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A Training Program to Develop Specific Manual Dexterity Skills of Down's Syndrome Children

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A TRAINING PROGRAM TO DEVELOP SPECIFIC MANUAL DEXTERITY SKILLS OF DOWN'S SYNDROME CHILDREN

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ABSTRACT

This study was designed to determine if the fine motor skills of three young Down's Syndrome children functioning below average in manual dexterity skills could be improved through a systematic training program. The selected subjects were met individually for thirty minutes a day, four days per week (Monday through Thursday), for a period of seven weeks. Each child was trained by repeated practice on ten specific tasks involving arm, hand, and finger manipulation. Subjective data recorded during each session by the investigator indicated that, generally, all three subjects appeared to improve on the manual dexterity tasks. These results were supported by gains generally found in the Purdue Pegboard, the Crawford Small Parts Dexterity Test, and the Stromberg Dexterity Test which were administered prior to and at the completion of training. However, limitations of the study prohibit the conclusion that improvement was due to the systematic training program employed in the study.

To

Mom and Dad

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CHAPTER I

INTRODUCTION

Down's Syndrome (Mongolism) constitutes the largest, single identifiable, clinical category of mental retardation. This group represents approximately one-third of the trainable mentally retarded population. From ten to twenty percent of profoundly mentally retarded children are of this etiological classification with an average Intellectual Quotient (IQ) between twenty-five and forty-nine.

Down's Syndrome (DS) infants, as a group, demonstrate a developmental lag in motor performance as early as six months of age in comparison to the normal infant. At six months of age the DS child is already two months behind the normal child in motor performance. By the time the infant reaches one year of age he or she is four to five months below normal chronological age expectation. By the fifth year of life, the child is approximately two years behind and unable to perform such specific tasks as buttoning a shirt or riding a tricycle.[1] Also at this chronological age

[1]Karl Fishler, Jack B. Share, and Richard Koch, "Adoptation of Gesell Developmental Scales for Evaluation of Development in Children with Down's Syndrome (Mongolism)," American Journal of Mental Deficiency, 68:643, 1964; see also Janet Carr, "Mental and Motor Development in Young Mongoloid Children," Journal of Mental Deficiencies Research, 14:209,

gross eye-hand coordination is quite poor and hand movements are unsteady.[2]

Investigators have reported that overall gross motor skills of the DS child are also below those of the normal child and non-DS retarded child.[3] DS individuals also are inferior to non-DS individuals in tasks involving fine motor discrimination and control.[4] In addition to fine and gross motor skills, the DS child does not appear as physically

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1970; see also Jack B. Share and Ronald W. French, "Guidelines of Early Motor Development in Down's Syndrome Children for Parents and Teachers." Special Children, 1(2): 63-64, Fall 1974.

[2]Mary M. Thompson, "Psychological Characteristics Relevant to the Pre-School Mongoloid Child," Mental Retardation, 1:148, 1963.

[3]Sensina J. Pertejo, "La Escuela Metrica de Osertsky Paraclexamen de la Motorica," Rev. Psychol. Gen. Apl, 539-53, 1950, as quoted in Behavioral Abstracts, 26:6283, 1952; see also Gerard J. Bensberg and Gordon N. Cantor, "Reaction Time in Mental Defectives with Organic and Familial Etiology," American Journal of Mental Deficiency, 62:537, 1957; see also Kenneth R. Blessing, "The Range of Mongoloid in Trainable Classes," American Journal of Mental Deficiency, 63: 312, 1959; see also Robert B. Kugel and David Reque, "A Comparison of Mongoloid Children," Journal of American Medical Association, 175:961, 1961; see also Bryant J. Cratty, "The Perçeptual-Motor Attributes of Mentally Retarded Children and Youth," Mental Retardation Services Board of Los Angeles County, 6:45-50, August 1966.

[4]Robert H. Cassel, "Relation of Design Reproduction to the Etiology of Mental Defectives," Journal of Consulting Psychology, 13:427, 1949; see also Beates Hermelin and N. O'Connor, "Shape Perception and Reproduction in Normal Children and Mongol and Non-Mongol Imbeciles," Journal of Mental Deficiencies Research, 5:71, 1961; see also Robert M. Knights, Brian R. Atkenson, and Joseph A. Hyman, "Tactual Discrimination and Motor Skills in Mongoloid and Non-Mongoloid Retardates and Normal Children," American Journal of Mental Deficiency, 71:899, 1967.

fit[5] or have as fast reaction times[6] as other retarded individuals.

The DS child suffers the additional burden of being born with brain injury where pathology to the central nervous system contributes to poor motor development.[7] Also, poor motor skills of the DS child are attributed to hypotonia.[8] The lack of muscle tone is tentatively related to a smaller cerebellum or to cerebellar impairment (not yet verified).[9] Investigators have demonstrated that the brain-stem and cerebellum of DS children are considerably smaller than those of normal children.[10]

A disproportionate number of Down's Syndrome children

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[5] L.T. Hilliard and Brian H. Kirman, "Down's Disease (Mongolism)," Mental Deficiency, London: J. and A. Churchill Ltd., pp. 449-83, 1957.

[6] G. Berkson, "An Analysis of Reaction Time in Normal and Mentally Retarded Young Men," Journal of Mental Deficiencies Research, 4:59-67, 1960.

[7] Charles W. Telford and James M. Sawrey, The Exceptional Individual, New Jersey: Prentice-Hall, pp. 254-55, 1972.

[8] N. O'Connor and Beate F. Hermelin, Speech and Thought in Severe Subnormality, New York: Macmillan Co., p. 101, 1963; see also Hilliard and Kirman, loc. cit.; see also B. H. Kirman, "Epilepsy in Mongolism," Archives of Disease in Childhood, 26:501-3, 1951.

[9] Brian H. Kirman, "Epilepsy in Mongolism," Archives of Disease in Childhood, 26:501-3, 1951.

[10] L. Crome, Valerie Cowie, and Eliot Slater, "A Statistical Note on Cerebellar and Brain Stem at Eight in Mongolism," Journal of Mental Deficiencies Research, 10:71-2, 1966.

have skeletal deformities which could possibly contribute to inferior motor behavior and it has been found that DS children are significantly retarded in measures of linear growth and assessed skeletal age when compared to normals of the same chronological age and sex. Causal factors for defective motor patterns may be (1) the characteristics of the DS individual's growth patterns, (2) lack of motivation in an institutional setting, (3) inappropriate reinforcement techniques for maximal development of potential motor abilities, and (4) possible regression in motor patterns due to association with intellectually subnormal peers or models.[11]

Knowledge concerning individuals with DS indicates that expected mental development will ordinarily allow no more advanced economic endeavor than employment in a sheltered workshop.[12]

> Great accuracy of motor control is rarely achieved, and even those with higher mental ages have imperfect motor control...Most mongoloids are unable to help in any trade requiring skilled motor control. This limits their usefulness...[13]

This finding is supported by researchers who have demonstrated that DS adults have imperfect fine motor control which limits

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[11]James Stiehl, "The Motor Abilities of Children with Down's Syndrome," Unpublished Thesis: University of California at Los Angeles, 1973.

[12]H.D. Bud Fredericks, "A Comparison of the Doman-Delacato Method and Behavior Modification Method Upon the Coordination of Mongoloids," Teaching Research Project #RD 2753-P-68, pp. 3-22, January 1969.

[13]G. Berkson, loc. cit.

their economic usefulness.[14] Sheltered workshop personnel who work with adult DS individuals have commented on the difficulty in their ability to synchronize both hands.[15] Further those with Intellectual Quotients below sixty have a marked inability to perform tasks involving manual dexterity. It is reported that DS subjects are inferior to normals matched on mental age on tactile discrimination tasks. While more research is needed, the lack of muscle coordination and poor motor development seem to play a major role in preventing the DS adult from even limited economic usefulness in the majority of sheltered workshop activities.[16]

Employment of DS persons has not been of major concern in years past because of high mortality rate during infancy and early childhood.[17] Diseases of the respiratory organs and the heart were among the major causes of death. These diseases in the past extracted a high death toll among the Down's Syndrome population. However, with improved medical attention and the use of antibiotics the span of life of the Down's indivivual has been increased.[18] Over the

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[14]T.M. Foreman, "The Mongoloid Child-Behavioral Description," Special Education in Canada, 41: 11, 1967; see also Fredericks, loc. cit.

[15]Gordon N. Cantor and Chalmers L. Stacey, "Manipulative Dexterity in Mental Defectives," American Journal of Mental Deficiency, 56:408, 1951.

[16]Foreman, loc. cit.; see also Fredericks, loc. cit.

[17]Fredericks, loc. cit.

[18]Abraham Levinson and J. Bigler, Mental Retardation

institutionalizing the trainable mentally retarded.[23] Whenever possible, DS persons should either live at home or maintain contact with their families. It is essential that DS persons be regularly employed; thus supervised workshops provide one solution for these occupational problems.

Measures to secure adequate workshop facilities have already been undertaken. The Vocational Rehabilitation Act of 1965 authorized a comprehensive program of federal financial assistance for state planning of rehabilitation and workshops, for the construction of new sheltered workshops, and for the improvement of existing workshops. Special provisions were made for the mentally retarded to permit the inclusion of residential facilities.[24] Expanding the Act of 1965, the Vocational Rehabilitation Act of 1973 provided for individualized rehabilitation programs for the severely disabled, and authorized state vocational rehabilitation agencies to make federal matching funds available for meeting the costs of construction and equipping rehabilitation facilities, including the expansion and remodeling of existing buildings and the purchase of workshops and facilities for work evaluation and personal and work adjustment. The Act also provided grants for programs and

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[23]Samuel A. Kirk, Educating Exceptional Children, Boston: Haughton-Mifflin Co., p. 226, 1962.

[24]Marvin Rosen, "Rehabilitation, Research, and Follow-Up Within the Institutional Setting," Mental Retardation, 5(5):7-11, October 1967.

construction planning, initial staffing (for four years, three months) residential accommodations for mentally retarded workers and those with severe mobility problems, and training services directed toward career advancement.[25] Further, to amend the Vocational Rehabilitation Act of 1973, Public Law #95-602 cited as the "Rehabilitation, Comprehensive Services, and Developmental Disabilities Amendment of 1978," provided for a community service employment program for handicapped individuals and comprehensive services for independent living for handicapped individuals.[26] With workshops expanding, there is a need to prepare DS adults to function effectively in a sheltered workshop; but with limited intelligence and poor coordination, performance is prohibited.

There is some evidence that the individual with DS can reach a suitable level of manipulative skill. Langdon Down[27] found that the manipulative ability of DS individuals is deficient but can be strengthened by a systematic training program. Further, Fort[28] suggested that training should begin at seven years old and even younger. Fredericks[29]

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[25]Goldenson, loc. cit.

[26]Public Law 95-602, 92 STAT. 2885, November 6, 1978.

[27]Langdon H. Down, "Observations on an Ethnic Classification of Idiots," London Hospital Lecture Reports, 3:259, 1866.

[28]Samuel H. Fort, "The Training of an Idiotic Hand," Association of Medical Officers and American Institutions for Idiotic and Feebleminded Persons Proceedings, p. 547, 1895.

in a specific nine-week experimental study compared the Doman-Delacato Method and a structured physical education program plus behavior modification methods and found the Doman-Delacato Method improved the coordination of the young DS individual. In his study he assumed that improved coordination during childhood will improve the DS individual's coordination as an adult and thus improve their vocational potential. Several studies demonstrated that after two years of training in sheltered workshops, successes can be achieved in various manual dexterity skills.[30]

Part of the difficulty which individuals with DS have with learning skills that are necessary for workshop employment is the inability to effectively perform tasks which involve manual dexterity. If manual dexterity tasks can be broken down to fine motor components rather than the acquisition of the total motor pattern, task performance may increase, and perhaps more trainable mentally retarded DS individuals will be able to accomplish specific manual dexterity tasks.

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[29] Fredericks, loc. cit.

[30] J. Tizard and F.M. Loos, "The Learning of a Spatial Relations Test by Adult Imbeciles," American Journal of Mental Deficiency, 59:86, 1954; see also Clarke and Hermelin, loc. cit.

Summary

It has been demonstrated that the DS manifest a progressive developmental lag in motor performance in comparison to the normal individual. Not only is the DS individual below his intellectual normal counterpart in gross and fine motor skills, but may also be below the non-DS trainable mentally retarded. Possible factors attributing to poor motor performance of DS individuals are skeletal deformities and brain injury.

As a result of poor motor performance, DS individual economic usefulness is greatly limited. In the past, employment of DS individuals was not of concern to the community due to the short life expectancy of the DS. However, with improved medical attention their span of life has been increased. It has been noted that the trainable mentally retarded must be placed in the least restrictive environment, thus more will be in the community which poses a problem for the general public. With the increasing number of DS individuals it is necessary to provide sheltered workshops for the DS as is stated and provided for in the Vocational Rehabilitation Acts of 1965[31] and 1973[32].

Having workshops available, consequently one must prepare the Down's Syndrome population to reach a suitable level of manipulative skill to be employed. It has been

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[31]Rosen, loc. cit.

[32]Goldenson, loc. cit.

demonstrated in Frederick's study that successes can be achieved in manual dexterity skills through systematic training programs for the trainable mentally retarded adolescent. While training programs have been initiated for the adolescent and adult DS, no reported program for the younger DS individual has been researched. It has been suggested by many professionals that training can begin as young as seven years of age. To date, no research could be found that applied to this suggestion. It is necessary to break down manual dexterity skills to less complexity in a training program to increase the motor performance of DS individuals. If the acquisition of these patterns can be improved, possibly the DS will be successful on specific tasks required for sheltered workshop employment.

Statement of the Problem

The purpose of this study was to investigate whether the fine motor performance of the young trainable mentally retarded child with Down's Syndrome could be improved through training on specific manual dexterity tasks. The selected subjects were trained by repeated practice on ten specific tasks involving arm, hand, and finger manipulation. The one main question in this study was the following: Would this training program improve the motor performance of DS subjects as determined by results on the manual dexterity tasks?

Importance of the Study

The results of this study would determine if manual dexterity skills of DS could be improved at an early age. If the results were positive, a specific training program as presented in this study could be utilized in a school setting.

Limitations of the Study

An important aspect in any investigation is the consideration of the factors and variables that could possibly effect its internal and external validity. As is apparent in the review of literature presented in the next chapter, there are many factors involved in the development of fine motor skills, and it would be impossible to control all of these in a case study of motor performance. Some of the factors that could influence motor performance during the training period and certain other limitations of the study's design are discussed below.

1. It is realized that the time spent in training (thirty minutes each day, four days a week) covered only a small portion of the total seven weeks of the training period. Fine motor functions taking place at home, on the street, and in the classroom are certainly of significance, but could not be controlled in the study.

2. It is realized that the setting and methods employed in this study limited the generalizability of eventual findings. The population of the study was limited to three DS boys, ages nine to twelve, enrolled in public school.

3. The implementation of the treatment was undoubtedly influenced by the investigator's personal style and idiosyncrasies of teaching and momentary intuitions.

4. Another limitation of the study with respect to causality of changes was the fact that no control group was included. It is not certain that the results in this study were due to the treatment or other factors. However, to allow for analysis of this type, a second group would have been necessary that would receive another particular training other than that employed in this study.

Definition or Clarification of Terms

For the purpose of this study, the terms presented below are defined or clarified as follows:

Down's Syndrome. A genetic disorder, usually not inherited, in which there is an error in cell division.[33]

Manual Dexterity. The ability to make controlled manipulations of objects involving arm, hand, and finger movements.[34]

Performance. The measure of a child's skill on a distinct motor task.[35]

Trainable Mentally Retarded. As determined by the Stanford-Binet Individual Intelligence Test, those who score

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[33] Fredericks, loc. cit.

[34] Edwin A. Fleishman, The Structure and Measurement of Physical Fitness, New Jersey: Prentice-Hall, pp. 23-4, 1964.

[35] Daniel Zachofsky, "The Effects of Extrinsic

from twenty-five to forty-nine are termed "trainable,"[36]

Reinforcement Upon the Motor Performance of Learning Disabled Children on a Selected Motor Task," Unpublished Thesis: State University College of New York at Brockport, 1974.

[36]Rick A. Heber, "Manual on Terminology and Classification in Mental Retardation," American Journal of Mental Deficiency Mongoloid Supplement, 63:214, 1958.

CHAPTER II

REVIEW OF LITERATURE

In this chapter, literature pertaining to the performance of the trainable mentally retarded with Down's Syndrome (DS) on fine motor skills is reviewed.

One of the most recent investigations on the motor development of DS individuals was conducted by Share and French.[1] Specifically, from the information collected on fine motor skills, Share and French demonstrated that the fine motor skills of DS children are inferior to those of the intellectually normal. The Down's child not only has deficit motor skills, but also there is a gradual but steady discrepancy in subsequent progress. For instance, DS infants are slightly below the normal motor pattern of development during the first six months of life. By the time infants reach one year of age they are often developmentally four to five months behind normal chronological age performance. This lag nearly doubles by the time children reach their second birthday. In this investigation scores were given for selected developmental landmarks,

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[1]Jack B. Share and Ronald W. French, "Guidelines of Early Motor Development in Down's Syndrome Children for Parents and Teachers," Special Children, 1(2):61-65, Fall, 1974.

(for example, transferring objects in hands, walking unsupported, dressing self into simple garments, etc.) in comparison to the age of onset of Gesell normals (based on the Gesell Developmental Schedules[2]) to Down's Syndrome subjects. Directly related to fine motor skills, the Down's infant was three months behind the intellectually normal when transferring objects from one hand to another. Further, at four years of age, the Down's child was already two years behind a normal child in drawing or imitating a circle. This study pointed out that there exists a wide variation in the age of onset on the motor landmarks contributing to individual differences such as various genetic determiners, physical status, socio-economic background, home versus institutional care, and a host of other variables apparently accounting for the range in motor development.

A study by Berkson[3] presented a series of experiments to analyze reaction time in simple manual dexterity and visual tasks. In this study, a reaction time (RT) technique was employed to determine whether intelligence is related to psychological functions involved in RT situations which vary in complexity. Four experimental procedures

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[2]Arnold Gesell, Henry M. Halverson, Helen Thompson, Frances I. Ilg, Burton M. Costner, Louise Bates Ames, and Catherine Amatruda, The First Five Years of Life, London: Methuen and Co., pp. 319-43, 1940.

[3]G. Berkson, "An Analysis of Reaction Time in Normal and Mentally Retarded Young Men," Journal of Mental Deficiencies Research, 4:59-67, 1960.

consisting of a Simple Response, Complex Response, Simple Button Press, and a Choice Button Press were administered on three successive days. The importance of speed was emphasized to the subjects in all four tests. Sixty-six subjects, sixteen with DS were given twenty trials in each of the four procedures. The results demonstrated that the DS group were significantly slower on reaction time than a group of undifferentiated defectives matched on IQ. In summary, the experiments confirmed the existence of a relationship between IQ and speed of reaction on manual dexterity tasks in the lower half of the IQ range (between twenty-five and forty-nine).

