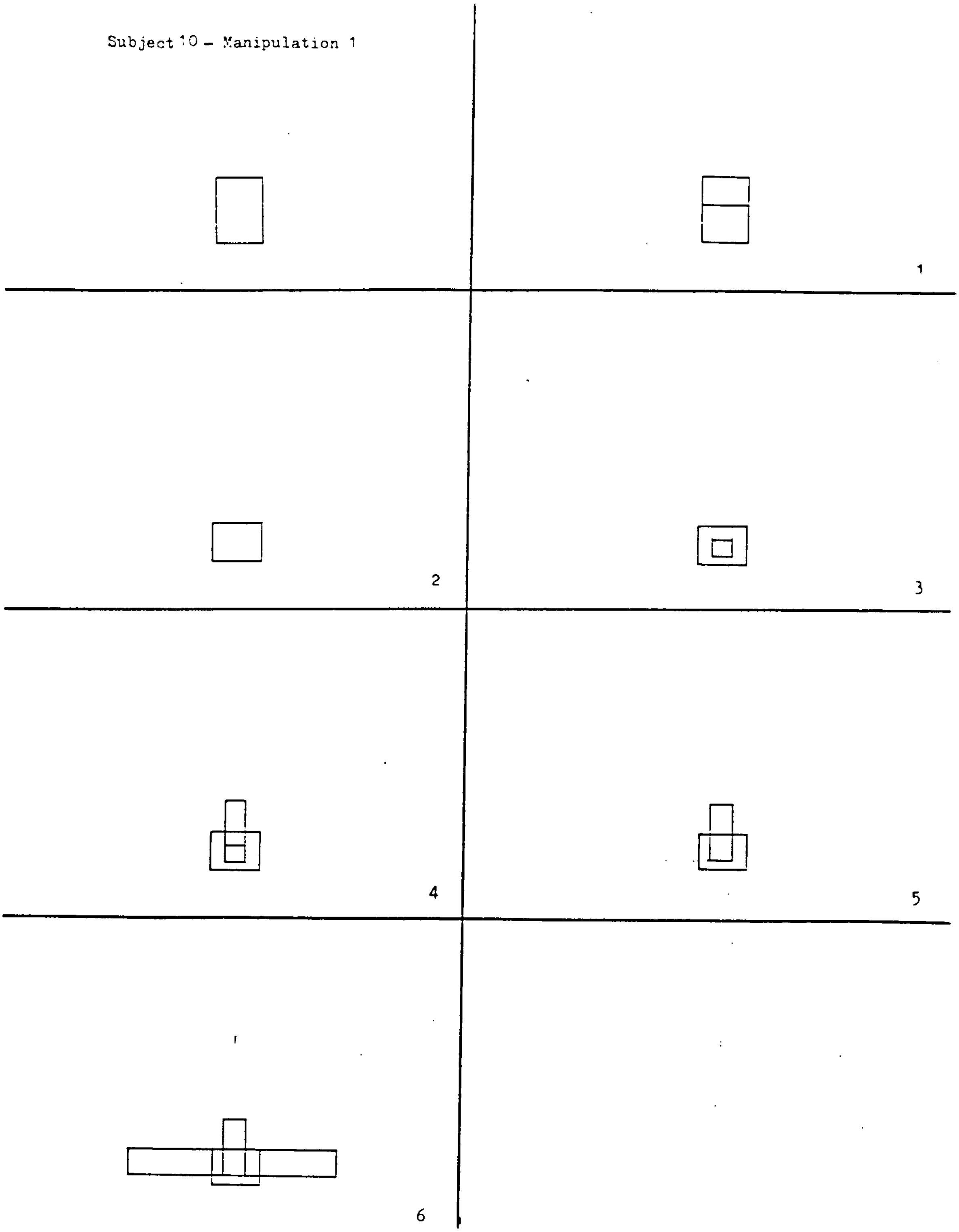


Subject 9 - Manipulation 1

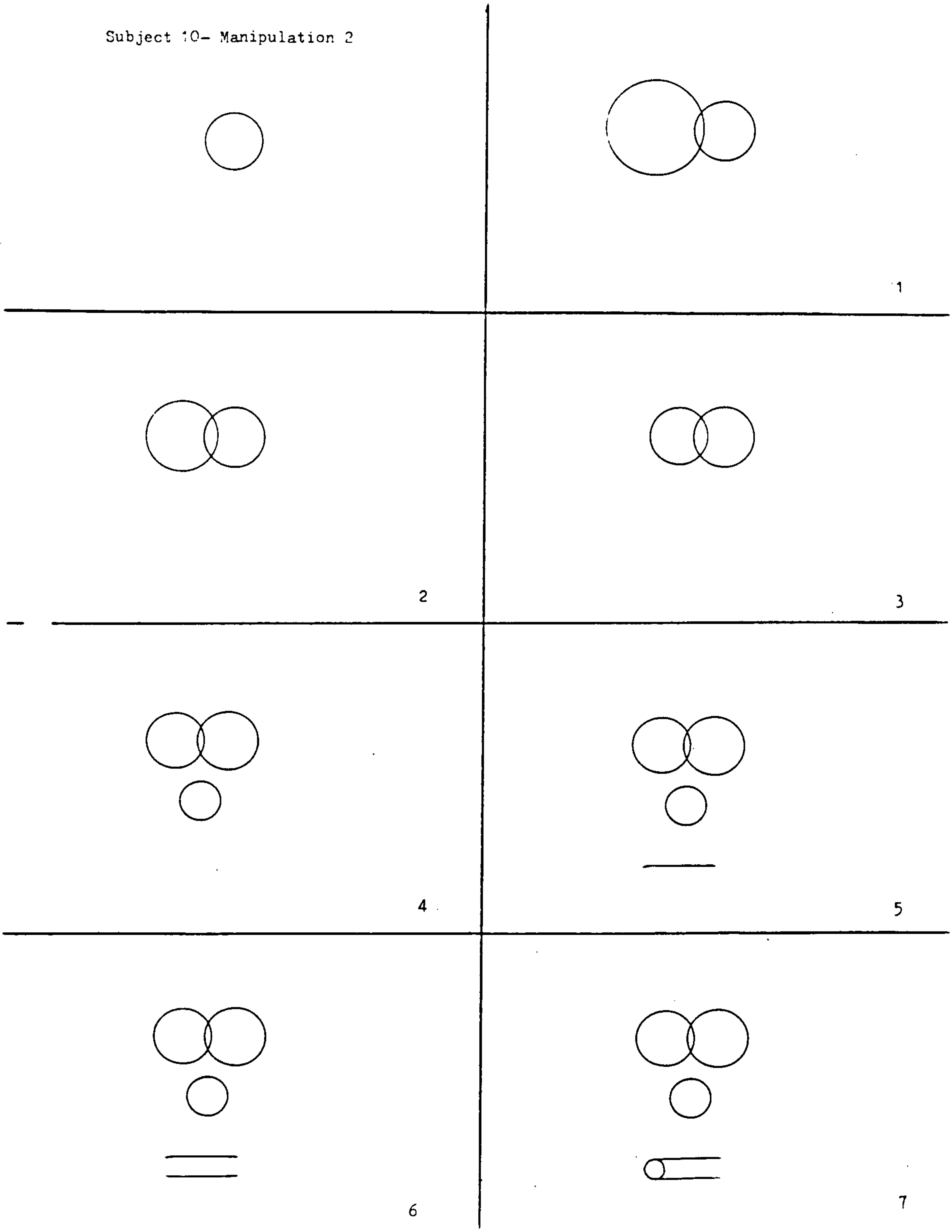



Subject 9 - Manipulation 2
1
orange
2
3
white
4

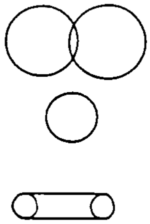
Subject 10 - Manipulation 1



Subject 10- Manipulation 2



10 - 2



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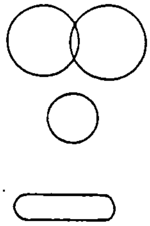
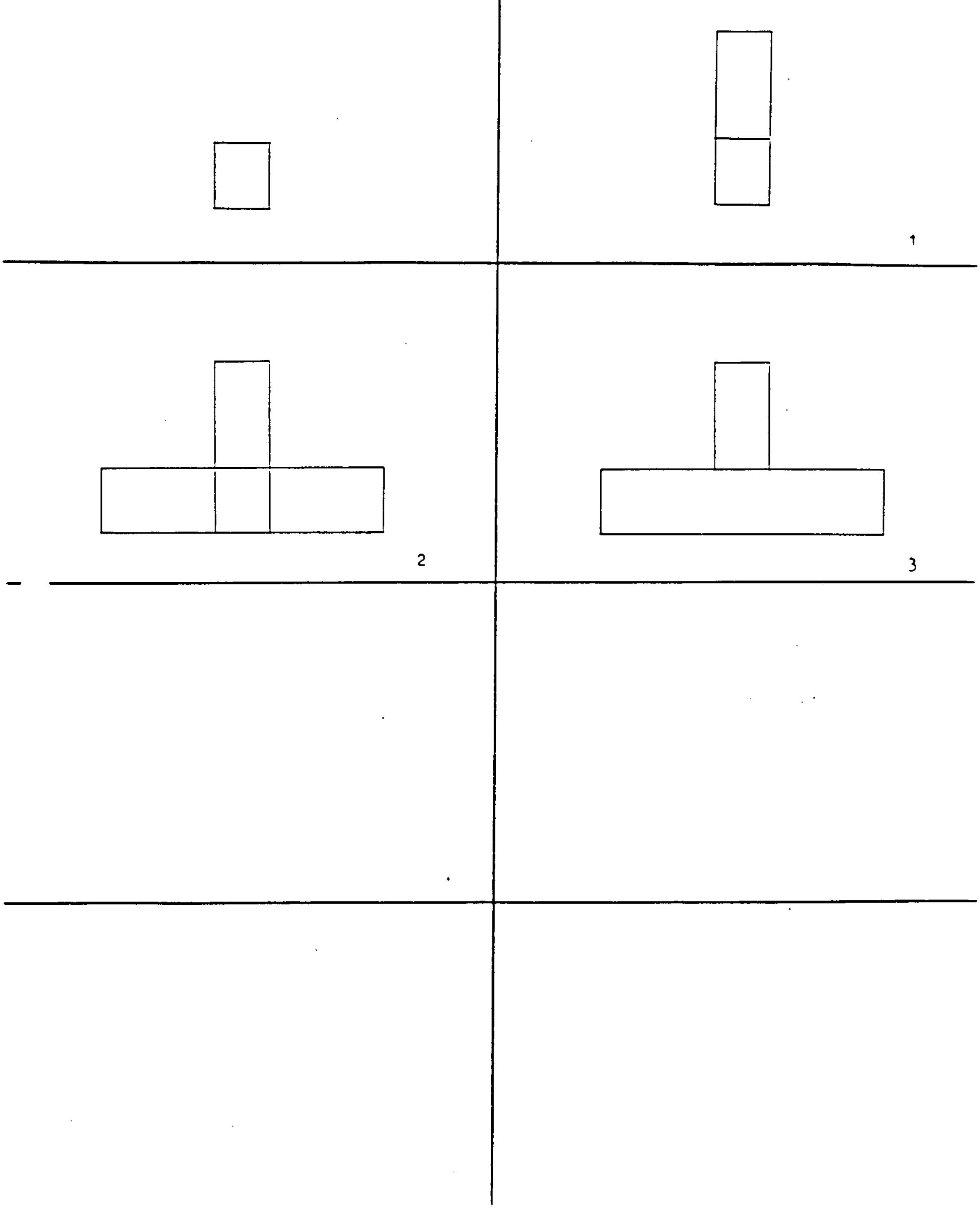
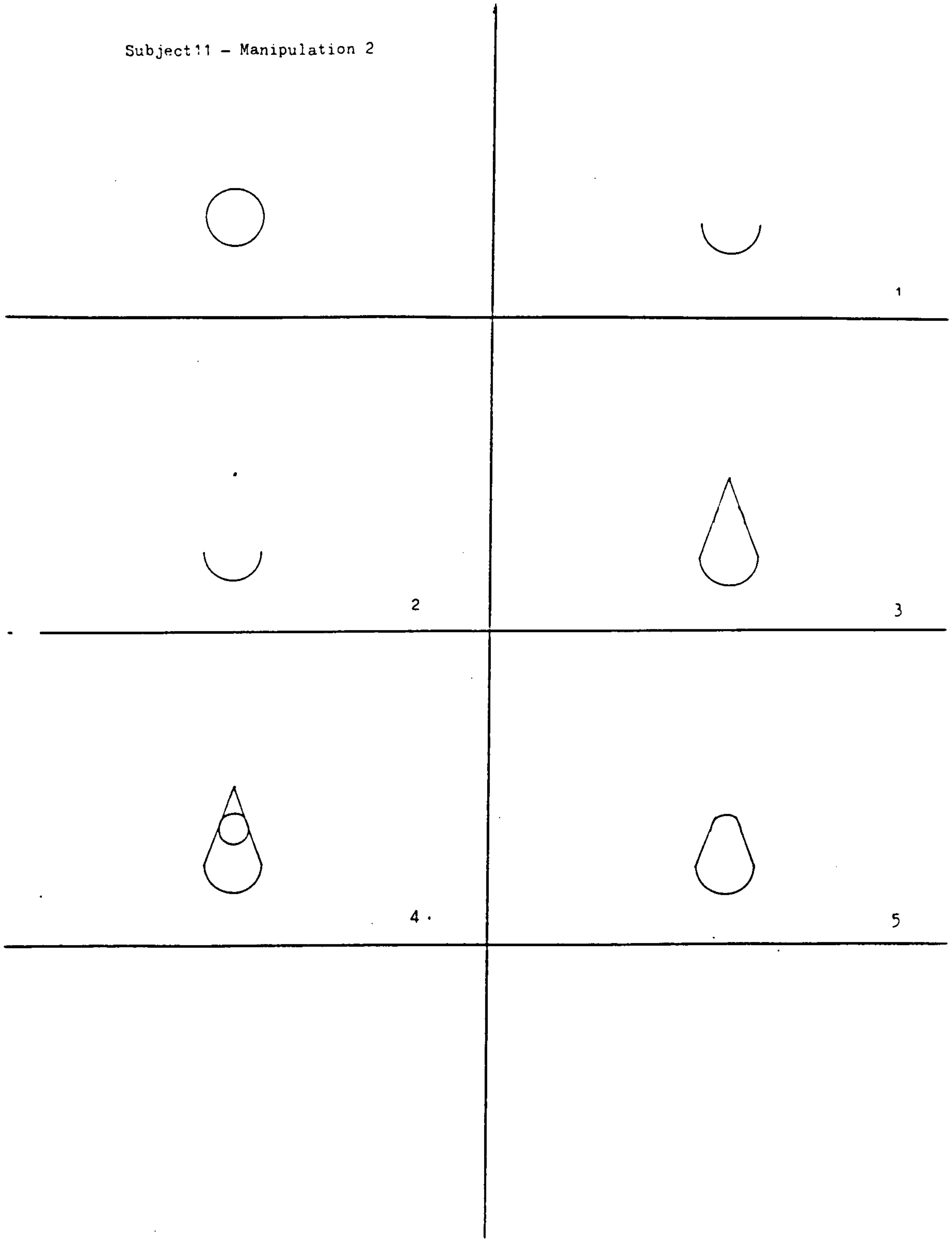