A study by Knights, Hyman, and Wozny[4] compared the performance of brain injured children (mean chronological age of 14.06 years), Down's Syndrome children (mean chronological age of 11.71 years), and familial mentally deficient (chronological age of 11.3 years) on a task involving tactual, spatial, and kinesthetic abilities. The forty-one children performed the Sequin-Goddard Formboard, modified to contain eight blocks, first with the dominant hand, then with the non-dominant hand, and then with both hands. The subject was not allowed to see the board or blocks at any time before, during, or after the three trials.

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[4]Robert M. Knights, Joseph A. Hyman, and Marius A. Wozny, "Psychological Abilities of Familial, Brain Injured, and Mongoloid Retarded Children," American Journal of Mental Deficiency, 70:454-7, 1965.

Each trial was timed with a stopwatch. In general, the data indicated that on a non-visual psychomotor task a majority of DS children were unable to perform as well as other familial mentally retardates and brain injured children. Also, DS subjects were unable to interpret their tactual-kinesthetic sensations. The results indicated that tactual perception appeared to be nearly equivalent in the three groups.

Knights, Atkenson, and Hyman[5] compared the performance of nineteen matched DS (mean chronological age of 14.7 years) and nineteen non-DS (mean chronological age of 15.1 years) mentally retardates on fine tactual discrimination tasks and six motor skills. In the first experiment, the results suggested that fewer DS subjects who were matched with non-DS retardates on chronological age and IQ were capable of performing tactual and kinesthetic discrimination tasks. However, those DS subjects who were able to reach the criterion, performed as well as the non-DS subjects. In the motor skills experiment, although the differences between the two groups were not significant, it is interesting to observe the direction of the results. The DS children were inferior to the non-DS on a steadiness test, the dynanometer, and the reaction time test. The DS subjects tapped somewhat more rapidly and completed the

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[5]Robert M. Knights, Brian R. Atkenson, and Joseph A. Hyman, "Tactual Discrimination and Motor Skills in Mongoloid and Non-Mongoloid Retardates and Normal Children," American Journal of Mental Deficiency, 71:894-900, 1967.

pegboard quicker than the non-DS subjects. The performance of both DS and non-DS mentally retarded (mean age of fourteen years) was comparable to five year old intellectually normals on all tasks except the dynanometer. Similarly, Gordon[6] found DS individuals equal to intellectually normal children on visual tasks and inferior on tactile discrimination tasks.

Also, O'Connor and Hermelin[7] compared twelve intellectually normal children (mean chronological age of five years), matched with subnormals for mental age, twelve DS adults (mean chronological age of twenty-four years), and twelve non-DS mentally retarded adults (mean chronological age of twenty-four years) on visual and stereognostic shape recognition tasks as determined by a discrimination task involving five shapes based on Greek letters. The subjects were instructed to look at the figures and trace their outline carefully with their hands. After one minute of presentation the same shapes as well as five other novel ones were presented again and the subjects were to say which shapes were new and which were familiar. The results demonstrated differences between the three groups in stereognostic shape recognition, while no differences in visual

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[6]Alan M. Gordon, "Some Aspects of Sensory Discrimination in Mongolism," American Journal of Mental Deficiency, 49:55-63, 1944.

[7]N. O'Connor and Beates R. Hermelin, "Visual and Stereognostic Shape Recognition in Normal Children and Mongoloid and Non-Mongoloid Imbeciles," Journal of Mental Deficiencies Research, 5:63-66, 1961.

discrimination were reported. Non-DS subjects performed the stereognostic recognition tasks better than the DS subjects; and further, imbecile adults were superior to normal children (matched on mental age) in stereognostic shape recognition.

Another experiment by Hermelin and O'Connor[8] confirmed the findings of differential abilities in normals, DS, and non-DS mentally retarded subjects in motor response skills. Normal, DS, and non-DS mentally retarded children were compared on matching, recognition, copying and reproduction tasks. All groups were found to obtain higher scores on matching tasks than on recognizing designs from memory. On the other hand, there was a group difference in the drawing tasks. DS subjects' performance on both copying and reproducing from memory was inferior to the non-DS mentally retarded and intellectually normal subjects. These results support previous findings that DS subjects are inferior to non-DS individuals in tasks involving fine motor discrimination and control. Similar to Hermelin and O'Connor's findings, Cassell[9] found that the DS group was inferior to the non-DS group in reproducing designs from

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[8]Beates F. Hermelin and N. O'Connor, "Shape Perception and Reproduction in Normal Children and Mongol and Non-Mongol Imbeciles," Journal of Mental Deficiencies Research, 5:67-71, 1961.

[9]Robert H. Cassell, "Relation of Design Reproduction to the Etiology of Mental Defectives," Journal of Consulting Psychology, 13:421, 1949.

copy. He concluded that faulty reproduction of design cannot be attributed to perceptual impairment but is due to some other factor, such as lack of attention and memory or inability to imitate and carry out a motor response.

Cantor and Stacey[10] investigated the phenomenon of manipulative dexterity in mental retardates. The study consisted of one hundred and seventy-five male mental defectives with a mean chronological age of 15.34 years and a mean IQ being 64.8. Using the Purdue Pegboard as a test to measure right-hand, left hand, both hands, and an assembly operation, they found that intelligence and dexterity are significantly related; that the higher the IQ, generally the better the subject will perform on manual dexterity tasks. Further, the experiment indicated that in this group of defectives at least, manipulative dexterity as measured by the Purdue Pegboard reaches its maximum level of development by the age of fourteen or perhaps earlier.

Studies have demonstrated that DS mentally retarded individuals can reach a suitable level of manual dexterity skills. In the first recorded publication on Down's Syndrome, Langdon Down[11] observed that the manual ability of DS subjects is deficient but could be strengthened by a

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[10]Gordon N. Cantor and Chalmers L. Stacey, "Manipulative Dexterity in Mental Defectives," American Journal of Mental Deficiency, 56:401-10, 1951.

[11]Langdon H. Down, "Observations on an Ethnic Classification of Idiots," London Hospital Lecture Reports, 3:259, 1866.

structural training program. Not until just the last thirty years or so has the research of motor development of DS children begun. Tizard and Loos[12] demonstrated that after two years of training in sheltered workshops, successes were achieved by six DS adults in various manual dexterity skills. Given practice on the Minnesota Spatial Relations Test, all showed rapid improvement and considerable transfer of learning. Fredericks[13] in a nine-week study, used two systematic training programs, the Doman-Delacato Method versus a structured physical education program plus behavior modification. In his investigation he assumed that improved coordination during childhood would improve their vocational potential. It was the purpose of his study to determine if a systematic training program would improve the manipulative ability of Down's Syndrome adolescents. At the conclusions of his investigation he found that the Doman-Delacato Method improved the coordination of DS mentally retarded individuals.

In conclusion, studies by Share and French,[14]

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[12] J. Tizard and F. M. Loos, "The Learning of a Spatial Relations Test by Adult Imbeciles," American Journal of Mental Deficiency, 59:80-90, 1954.

[13] H.D. Bud Fredericks, "A Comparison of the Doman-Delacato Method and Behavior Modification Method Upon the Coordination of Mongoloids," Teaching Research Project, #RD 2753-P-68, January, 1969.

[14] Share and French, loc. cit.

Berkson,[15] Knights, Hyman, and Wozny,[16] Knights, Atkenson, and Hyman,[17] Gordon,[18] O'Connor and Hermelin,[19] Hermelin and O'Connor,[20] Cassell,[21] Cantor and Stacey,[22] Down,[23] Tizard and Loos,[24] and Fredericks[25] confirm the fact that DS individuals are inferior to both intellectually normal and non-DS retarded on tasks requiring fine motor skills; however, the precise reasons for inferiority in the development of motor skills are presently unknown. A number of studies support a hypothesis that DS children demonstrate a developmental lag in motor ability. Furthermore, it has been demonstrated that IQ is related to performance and total reaction times. That is, individuals in the lower half of the IQ range are unable to perform and are significantly slower on manual dexterity tasks requiring speed of

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[15]Berkson, loc. cit.

[16]Knights, Hyman, and Wozny, loc. cit.

[17]Knights, Atkenson, and Hyman, loc. cit.

[18]Gordon, loc. cit.

[19]O'Connor and Hermelin, loc. cit.

[20]Hermelin and O'Connor, loc. cit.

[21]Cassell, loc. cit.

[22]Cantor and Stacey, loc. cit.

[23]Down, loc. cit.

[24]Tizard and Loos, loc. cit.

[25]Fredericks, loc. cit.

reaction than the upper half of the IQ range.

There is some evidence that the DS individual can reach a minimal level of manipulative skill through systematic training programs to function adequately in a sheltered workshop. More work is needed to establish whether their impairment of poor fine motor coordination is permanent as indicated by Cantor and Stacey,[26] and to what extent suitable training methods may result in improved performance at the younger ages. While training programs have been initiated for the adolescent and adult DS, no reported program for the younger DS individual has been researched. It has been suggested by many professionals that training can begin as young as seven years of age. To date, no research could be found that applied to this suggestion. It is the purpose of this investigation to determine if the fine motor skills of trainable mentally retarded children with Down's Syndrome can be improved through systematic training programs of manual dexterity tasks at an early age.

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[26] Cantor and Stacey, loc. cit.

CHAPTER III

METHODS AND PROCEDURES

This study analyzed the effects of a training program of selected tasks on the development of manual dexterity skills in mentally retarded Down's Syndrome children. The treatment was administered over a seven week period. This chapter deals with the description and selection of subjects, description of training tasks, tests and procedures, and program procedures.

Description and Selection of Subjects

The subjects consisted of three males diagnosed as Down's Syndrome. George, the youngest of the three was nine years and one month old at the onset of this investigation, recorded an IQ of thirty-five as determined by the *Stanford-Binet Intelligence Test*, and functioned at a mental age of four years and nine months old. Danny, the oldest of the three was eleven years and eight months old, recorded an IQ of thirty-four as determined by the *Stanford-Binet Intelligence Test*, and functioned at a mental age of three years and ten months. Paul was nine years and eleven months old at the onset of this investigation, recorded an IQ of forty-five as determined by the *Stanford-Binet Intelligence Test*, and functioned at a mental age of four years old.

No subject had any gross neurological or sensory impairments.

Those subjects meeting the established criteria, that is, diagnosis of DS, between nine and twelve years of age, and no gross impairments were randomly selected from the trainable mentally retarded classes of the Board of Cooperative Educational Services, Secondary Supervisory District, Spencerport, New York. For School Record Information refer to Case Studies #1, #2, and #3 (Chapter IV).

Description of Training Tasks

The following training tasks were randomly chosen, primarily because each task involved arm, hand, and/or finger manipulation and were used in other research studies.[1] Each task was easy to administer and could be performed by the subjects successfully because of the various levels of performance specified in each task.

Nut and Bolt Board - This task required turning a nut clockwise and counterclockwise, on and off a bolt pushed through a hole in an upright board with the fingers (refer to Appendix A for the Objectives, Materials, Subject Matter, Procedures, and Illustration).

Pegs and Holes - This task required hand and arm dexterity for placing appropriate sized pegs into a wooden

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[1] H.D. Bud Fredericks, "A Comparison of the Doman-Delacato Method and Behavior Modification Method Upon the Coordination of Mongoloids," Teaching Research Project #RD-2753-P-68, pp. 3-22, January, 1969; see also Max G. Frankel, William F. Happ, and Maurice P. Smith, Functional Teaching of the Mentally Retarded, Illinois: Charles C. Thomas, 1960.

pegboard. Three different sized pegs and boards were utilized to allow for different levels of performance (refer to Appendix A for the Objectives, Materials, Subject Matter, Procedures, and Illustration).

<u>Knot Untying</u> - This task required finger dexterity for untying single, double, and complex knots. Materials of various length, thickness, and color were used to increase levels of difficulty (refer to Appendix A for Objectives, Materials, Subject Matter, Procedures, and Illustration).

<u>Bead Threading</u> - This task required finger, hand, and arm coordination for stringing assorted spools and beads on a long cord. The degree of difficulty ranged from large spools to medium sized spools and medium sized beads to small beads (refer to Appendix A for Objectives, Materials, Subject Matter, Procedures, and Illustration).

<u>Bean Placement</u> - This task required finger and arm manipulation employed in placing X number of beans into a specified container. Three different sizes of beans and containers ranging from large, medium, to small were used to increase the level of difficulty (refer to Appendix A for Objectives, Materials, Subject Matter, Procedures, and Illustration).

<u>Tracing Outlines</u> - This task required fine hand-eye coordination for tracing dotted vertical and horizontal diagrams using a writing utensil such as a crayon. The levels of difficulty ranged from simple geometric figures to complex designs (refer to Appendix A for Objectives,

Materials, Subject Matter, Procedures, and Illustration).

<u>Gluing Cut-Outs</u> - This task required hand and arm manipulation for gluing paper cut-outs onto corresponding outlined papers. The levels of difficulty ranged from large outlines for smaller corresponding cut-outs to outlines and paper cut-outs of equal size (refer to Appendix A for Objectives, Materials, Subject Matter, Procedures, and Illustration).

<u>Dressing Techniques and Shoe Lacing</u> - This task required fine finger, hand, and arm coordination for practicing dressing techniques such as buttoning, zippering, snapping, hooking, and shoe lacing. The levels of difficulty were apparent in the different sizes of the buttons, zippers, snaps, and hooks and eyes (refer to Appendix A for Objectives, Materials, Subject Matter, Procedures, and Illustration).

<u>Lids and Containers</u> - This task required fine finger and hand coordination for snapping and unsnapping the lids and caps on and off of appropriate plastic containers and bottles (refer to Appendix A for Objectives, Materials, Subject Matter, Procedures, and Illustration).

<u>Screwdriver Manipulation</u> - This task required hand and arm manipulation for turning screws into a board with the utilization of a screwdriver. Screws of different diameter were used to increase the level of difficulty (refer to Appendix A for Objectives, Materials, Subject Matter, Procedures, and Illustration).

Tests and Procedures

Three subjects received a pre-test and a post-test. Each subject was tested individually on three different tests: (1) Stromberg Dexterity Test,[2] (2) Purdue Pegboard,[3] and (3) Crawford Small Parts Dexterity Test.[4]

Stromberg Dexterity Test (SDT). This test measures speed and accuracy of arm and hand movement. Basically, this test involves placing fifty-four colored blocks (red, yellow, and blue) in their respective holes either in columns or rows as determined in the trials. There are four trials. During the first and third trials, the subject places the blocks in rows of red, yellow, and blue. Then in the second and fourth trials, the subject places the blocks in columns of red, yellow, and blue. The first and second trials are for practice and are not timed; they allow the subject to become familiar with the materials and the two tasks. The second two trials are the same as the first two, but are timed.

The subject must pick up a certain block, note its color, move it to the formboard, place it in a specified hole, pick up another block, observe its color, and place it, continuing this for fifty-four blocks. The score is simply

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[2]Stromberg Dexterity Test, University of California at Los Angeles, Psychological Corporation, New York, 1951.

[3]Purdue Pegboard, Science Research Associates Inc., Illinois, 1948.

[4]Crawford Small Parts Dexterity Test, New York:

the total number of seconds required to complete the last two trials.

Evidence of the reliability of the SDT came from two studies. The first of these was a correlation of the scores of seventy female assembler and welder job applicants. Since the value found was based on the correlation of the scores on one-half of the test with scores on the other half, it had to be corrected in order to represent the test as a whole. This correlation, by the Spearman-Brown Formula, resulted in a reliability coefficient of .84[5]

The second study to test for reliability of the SDT, was a correlation of the scores of eighty male trade school students on the third and fourth trials of the SDT. Corrected by the Spearman-Brown Formula, the value found was .87. (Similar value, .90, was found for fifty male and female college students).[6]

The test's validity showed a tendency for workers with the better SDT scored (shorter times, in seconds) to earn higher wages than workers with the poorer scores (longer time, in seconds).[7]

<u>Purdue Pegboard</u>. The Purdue Pegboard is a test of manipulation dexterity providing separate measurements of

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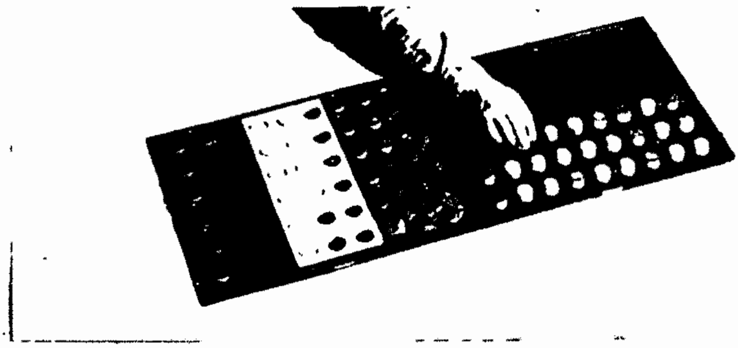
Psychological Corporation, 1965.

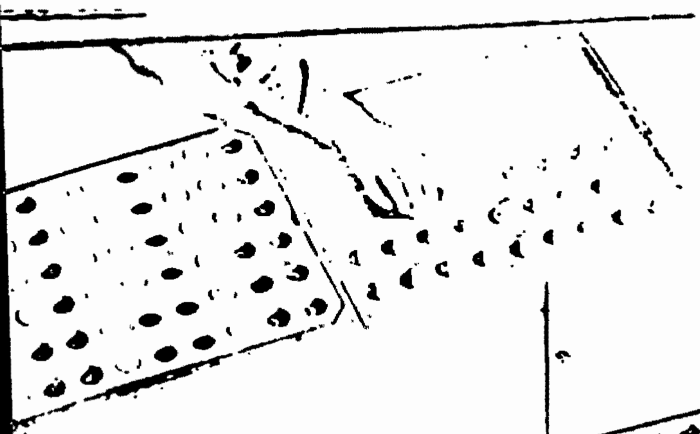
[5]<u>Stromberg Dexterity Test</u>, loc. cit.

[6]Ibid.

[7]Ibid.

Illustration: Stromberg Dexterity Test





the right hand, left hand, and both hands together. It also measures dexterity for two types of activities: one involving gross movements of hands and fingers and the other involving primarily what might be called "tip of the finger" dexterity needed in small assembly work.