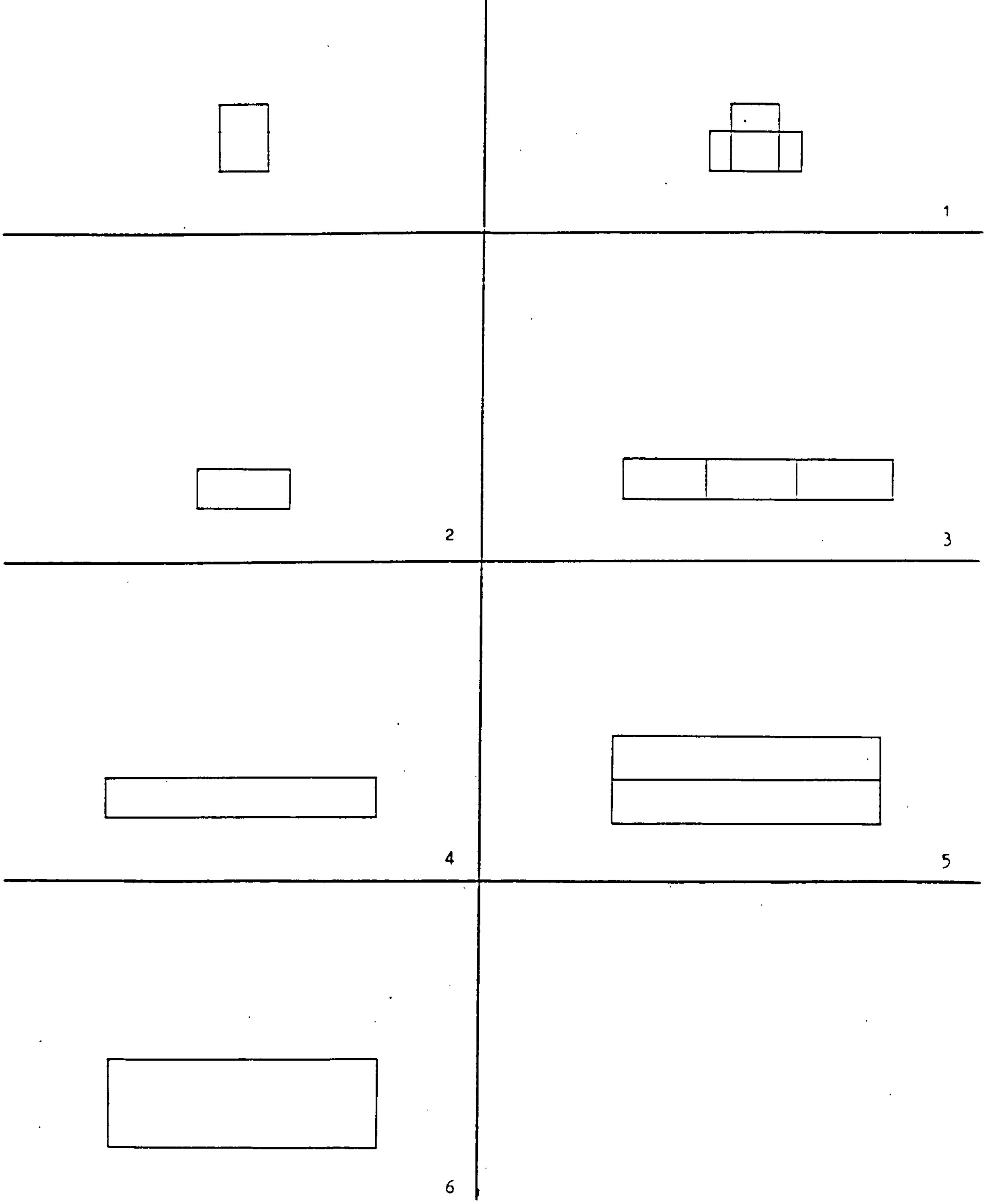
9

Subject 11- Manipulation 1

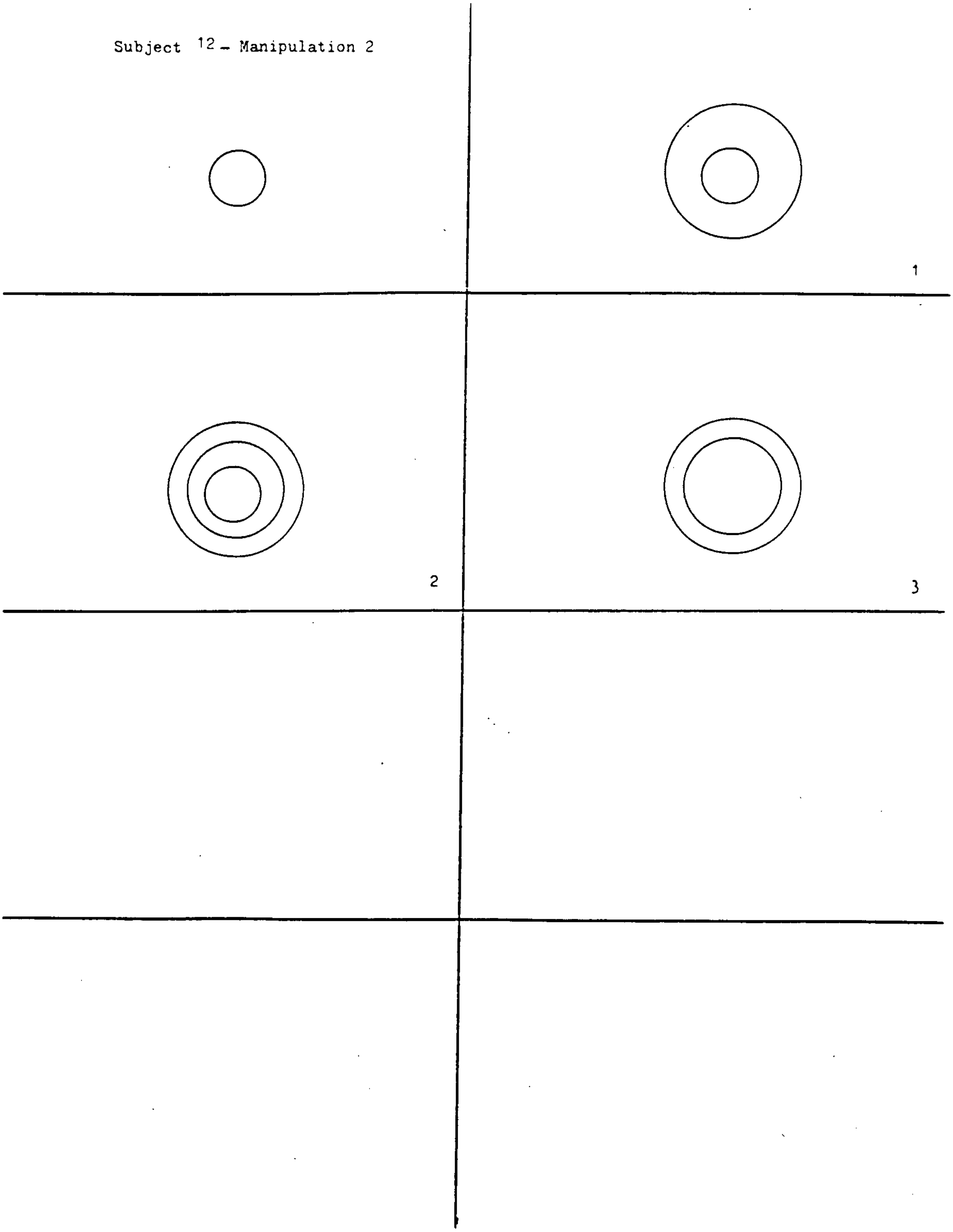



Subject11 - Manipulation 2
1
2
3
4
5

Subject 12 - Manipulation 1



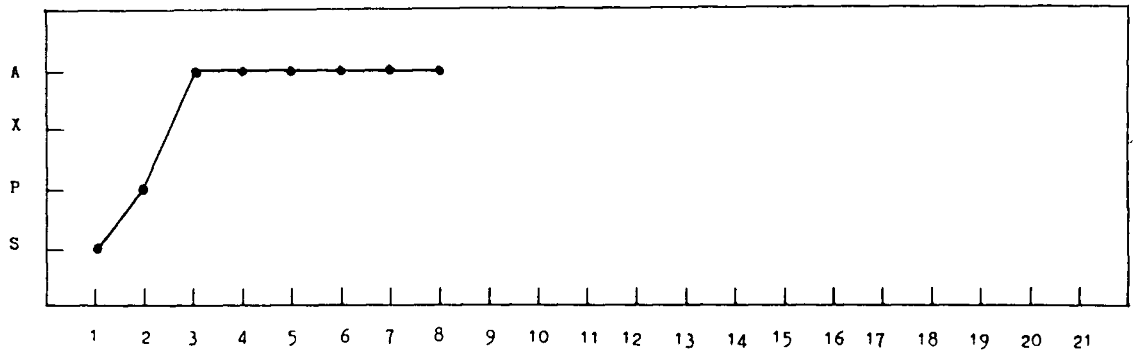
Subject 12 – Manipulation 2



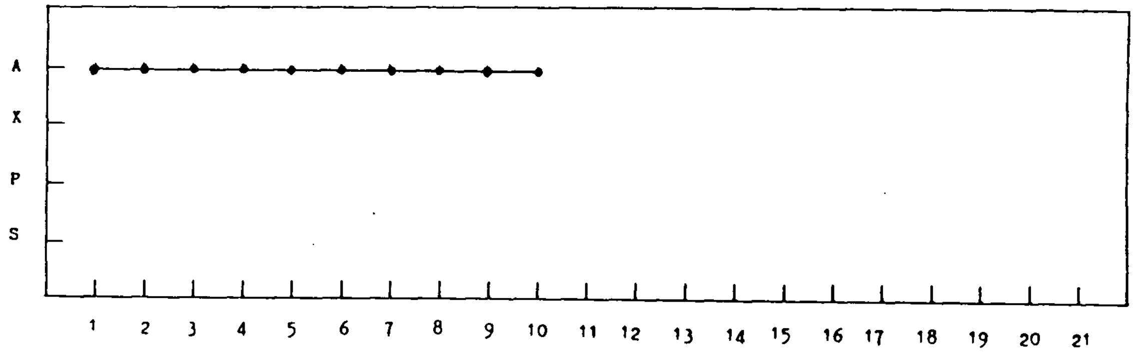
APPENDIX O

Operations Used by Subjects

Subject 1



Manipulation 1 - Rectangle



Manipulation 2 - Circle

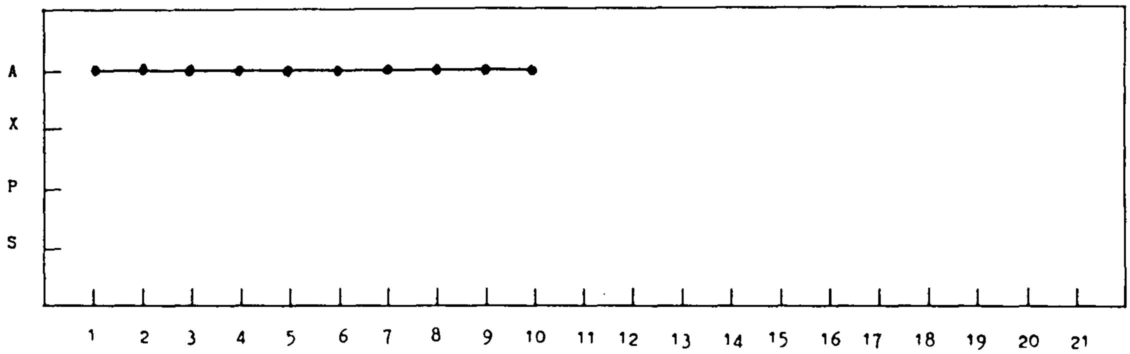
A = Additive

X = Alterational

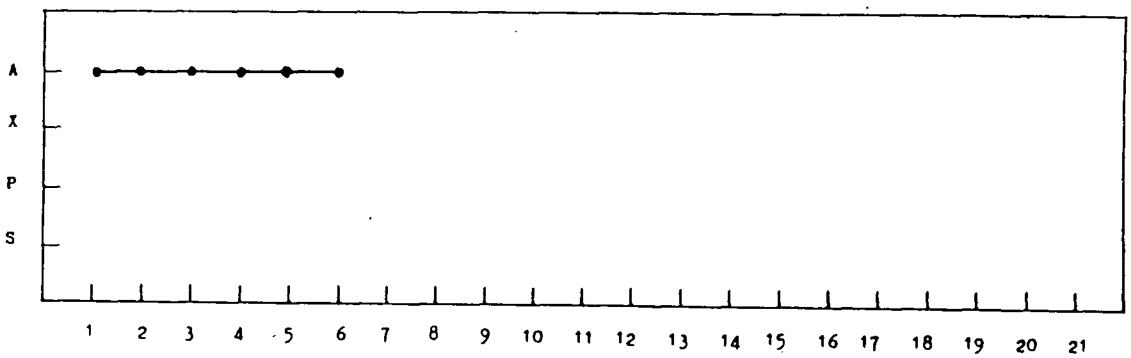
P = Positional

S = Subtractive

Subject 2

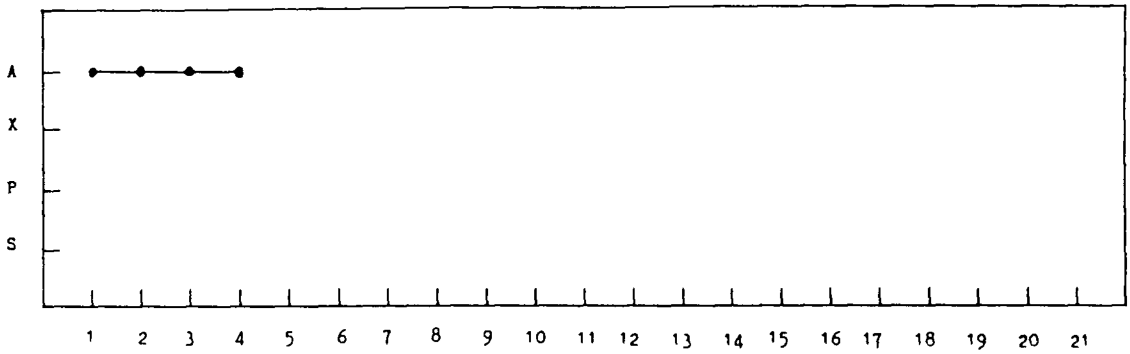


Manipulation 1 -Rectangle

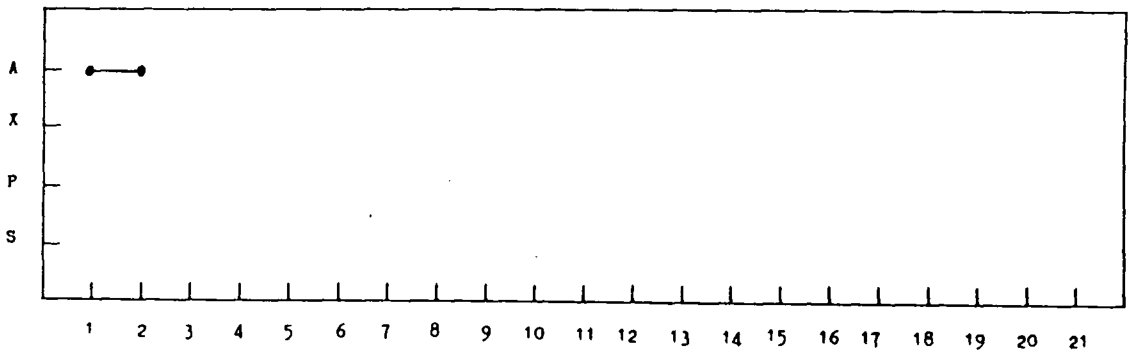


Manipulation 2 - Circle

Subject 3

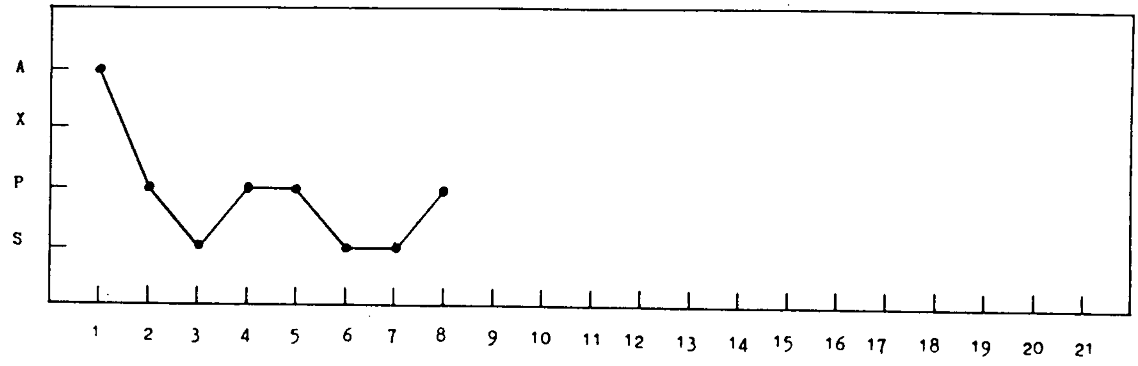


Manipulation 1 - Rectangle

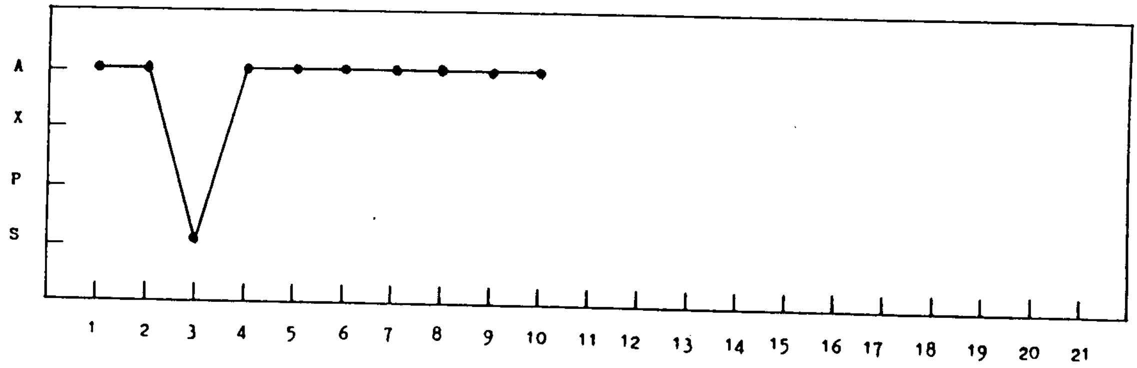


Manipulation 2 - Circle

Subject 4

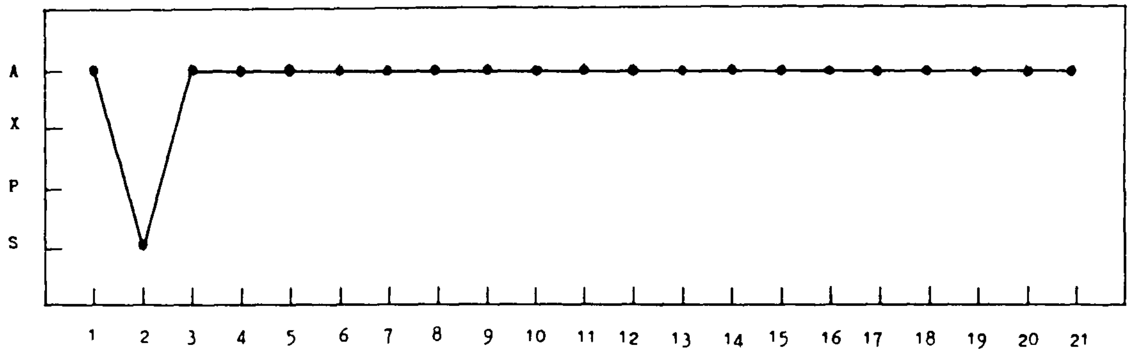


Manipulation 1 - Rectangle

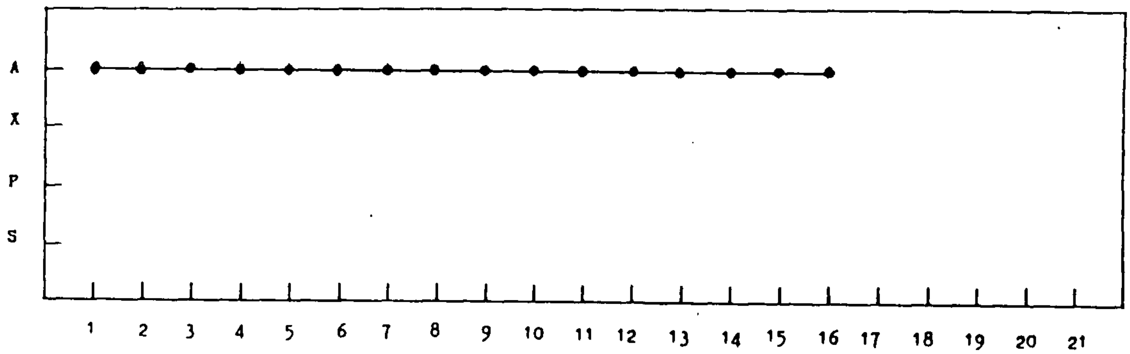


Manipulation 2 - Circle

Subject 5

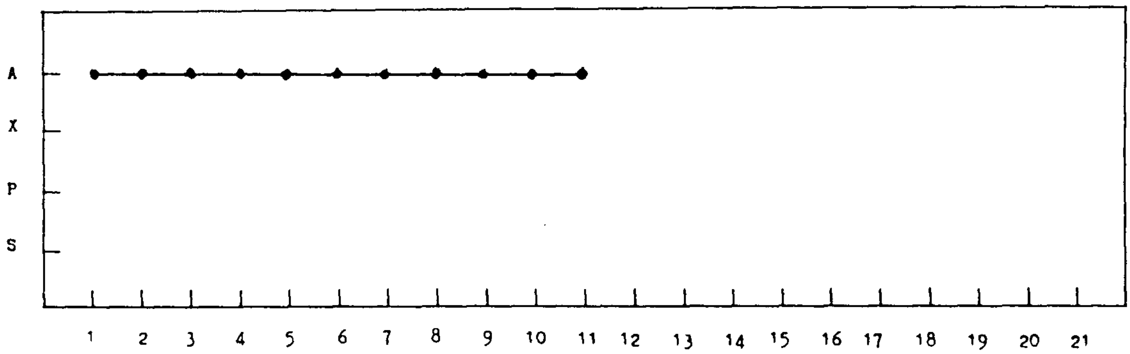


Manipulation 1 - Rectangle

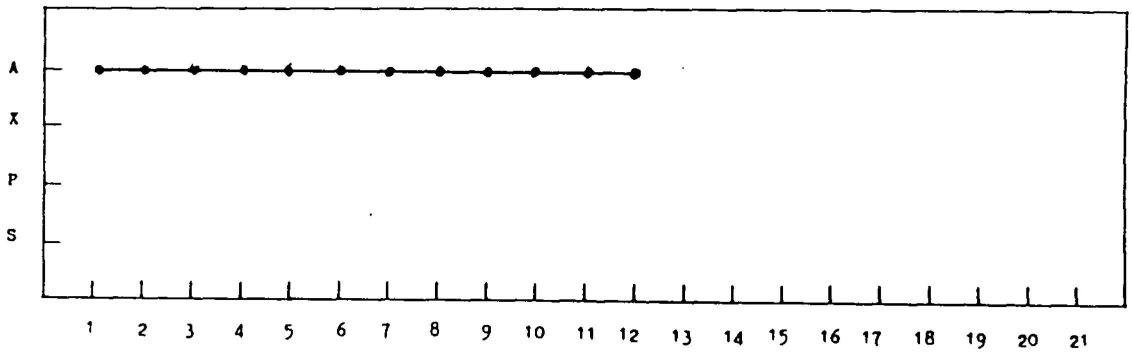


Manipulation 2 - Circle

Subject 6

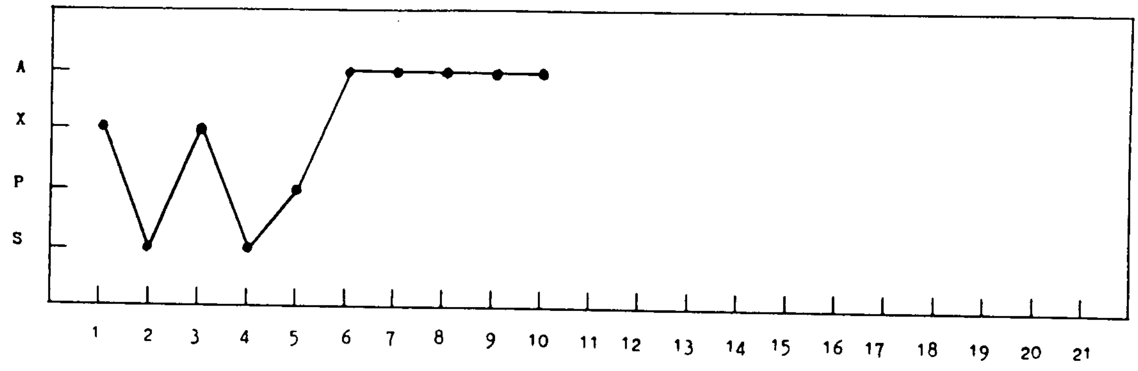


Manipulation 1 - Rectangle

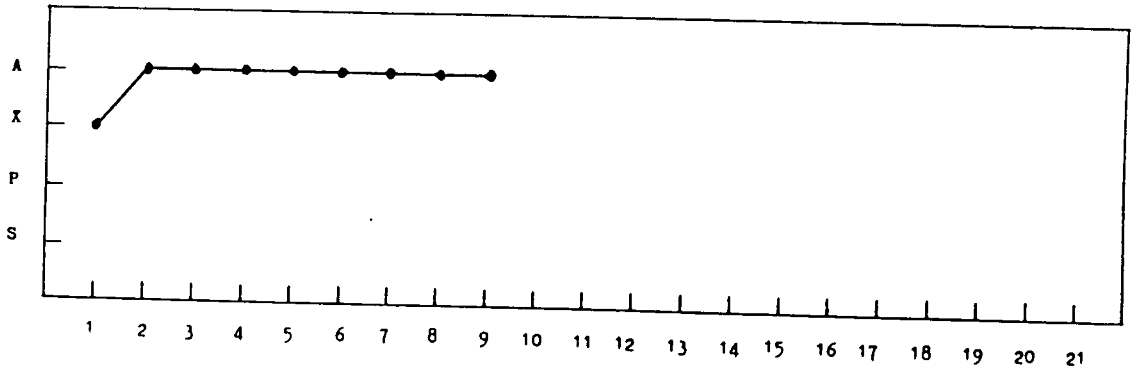


Manipulation 2 - Circle

Subject 7

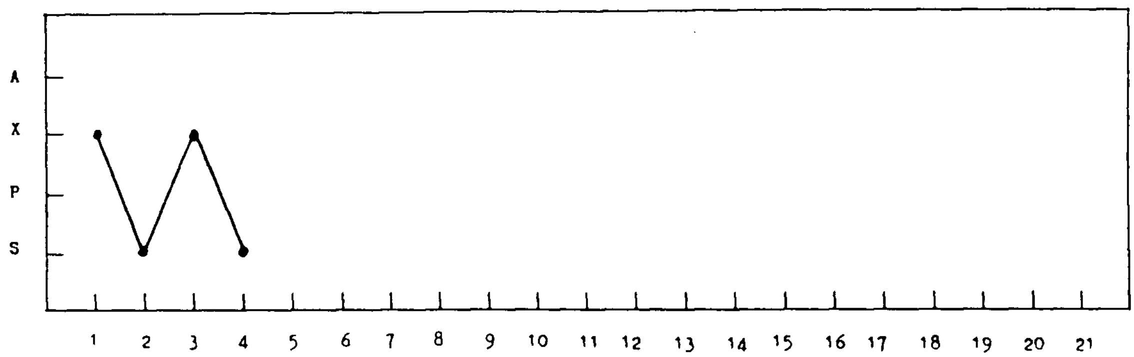


Manipulation 1 - Rectangle

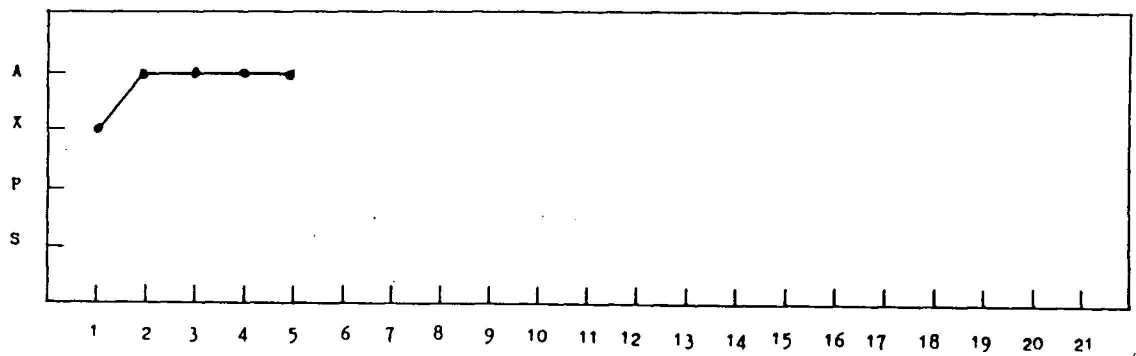


Manipulation 2 - Circle

Subject 8

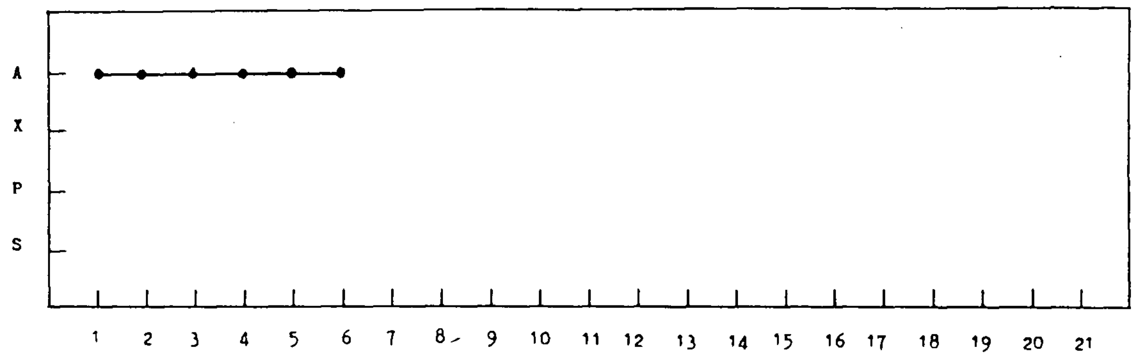


Manipulation 1 - Rectangle

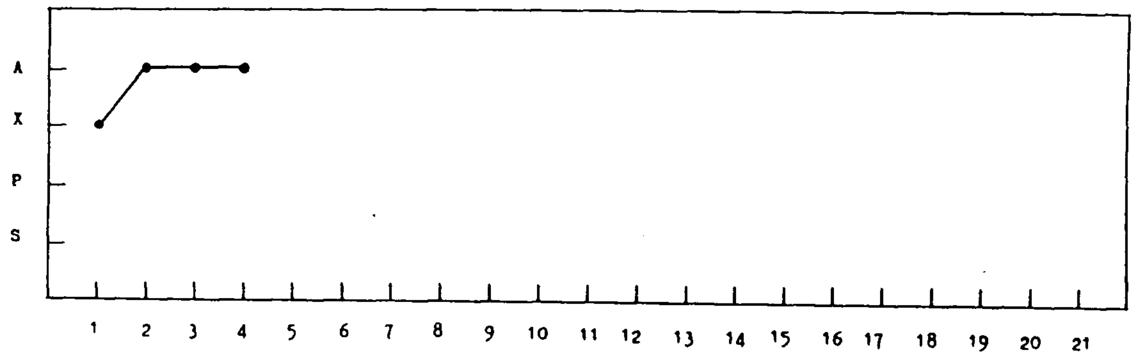


Manipulation 2 - Circle

Subject 9

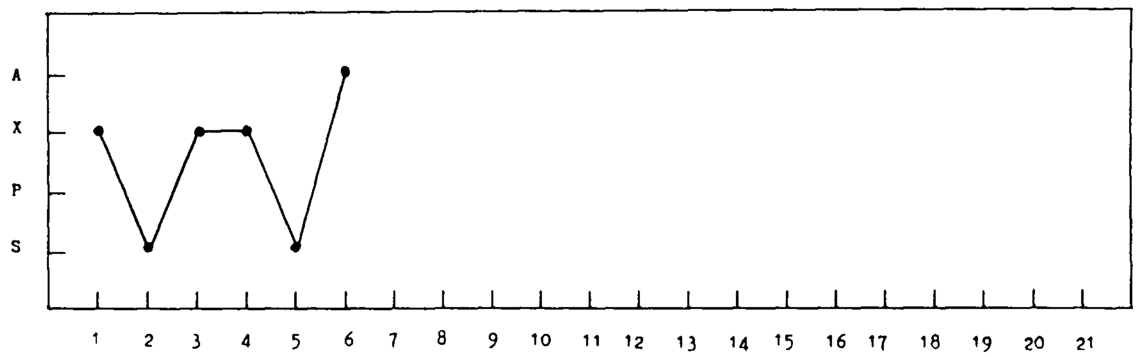


Manipulation 1 - Rectangle

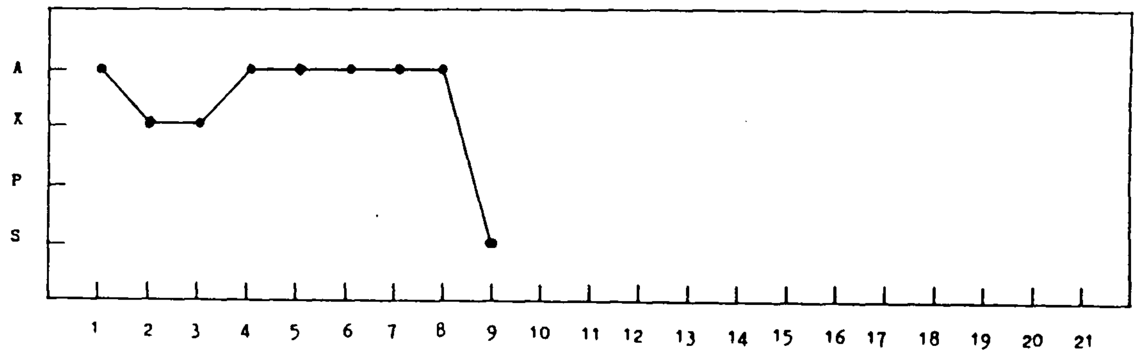


Manipulation 2 - Circle

Subject 10

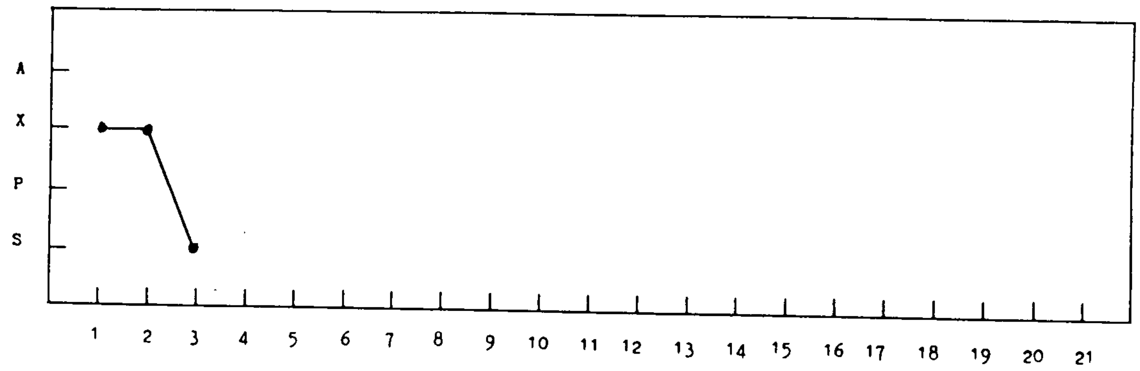


Manipulation 1 - Rectangle

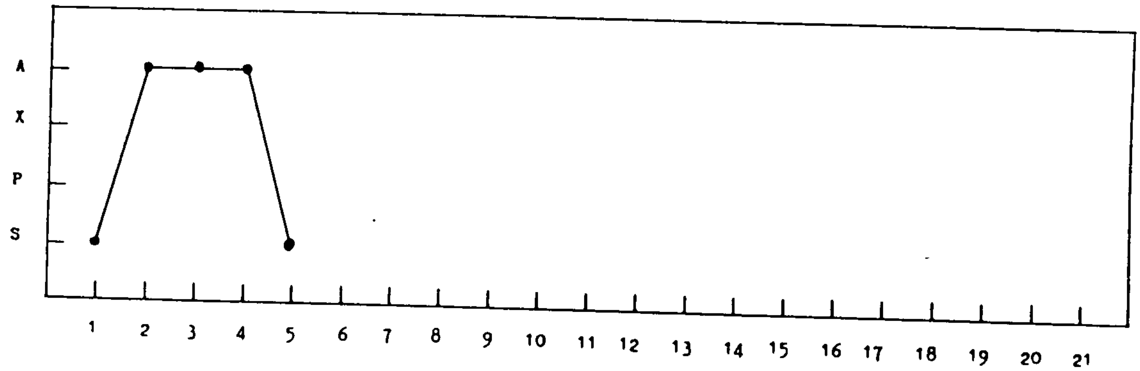


Manipulation 2 - Circle

Subject 11

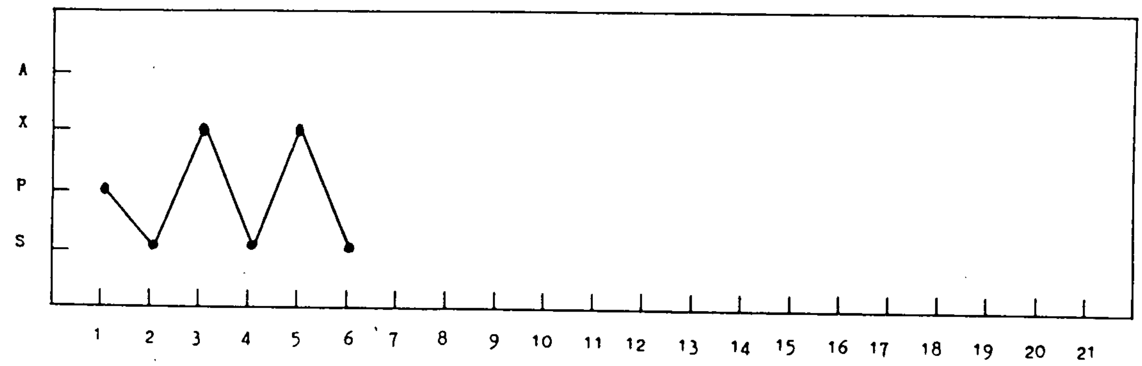


Manipulation 1 - Rectangle

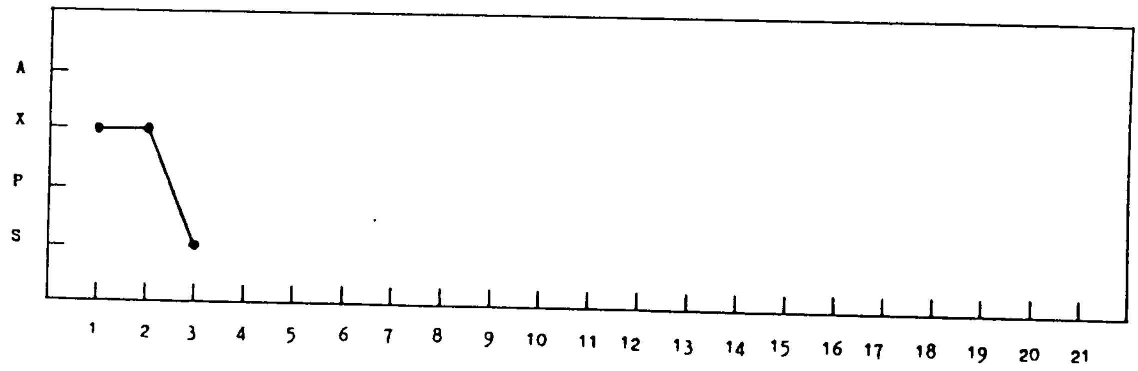


Manipulation 2 - Circle

Subject 12



Manipulation 1 - Rectangle



Manipulation 2 - Circle

APPENDIX P

Identfication of Representational Images

Appendix

Subject Identification of Representational Images

Subject	Manipulation	Operation	Comment
Subject 1	1	5	Make one equals one.
	2	5	That looks like a person.
Subject 2	1	1	Cause then we could make a battery.
		2	Cause then you got an airplane.
		5	Cause then you got a house. I mean a fire-place.
	2	3	Then it's an upside-down person except no feet.
Subject 4	1	3	Like a box opening.
		5	Flip it over so it's like a staircase.
	2	4	Looks like the Expo sign.
		10	Looks like two giraffe heads, or you could change it into a spaceship.

Subject 5	2	11	Four circles around the hands.
		14	I wish we had ovals so we could put a skate-board under there.
		15	Some buttons there.
		16	We could put a sun up there.
Subject 10	1	3	It's like a camera.
	2	4	We can do a little face.

APPENDIX Q

Verbal Responses in the Recognition Sequence

Appendix

Verbal Responses of Subjects to Questions Concerning the Recognition of a Given Shape

Subject	T	Q*	Response
Subject 1	1	1	By looking at the way it's standing, and the shape.
		4	I just looked at it. I thought it was supposed to be taller because of those two. They might have been covering it up. I just guessed because sometimes my guesses are right.
	2	1	I can look at the shapes because some are bigger than other ones and some are skinnier.
		2	No. I"ll try to remember it in my head.
	3	1	I'm going to try and find the one with pink, like just with the pink ones on it.
		2	I'm still trying to look for it, but there's too much, too many rectangles in it.
	4	1	No./ Just keep on looking.
		2	No./ Just keep on looking. That's the best way.
		3	Just looking at the shapes. Some of them are

wide like that and others are thin like that.

5 1 It's always as I said, just keep on looking. (How is that?) I don't know.

2 No.

3 No.

6 1 ...I'm going to try and remember it and then I'll probably be able to find it/ I'll try and remember what it looked like by itself.

2 Just keep on looking.

3 Still the same way.

4 I think I tried everywhere else, so I picked that one.

7 1 No, not really./ Just keep on looking. (How will you look?) Try and find it.

2 No.

4 They all look the same but this one has a little edge right there, and this one I don't think does, because I can't really see it because it's covered from this one.

8 4 I don't know./ It just wasn't hidden very good, I guess.

9 1 ...Just keep on looking. (How?) Like trying to remember from when it was by itself.

4 I said that people wouldn't look on the

bottom so I thought it would be on the bottom./ I started at the top, then the middle and then the bottom. (Always use this way?) No. Before I used the middle and the bottom.