Five separate test scores may be obtained with the Purdue Pegboard: (1) Right Hand; (2) Left Hand; (3) Both Hands; (4) Right plus Left plus Both Hands (abbreviated R+L+B); and (5) Assembly. All tests are performed on a pegboard which is equipped with fifty pins, twenty collars, and forty washers located in the proper cups. The testee should be seated comfortably at a table with the cups containing the pins and other parts at the far end of the board. Test #1, Right Hand requires placing as many pins as the testee can in the upper right hand row, one at a time, starting with the top hole. The testee keeps working as rapidly as he can until the end of exactly thirty seconds. The number of pins inserted is the score to be recorded on the Profile Sheet. Test #2 is the same for the Left Hand. On Test #3, Both Hands together. The testee picks up a pin from the right hand cup with his right hand and at the same time picks up a pin from the left hand cup with his left hand and places the pins down the rows simultaneously for thirty seconds. The total number of pairs inserted is the score to be recorded on the Profile Sheet. Test #4, Right plus Left plus Both Hands is not based on a separate test; it is obtained by combining the test scores of the sequences described above. The score is the number of pins placed with the right hand plus the number of pins placed with the left hand plus the number of pairs of pins placed with both hands. Test #5 (Assembly) tests more minute finger dexterity and consists of assemblying the pins, collars, and washers. The testee picks up one pin from the right hand cup with his right hand and when placing it in the top hole in the right hand row picks up a washer with his left hand. As soon as the pin has been placed, he drops the washer over the pin. While the washer is being placed over the pin with the left hand, the testee picks up a collar with the right hand. While the collar is being dropped over the pin, he picks up another washer with his left hand and drops it over the collar. This completes the first "Assembly" consisting of a pin, a washer, a collar, and a washer. As the final washer for the first assembly is being placed with the left hand, the testee starts the second assembly immediately by picking up another pin with his right hand placing it in the next hole. It is important in the sequence that both hands operate all the time, one picking up a pin, one a washer, one a collar, and so on. Test for exactly one minute. The number of parts assembled is the score to be recorded on the Profile Sheet. Three trials for each test may be administered, if desired.

Table 3.1 summarizes the results of several studies on the reliability of the several tests given by means of

Reliability of the Purdue Pegboard

Test	Group	N	One Trial	Three Trial***
Right Hand	College Students (men and women)	434	.63*	.84
Left Hand	College Students (men and women)	434	.60*	.82
Both Hands	College Students (men and women)	434	.68*	.86
Right+Left+Both	College Students (men)	175	.71*	.88
Assembly	College Students (men and women)	434	.68*	.86
Assembly	Radio Tube Mounter Trainees (women)	233	.76*	.91

*Test-retest reliabilities of college students at Purdue University

**From L. V. Surgent, "The Use of Aptitude Tests in the Selection of Radio Tube Mounters," Psycholo. Monog, 1947, 61, No. 2, 1-40.

***Three-trial reliabilities obtained in each case by "stepping up" one-trial reliability by means of the Spearman-Brown Prophecy Formula.

the Purdue Pegboard.[8] The reliability coefficients for the one-trial method of administration and scoring the several tests were obtained by correlating test-retest scores on the groups indicated. The reliability coefficients for three-trial administration have been predicted from the one-trial reliabilities by means of the Spearman-Brown Prophecy Formula. When the most precise measurement possible of every individual is desired, it is recommended that the three-trial method of administering the tests be followed.[9]

Generalizations concerning the validity of any test should be made with great caution, and this is particularly true of dexterity tests. As Seashore[10] has reported, motor skills are quite specific and ordinarily not highly correlated with each other. This situation perhaps accounts for the fact that a given dexterity test may have a rather satisfactory validity for certain manipulative jobs and yet be unsuitable for other manipulative jobs which might seem to be very similar. It is therefore highly desirable to conduct a study of the validity of several Pegboard tests among employees on a specific job for which the use of the test is contemplated, rather than attempt to generalize

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[8]Purdue Pegboard, loc. cit.

[9]Ibid.

[10]R.H. Seashore, "Standard Motor Skills Unit," Psychol. Monogr., 39:51-66, 1928, and "Individual Differences in Motor Skills," Journal of General Psychology, 3: 38-66, 1930.

from available validity studies.[11]

Crawford Small Parts Dexterity Test (CSPDT). The Crawford Small Parts Dexterity Test is a performance test designed to measure fine eye-hand coordination consisting of two parts. Part I, Pins and Collars, measures dexterity in using tweezers to insert small pins in close fitting holes in a plate and screwing them down with a screwdriver. Separate scores are obtained for each part. The test probably offers a more realistic indication of dexterity in handling small parts than do tests involving the use of one total of arm, hand, and/or fingers or fingers alone.

The CSPDT was developed as a work-limit test; that is the subject completes the entire task and his score is the time required. Practically all of the normative data for the CSPDT have been based on individual administration of test under work-limit conditions. The average subject can be tested in about fifteen minutes. Because this test is not designed for the DS individual, adaptations were arranged for this study; that is, instead of completing all thirty-six holes of Part I and all thirty-six holes in Part II the subject was instructed to complete six holes in Part I and six holes in Part II.

For a group of war veterans tested at Trenton, New Jersey, the reliability of each part of the CSPDT was estimated by correlating the time required to complete the first three rows with the time for the last three rows.

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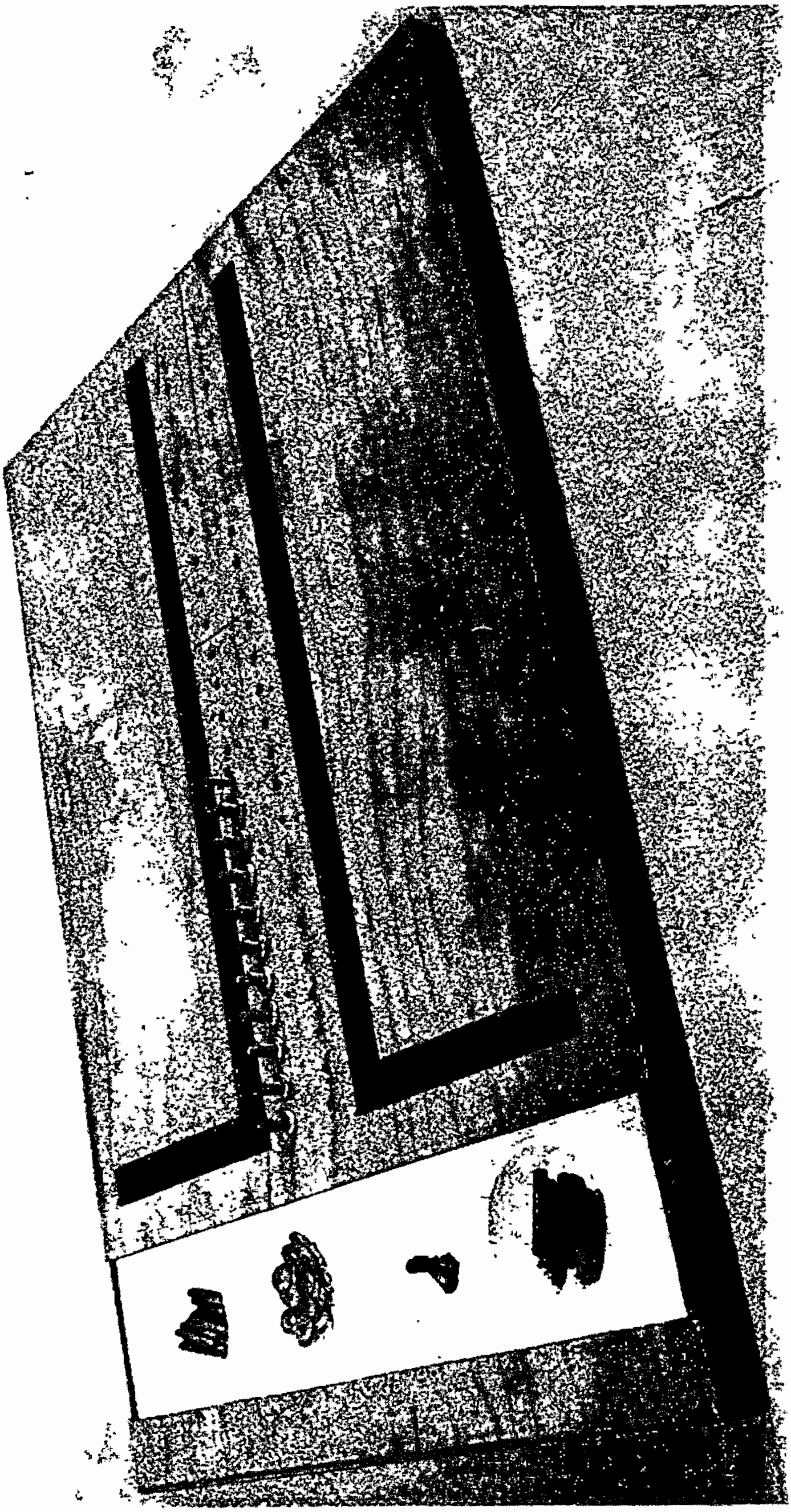
[11] Purdue Pegboard, loc. cit.

Illustration: Purdue Pegboard



For trade, technical, and academic students in the Yonkers, New York High Schools, coefficients of correlation were computed between the time for the first, third, and fifth rows and the time for the second, fourth, and sixth rows. The correlation coefficients, corrected by the Spearman-Brown Formula, are presented in Table 3.2 for each of the four groups. Under work-limit conditions the reliability coefficients for the parts of the CSPDT seem entirely satisfactory.

The "face validity" of the Crawford Small Parts Dexterity Test, like that of other dexterity tests, simply refers to the extent that it obviously resembles or parallels the activity or operation of a training course in which the success or failure of the examiner is to be predicted. Studies suggest the possibility of using the CSPDT as one of the instruments in the selection of assemblers.[12]

Program Procedures

Before training sessions were initiated, the subjects explored each task, then the investigator determined the level of functioning of each subject through observation. The subject then began practicing each task at that phase at which he exhibited performance difficulties.

Each child was met individually for thirty minutes a day, four days per week (Monday through Thursday), for a period of seven weeks. Training took place in a quiet room,

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[12] Crawford Small Parts Dexterity Test, loc. cit.

TABLE 3.2

Reliability Coefficients for Work-Limit Scores on the

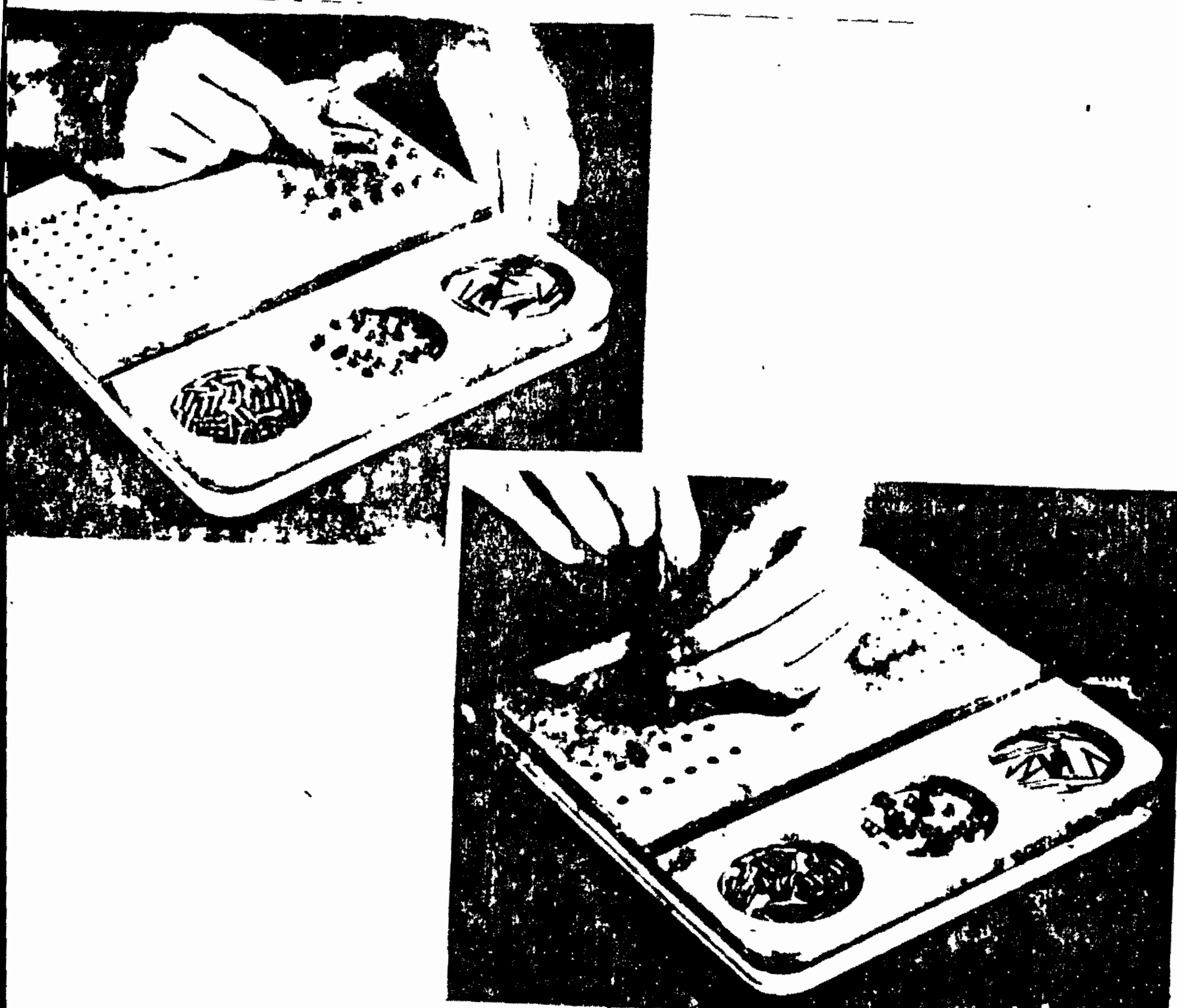
Crawford Small Parts Dexterity Test

Males

Group	N	r	Part I mean	SD	r	Part II mean	SD
Veterans	66	.91	5'07"	0'55"	.95	7'01"	1'13"
Trade High School Students	93	.80	4'49"	0'49"	.91	7'40"	1'33"
Technical Students	56	.84	4'55"	0'51"	.90	8'15"	1'13"
Academic Students	118	.90	5'22"	1'12"	.94	9'12"	1'36"

*From Crawford Small Parts Dexterity Test, Psychological Corporation, New York, 1965, p. 9.

Illustration: Crawford Small Parts Dexterity Test



with no distractions with the investigator sitting next to the subject at a table. Each subject received four different tasks each day (alternating each week) working approximately five minutes on each task. (Refer to Appendix B for Training Schedule).

The first and last three days of the investigation were used for pre-testing and post-testing each subject on their manual dexterity skills. The tests included the Purdue Pegboard, the Crawford Small Parts Dexterity Test, and the Stromberg Dexterity Test. Results were individually and descriptively analyzed because of the small number of subjects (refer to Chapter IV for Analysis of Data).

The training sessions were conducted in a systematic manner. Adult demonstration and exploration were given to help the subjects achieve and maintain the fine motor skills that were to be developed according to each task. In order to assess the progress of each subject's performance, subjective data was obtained each session by the investigator. The subject's performance rate of manipulation, behavior, and consistency were recorded for each task (refer to Appendix C).

CHAPTER IV

RESULTS AND DISCUSSION

This study was designed to determine if the fine motor skills of three young Down's Syndrome children functioning below average in manual dexterity skills could be improved through a systematic training program. The primary focus of this chapter is to present the results of this program in terms of fine motor performance. As a matter of interest, information pertaining to subjective analysis of social and emotional behavior is also presented.

<u>Case Study #1 George</u>

George was nine years and one month old at the onset of the investigation. He was enrolled in a primary trainable mentally retarded class at the Board of Cooperative Educational Services, Spencerport, New York. His intelligence level, as measured by the Stanford-Binet Intelligence Test, was thirty-five and his mental age was approximately four years and nine months. He demonstrated poor articulation which made it difficult to clearly understand what George verbalized; however basic language skills were acceptable. Throughout the twenty-one training sessions George listened and followed instructions adequately. His meticulous work demonstrated that he would try and was anxious to please. Tiredness, boredom, and frustration were common traits that George frequently demonstrated. These traits were evidenced by his switching of an object from his preferred hand to his non-preferred hand. Hartman[1] stated that fatigue can cause a subject to switch hands during testing. Inappropriate behaviors such as making faces in a nearby mirror, pretending to eat the small task items, and chewing his tongue were exhibited often and detracted George's attention from the assigned tasks.

The first three meetings with George involved pre-testing his manual dexterity ability utilizing the Purdue Pegboard, the Crawford Small Parts Dexterity Test, and the Stromberg Dexterity Test (refer to Chapter III, for complete test descriptions). During the first few days with George, the investigator observed the subject's slow pace of performing and his quiet disposition. In the new and unfamiliar situation George was very observant to the surroundings and less attentive to the tests being administered. This undoubtedly affected his test performance. In Table 4.1 George's pre-test scores are provided for the Purdue Pegboard, the Crawford Small Parts Dexterity Test, and the Stromberg Dexterity Test.

Observations Made During the Training Period

Initially, George demonstrated a very low level of performance. He demonstrated difficulty in such tasks as

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[1]Hartman, "A Comparison of Motor Skills of Mentally

TABLE 4.1

George's Pre-Test Scores for the

(1) Purdue Pegboard,

(2) Crawford Small Parts Dexterity Test, and (3) Stromberg Dexterity Test

Test	Description	Scoring			
Purdue Pegboard		Trial 1	Trial 2	Trial 3	Total
	Right Hand	4	5	6	15
	Left Hand	3	3	4	10
	Both Hands	3	3	3	9
	R+L+B	15	10	9	34
	Assembly	7	7	8	22
Crawford Small Parts Dexterity Test		Time			
	With 6 pins	11:12.5			
	With 6 screws	13:57.3			
Stromberg Dexterity Test		Time			
	Part I	9:21.3			
	Part II	7:28.8			

placing the small beans into the bowl, cup, and bag; untying simple and complex knots; securing the bottle and can lids; and executing the Dressing Techniques and Shoe Lacing Task; Nut and Bolt Board Task; Gluing Cut-Outs Task; Tracing Outlines Task; and the Screwdriver Task. George was able to perform at an acceptable level of functioning with the Pegs and Holes Task, placing large beans into the bowl and cup, threading the spools and large beads on a long cord, and securing lids on the larger containers.

Gesell[2] tested normal children on fine motor coordination and found that (1) the normal child at five years of age can place ten pellets in a bottle within twenty seconds and that this particular skill of pellet placement is ordinarily developed at fifteen months of age, (2) begins to dress himself at three years of age and by age five will completely dress himself unassisted, and (3) can tie and untie knots at age six. Share[3] who demonstrated the same schedule with 211 Down's Syndrome subjects found that (1) DS children up to chronological age of six years old could not place 10 pellets in a bottle within 20 seconds and that

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Retarded and Normal Children," Exceptional Children, 25:352-4, 1959.

[2]Arnold Gesell, et. al., The First Five Years of Life, London: Methuen and Co., pp. 319-43, 1940.

[3]Jack B. Share, "A Study of New Zealand Down's Syndrome Children Under Six Years of Age," Unpublished Doctoral Dissertation, National University of Mexico, 1971.

pellet placement was developed at 36 months of age in comparison to normal children who develop this skill at 15 months of age, (2) dressing skills were not accomplished until after age six for the DS child, and (3) DS children cannot tie and untie knots until after age six. (Information pertaining to rotational movements, such as in the Nut and Bolt Board Task and the Screwdriver Task could not be obtained).