10 4 I don't know. That's another one I don't know./ I guess I just remembered it from before. (Did you look the same way?) Yes. From the top, the middle and the bottom. This time I looked from the bottom first... The top, I mean.

11 1 ...Not really, just trying to find it.

4 .....I looked./ Carefully./ (What is carefully?) Like I didn't want to pick any one. I just wanted to look all over first, then I would pick the one I wanted to pick and that would probably be right./ I just try to look at it, like I look there, there, and there, then I look over that way and then I look that way, then I look every way I can, like the first time I looked. I don't know how I got it.

12 1 Just keep on looking till it gets less and less.

4 It's kind of hard but I just found it. I don't

know how, though./ I told myself, look that way, that way, and that way...Then I looked all the ways that I could. That way, that way, every way I could. (Was that the same as always?) Yes, but sometimes I just do what I want, like I just guess.

Subject 2 1 1 Remembering the size.

2 Looking very carefully./ Looking very closely.

3 No.

2 1 Looking.

2 No.

3 1 Looking.

4 1 Always the same. Looking.

4 I just looked...And then I remembered the size and then I thinked and then I said, That's it.

5 1 Remember where I was going to hide it.

2 Looking.

6 1 No.

2 No.

7 1 Looking. Looking just carefully. (How?) Open you eyes up and don't fall asleep.

4 I remembered the lines on the top were sort

of long and I remembered the size and I knew it was a real circle, and I just knew it.

8 1 No.

4 I remembered you had the side hanging down like that. The little lines that make the circle, you had 4, one at the top and one at the bottom and then the edges.

9 1 No.

2 No. Looking.

10 4 I don't know. Because I knew that this side was fatter than that side.

11 1 Looking and not sleeping.

12 4 Well, the big it was, I knew it couldn't be a small one, and I knew it couldn't be a very big one. I knew it was just a medium. I start at the edges and I look at every line, and if I find it, I find it.

Subject 3 1 1 No, I don't think so.

2 I'm looking for the certain shape, the way it's sitting. I can't find it.

4 I don't know. I was just looking at the lines and seeing which way it went, but I thought it had been about that size, but I had forgotten.

2 1 Yes. I'm going to look at the size and shape and things like that.