The investigator gave approving recognition to George's manipulative performance, offered assistance when he demonstrated extreme difficulty when executing a desired skill, carefully demonstrated each task for him, and provided him with verbal instructions.

Within the first nine training sessions George's manual dexterity skills were slowly developing. Familiarity with the environment and improved social interaction with the investigator were factors which accounted for improvement in training sessions. Improvement was noted in the Dressing Techniques and Shoe Lacing Task (buttoning, snapping, and zipping), in placing beans in a bowl and cup (Bean Placement Task), and in securing all lids on their respective containers (Lids and Containers Task). In some instances it appeared that progress was so rapid that the immediate change could be attributed to the fact that the subject already had a repertoire of skills readily adapted to perform with his hands and fingers and momentarily he was relearning the skills. Previous investigators have demonstrated that the development of adequate manual dexterity skills is not as rapid as was found in George's case.[4] Tasks involving radial movement patterns as in the Nut and Bolt Board Task, were slowly improved. It was noted by the investigator that performing rotational movement on a horizontal axis was less difficult for the subject than executing this task on a vertical axis. Utilizing a screw-driver on a vertical axis added to increased difficulty in performing the skill of rotational movement. No apparent difference in the performance of clockwise and counter clockwise direction was observed in rotational movements. No apparent progress was accomplished with knot untying, a very difficult task for the subject.

Further into the training period successes, as specified in the daily checklists, were met with the Pegs and Holes Task, Bead Threading Task, and Bean Placement Task and consequently performance speed was then taken into account. Improvement in these tasks may have been due to the adaption of the grip most compatible with the task requirement, an understanding of the requirements of each task, and the manual repetition of each task. Nonetheless, it appeared that accomplishments were achieved and rate of manipulation was then recorded as demonstrated in Table 4.2.

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[4]James Stiehl, "The Motor Abilities of Children With Down's Syndrome," Unpublished Thesis: University of California at Los Angeles, 1973; see also Samuel A. Kirk, Educating Exceptional Children, Boston: Haughton-Mifflin Co., 1962.

TABLE 4.2

George's Rate of Manipulation for the Pegs and Holes Task, Bean Placement Task, and the Bead Threading Task

Task	Initial Time Trial	Final Time Trial
Small Pegboard:		
Both Hands	1:27	1:39
Right Hands	3:00	2:07
Left Hands	3:00	2:30
15 Small Beans into Bag:		
Right Hand	1:50	1:28
Left Hand	1:00	1:04
10 Small Beads:		
Both Hands	2:28	1:25

All other tasks continued as programmed.

Improvement was not noticeable from training session to training session. However, it appeared that definite improvement was made over the course of the entire training period. Progress in fine motor performance was slow, but appeared to be steady. Tasks that required finger dexterity improved to an acceptable level of performance (able to perform a skill independently without difficulty) as demonstrated in manipulating the nut and bolt board, buttoning and unbuttoning, snapping and unsnapping, fastening and unfastening the hooks and eyes, and removing and securing the lids of various containers. In no instance did performance drop any great degree; however, performance remained at the same level in knot untying, shoe lacing, fastening the zipper, gluing cut-outs, tracing outlines, and manipulating the screwdriver appropriately. George's failure to progress with these forementioned tasks may have been due to (1) task complexity, (2) variability in anatomical features in which the long fingered child may have certain manipulative advantages over the short fingered child,[5] (3) motivational procedures, and (4) an insufficient number of instructional sessions for each task. As mentioned earlier, rapid progress, as recorded in the daily check lists, was noted for the Pegs and Holes Task, Bean Placement Task, and the Bead Threading

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[5]Jack B. Share and Ronald French, "Early Motor Development in Down's Syndrome Children," Mental Retardation, 12:6, December, 1974; see also Gesell, et. al., loc. cit.

Task which could be attributed to (1) familiarity of the task done at school or home, (2) a repertoire of skills readily adapted to perform the desired task, (3) repetition of the task, and (4) motivational procedures.

Analysis of Test Scores

The last three days involved post-testing George on his fine motor performance using the Purdue Pegboard, Crawford Small Parts Dexterity Test, and the Stromberg Dexterity Test. Post-test scores are presented in Table 4.3.

In comparing pre-test and post-test scores of the Purdue Pegboard, Crawford Small Parts Dexterity Test, and the Stromberg Dexterity Test, overall improvement was found in fine motor manipulation. Improvement ranged from twenty to seventy percent in the Purdue Pegboard test items Right Hand, Left Hand, Both Hands, and Assembly. The lowest percent of increase was demonstrated in the Assembly test item which required both the right and left hands working together. George exhibited difficulty synchronizing his hands even though he could work with either hand. Continued training on this particular skill proved to be beneficial as is indicated in the post-test scores. The highest percent of increase was demonstrated in the Left Hand test item (George's preferred hand).

In the Crawford Small Parts Dexterity Test, Part I, the subject performed at a slower time trial in the post-test. This test item required the subject to pick up pins with tweezers. No task in this study utilized the use of an

TABLE 4.3

George's Post-Test Scores for the

(1) Purdue Pegboard,

(2) Crawford Small Parts Dexterity Test, and (3) Stromberg Dexterity Test

Test	Description	Scoring			
Purdue Pegboard		Trial 1	Trial 2	Trial 3	Total
	Right Hand	8	8	7	23
	Left Hand	5	6	6	17
	Both Hands	3	5	4	12
	R+L+B	23	17	12	52
	Assembly	9	10	8	27
Crawford Small Parts Dexterity Test			Time		
	With 6 pins		12:40.1		
	With 6 screws		12:43.5		
Stromberg Dexterity Test			Time		
	Part I		7:45.0		
	Part II		6:07.9		

implement for picking up small items. George's post-test time was faster in Part II of the CSPDT. This test required the utilization of a screwdriver. George improved one minute and fourteen seconds over his pre-test time trial.

George demonstrated approximately one minute and thirty seconds improvement in both Part I and Part II of the Stromberg Dexterity Test. Basically, this task required placing different colored blocks in rows and columns. George's better time could possibly be due to his training on the Pegs and Holes Task and the Bean Placement Task. His previous knowledge and acquired skill of color discrimination, sorting, and matching were also factors to consider in his completing this task successfully.

Further confirmation of positive test results in fine motor manipulation is supported by the progress recorded in daily check lists.

<u>Case Study #2 Danny</u>

Danny was eleven years and eight months old at the onset of the investigation. He was enrolled in a primary trainable mentally retarded class at the Board of Cooperative Educational Services, Spencerport, New York. His intelligence, as measured by the Stanford-Binet Intelligence Test, was thirty-four. His mental age was approximately three years and ten months of age. A hearing loss due to an impacted cerumen was medically corrected with the use of a hearing aid at an early age. Due to this handicap, his language skills were limited. This made it difficult to clearly understand what Danny verbalized; however, basic language skills were acceptable. During the study Danny was cooperative, but at times could be obstinate and insist that he instruct the investigator on several tasks. Verbal reprimand would alleviate this behavior and he would then resume the assigned tasks with little disturbance on his part. Danny's tendency to hurry through several tasks resulted in failure on task, and tasks were slovenly executed. It is to be noted that this subject was capable of success on many tasks. This was demonstrated when he was instructed to work at a slow pace with consistent verbal prompting. Overall, Danny was a likeable, friendly child who on occasion would harmlessly misbehave.

The first three meetings with Danny involved the assessment of his manual dexterity ability utilizing the Purdue Pegboard, the Crawford Small Parts Dexterity Test, and the Stromberg Dexterity Test (refer to Chapter III, for complete test descriptions).

During the first few days the investigator observed Danny's behaviors and manual dexterity ability. He appeared to be unaffected by a new teaching situation and/or unfamiliar person. At times he would seek attention even though he was working on a one-to-one basis. Danny would attend to the tests being administered except on occasion when he would exhibit inappropriate behavior, such as non-compliance, which affected his test scores. In Table 4.4 Danny's pre-test scores are provided for the Purdue Pegboard, Danny's Pre-Test Scores for the

(1) Purdue Pegboard,

(2) Crawford Small Parts Dexterity Test, and (3) Stromberg Dexterity Test

Test	Description	Scoring			
Purdue Pegboard		Trial 1	Trial 2	Trial 3	Total
	Right Hand	4	7	5	16
	Left Hand	6	6	6	18
	Both Hands	2	3	3	8
	R+L+B	16	18	8	42
	Assembly	8	7	7	22
Crawford Small Parts Dexterity Test		Time			
	With 6 pins	9:36.4			
	With 6 screws	12:40.2			
Stromberg Dexterity Test		Time			
	Part I	9:09.0			
	Part II	7:29.1			

the Crawford Small Dexterity Test, and the Stromberg Dexterity Test.

Observations Made During the Training Period

During the first few days while tasks were introduced, Danny demonstrated potential for acceptable manual dexterity skills, but appeared to lack refinement. Initially, in the Nut and Bolt Board Task, the subject was able to turn the nut clockwise and counterclockwise around the bolt but was not consistent in turning the nut continually in one direction. In the Pegs and Holes Task, the subject was successful at completing the Knot Untying Task. Obviously, Knot tying and untying are skills that Danny previously learned at home and/or school. The subject performed successfully at the lower spectrum of the Bean Placement Task, but demonstrated difficulty as the task became more complex. He was unable to synchronize both hands simultaneously in placing the beans into the various containers, but was able to coordinate both hands as one hand held a bag open while the other hand placed several beans into the bag. In the Bead Threading Task, the subject could not comprehend where to hold the cord to place the beads on correctly, despite multi-sensory directions, and consequently was not successful at this task. To the subject, the Tracing Cut-lines Task was not at all motivating. He performed this task quickly and carelessly. Danny did not trace within the margins, his drawing lines were not continuous, and many times he would not complete the tracing task. Similar to the

Tracing Outlines Task, the Gluing Cut-Outs Task was also performed carelessly. The subject pressed down the paper cut-out anywhere without concentrating on centering it within the designated outline. In the Dressing Techniques and Shoe Lacing Task, the subject had difficulty fastening and unfastening the buttons, hooks and eyes, and zipper. Fastening and unfastening snaps was the only dressing technique he could initially perform. In the Lids and Containers Task, the subject was capable of removing and securing all lids to their respective containers, but demonstrated some difficulty with the bottle and square lids and containers. The subject demonstrated much difficulty and frustration with the Screwdriver Task. As was noted in the Bean Placement Task, where he had difficulty working with both hands simultaneously, Danny had similar difficulty in the Screwdriver Task. Danny preferred to perform this task with one hand even though it required the use of both hands. Further, as was noted in the Nut and Bolt Board Task, Danny had similar difficulty in the Screwdriver Task; that is, turning the screw continously in one direction. Graduated guidance (physical and verbal prompting) was the only method to employ with Danny to ensure success.

Overall, Danny had the basic skills for acceptable manual dexterity. It was exposure and practice that would refine his fine motor coordination. This was demonstrated during the course of the training sessions.

During training sessions nine through twelve, it appeared that definite improvements were made. The Pegs and Holes, Bean Placement, and Bead Threading were three tasks where the subject reached the highest level of attainment. Timing for speed of performance was then taken into account. Specifically, in the Pegs and Holes Task, improvement was noted in placing the small pegs in their respective pegboard. Also, vertical patterning of the pegs was executed by the subject. As was demonstrated from the onset of the training program, using both hands simultaneously was still a difficult skill for the subject to coordinate. After repeated graduated guidance and multi-sensory direction, the subject independently held the cord correctly to string any size bead without any difficulty and the same for placing any size bean into any container. (Due to insufficient number of time trials, improvement in speed of performance cannot be substantiated).

Other areas of improvement were noted in the Nut and Bolt Board Task and the Dressing Techniques and Shoe Lacing Task. After several instructional periods Danny was able to put the nuts completely on their respective bolts and remove each one independently. With limited graduated guidance (mostly verbal prompting) the subject was able to fasten and unfasten buttons, hooks and eyes, and a zipper. No apparent improvement was noted in the Tracing Outlines Task, Gluing Cut-Outs Task, Screwdriver Task, or the Knot Untying Task. The most prevalent factor for no improvement in these tasks was the low motivational level of the tasks for the subject. He hurried through the tasks to finish as soon as possible.

During the entire training sessions, Danny excelled in the Pegs and Holes Task, Bead Threading Task, and the Bean Placement Task. It appeared that progress was so rapid, that the immediate change may be attributed to the fact that the subject already had a repertoire of skills readily adapted to perform with his hands and fingers and momentarily he was relearning the skills. Previous investigators have demonstrated that the development of adequate manual dexterity skills is not always as rapid as was found in Danny's case.[6] Improvement was gradual but not necessarily visible until comparing training session notes from the beginning to end. Tasks that demonstrated this included the Lids and Containers Task and Dressing Techniques and Shoe Lacing Task. In the Lids and Containers Task, it appeared that improvement was made since the subject removed and replaced the lids to respective containers with less difficulty. For the Dressing Techniques and Shoe Lacing Task improvement was demonstrated from graduated guidance to verbal prompt to complete independence in fastening and unfastening buttons, hooks and eyes, and the zipper. Apparent improvement in this area may be attributed to the fact that the subject was also learning these skills at home and/or at school. No apparent improvement was demonstrated in the Knot Untying Task, Gluing Cut-Outs Task, Tracing Outlines Task, and the Screwdriver Task. This may have been due to (1) task complexity, (2) variability

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[6]Stiehl, loc. cit.; See also Kirk, loc. cit.

in anatomical features in which the long fingered child may have certain manipulative advantages over the short fingered child,[7] (3) motivational procedures, and (4) an insufficient number of instructional sessions for each task.

Analysis of Test Scores

The last three days involved post-testing Danny on his fine motor performance using the Purdue Pegboard, the Crawford Small Parts Dexterity Test, and the Stromberg Dexterity Test. Post-test scores are presented in Table 4.5.

In comparing pre-test and post-test scores of the Purdue Pegboard, the Crawford Small Parts Dexterity Test, and the Stromberg Dexterity Test, better scores were noted in fine motor manipulation. Danny scored extremely higher in speed of performance from pre-test to post-test trials on both the Crawford Small Parts Dexterity Test and the Stromberg Dexterity Test. Rate of manipulation improved from one minute faster on Part II of the SDT (placing colored blocks in columns) up to six minutes faster on Part II of the CSPDT which required the utilization of a screwdriver. The validity of these scores are questionable especially where the subject's time improved more than six minutes working with six screws and yet, during the instructional sessions in the Screwdriver Task, Danny demonstrated much difficulty throughout. It is believed that the extreme changes in performance were due to factors other than the training of specific tasks.

[7]Share and French, loc. cit.; see also Gesell, et. al., loc. cit.

Danny's Post-Test Scores for the

(1) Purdue Pegboard,

(2) Crawford Small Parts Dexterity Test, and (3) Stromberg Dexterity Test

Test	Description	Scoring			
Purdue Pegboard		Trial 1	Trial 2	Trial 3	Total
	Right Hand	3	7	5	15
	Left Hand	6	7	7	20
	Both Hands	5	3	5	13
	R+L+B	15	20	13	48
	Assembly	9	9	6	24
Crawford Small Parts Dexterity Test		Time			
	With 6 pins	4:30.0			
	With 6 screws	6:21.7			
Stromberg Dexterity Test		Time			
	Part I	5:40.0			
	Part II	6:21.4			

On the Purdue Pegboard, better scores were achieved in all areas except for use of the Right Hand, which was decreased by a total of one score. Left Hand, Both Hands, and Assembly test items improved slightly.

Case Study #3 Paul

Paul was nine years and eleven months old at the onset of the investigation. He was enrolled in a primary trainable mentally retarded class at the Board of Cooperative Educational Services, Spencerport, New York. His intelligence level as measured by the Stanford-Binet Intelligence Test was forty-five and his mental age was approximately four years old. His basic language skills were acceptable; however on occasion he had to be reminded to speak slowly in order to be understood. Paul's behavior pattern fluctuated between appropriate behavior and good work habits to stubbornness and bossiness. On the whole, he was cooperative and very capable on task completion. One outstanding characteristic, different from the other subjects was Paul's competitive nature. Utilizing a stop-watch on several tasks was an excellent motivator for the subject. To Paul's disadvantage he worked very close to the table which may have been an indication of visual difficulties. (School records reported of the condition, but made no mention of having his eyes examined by a physician).

The first three meetings with Paul involved pre-testing his manual dexterity ability utilizing the Purdue Pegboard, the Crawford Small Parts Dexterity Test, and the

Stromberg Dexterity Test. (Refer to Chapter III). Paul readily adjusted to the new environment. In Table 4.6 the pre-test scores are provided for the Purdue Pegboard, the Crawford Small Parts Dexterity Test, and the Stromberg Dexterity Test.

Observations Made During the Training Period

From the beginning, Paul exhibited a higher level of functioning on tasks than the other two subjects. The tasks that he performed initially without any difficulty were the Nut and Bolt Board, Knot Untying, Bean Placement, Dressing Techniques and Shoe Lacing, Tracing Outlines, Gluing Cut-Outs, Pegs and Holes, and Lids and Containers. In the Nut and Bolt Board Task, he removed all nuts and bolts then matched them according to size when replacing the nut onto the bolt. He performed the Knot Untying Task easily tying and untying knots and bows. Obviously, this was a skill previously learned at home and/or school. In the Bean Placement Task, he was able to place large, medium, and small sized beans into the designated bowl, cup, and bag. This required one hand to hold the bag open while the other hand placed the beans into the bag. On the Dressing Techniques and Shoe Lacing Task he fastened and unfastened the larger sized items (buttons, hooks and eyes, and snaps) best. He demonstrated some difficulty on the smaller sizes and also difficulty fastening a zipper. On the simple shapes of the Tracing Outlines Task, he traced following the outlines as printed. It is stated in his school record that tracing is

TABLE 4.5

Paul's Pre-Test Scores for the

(1) Purdue Pegboard,

(2) Crawford Small Parts Dexterity Test, and (3) Stromberg Dexterity Test

Test	Description	Scoring			
Purdue Pegboard		Trial 1	Trial 2	Trial 3	Total
	Right Hand	9	10	7	26
	Left Hand	9	7	7	23
	Both Hands	7	5	4	16
	R+L+B	26	23	16	65
	Assembly	11	9	13	33
Crawford Small Parts Dexterity Test			Time		
	With 6 pins		5:47.1		
	With 6 screws		10:19.9		
Stromberg Dexterity Test			Time		
	Part I		4:47.2		
	Part II		4:21.8		

one of his strong areas in fine motor skills and that he does "beautiful work". Similar to the Tracing Outlines Task, Paul was capable of keeping within the outlines of the Gluing Cut-Outs Task. He pasted the various shaped cut-outs into their respective outlines keeping all cut-outs within the boundary lines. In the Pegs and Holes Task, he placed the small pegs into the small pegboard quickly and easily. A stopwatch was utilized from the beginning to time for speed of performance. Obviously, this was another task that Paul previously learned at home and/or school. On the Lids and Containers Task he was able to remove and secure all lids to their respective containers except for the bottle cap, a task which was difficult for all subjects. As pointed out later in this study, securing the bottle cap was one task that Paul met with no success.

In general, Paul's fine motor skills were highly developed in comparison to Danny and George and his rate of performance was a major determinate in Paul's progress and then refinement. In some cases where he demonstrated difficulty, training focused on learning the skills to perform the manual dexterity tasks.

Unlike the other two subjects who demonstrated rapid progress in some areas, Paul exhibited steady progress and in some cases, none at all. On the Screwdriver Task he experienced extreme difficulty. Initially he had difficulty keeping the screwdriver stable in the slot of the screw. As frustration built because of failure, he would resort to hammering in the screw. Difficulty with this task may have been due to (1) task complexity, (2) variability in anatomical features in which the long fingered child may have certain manipulative advantages over the short fingered child,[8] (3) motivational procedures, and (4) an insufficient number of instructional sessions for the task.

The tenth task (not forementioned) was the Bead Threading Task. On this task Paul originally demonstrated slight difficulty. He could not conceive where to place his fingers on the cord to string the beads. With a prompt of graduated guidance in placing his fingers at the most comfortable position on the cord, he was then successful at stringing beads. However, this was one task where there was no carry over. Each subsequent session he performed the Bead Threading Task, he would hold the cord too close to the end and needed the prompt of graduated guidance to execute this task successfully. Speed of performance was taken into account. As shown in Table 4.7, Paul's rate of manipulation improved during several training sessions for the Pegs and Holes Task, Bean Placement Task, and Bead Threading Task. In the Pegs and Holes Task, Paul performed well from the onset of training and timing was the next step to determine progress. All other tasks progressed as described. No observable progress was met in the Nut and Bolt Board Task. From the

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[8] Ibid.

TABLE 4.7

Paul's Rate of Manipulation for the Pegs and Holes Task, Bean Placement Task, and Bead Threading Task

Task	Initial Time Trial	Final Time Trial
Small Pegboard		
Right Hand	1:25	1:08
Left Hand	1:20	1:04
Both Hands	1:00	1:04
15 Small Beans into Bag:		
Right Hand	1:15	:55
Left Hand	1:11	:52
String 10 Small Beads:		
Both Hands	1:55	1:49

beginning Paul removed and secured all the nuts and bolts according to size. Minimal progress was met in the Knot Untying Task. Paul previously knew how to tie and untie knots and bows. To increase the level of difficulty, Paul was also capable of untangling yarn and cord that was knotted several times. Generally, performance of the Dressing Techniques and Shoe Lacing Task remained the same except for fastening and unfastening the small sized snaps which Paul was able to execute after four training sessions. In the Tracing Outlines Task, apparent improvement was noted on the more difficult outlines. Initially, Paul did not connect the lines on the spiral or the checkerboard forms. After several training sessions he was able to trace the outlines as designated. As mentioned earlier, tracing was one of Paul's highly developed fine motor skills. No observable improvement was noted in the Gluing Cut-Outs Task. Paul was very capable on this task from the beginning. The investigator could possibly have provided more complex outlines in this task to make it more challenging for her subject. No observable improvement was noted in the Lids and Containers Task. Paul's performance remained the same. He was able to remove and secure all lids except for the bottle cap which was much more tight fitting than the other lids to their respective containers.

Overall, throughout the training period, Paul appeared to demonstrate substantial progress in those tasks which were familiar to him. He appeared to make little or no progress on tasks unaccustomed to him. Perhaps the training period was insufficient in duration of time or motivational procedures were inadequate.

Analysis of Test Scores

The last three days involved post-testing Paul on fine motor performance using the Purdue Pegboard, the Crawford Small Parts Dexterity Test, and the Stromberg Dexterity Test. Post-test scores are presented in Table 4.8. Surprisingly Paul's post-test scores do not reflect his work during the training period. The Purdue Pegboard scores were lower in the post-test scores than in the pre-test scores for all test items except Assembly, and yet during the training period the subject appeared to improve substantially with the Pegs and Holes Task. On the other hand, Paul demonstrated extreme difficulty when manipulating implements as in the Screwdriver Task and yet post-test scores in the Crawford Small Parts Dexterity Test Part I and Part II, were higher than the pre-test scores. Paul scored higher in the second administration of the Stromberg Dexterity Test, which is basically matching colors, and yet no color discrimination task was included in this study. Paul also scored higher in the post-test of the assembly part of the Purdue Pegboard than in the pre-test. The test required the use of both hands working together and this was a skill Paul performed well. Despite the unexpected post-test scores progress was observed and noted by the investigator during the training period.

TABLE 4.8

Paul's Post-Test Scores for the

(1) Purdue Pegboard,

(2) Crawford Small Parts Dexterity Test, and (3) Stromberg Dexterity Test

Test	Description	Scoring			
Purdue Pegboard		Trial 1	Trial 2	Trial 3	Total
	Right Hand	5	8	10	23
	Left Hand	8	8	5	21
	Both Hands	6	3	7	16
	R+L+B	23	21	16	60
	Assembly	13	12	10	35
Crawford Small Parts Dexterity Test			Time		
	With 6 pins		5:23.8		
	With 6 screws		8:38.0		
Stromberg Dexterity Test			Time		
	Part I		3:04.7		
	Part II		3:49.4		

Summary of Findings

This study was conducted to determine if the fine motor skills of young trainable mentally retarded children with Down's Syndrome could be improved through systematic training on specific manual dexterity tasks. To assess improvement on the selected tasks subjective data was recorded each session by the investigator. In Table 4.9 a Summary of Results on the Training Tasks and Related Tests is presented.

Due to the limitations in this study, the investigator cannot offer scientific evidence that the subjects did improve in fine motor manipulation and that improvement could be attributed solely to the training program. The results of the study are based purely on observation and pre and post-test scores. These findings indicate that all three subjects demonstrated improvement on sixty per cent of the manual dexterity tasks. It appeared that improvement on some tasks was so rapid that the immediate change may be attributed to the fact that the subjects already had a repertoire of skills readily adapted to perform with their hands and fingers and momentarily they were relearning the skills. The remaining forty per cent, where no apparent improvement was noted, was perhaps due to several variables such as motivational procedures, inability to perform the task, insufficient number of training sessions, task complexity, and initially performing the task at the most difficult level.

As a matter of interest the Purdue Pegboard, the Crawford Small Parts Dexterity Test, and the Stromberg

TABLE 4.9

Summary of Results on the Training Tasks and Related Tests

Observations During Training			
George's Performance on Task	Improvement	No Improvement	Related Tests
Nut and Bolt Board	X		PP, CSPDT
Pegs and Holes	X		PP,CSPDT,SDT
Knot Untying		X	CSPDT
Bead Threading	X		PP,CSPDT,SDT
Bean Placement	X		PP,CSPDT,SDT
Tracing Outlines		X	PP,CSPDT,SDT
Gluing Cut-Outs		X	PP,CSPDT,SDT
Dressing Techniques and Shoe Lacing	X		PP,CSPDT,SDT
Lids and Containers	X		PP,CSPDT,SDT
Screwdriver Manipulation		X	CSPDT

George's Test Results	Improvement	No Improvement
Purdue Pegboard (PP)	X	
Crawford Small Parts Dexterity Test (CSPDT)	X Part II	X Part I
Stromberg Dexterity Test (SDT)	X	

TABLE 4.9 Continued

Observations During Training			
Danny's Performance on Task	Improvement	No Improvement	Related Tests
Nut and Bolt Board	X		PP, CSPDT
Pegs and Holes	X		PP,CSPDT,SDT
Knot Untying		X	CSPDT
Bead Threading	X		PP,CSPDT,SDT
Bean Placement	X		PP,CSPDT,SDT
Tracing Outlines		X	PP,CSPDT,SDT
Gluing Cut-Outs		X	PP,CSPDT,SDT
Dressing Techniques and Shoe Lacing	X		PP,CSPDT,SDT
Lids and Containers	X		PP,CSPDT,SDT
Screwdriver Manipulation		X	CSPDT

Danny's Test Results	Improvement	No Improvement
Purdue Pegboard (PP)	X	
Crawford Small Parts Dexterity Test (CSPDT)	X	
Stromberg Dexterity Test (SDT)	X	

TABLE 4.9 Continued

Observations During Training			
Paul's Performance on Task	Improvement	No Improvement	Related Tests
Nut and Bolt Board		X	PP,CSPDT
Pegs and Holes	X		PP,CSPDT,SDT
Knot Untying	X		CSPDT
Bead Threading	X		PP,CSPDT,SDT
Bean Placement	X		PP,CSPDT,SDT
Tracing Outlines	X		PP,CSPDT,SDT
Gluing Cut-Outs		X	PP,CSPDT,SDT
Dressing Techniques and Shoe Lacing	X		PP,CSPDT,SDT
Lids and Containers		X	PP,CSPDT,SDT
Screwdriver Manipulation		X	CSPDT

Paul's Test Results	Improvement	No Improvement
Purdue Pegboard (PP)		X
Crawford Small Parts Dexterity Test (CSPDT)	X	
Stromberg Dexterity Test (SDT)	X	

Dexterity Test were administered prior to and at the completion of the training period to further assess improvement. Generally, the manual dexterity tests indicated improvement by all three subjects, but within the limitations of this study it is highly probable that the pre and post-test scores were influenced by other factors. Specifically, during pre-testing, George was observant to the environment and less attentive to the tests being administered and Danny was non-compliant, both which undoubtedly resulted in low test scores. During post-testing Danny improved markedly and George demonstrated substantial improvement. On the other hand, Paul readily adjusted to the new environment and being a competitive child, performed well during the pre-tests. However, his post-test scores were lower. This may have been due to sheer boredom of task repetition or any other factor. Regardless of improvement or not, limitations of the study prohibit the conclusion that improvement was due to the systematic training program employed in the study.

Discussion

The case studies involved in this investigation have suggested that fine motor performance of the young Down's Syndrome child can be improved through a systematic training program. Generally, all three subjects exhibited apparent improvement in arm, hand, and finger manipulation as demonstrated in their performance on the selected tasks during the training period and further supported by the higher scores in all three post-tests. The purpose of this section is to discuss the findings of this investigation.

Similar to the stages of development for the normal child from arm and hand manipulation to fingers and hand manipulation, the DS subjects follow the same pattern of development at a later chronological age. As expected, manipulative movements of the arm and hand were much more developed than the manipulative movements of the fingers and hands. Development of the use of the hand and fingers has received attention from Gesell, et. al.[9] in their description of manipulative development of the young child. Early stages of development of normal children indicate steady adjustments of directed arm and hand movements until the age of fifteen months when prehension becomes deft and precise. The child has almost complete mastery over his fingers but not over his tools.[10] By eighteen months the child can build towers of three or four blocks (arm and hand manipulation) and his manual dexterity skills continue to increase so that by age four he is able to fasten and unfasten buttons, lace shoes, and use scissors to attempt the cutting of a straight line (fingers and hand manipulation).

The selected tasks in this study that directly involved arm and hand manipulation (Pegs and Holes Task, Lids and Containers Task, and Gluing Cut-Outs Task) were easily performed by the subjects from the onset of the investigation.

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[9]Gesell, et. al., loc. cit.

[10]Ibid. p. 80.

Obviously, arm and hand coordination was a skill previously developed. The tasks directed to arm and hand movements were included in this study to enhance those skills already mastered.

Most of the tasks in this study involved finger and hand manipulation which included small items on the Pegs and Holes Task, Bean Placement Task, Bead Threading Task, Tracing Outlines Task, Dressing Techniques and Shoe Lacing Task, Knot Untying Task, and the Nut and Bolt Board Task. Tip of the finger manipulation is a skill all subjects exhibited overall improvement as demonstrated in their performance on the selected tasks. The higher scores and in some cases, rapid progress may be attributed to (1) familiarity of the task done at school and/or at home, (2) a repertoire of skills readily adapted to perform the desired task, (3) repetition of the task, and/or (4) motivational procedures.

In some individual cases (as discussed in the case studies) apparent improvement was not noted. Inability to progress in task manipulation may have been due to (1) task complexity, (2) variability in anatomical features in which the long fingered child has certain manipulative advantages over the short fingered child,[11] (3) motivational procedures, and/or (4) an insufficient number of instructional sessions for the task.

Progress was slow; however, it appears that improve-

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[11]Share and French, loc. cit., see also Gesell, et.al., loc. cit.

ments were made by all three subjects as was illustrated in each subject's task performance and further supported by post-test scores. Generally, all three subjects improved in the manual dexterity tests from pre-test to post-test except for two instances where the test results do not correlate with daily observations recorded during the training period. These inconsistencies in the post-test scores, may be due to (1) motivational procedures, (2) subject's health at that time of post-testing, (3) inability to transfer similar fine motor skills from one task to another, (4) the subject's attitude at the time of post-testing, and/or (5) environmental stimuli.

Progress was not clearly defined daily, but when reviewing daily observation notes from the onset of the training period to the final stages, progress was clearly evident. Kirk[12] stated that one characteristic of retarded children is that they do not learn as rapidly as others of the same chronological age. Further, Knights, Hyman, and Wozny[13] adopt the position that some retardates have known physiological defects, whereas the majority of retardates are not defective or pathological, but are essentially normals of low intelligence whose slower rate of development is a particular manifestation of the general developmental process.

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[12]Kirk, loc. cit.

[13]Robert M. Knights, Joseph A. Hyman, and Marius A. Wozny, "Psychomotor Abilities of Familial, Brain Injured, and Mongoloid Retarded Children," American Journal of Mental Deficiency, 70:454-7, 1965.

It is suggested in this case study that the DS individual can improve at a young age on manual dexterity tasks. Down[14] found that the manipulative ability of DS individuals is deficient but can be strengthened by a systematic training program. Further, Fort[15] suggested that training should begin at seven years old and even younger. Several studies demonstrated that successes could be achieved in various manual dexterity skills after two years of training the DS adult.

Differences in performance between children may have been a function of prior experience.[16] Other possibilities are visual impairment which is always suspect in DS children,[17] variability in anatomical features in which the long fingered child may have certain manipulative advantages over the short fingered child,[18] and motivational differences.[19]

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[14]Langdon H. Down, "Observations on an Ethnic Classification of Idiots," London Hospital Lecture Reports, 3:259, 1866.

[15]Samuel H. Fort, "The Training of an Idiotic Hand," Association of Medical Officers and American Institutions for Idiotic and Feebleminded Persons Proceedings, P. 547, 1895.

[16]Stiehl, loc. cit.

[17]John Clausen, "Behavioral Characteristics of Down Syndrome Subjects," American Journal of Mental Deficiency, 73:118-26, 1968.

[18]Gesell, et. al., loc. cit., see also Share and French, loc. cit.

[19]Stiehl, loc. cit.

When presenting each task, demonstration and explanation appeared to be more effective than explanation alone, which may be due to the unfamiliarity of the task or the way children learn.

CHAPTER V

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Summary

The major question posed in the present study was to determine if the fine motor skills of young trainable retardates with Down's Syndrome could be improved through systematic training on specific manual dexterity tasks.

Three DS-boys, ages nine, ten, and eleven, were trained individually on ten selected manual dexterity tasks for a period of seven weeks, Monday through Thursday, for thirty minute sessions each day. Subjective data were obtained for each task throughout the entire training period. Investigator demonstration, explanation, and assistance were given consequent upon the manipulation of the selected tasks. A descriptive analysis for noting change in performance for each subject was outlined in Chapter IV.

As expected, progress was slow. However, it appeared that improvements were made by all three subjects on the manual dexterity tasks throughout the training period and in the Purdue Pegboard, the Crawford Small Parts Dexterity Test, and the Stromberg Dexterity Test. Accomplishments made by the subjects suggest that fine motor coordination can be improved through systematic training. However, the exclusion of a control group and other limitations in this study prohibit attributing results solely to the training program.

The tasks which appeared most practical and promising in developing manual dexterity skills included the Pegs and Holes Task, Bean Placement Task, Bead Threading Task, Dressing Techniques and Shoe Lacing Task, and the Nut and Bolt Board Task. Generally these tasks were performed successfully by all three subjects and demonstrated the highest percentages of improvement in comparison to the other tasks. The Screwdriver Task may be useful in training specifically for sheltered workshop employment, but it was not successfully performed by any subject in this investigation. The remaining tasks of gluing cut-outs, tracing outlines, knot untying, and securing and removing lids to their respective containers are tasks that appear to be practical and may be useful, depending upon the individual.

Overall performance of the three subjects suggests that fine motor performance can be improved at an early age through systematic training sessions.

<u>Conclusion</u>

Although the trainable mentally retarded children with Down's Syndrome appeared to improve in their fine motor coordination, the limitations of the study prohibit attributing changes in performance to the systematic training program employed in the study.

Recommendations for Further Research

Listed below are suggestions for future studies:

1. Enlarge the population.

2. Include female and male subjects in a study or investigate the fine motor performance of young female DS individuals.

3. Study a younger group of DS individuals.

4. Extend the length of time of the training program.

5. Conduct an experimental investigation with a control group.

6. Utilize different modes of reinforcement.

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APPENDIX A
MANUAL DEXTERITY TASKS

Nut and Bolt Board[1]

1. Objectives:

   a. To develop integration between physical and perceptual functions.

   b. To develop fine hand and finger coordination.

   c. To develop skills in noting similarities and differences.

   d. To develop utilization of the tactile-kinesthetic sensations.

   e. To lengthen the child's attention span.

2. Materials:

   A board ten inches wide by twelve inches in length and one inch thick, standing on edge. Holes are bored into the board to receive bolts of different diameter. The selection includes machine, carriage, and stove bolts. Matching nuts are provided.

3. Subject Matter:

   Discrimination of size, manual dexterity.

4. Procedure:

   Place a bolt through one of the holes in the board. Demonstrate placing the nut on the screw end of the bolt. Have the subject repeat the demonstration until he is capable of performing the task. Then place two other bolts which are in small contrast in size into the holes, and have the subject find the proper nuts to fit those bolts. Proceed to more difficult presentations.