4 I looked for it really hard.

3 4 It's kind of hard. It's hard to see them with all the other colors behind them./ I don't know./ I just looked at the shapes.

4 1 Same way as most times. As the other times. (How is that?) I forgot.

4 I don't know./ I started looking from up here [right top] then I came around here, then I came back up and then I came down [right top to left, down, back across]. (Do you always use this way?) No. I use different ways each time.

5 1 I'm going to look at them one by one. Starting up here, and then down and there and there and then go in the middle.

2 I'm looking. I'm looking.

3 No.

4 There were'nt very many left. The less there are the easier it gets. That's why I take so long.

6 1 Looking at the shape. I don't know./ I don't know.

		4	No real way. I was going to come down kind of squishy squashy [top right to left, and back and forth]
	7	1	The same. The shape and size and that. Looking squishy squashy again.
		2	No.
		4	It's kind of like an eyeball with a pupil in the circle.
	8	1	.....I don't know.
		4	I don't know. I just did.
	9	4	I don't know./ I was about to guess that one but I said no because it was a little jaggeder around the edges.
	10	4	Because it looked the same./ I came across here and I came down [right top, along, then diagonal]. (Do you always use this way?) Nope. I don't think so. Except when I went swirls, sort of the same.
	11	1	No.
		2	No.
	12	4	I don't know. / I started up there and I came down, across and down [right to left]. (Is that the way you usually use?) Yes.
Subject 4	1	1	No.

2 No.

4 Well, it's kind of the fat lines and I remembered it.

2 1 I start looking all over the place and then thinking before I choose.

3 1 No, because there is so much color.

4 1 Well, probably I'll compare. I'll see which ones are the same and the best one of all of them that I remember, I'll pick.

2 I'll probably just keep on going the way I am.....like, just keep on guessing.

5 1 Not really.

2 Not really. Look closely.

6 1 No, not really.

7 1 Probably keep on moving my head around, like this, and then when I first see it, I keep on going around and around...I go like this, or this [moves head in apparently random fashion].

8 1 No. Keep on guessing probably.

9 4 Well, it's a little bit hard, but I just guessed.

12 1 No. I'll just say, "wiggly, wiggly." That will probably get it.

Subject 5 1 1 Look for the rectangle that's about this big, sitting this way up and...see if I can find it.

2 See if there are any smaller ones. It's a little smaller than some of these bigger ones up there, the ones that I picked.

3 That one is my only choice because there's no more that are sitting the right way up, except for that one which I already picked.

4 Can you show me that again. I'll look right there [at the shape] and you...[image 10 goes on]...Oh, I thought it was bigger than that!

2 1 I'm going to look around the corners because that's where I hide them a lot and I sometimes think that if I tell somebody where I hide them, they will use my idea.

3 1 I'm going to look at all the pink rectangles standing straight up.

4 1 Just look around.

2 I'm getting some ideas but they're not straight enough./ I'm looking around the side because it was kind of bumpy, but some of these are a little bumpy. They go down and come up again.

5 1 ...Looking for the bumpy one that kind of has a crown at the top, starting in the middle going out.

6 4 I just looked around and I saw the one that had the crown.

7 1 It's kind of weird because there's all sorts of squished circles. It seems like there's only going to be one circle that's going to be a circle. The others will be all squished.

2 No. It's just kind of hard./ Just looking around.

8 4 I just started looking around and I saw that one that looked like it but it was too much of an oval, and I just came up this way and I saw it.

9 4 I just looked around. I saw a perfectly round circle about that size and I pointed to it. [starts in center, moves out in a spiral way].

10 1 No. I don't think so.

4 I just saw the whole screen at the same time, and I just saw it and pointed to it.

11 1 I start in the middle and go out in a spiral.

2 I had two choices. I looked at the first one

and then I got the second one./ I looked spiral until I got up to the end and then I just went back and forth [bottom, left to right, and then back]. And then I saw this person with the head and the face and there's the arm, and the bean is where the legs would be.

12 4 Well, there were two that looked kind of alike. Instead of doing the spiral, I just looked and I saw them. I chose one. It was wrong. I got the other one.

Subject 6 1 1 Look for one that's up like this with it smaller there./ Standing up straight.

2 No.

4 I thought it was bigger.

2 1 Remember it was that big. Before I thought it was that big [using finger as guide to size]./ Look where they're hidden. Looking where there's lots more rectangles.

4 I don't know.

3 1 No./ I'm going to look at the ones that are not filled up. Just the ones that have the pink outline.

4 I don't know. It looked the most like it.

4 1 No./No. There was something, but I don't think it was that. It just had little jaggedier edges and it was that long.

4 It had two jagged edges and a flat bottom. (This one also has that?) This one was smaller and chubbier.

5 1 No./ I'm just going to start looking.

4 ...I thought it was this one, but I pointed to this one. Because it's a different size./ I start looking where there's most of them.

6 4 I looked down through here, some of them are bent the other way. Most of them are. [left hand top, straight down, along bottom, then back to right].

7 4 Most of the other ones were crooked, sort of, and that's bigger and that one's smaller. I looked for the ones that had this little straight ends and then a crooked body.

8 4 I looked for the ones that were'nt crooked.

9 4 ...../ I just look where my eyes are.

10 4 It had a flat top and was sort of curved in there and had stairs coming down. (What about that one?) It wasn't curved enough in

			there.
	11	1	No. I'm just going to look for the same thing as last time. The stairs coming down and the curve up there.
		4	I saw it before you put the cover over.
	12	1	No. (Starting in any particular place?) No.
		4	I don't know.
Subject 7	1	1	I'm going to look at every rectangle.
		4	I remembered the size and the shape, and how it was sitting and how long the top was and how long the sides were and I looked really hard./ I sort of looked at the lines, the outlines of everything.
	2	1	No. I think I'm going to start at the bottom again.
		4	I looked through the bottom and then I went across, across, and then I found that one. I looked at it and looked at it. I wasn't sure if it was the one, so I looked around the screen quickly to see if there were any others that looked a little more like it, and that one looked like it. [bottom right, across, then work way back up]. (Is that always the way you use?). No. Sometimes I

look quickly around and see if it's there, and then I start in the middle sometimes, and then I start on the edges and the corners.

3 4 I looked around here and I saw it right off the bat. I looked at everything pink. All the square outlines in pink. [bottom, then straight up].

4 1 No./ I'm probably going to start from the left side and look across.

4 I looked across and before you covered it up, I had started looking and I noticed that one and it looks pretty much the same, cause its basically the only one in there that the three sides are the same.

5 1 Up and down that way. (Is that a different way?) Yes. But I use a different way most of the time.

4 I started by that way [sideways] and then up and down.

6 1 I'm not sure. I haven't decided yet. I'm probably going to look in all different directions, which isn't probably a good idea.

2 I'm looking across.

3 I'm having troubles deciding whether it is

any of the ones sitting up. When everything turns to just pink outlines, then I'll be able to know. I'm looking for the one that if you turn it any direction with the point up it'll be the same.

7 1 I don't know./ No.

2 No.

4 It's perfectly round. I looked around and after twice I didn't get it, I looked around and when some erased I noticed that one.

8 4 I looked and I just found it. My eyes just went across the screen and I found it. My eyes just looked at the whole screen.

9 1 I'm just scattering all over the place. I'm probably just going to scatter and then if I can't find it, I will go up and down the screen.

4 Scattered.

10 4 I scattered again and I looked for the wide end and then the thin end.

11 1 Across. (Are you using a pattern?) Yes. Because it looks harder. I'm looking from the left side to the right side and then from the

right side to the left side. [starting at the bottom].

12 4 I scattered again. I went like this. [indicates a pattern]. (So you used a pattern?) Yes. It was too complicated to look scattered, cause there was so much orange in it and everything, that it sort of hides the lines.

Subject 8 1 1 Well, I have an idea of the length and the width, so, I'm going to start from this side and work one way through [left top, to bottom].

2 I'm going to start from the center.

3 Wild guesses.

4 Well, after all that you just take a wild guess.

2 4 Well, I concentrated a lot. I knew it was something like this, like it was about this size, and when you showed me just the rectangle itself, I concentrated and I looked at the shape more carefully, and the size. (same way of looking?). No. I just went all over the place.

3 1 Well, I just look for the ones with the pink outlines first. I'm looking just whatever way.

2 Now I'm just going like that [horizontally].

3 No.

4 Well, I looked at the other ones and I found that the other ones I said were too long or too skinny and that one was a little fatter.

4 1 No. Just go sideways, back and forth.

2 No.

3 I can't even take a wild guess.

5 1 Sideways. [back and forth from bottom].

4 Well, I was doing the same thing. I was going sideways and I thought that this was kind of similar. The shape was bigger so I decided to look for something smaller.

6 1 Well, first of all, when you just showed the one triangle, I concentrated not on the outside pink, but the shape inside. How big it was and stuff.

2 Same way.

3 No. I'm just looking sideways.

4 Well, like I said, after I started looking sideways I started looking for ones that are going the way it was, like, sitting that way. I looked inside all of them instead of the around part.

7 1 Well, just the size. Not too small, not too big.

4 First of all I noticed that the first ones I pointed to were bigger and so I started to look for little smaller. It didn't seem to be that big when you first showed it to me.

8 4 Well, I just really remembered. I concentrated on the size and shape when you showed me first.

9 1 From the pink circles that have a line around them.

4 Well I also concentrated on the size and shape and the pink line outside. I looked at all the circles with pink lines outside.

10 4 The size and the shape. First of all I picked this, but then I found out it was a little too wide and then this looked about the right shape. [bottom, sideways back and forth].

11 4 First of all I started here because you said it might be in a different spot, and then I did that as a clue. It wasn't there and so I just started going sideways, back and forth.

12 4 I concentrated on the shape and did this again [sideways]. You did three different ways to hide it and I kind of got the idea

what the shape was and how to find it.

Subject 9 1 1 Well, not really. Just by looking.

2 I'm just going to try and find the same size rectangle.

2 1 ...I just looked to see how the size of the rectangle is, and I looked in areas that were overlapping to see if they were there.

4 I don't know. I just looked around./ I sometimes go horizontally and sometimes vertically.

3 1 No. Not really. I'm just looking for the outline. I started horizontally.

4 I just looked all over the place for it.

4 1 ......I don't know. I guess I'm trying to find the same length of the sides.

4 ....I don't really know. I just looked for the angle of it...I just looked for the shape.

5 1 Try to sort out the different ones.

4 ....I just tried to see if there were any triangles that looked like that and then to see if they were the same size.

6 1 .....No. Well, I was looking horizontally trying to see it.

4 I looked horizontally because some of the

triangles were fitting this way. I started looking from the middle.

7 1 I'm looking in some things.

4 I just went all over the place.

8 4 I just looked around and that one seemed a lot rounder than the other ones, cause the other ones kind of look oval.

9 1 Just looking all over.

4 I just looked around for it and I came across it.

10 1 No. I'm just looking around.

4 Just kind of jumping around.

11 1 No.

2 Yes. I'm going vertically.

4 I looked vertically. When some of the little shapes inside disappear they look like they are going down this way. So, I just went that way.

12 1 No.

Subject 10 1 1 [Subject has measured shape with fingers]. Well, I know that it's going to be up lengthwise, the way it was in the picture, so first I'll corner out all the rectangles like that, then I know, that's about the really big thing I know about it.

2 No.

4 That's quite odd. It looks like a square with all those other rectangles, cause all those other rectangles, some of them are stretched like that and that and they are bigger and it makes the one in the corner look smaller.

2 1 Well, now I know that it will probably stand out a bit because it's not long and thin, and lots of those are long and thin, so I know it's not long and thin. That's about it.

4 I just looked really hard...It did stand out a bit./ I kind of blocked the long ones like that and that out of my mind, and I blocked out the more square looking shapes, like that, and then I only had a couple left, a couple of rectangles. And then I knew that it was in that size, so then I only had that and that, and that, and that. Then I kind of choose between them.

3 1 Well I know that it's pinkish, so I can look at all the ones that are pinkish and again I know that it isn't a long rectangle or very similar to a square rectangle, if there are

squares./ I just start anywhere and then look.

4 I did it by knowing that it was a rectangle, and I knew that it was around that size. It was kind of similar to a square, but it was stretched out a bit, and I kind of blocked out all the long ones like that that I knew. And the really tiny ones that I knew it wouldn't be and the very square like that and that, and all the rectangles that had the longest lines like that instead of like that, and then I came out with only, again, very few. About those two, really. I kind of knew it was that.

4 1 I knew that it was close to an equilateral. It isn't. And so I blocked out all the ones that didn't look very similar to an equilateral and then, that's about all I've done so far.

[during sub-tasks] Another thing I knew is that the triangle, the ridges look the same. The ridges are not different. I think the computer does that, and I can kind of notice what kind of length it is, if it is the same length or different.

4 I think I kept on looking at that triangle, when I looked at it I saw a triangle kind of starting at the longest line and it went out like that and didn't look like an equilateral. It looked like that line was longer because it was there, longer.

5 1 I knew that it was close to an equilateral, like it isn't, again. I knew that I could block out the other shapes that were'nt pretty much like that, and then I also knew that the two sides coming down like that were the same rough edges and the bottom one was pretty much straight./ I'm looking anywhere and then when I see a certain triangle I just close in on it and study it and if that wasn't it I would go to another area.

4 I looked around and that one kind of stood out.

6 1 The color throws me off a bit. I'll use the same way.

4 I looked and I tried to get the edges exactly the same. I knew that the lines were pretty much congruent.

7 4 The others are all pretty much wiggly and it looked really equal on its round shape./ I

started looking everywhere, really, and then I saw that one and it stood out cause it was so equal.

8 4 I just looked around and that one looked very equal./ I generally looked close-up and then maybe I pick out a few, like that one looked pretty good, and that one, and that one. Then I kind of looked at them more closely and then, they were'nt equal.

9 4 I was kind of torn in between that one too, because that one looked pretty even. But that one was more round there./ I looked at it and I kind of blocked out of my mind things like that, and the background which I knew defin .tely were not the shape.

10 1 There are a lot of fake moustaches that look very similar./ Actually I think I'll start up at the top and go like that and look at them closer. Go left, right, left, right, like I'm reading a book.

4 I just looked across and I knew that it was kind of rounded and I knew that there were two lines that were basically the same length and they were straight instead of edges, and

that's about all I went by. (Because it was harder you used a regular search pattern. Why?) Because it's a lot harder when you look at it generally. You can see a lot generally, like that, and that, that, and that, but there is a lot more that look very similar to it, than say the rectangle, or let's say the circles, because it's an actual definite shape. That's more built in my head. Also, through the whole school I've been taught to recognize circles and triangles and stuff.

11 4 It's a lot harder. I used the same way I did last time.

12 1 I'm doing it the same way, because again, it's really hard. Using the same search pattern [going across].

Subject 11 1 1 First of all, I'll try to look for the height and width of it.

4 It's sitting in the same position as you said, and it looks the same. It looks a bit smaller with all the other ones./ I was just going to go across looking for it [top left & across].

2 1 It's more difficult than the other one.

Because all those lines are in there and all the squares are overlapping./ Just do what I did before.

4 Well I was looking from here, and then the lines started disappearing and I went down here and I just saw that.

3 4 It's confusing with all the different colors and I just looked for the pink boxes and I just worked my way around here and I saw it. [top, along, down right edge, along bottom]. (Do you use that way often?) No. Like I just did that for this one, cause I don't know why. Also there's a little pink box in there I looked at and saw. I was just looking along and I saw that. It looked smaller, like I was just looking at this one and I saw that box.