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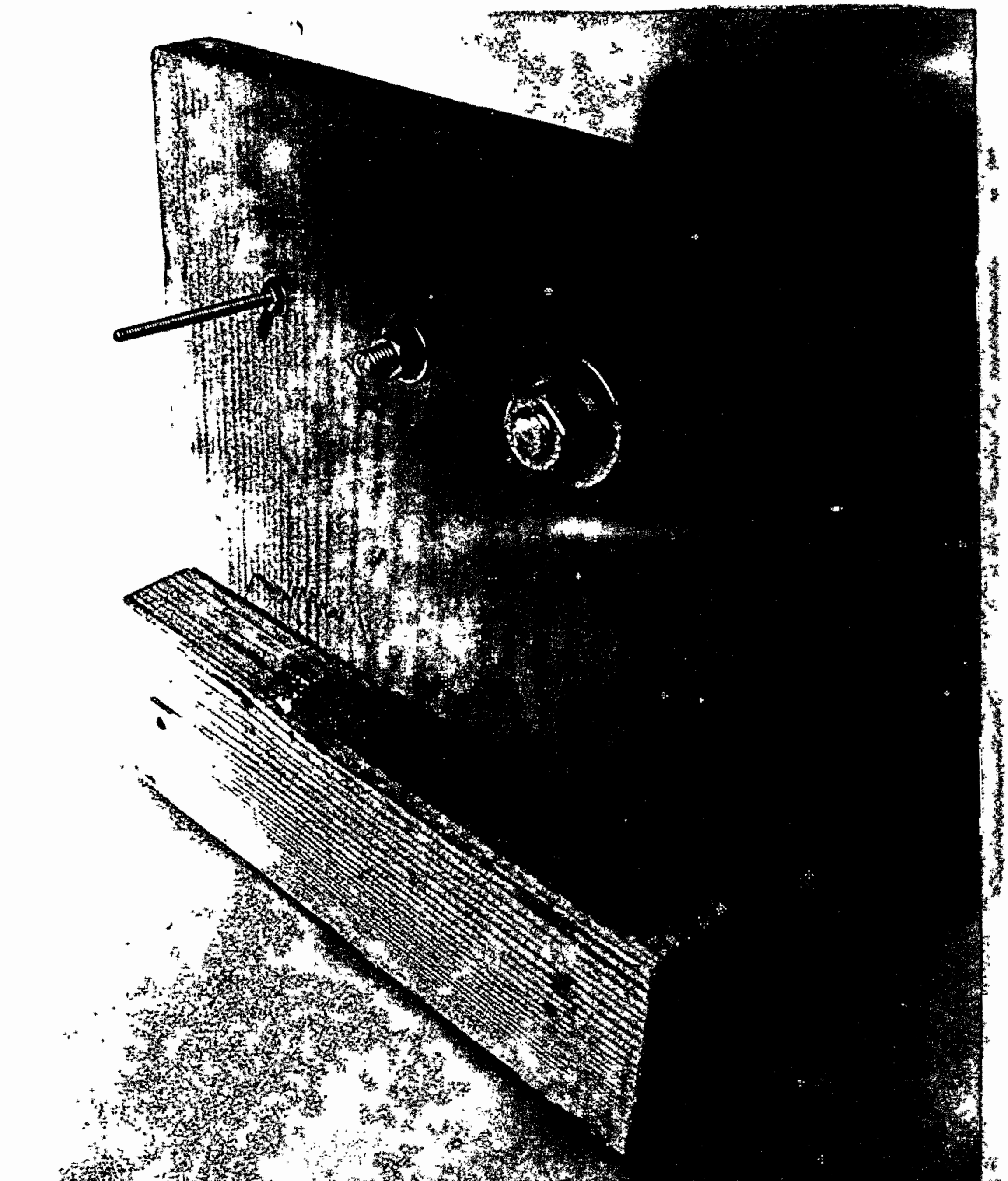
[1]Max G. Frankel, William F. Happ, and Maurice P. Smith, <u>Functional Teaching of the Mentally Retarded</u>, Illinois:

5. Illustration: Nut and Bolt Board

5. Illustration: Nut and Bolt Board continued



Pegs and Holes[2]

1. Objectives:

   a. To develop the ability to note similarities and differences.

   b. To improve the subject's (hand) coordination.

   c. To develop eye, arm, and hand coordination.

   d. To aid in increasing the subject's attention span.

2. Materials:

   This task consists of three phases, three wooden peg boards with appropriate sized pegs which the subject will be required to place in the holes. Phase I consists of a one foot square pegboard with four holes one and one-half inches in diameter. There are two sizes of pegs available for this board. One set being one and seven sixteenth inches in diameter and six inches high, the other set one inch pegs in diameter and four inches high. Phase II consists of a six inch square pegboard with sixteen holes, each one-half inch wide. Two sets of pegs are also available for this board, one set being seven sixteenth inches in diameter and four and one-half inches high. The other set three eighth inches in diameter and three inches high. In

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Charles G. Thomas, 1960.

[2]H.D. Fredericks, "A Comparison of the Doman-Delacato Method and Behavior Modification Method Upon the Coordination of Mongoloids," Teaching Research Project #RD-2753-p. 68, January, 1969.

Phase III the pegboard is three inches square and consists of sixteen holes, each one-quarter inch in diameter. Two sets of pegs are also available for this board. One set of pegs is two inches high and three sixteenths inch in diameter, another set of pegs is four inches high and one-eighth of an inch in diameter.

3. Subject Matter:

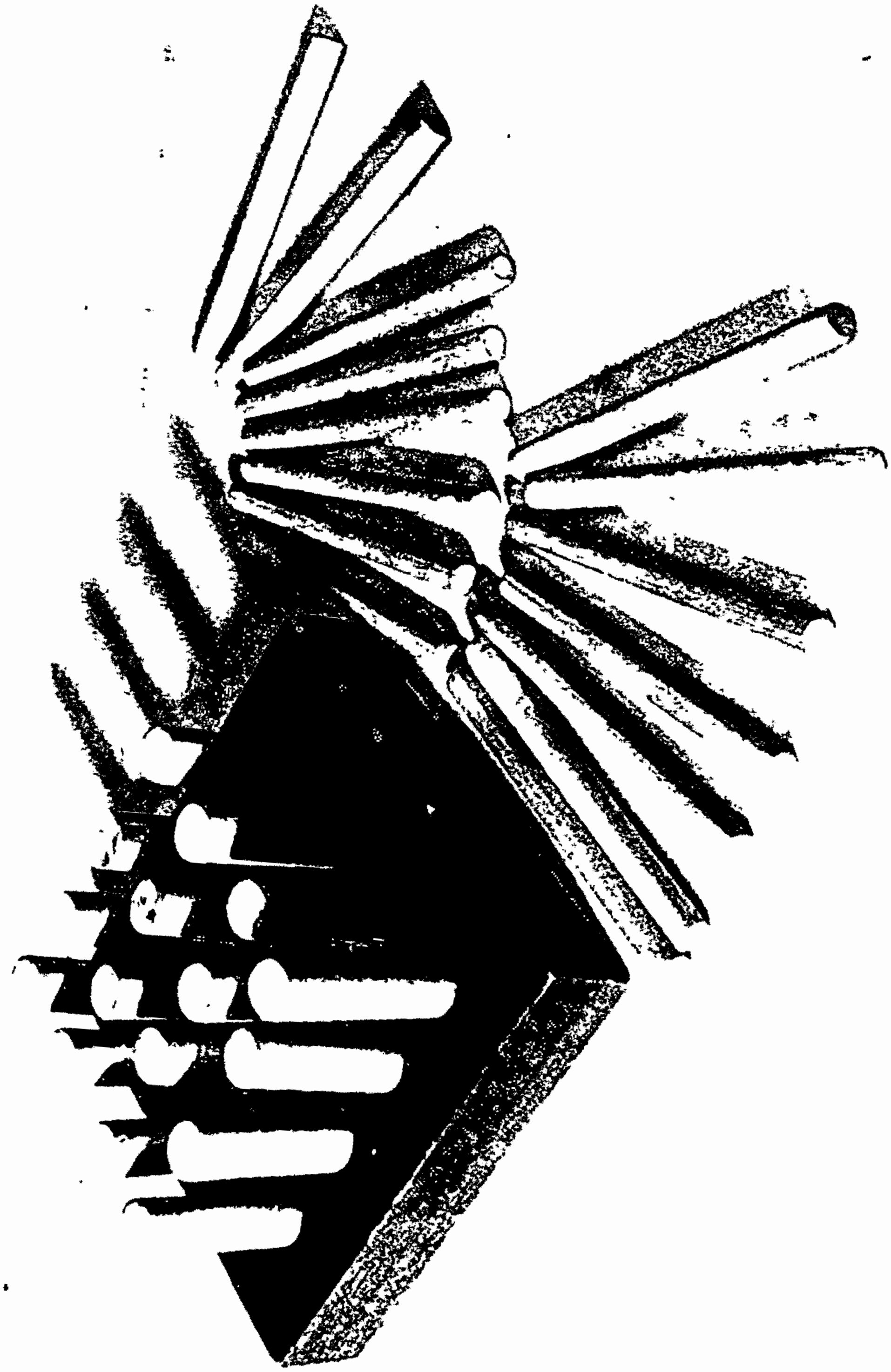
Discrimination of size; spatial orientation; manual dexterity.

4. Procedure:

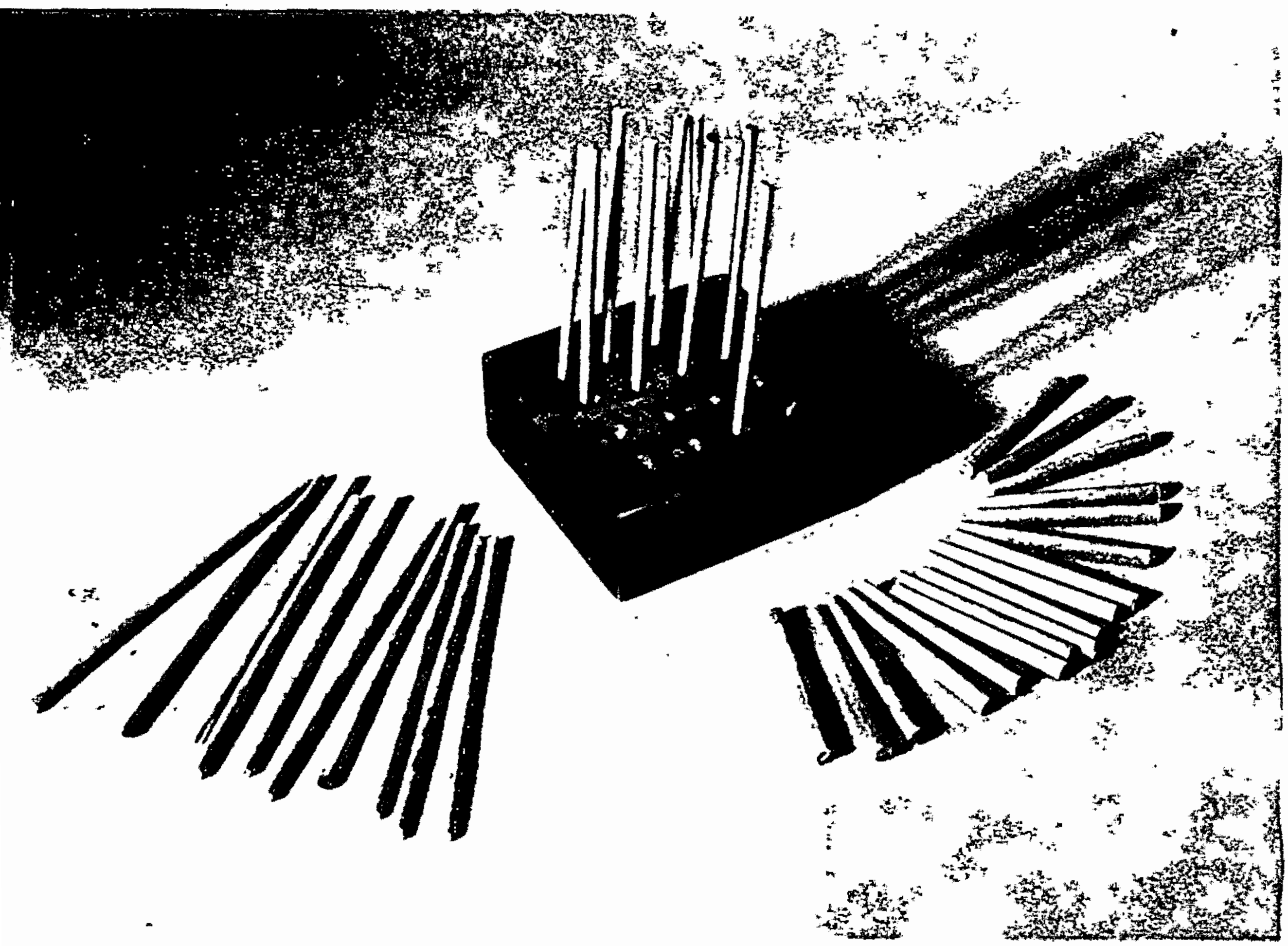
The purpose of this task is to have the subject place all the pegs of the wider diameter in each of the peg holes. Different sized pegs and boards are considered necessary in this task in order to allow some of the subjects who have very poor coordination to achieve success on the pegboards. The smaller diameter pegs in each phase will fall into the holes if the subject can approximate the peg and hole. The subject will not proceed to the next phase until he can successfully place all the pegs of the wider diameter in each of the peg holes. Once all three phases are completed successfully, he will then work for a better time each trial and/or place the pegs in vertical or horizontal patterns. Also, the subjects will perform the task first with his preferred hand, then with his non-preferred hand, and then with both hands.

5. Illustration: Pegs and Holes

5. Illustration: Pegs and Holes continued



5. Illustration: Pegs and Holes continued



Knot Untying[3]

1. Objectives:

   a. To develop finger dexterity.

   b. To develop physical-perceptual coordination.

   c. To aid the subject to note similarities and differences.

   d. To develop the ability to attend to stimuli.

2. Materials:

   Smooth curtain cord in one yard length. Heavy wrapping string, colored cotton wrap, knitting yarn, colored thread.

3. Subject Matter:

   Physical-perceptual coordination, manipulation.

4. Procedure:

   Allow the subject to untie simple knots at first, and gradually develop the ability to handle difficult knots. As progress indicates, knots are tightened and made more difficult (for example, by tangling knitting yarn and silk thread together). Two to five strands are used; colors are used to trace position of strings.

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[3] Frankel, Happ, and Smith, loc. cit.

5. Illustration: Knot Untying

Bead Threading[4]

1. Objectives:

   a. To develop eye, finger, hand, and arm (physical-perceptual) coordination.

   b. To lengthen the subject's attention span.

   c. To develop finger dexterity.

   d. To develop a sense of color discrimination.

2. Materials:

   Large white spools; medium sized colored spools; assorted medium sized beads; assorted small beads; cord.

3. Subject Matter:

   Discrimination of form, size, and color; manual dexterity.

4. Procedure:

   The subject is introduced to the process of stringing, using large white spools on a large cord. As the subject gains finger and hand dexterity along with eye coordination, gradually smaller spools of different colors, and finally, the beads are presented to him. He is then encouraged to string the beads according to a pattern. For more difficult presentations, time for speed of performance.

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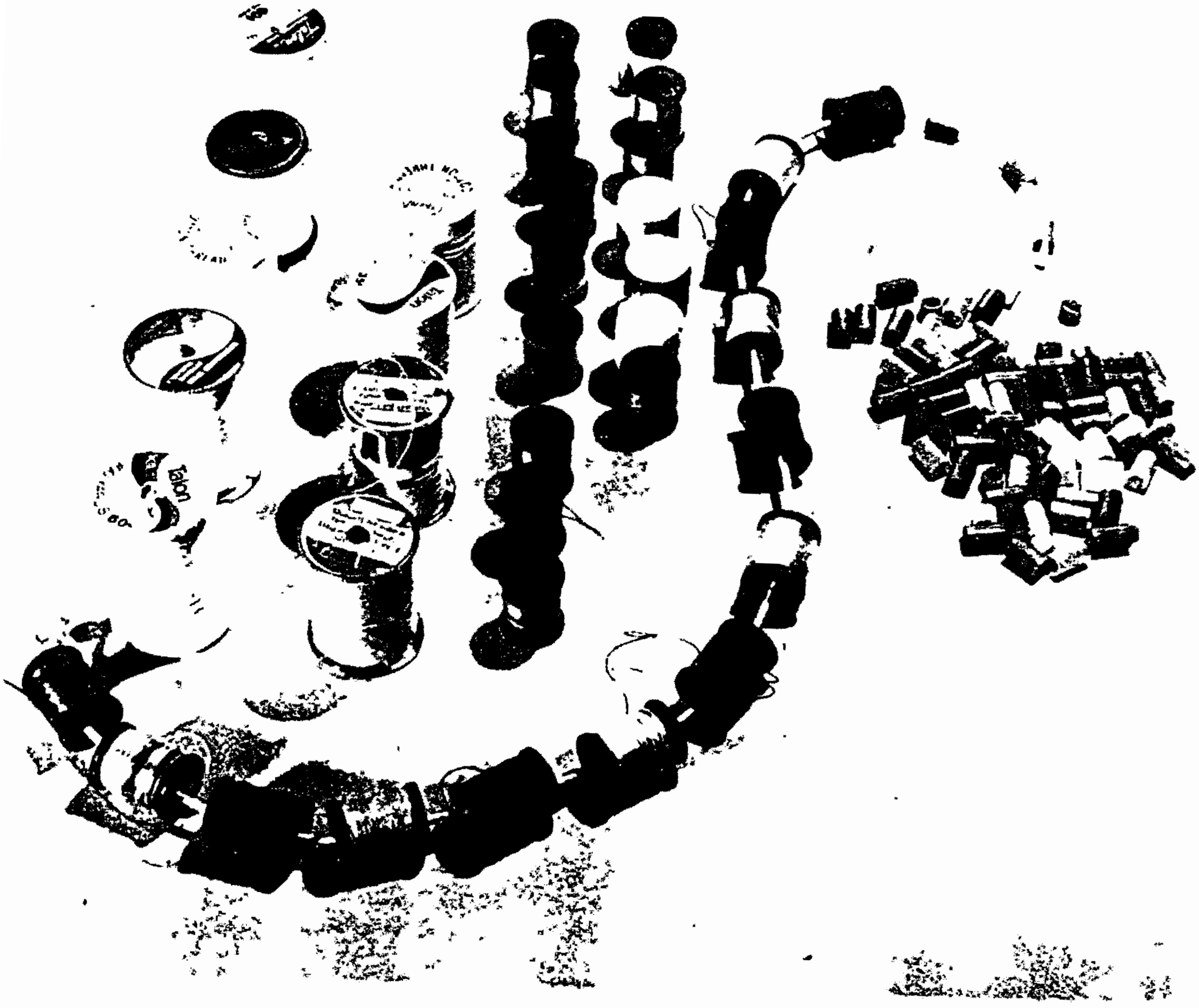
[4]Ibid.

5. Illustration: Bead Threading



Bean Placement[5]

1. Objectives:

    a. To develop manual dexterity.

    b. To develop the ability to attend to stimuli.

    c. To develop spatial orientation.

    d. To develop eye-hand coordination.

    e. To develop discrimination.

2. Materials:

    Twenty-five kidney beans, twenty-five lima beans, and twenty-five peas. Soup bowl, dixie cup, and sandwich size ziplock bag.

3. Subject Matter:

    Spatial orientation, manual dexterity.

4. Procedure:

    This task requires the subject to place the different sizes of beans into the containers, that is to put all the kidney beans in the soup bowl, then into the dixie cup and last the ziplock bag. He will then do the same with the lima beans and then with the peas. He will perform the task first with his preferred hand, then with his non-preferred hand, and then with both hands placing the beans in the containers. Variations: (1) instead of placing all twenty-five beans in each container, set a limit, for example place ten beans in the bowl and time for rate of manipulation; (2) instead of having beans in

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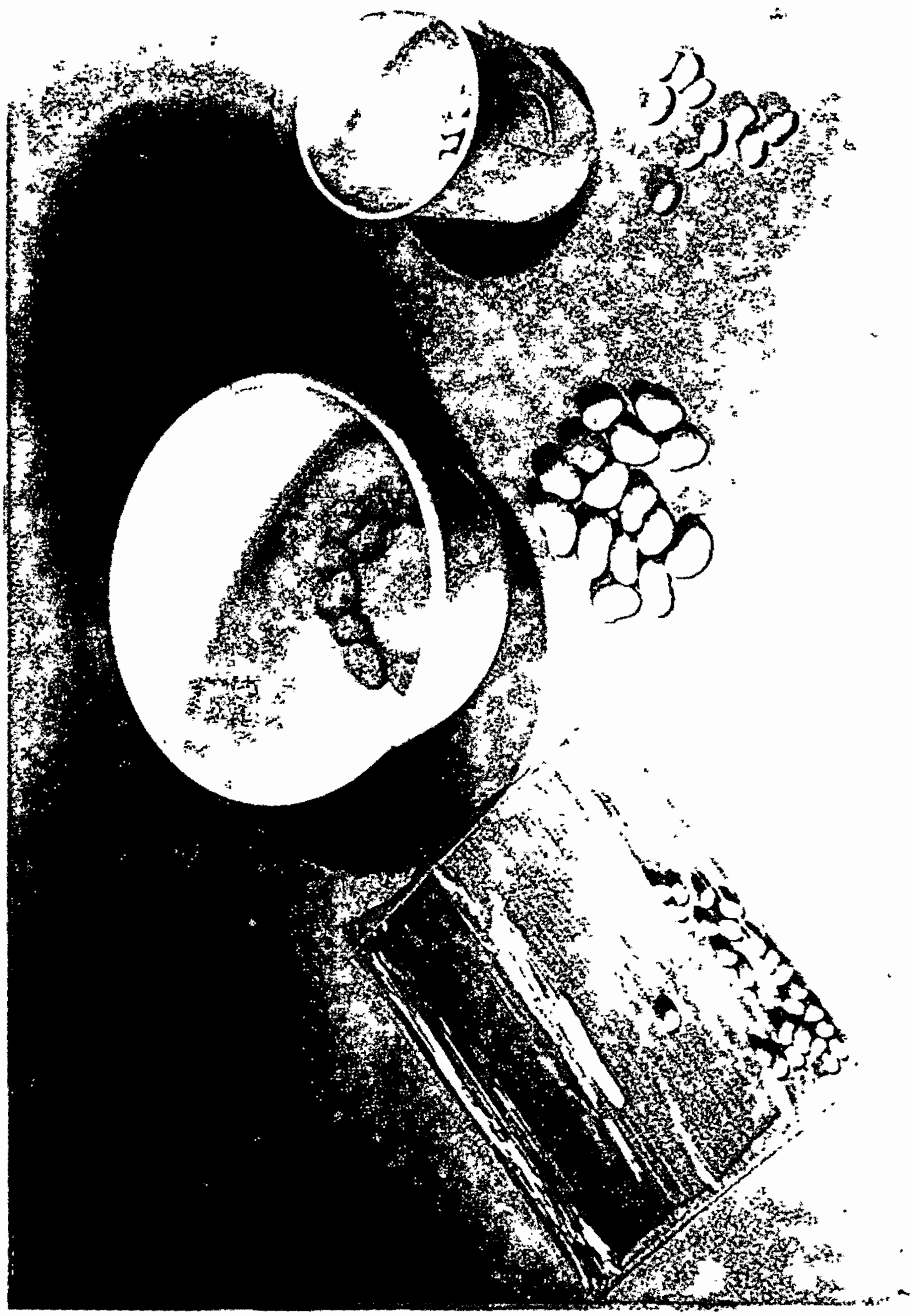
[5] Ibid.

separate piles, have the beans mixed together and have the subject sort the beans according to size.

5. Illustration: Bean Placement



Tracing Outlines

1. Objectives:

    a. To develop manual dexterity.

    b. To develop fine eye-hand coordination.

    c. To develop the ability to see relationships in terms of size, position, color, and shape of figures.

    d. To aid the subject to evaluate his own work for errors and corrections.

    e. To aid the subject to attend to stimuli.

2. Materials:

    Crayons. Pieces of paper with dotted vertical and horizontal lines, squares, circles, triangles, and such complex figures as demonstrated.

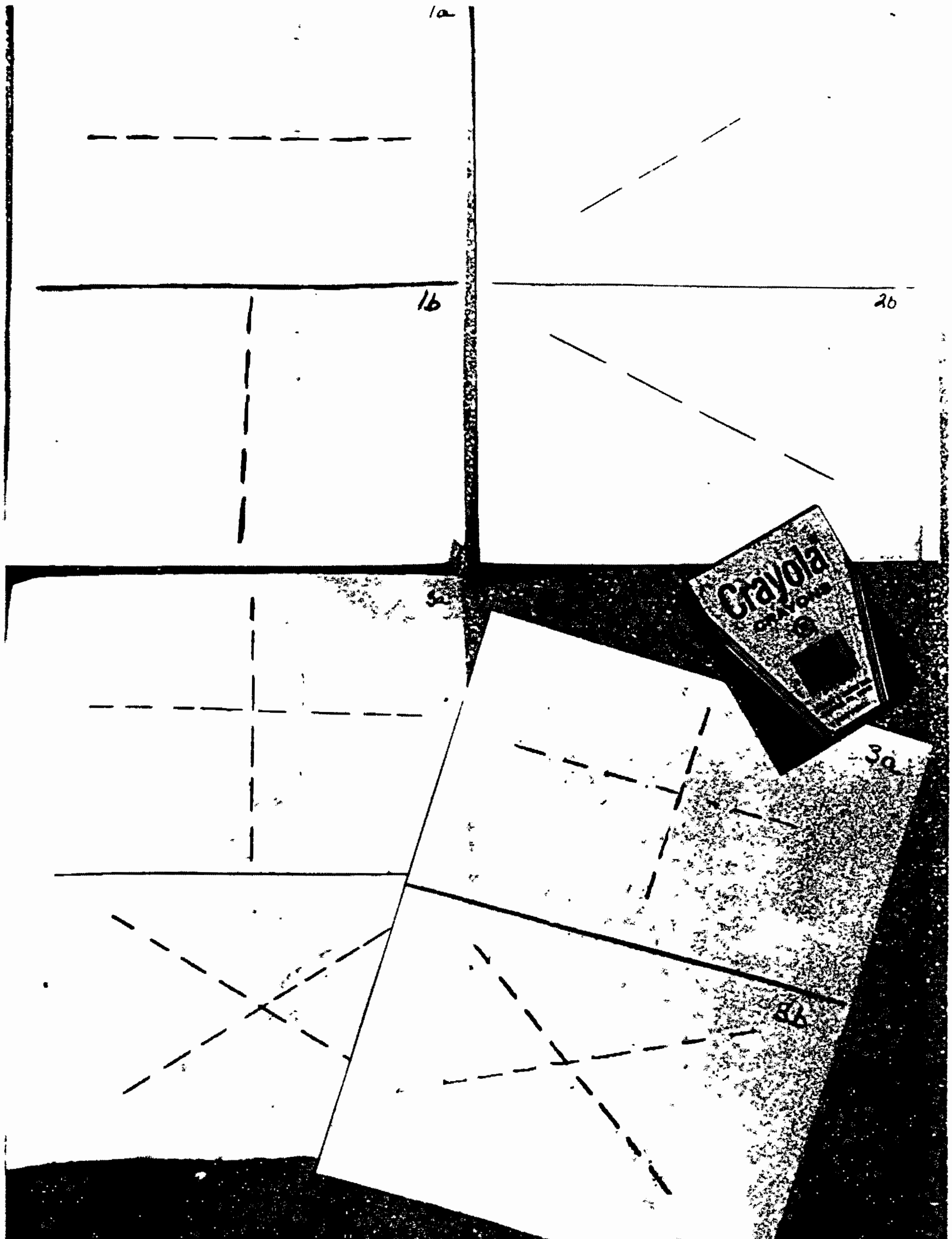
3. Subject Matter:

    Discrimination of form, manual dexterity.

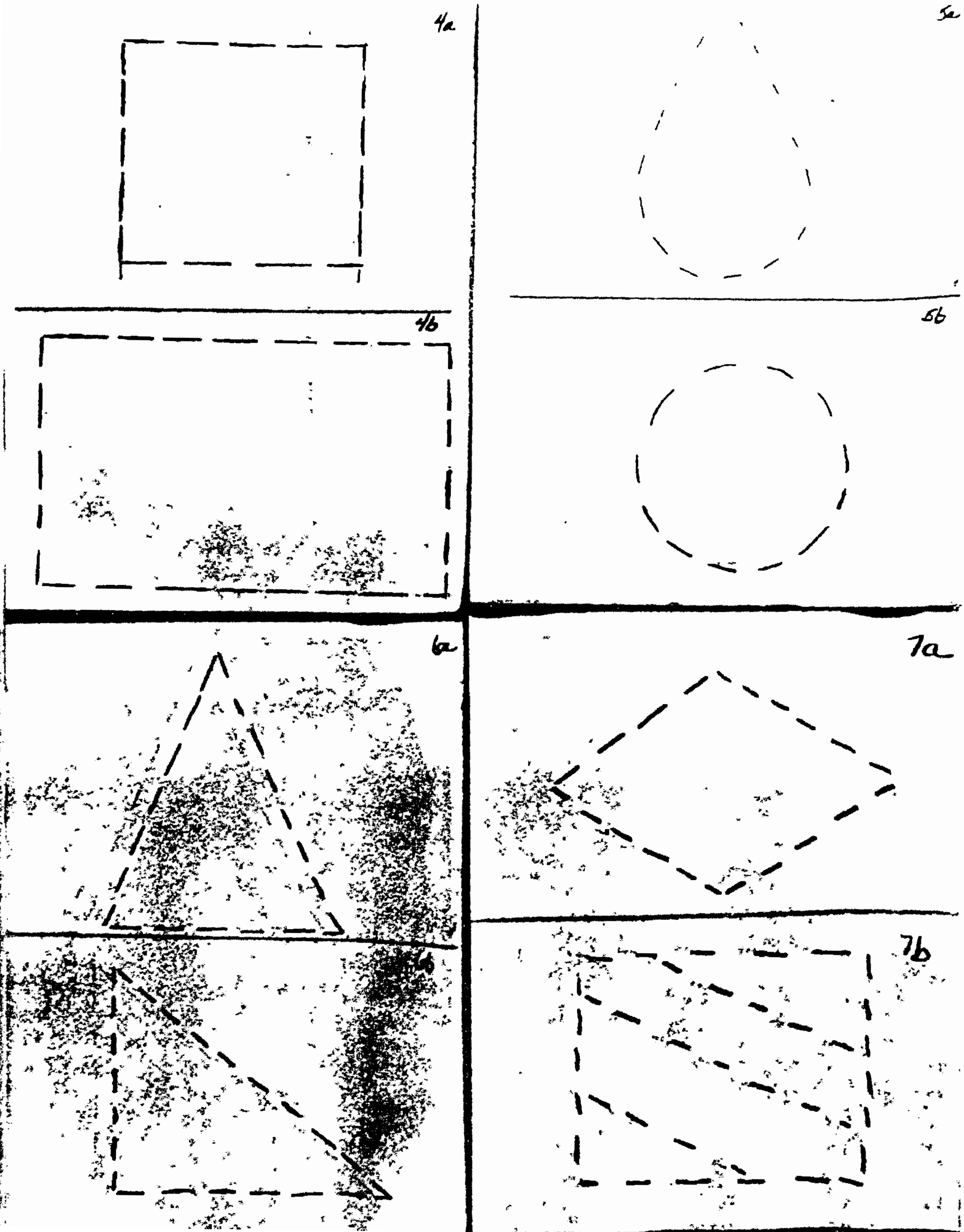
4. Procedure:

    In this task the subject is required to trace the lines drawn on several sheets of paper. Begin with the simple geometric figures; that is the lines, squares, circle, triangle to the complex figures. Variation - to color within the outline of various figures.

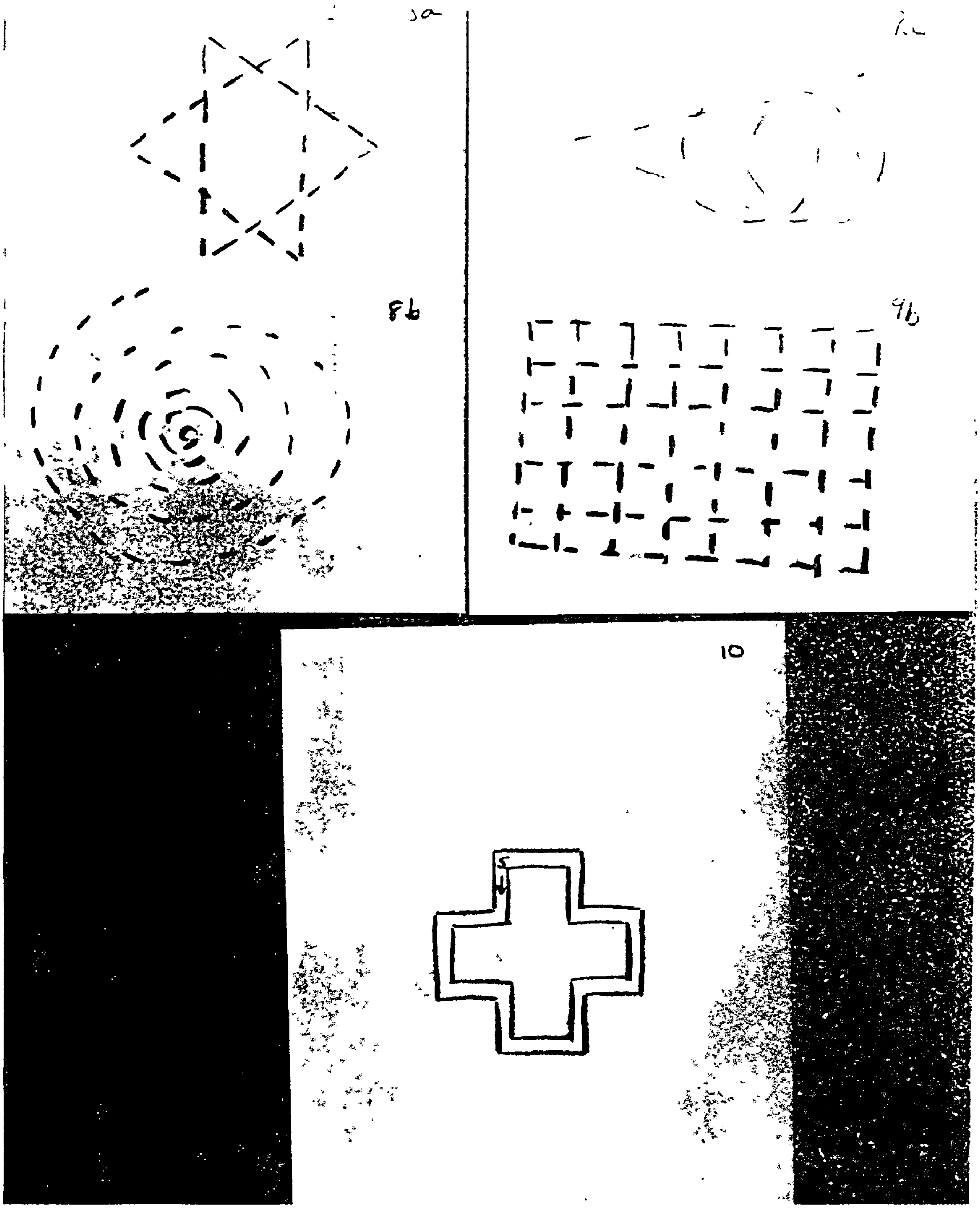
5. Illustration: Tracing Outlines



5. Illustration: Tracing Outlines continued



5. Illustration: Tracing Outlines continued



Gluing Cut-Outs

1. Objectives:

   a. To develop manual dexterity.

   b. To develop eye-hand coordination.

   c. To provide for the subject opportunities for noting similarities and differences.

   d. To aid the subject to attend to stimuli.

2. Materials:

   Glue, paper cut-outs, and pieces of paper with geometric designs and pictures (face, dog, clock, etc.)

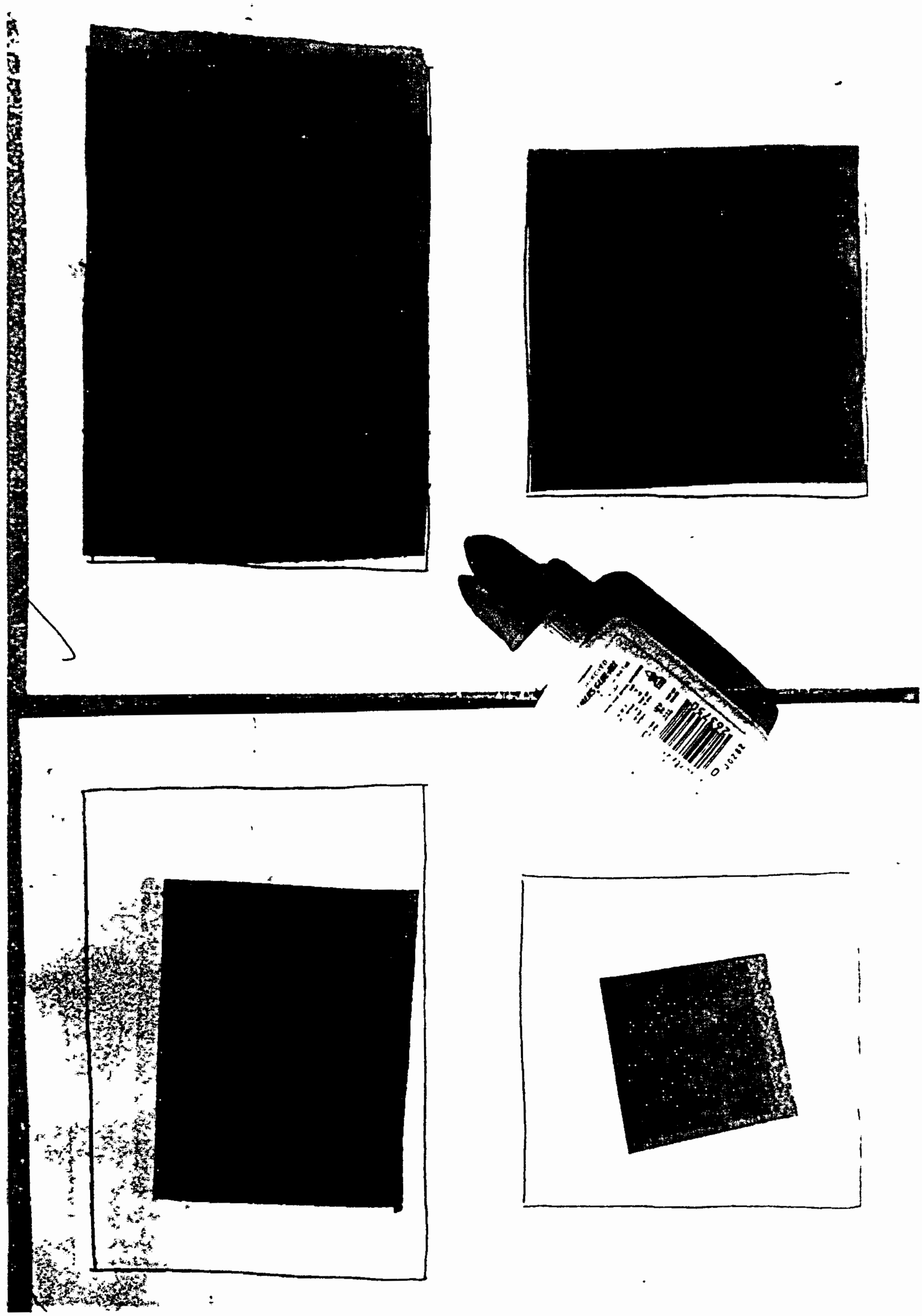
3. Subject Matter:

   Spatial orientation, manual dexterity.