4 1 I'm going to try and find the straight lines and then look for things going up.

2 Not really.

3 I just don't think that it's there.

4 In all the triangles, I thought it was larger than that. I thought it was larger.

5 1 As soon as it goes to the next screen, I'd look where it was before. Then I started

looking in the corner again. (Is the corner usually where you start?) Yes.

4 I was just looking and my eyes went up as they went up and I saw that one.

6 1 Not any different than the other times.

4 I was going on the edges and I came up and I turned and I saw it.

7 1 Try to find a circle that's not lop-sided.

4 I found there's been a couple hidden in there.

8 4 I've found there's been shapes hidden in here and here and I just looked up in that one cause it's kind of in from the corner a bit, so I looked up in that corner.

9 4 I don't know. I looked up there and then I looked down there and then I looked there. And it's also in from the corner again. (Do you use a pattern?) Not really. I don't know. I just look.

10 4 I just did the triangle again. I looked down there and over there [top middle to left bottom, to right bottom].

11 1 No.

4 I just moved across and down and just came up. That looks like a little man there. Two little

legs, arm, and head./ I went across, then around, then up.

12 1 This one's not in the corners.

4 That's another thing I've found, the corners. You look near the corners./ I kind of skimmed the corners and then I looked across here, across the center and then I looked at the corners again.

Subject 12 1 1 I remember the way it's sitting and I remember how tall it was and how wide it was, and if I see it again I can remember what it looks like.

2 ......No.

3 No. I'm just looking at the height and the way it was standing, and I thought that if I see it again I would recognize it.

4 I thought it was another one but it went off the screen. So then I picked another one.

2 1 Probably the same way./ I picked some and then the screen would erase some. The one I picked would erase. Then I would pick another one that looked the same./ I start from the corners. (Do you always do that?) No. Just sometimes. I started from the middle last time.

4 I don't know./ I started from this corner. I went this way[right] and then that way [left] and then just the bit in the middle.

3 1 By the color of the outside and how tall it is. I'm going to go around the outside and then into the middle.

4 ...I went on the outside ones then I went around on these ones, and then I just looked in the middle. I went around again, cause I couldn't find it and then I looked closely and then I could see it cause some of them were blending with the other colors and you couldn't see them.

4 1 I'm going to look for the shape and the height and this time I'm going to go around the outside again. It's easier to find that way. Easier for me.

2 I'm going around the outside then I'm going in the middle.

4 I went around the outside twice and then in to the middle once.

5 1 I'm going to start from the middle this time.

4 I don't know. I was just looking at this one and I started going that way and then I just

saw that one.

6 1 I'm going to go across, first line, then second line [top left, like reading a book].

2 No. Same way.

3 Same way. I'm going to start coming from the middle now.

4 ...This last one I went from the middle and I went around and looked around here.

7 1 I might go in order again, like from the top then the next one and next one. It would be easier.

4 This one looks not as crooked as these ones.

8 4 I found it again cause it looks like it's the roundest one there and all the other ones are crooked and things like that. I just looked at this corner, I don't know why. I just started at this corner first. I can tell cause it's so perfect and these other ones look like eggs.

9 4 I don't know. I started looking when the screen moved down. I sort of followed the screen and then I just sort of looked on the way down and I saw that.

10 1 I was going to start from this corner and then

I'm going to go around and then go up [lower right - start].

4 This one, this end is skinny and that end is fatter and I remembered that and I just thought that was that because it was the third one I looked at.

11 1 I'm going to start from the bottom and go up [bottom right]. I think it's easier that way when there's a lot.

2 Same way. Going across.

4 I could tell by the shape, the way each end was, cause these are really fat and everything. This one's sort of skinny and the ends are different.

12 1 I'm going to start from the corner and I'm going to look around and then go this way and this way. [upper left, down, then across and up].

2 Same way.

4 I looked across. Then I went around the outside. I was looking for the end shape too, like that.

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* Questions 1 (After sub-task 10) Do you have any ideas about

how you are going to find the shape?

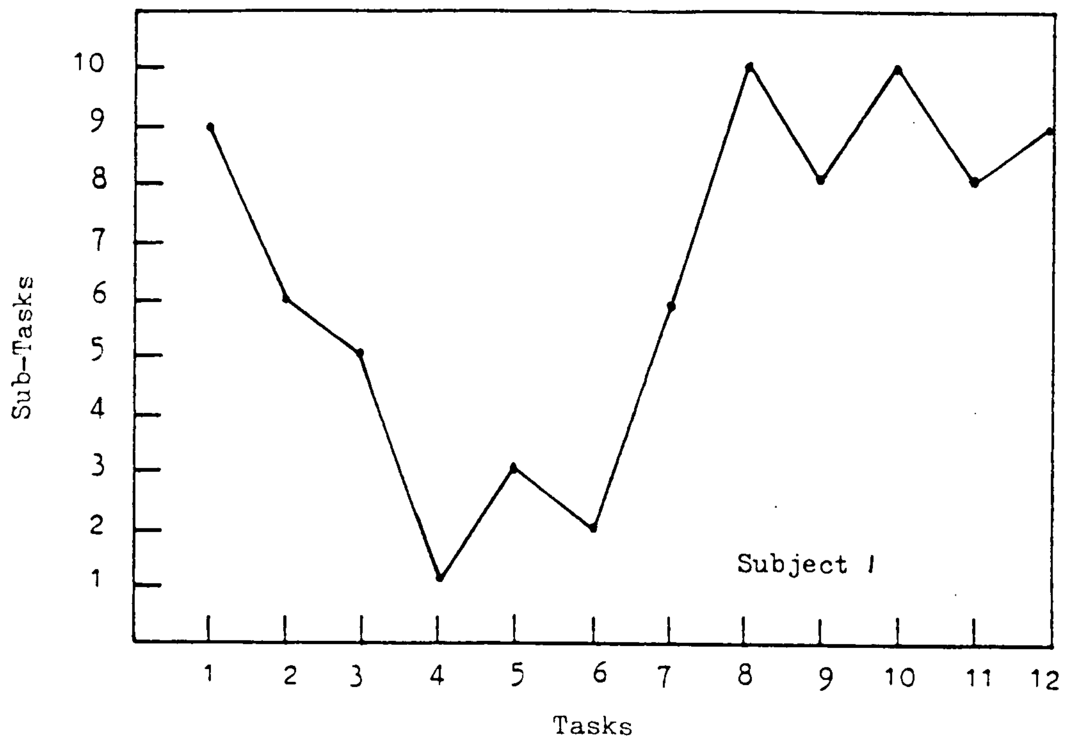
2 (After sub-task 7) Repeat Question 1.

3 (After sub-task 4) Repeat Question 1.

4 (After subject has located the shape) How did you find it?

APPENDIX R

Ability to Recognize Shape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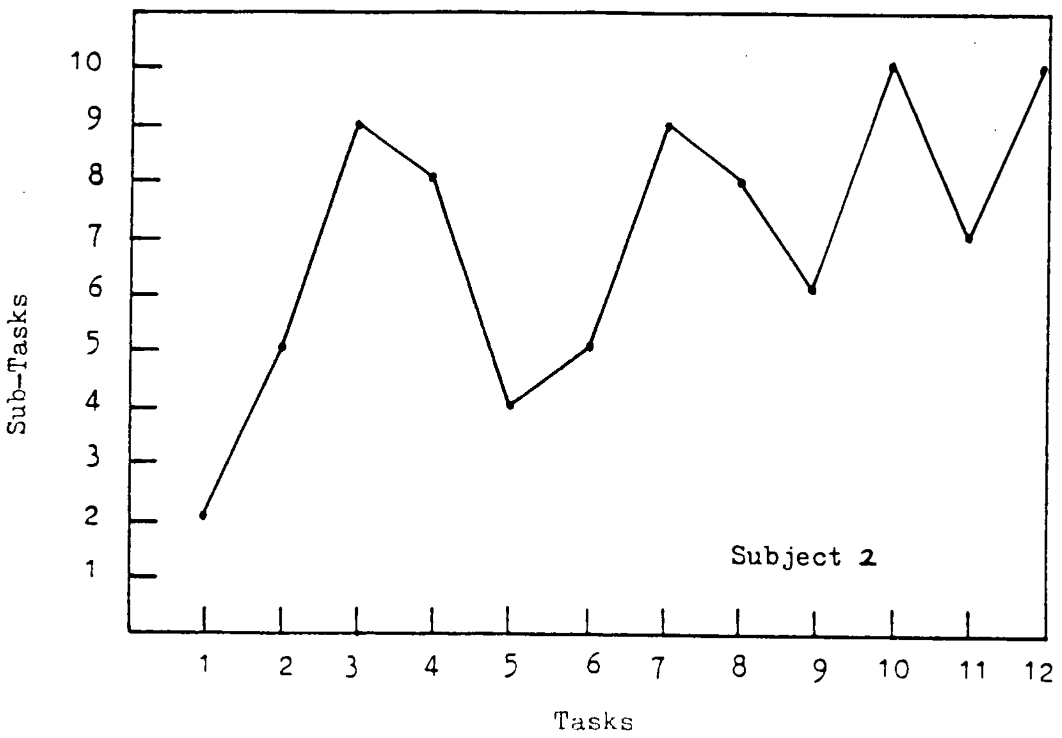
10
11
12
Tasks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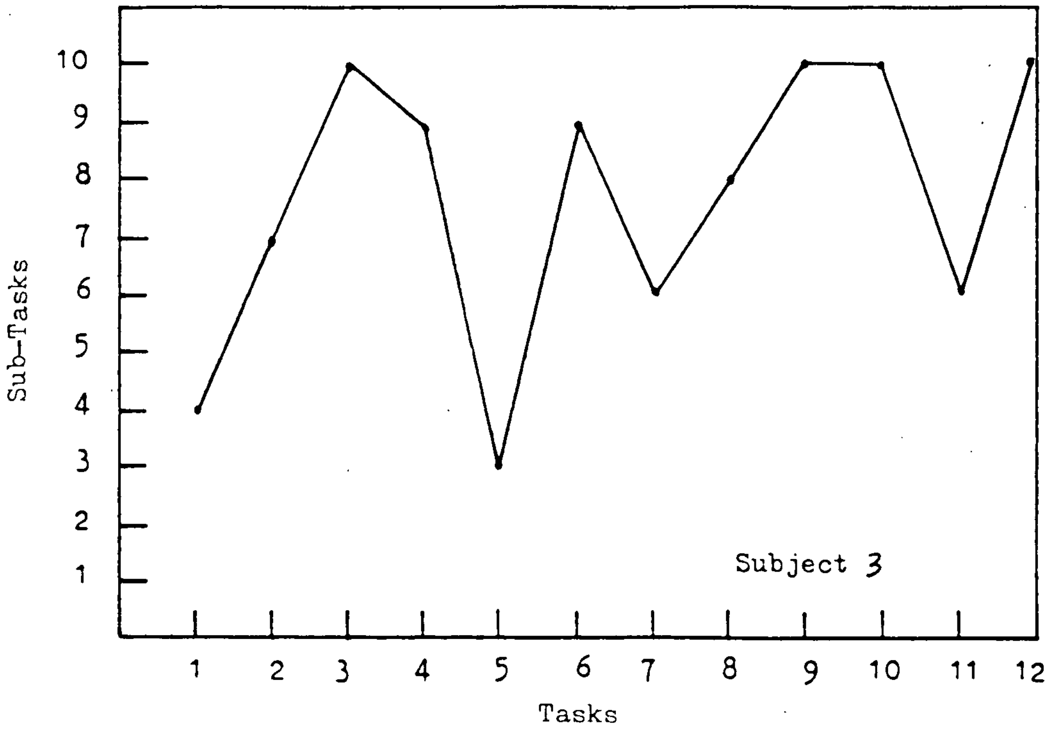
12
Tasks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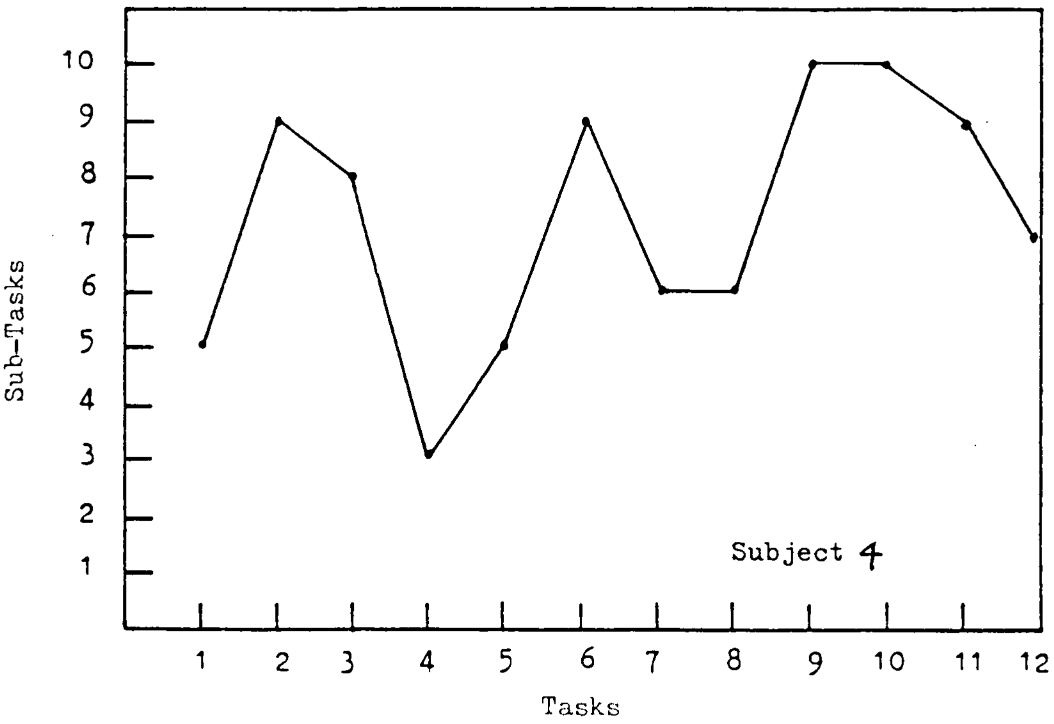
11
12
Tasks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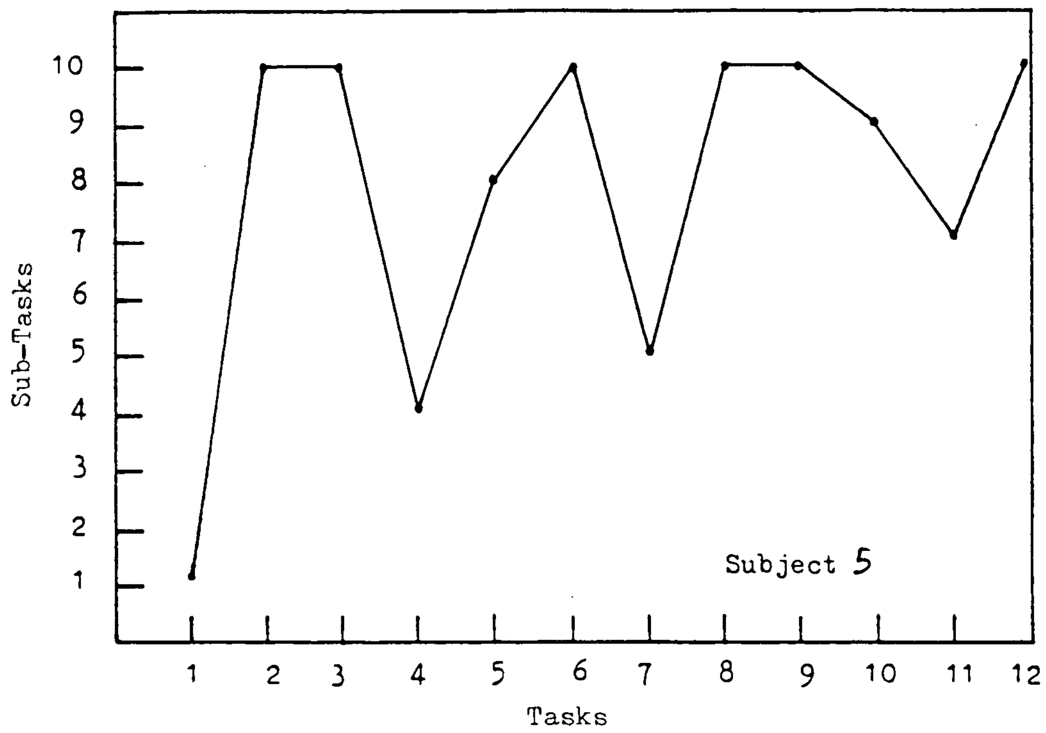
11
12
Tasks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5
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3
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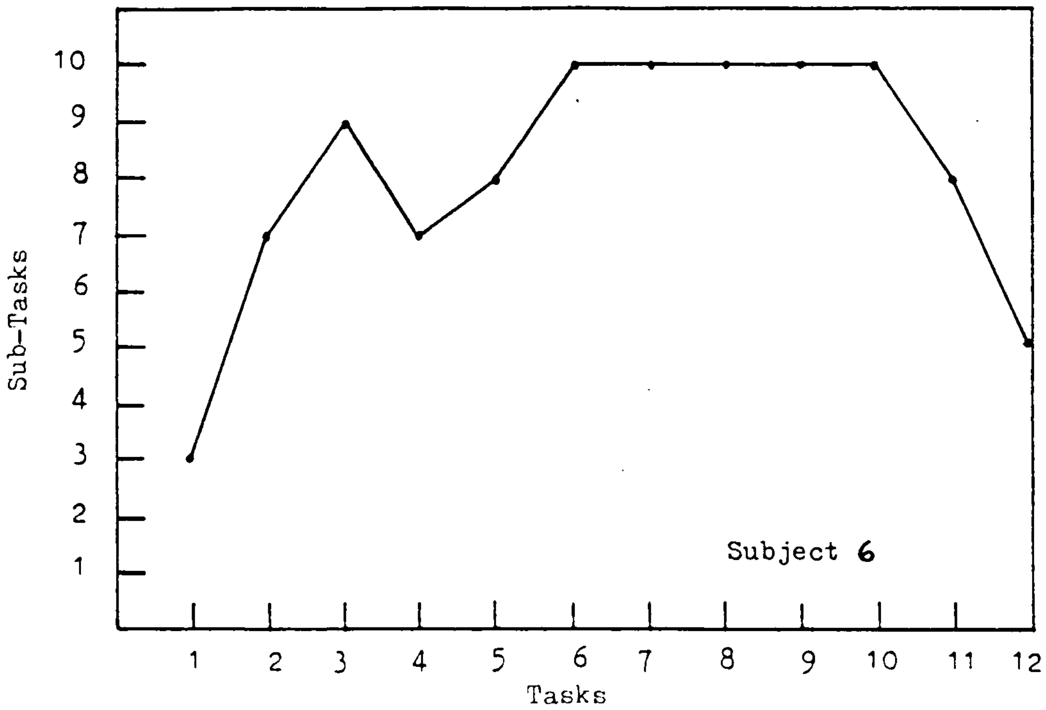
Tasks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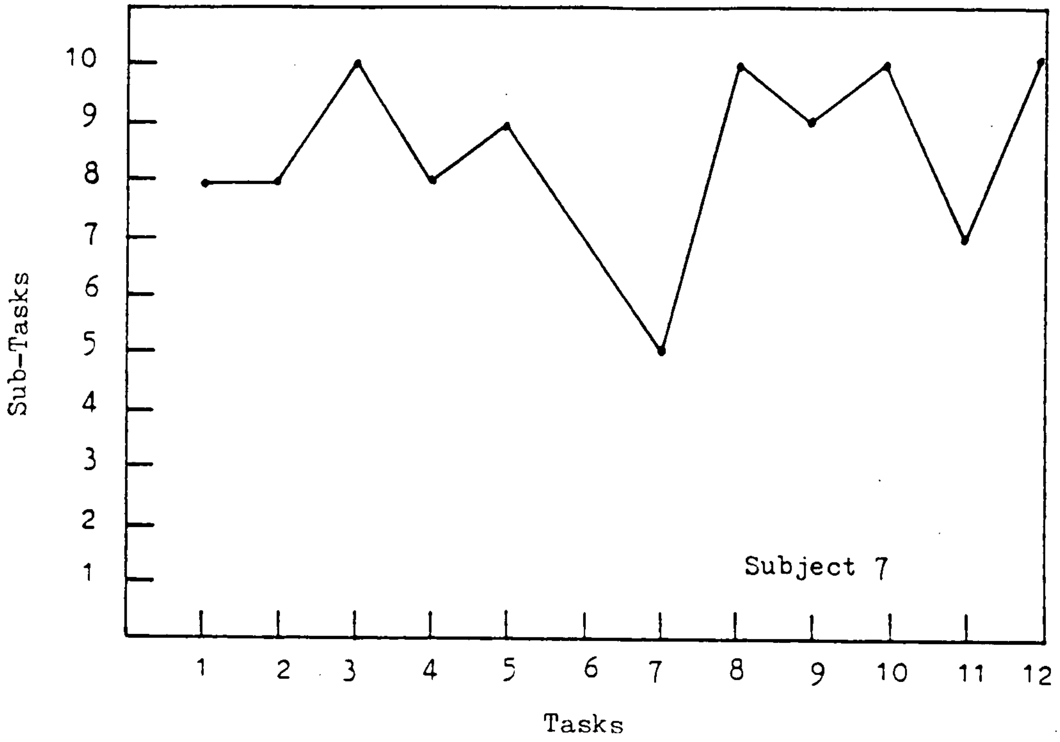

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2
1
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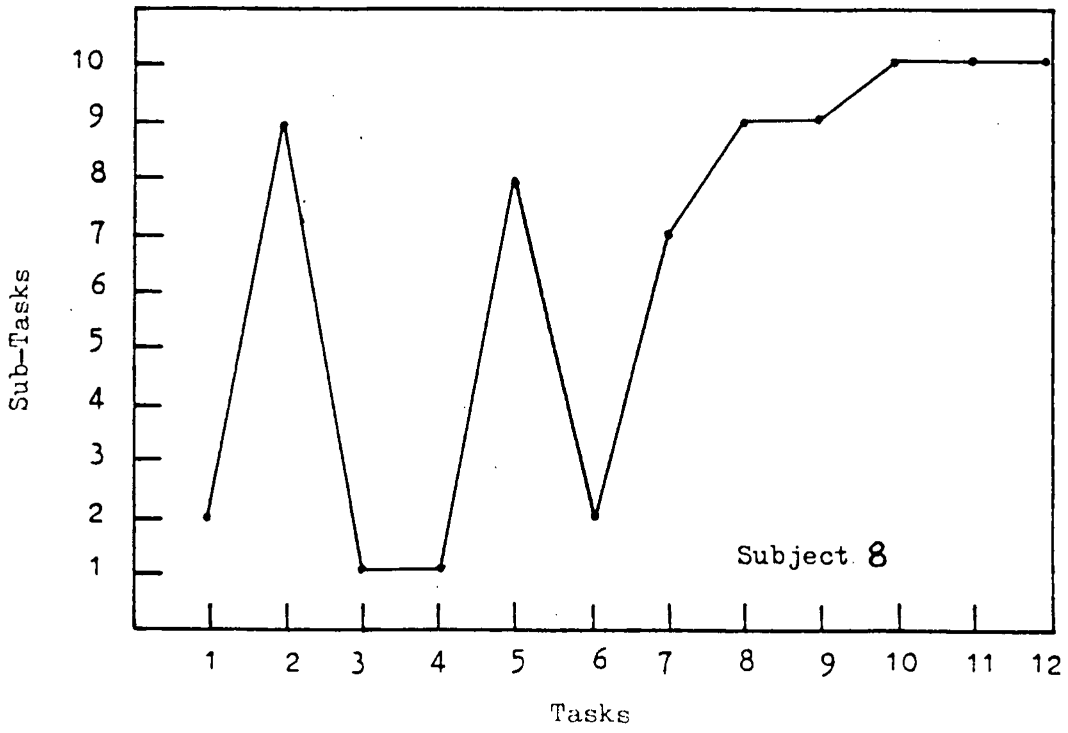
Tasks



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4
3
2
1
Subject 8
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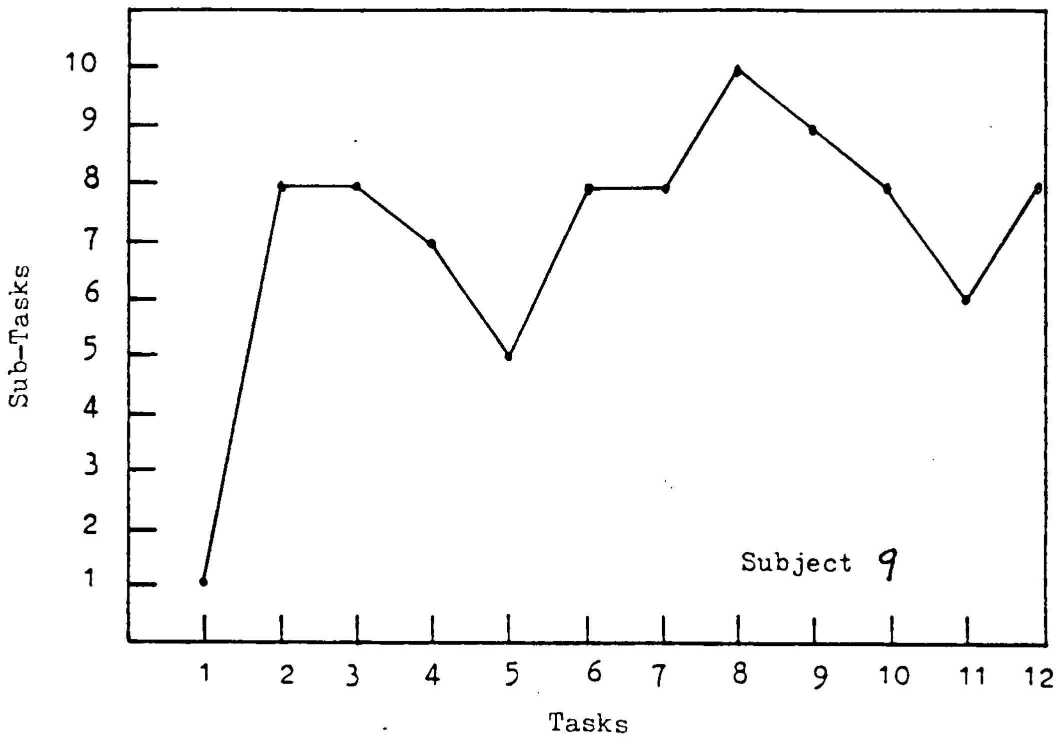
Tasks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Sub-Tasks
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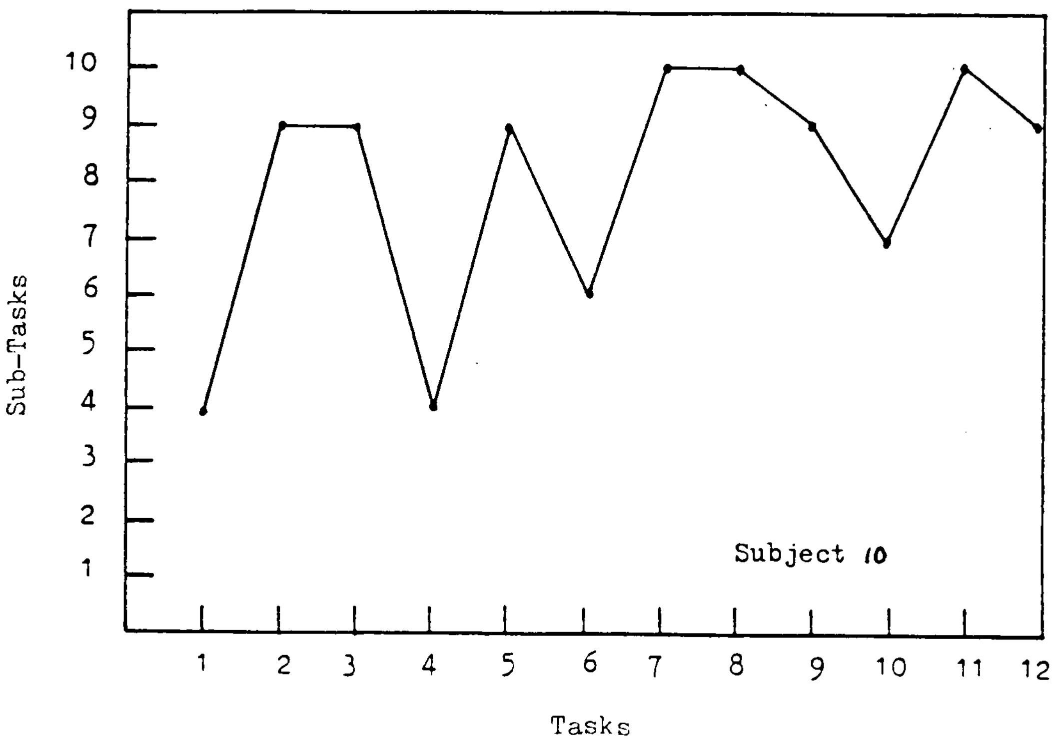
Tasks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3
2
1
Sub-Tasks
Subject 10
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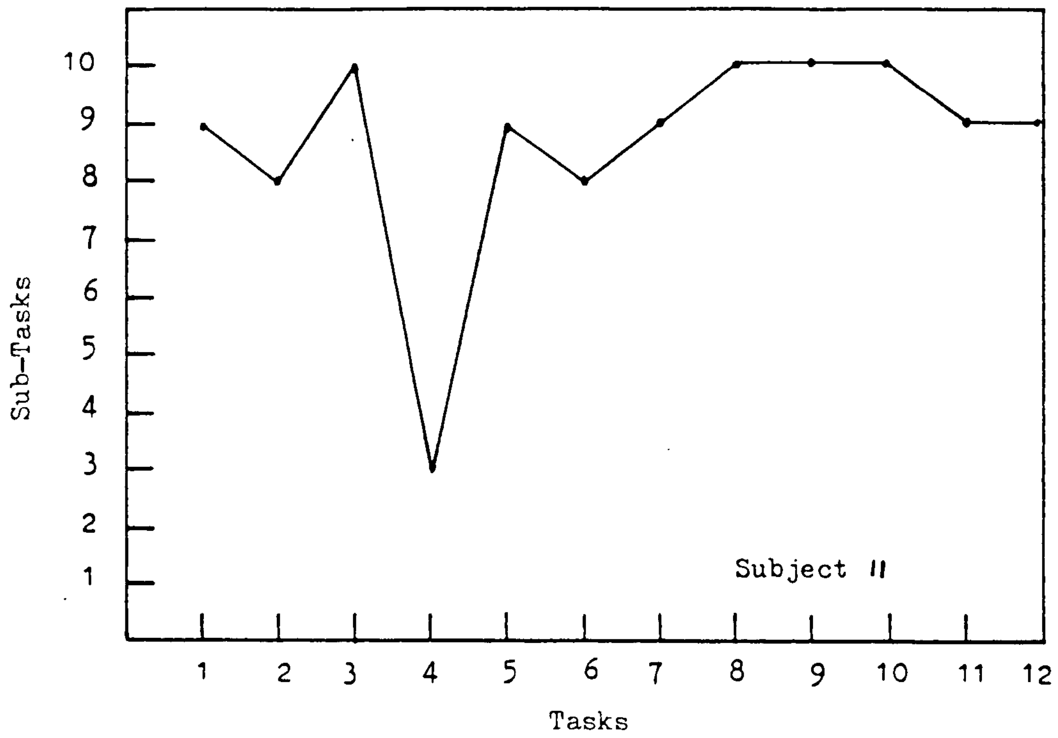
Tasks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1
Sub-Tasks
Subject 11
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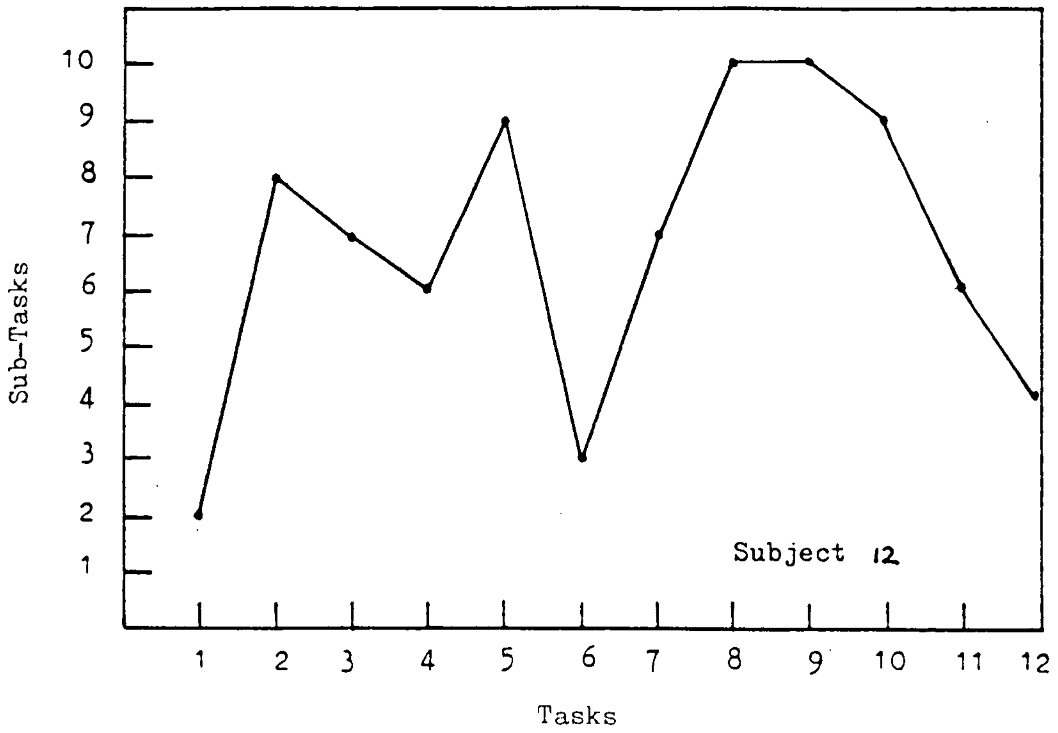
Tasks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4
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2
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Sub-Tasks
Subject 12
1 2 3 4 5 6 7 8 9 10 11 12
Tasks

APPENDIX S

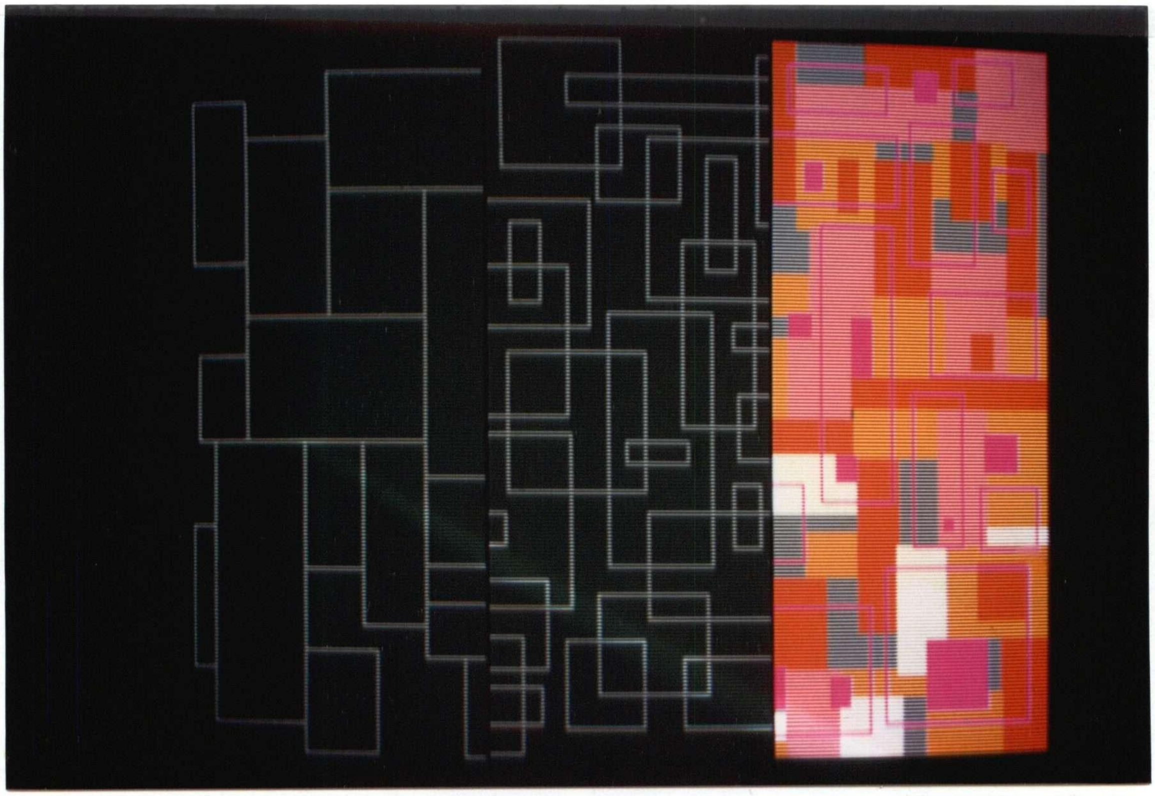
Criteria For Close Spatial Proximity

Close Spatial Proximity

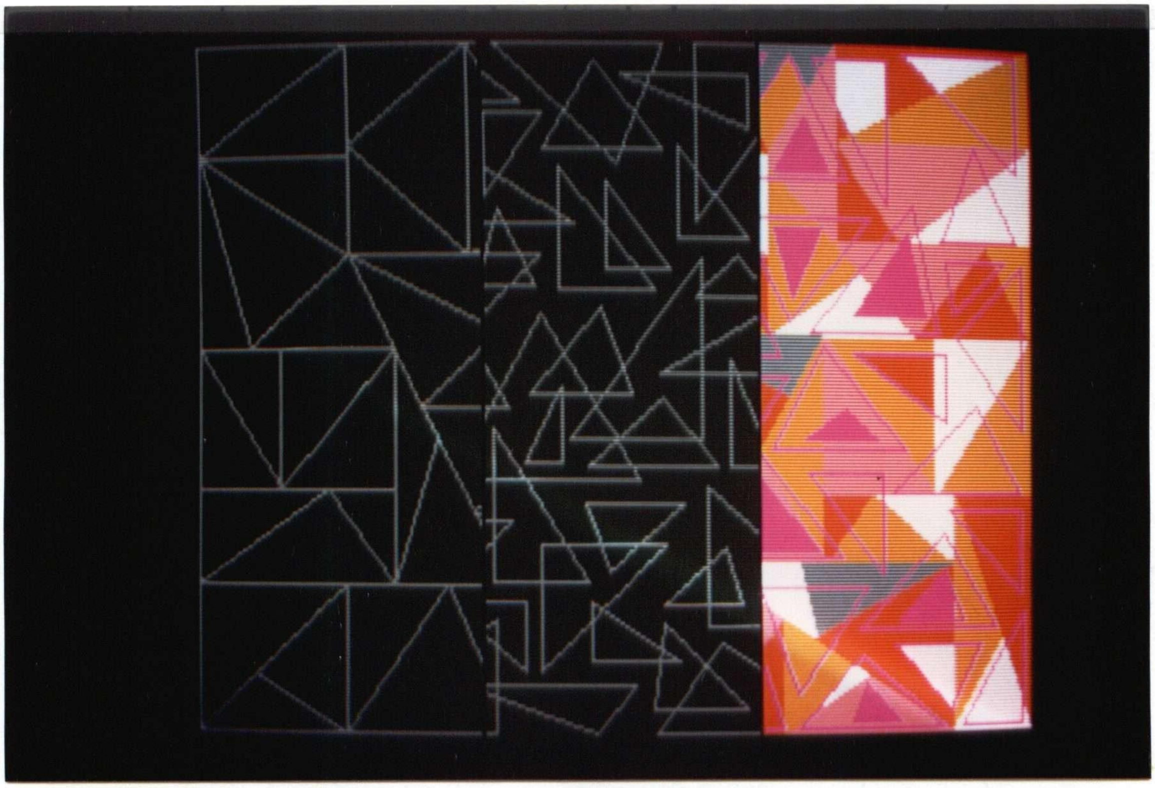
A shape was considered to be spatially proximate to the model shape if it fell within a certain specified area around the model shape. The specified area was determined to be 1/8th the size of the total visual field.

APPENDIX T

Discrimination Images



Discrimination - The three masking techniques - Rectangle



Discrimination - The three masking techniques - Triangle

Discrimination - The three masking techniques - Circle

APPENDIX U

Verbal Responses in the Discrimination Task

Identification of Procedures Used to Mask a Given Shape

Subject	Task	Mask*	
Subject 1	3	1	This one is not mixed up like these ones, they're not overlapping them.
		2	These ones are so close to each other you can't really see them.
	6	1	This, you didn't put so much triangles in it. You put lots, but you didn't put in too much.
		2	And this one you put them all little and big and you overlapped them.
		3	And this one was really hard because of the colors and you didn't know which way they were.
Subject 2	3	1	This one has less rectangles.
		2	This one has a little bit more.
		3	This one has totally different colors.
	6	1	This one has less triangles than that one.
		2	This one has less than that one (3).
	9	2	This one has less circles than that one (1).
		3	This one has less circles than that one (2)

Subject 3	3	1	This one has bigger shapes.
		2	This one has more different shapes than this one (1).
		3	This one has lots of different colors.
	6	2	That one has more triangles than that one (1).
		3	That one has more colors than the other two.
	9	1	This one has more circles than that one
		2	Because this one looks tied together more and these ones (1) look just sitting on each other.
		3	All colored.
Subject 4	3	1	This one's a bit more easier.
		2	This one's a bit more harder because it has more rectangles.
		3	This one's a way more harder because it's pink.
	6	1	This one has less.
		2	This one has more.
		3	This one has color.
	9	1	Bigger circles.
		2	Littler circles.
		3	Colored circles.
Subject 5	3	1	This one is just kind of plain, just

			lots of shapes.
		2	This was kind of all like overlapped.
		3	This was overlapped and all sorts of colors to make it quite hard.
	6	1	This one is just kind of plain.
		2	This one's overlapped.
		3	This one's overlapped color.
	9	1	That one kind of has circles all over the place, inside each other and out.
		2	This one's overlapped all over the place.
		3	This one's got color and overlapping.
Subject 6	3	1	This one's easy.
		2	This one's a little harder.
		3	This one's a little harder than this one (2).
	6	1	This one doesn't have so many triangles.
		2	This one has got a little more triangles.
		3	This one has more triangles.
	9	1	This one's easier, I think.
		2	This one's easier than that (3).
		3	This one's harder.
Subject 7	3	1	That one there is the whole box.

		2	And that one there is just the outline.
		3	That one has different colors and there is outlines and whole boxes.
	6	1	This one's whole.
		2	This one's lined.
		3	This one's color. Whole is when there's not just outlines, like we could color each one in, there's not one sitting behind it. This one (2) is only outlines, there's boxes behind it that you can see. And then this one (3) has color. It's colored and its a mixture of both of those.
	9	1	There's whole circles which is when there's no lines underneath interfering with the whole circle.
		2	There's the lines interfering.
		3	There's the colors and the lines and the whole and everything.
Subject 8	6	1	These are like squares and you make triangles in the squares.
		2	These are triangles and there's more space in the background. There's no space whatsoever in the background of

			this (1). Everything's triangles.
		3	You have different colors of triangles and some are just pink outlined and there's lots of colors in them.
	9	1	These circles were more like in each other.
		2	These were ringed around each other.
		3	These are colors, different colors and some were pink outline.
Subject 9	3	1	The first one should have been the easier to find because it's just around each other.
		2	The second one is harder because they were overlapping.
		3	The third one was hardest because they were doing all three things.
	6	1	It was more like trying to find angles because they were in each other.
		2	It was harder because they were little.
		3	It was harder because there were colors, some dark and some light, and the triangles are harder to see.
Subject 10	3	1	This one is just straight blocks all grouped together with no spacing. They are

			ll somehow grouped together and there's no definite color in any of them. They are just the same color and they also don't overlap each other.
		2	I think all of them overlap something, another shape, and again there is no definite color and they are not touching each other.
		3	They are all spaced out with none of them overlapping and there was color added in the back and shapes in some of the shapes.
Subject 11	3	1	It's simple. There's nothing overlapping.
		2	Here they overlap.
		3	Here it changes color and no overlapping.
	9	1	Same as I said before.
Subject 12	3	1	This one would probably be the easiest.
		3	Here it is different colors like the colors blend in so it's hard.
		2	This one has got lots of rectangles so it would be hard to find.
	6	1	The difference is in the way they are organized. The way it's put on the screen. It's a different order.
		2	This one is smaller triangles.
		3	These are all in different ways. The

		colored one is different from this one cause this one is not the same as this one and they don't look all the same.
9	1	This one's the same sort, like they are squiggly so this sort of fools you so you won't be able to find it.
	2	It's all squiggly and everything.
	3	It's the color again, it sort of fools you.

* Mask refers to the masking procedure used.

1 = Shared Contour

2 = Interrupted Contour

3 = Close-Color Harmony