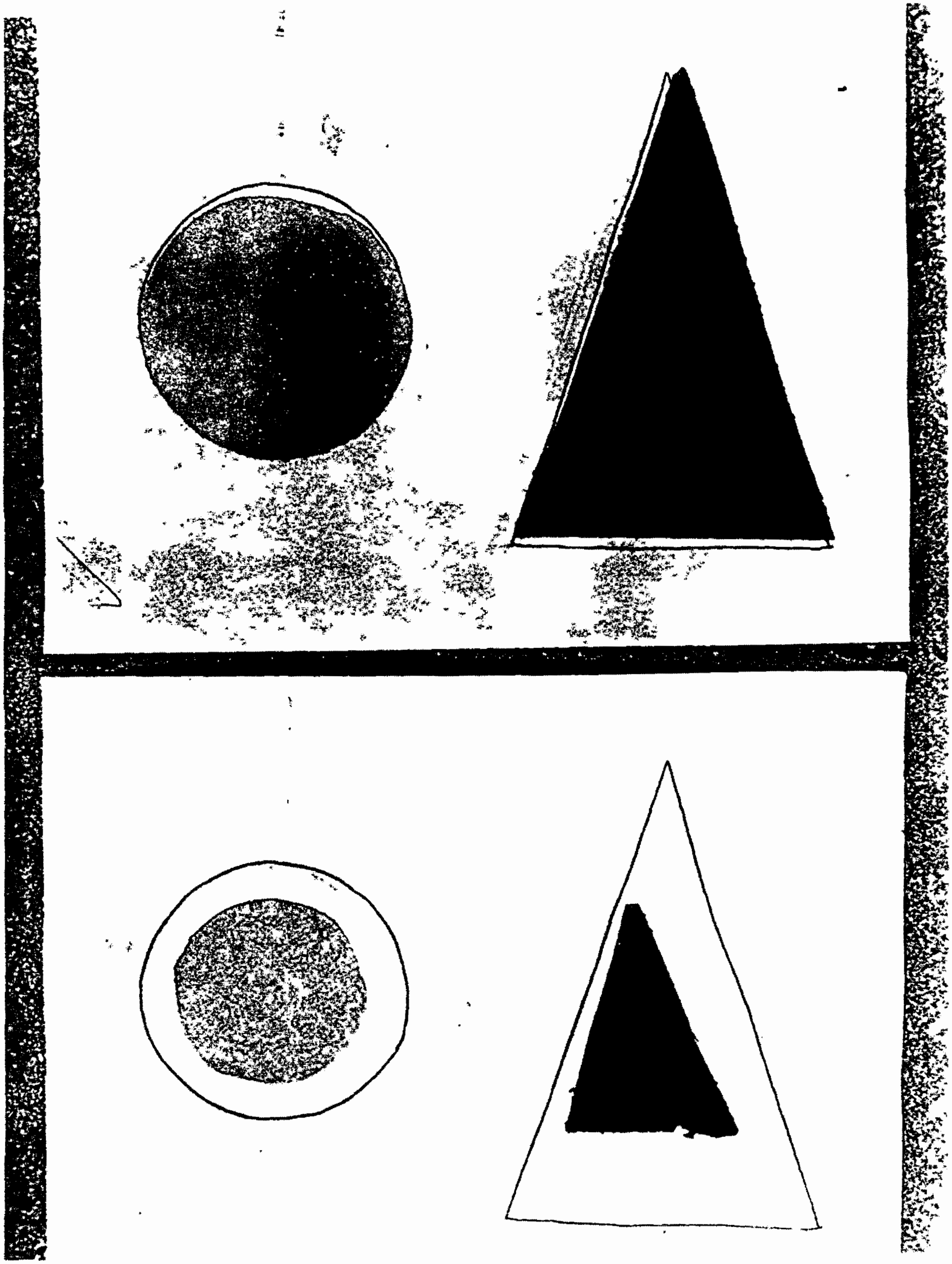
4. Procedure:

   The subject will glue the pieces of paper within designated lines. Begin with large outline for smaller piece of paper then to the outline and paper of equal size. Also, begin with the simpler shapes and then work with the more complex pictures. It is important that the subject put the correct shape into the corresponding outline and stay within the lines.

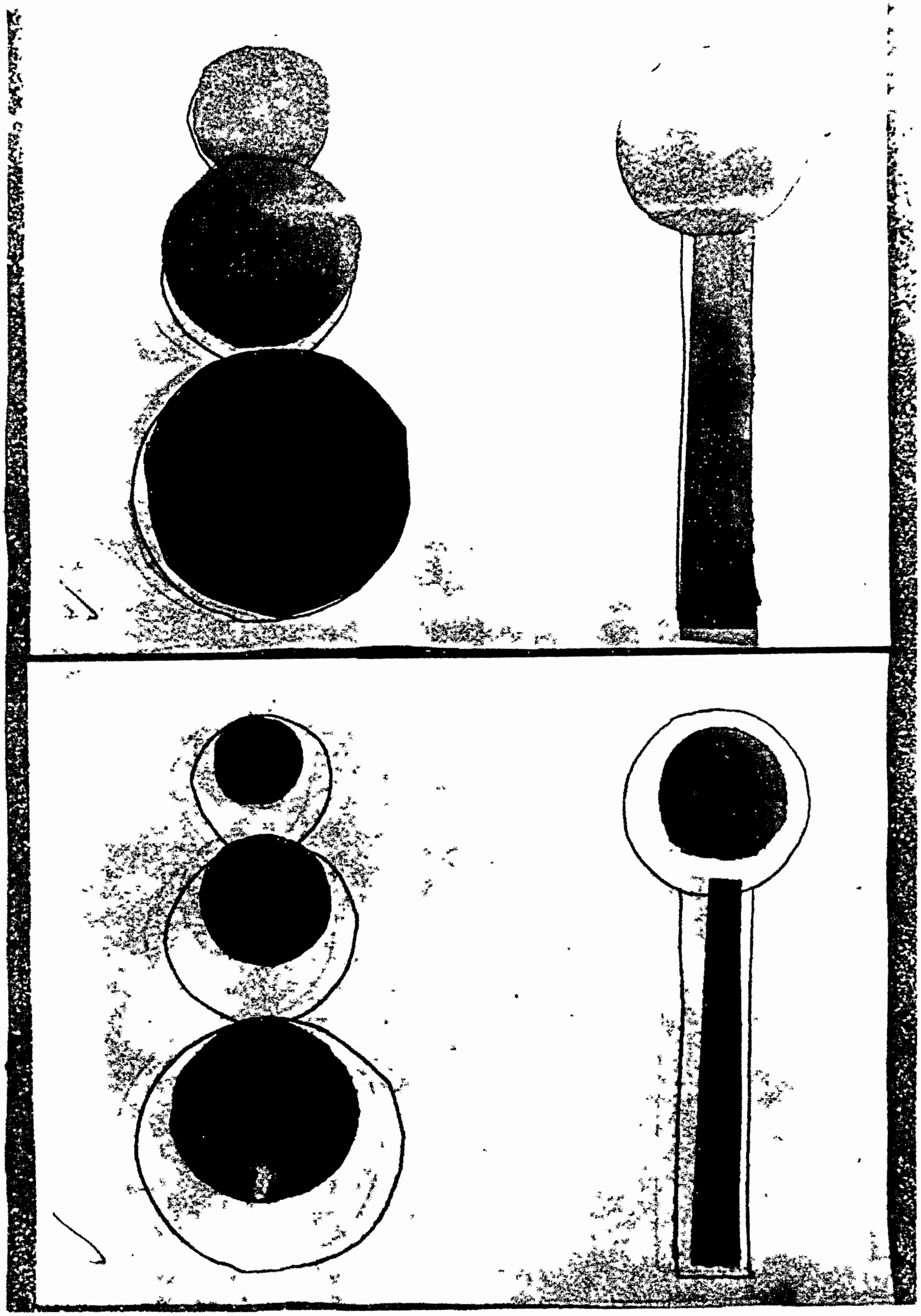
5. Illustration: Gluing Cut-Outs



5. Illustration: Gluing Cut-Outs continued



5. Illustration: Gluing Cut-Outs continued



Dressing Techniques and Shoe Lacing

1. Objectives:

   a. To develop manual dexterity.

   b. To aid the subject in assuming responsibility for his self-care.

   c. To aid the subject to identify the various dressing techniques of buttoning, lacing, tying, etc.

   d. To lengthen the subject's attention span.

2. Materials:

   Forms made of cloth covered porous rubber on which are sewen various kinds of buttons, zippers, snaps, hooks and eyes. Weighted cement foot forms and shoes, shoe laces.

3. Subject Matter:

   Dressing skills, manual dexterity.

4. Procedure:

   The subject holds forms, one at a time, against his body, to simulate clothing, and proceeds to practice buttoning, hooking, zippering, and snapping. In shoe lacing, he practices with the toe of the shoe pointed away from his body. Also, when kneeling on a chair with one leg, the subject practices with the shoe in front of his knee, again with the toes of the shoe pointing away from his body.

5. Illustration: Dressing Techniques and Shoe Lacing

5. Illustration: Dressing Techniques and Shoe Lacing continued

5. Illustration: Dressing Techniques and Shoe Lacing continued

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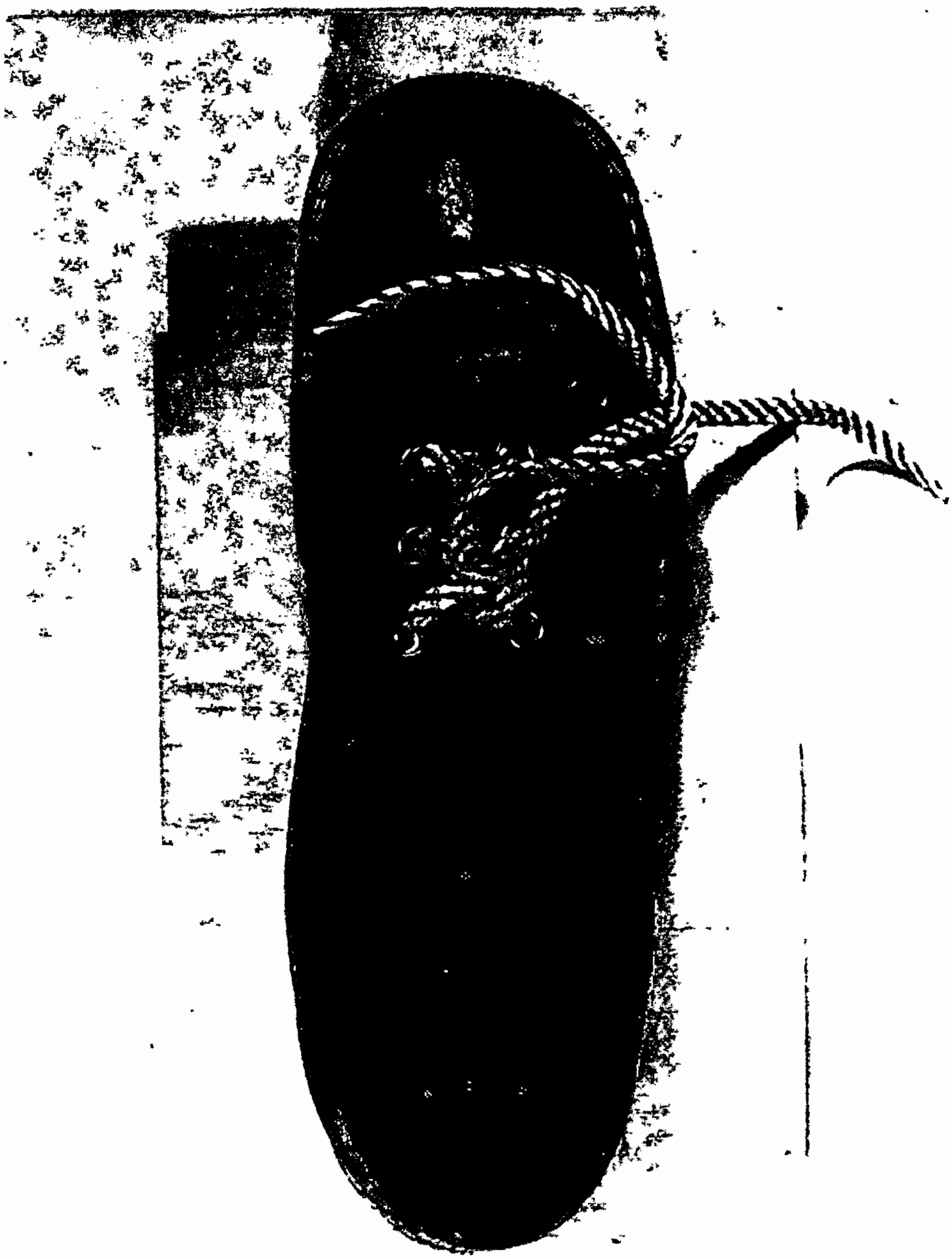


Lids and Containers

1. Objectives:

   a. To develop fine finger-hand coordination.

   b. To develop utilization of the tactile-kinesthetic sensations.

   c. To lengthen the subject's attention span.

2. Materials:

   Tupperware containers with snap lids, bottles with screw on lids, caps for soda bottles, and caps for soda cans.

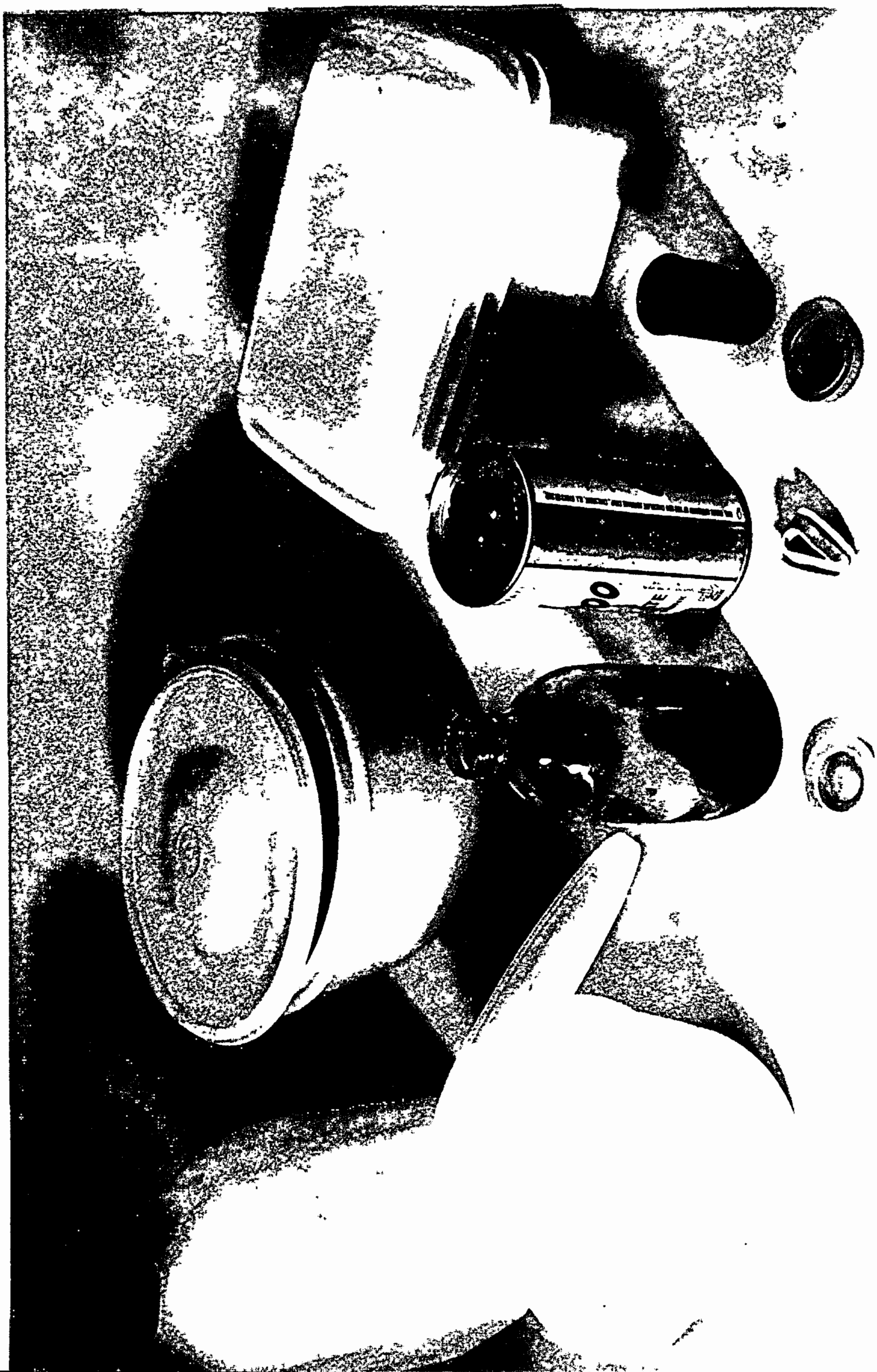
3. Subject Matter:

   Discrimination of size, manual dexterity.

4. Procedure:

   The subject is required to remove and secure the lids of their respective container, beginning with the least tight fitting lid and working in a progression to the more difficult lids and containers.

5, Illustration: Lids and Containers



Screwdriver Manipulation

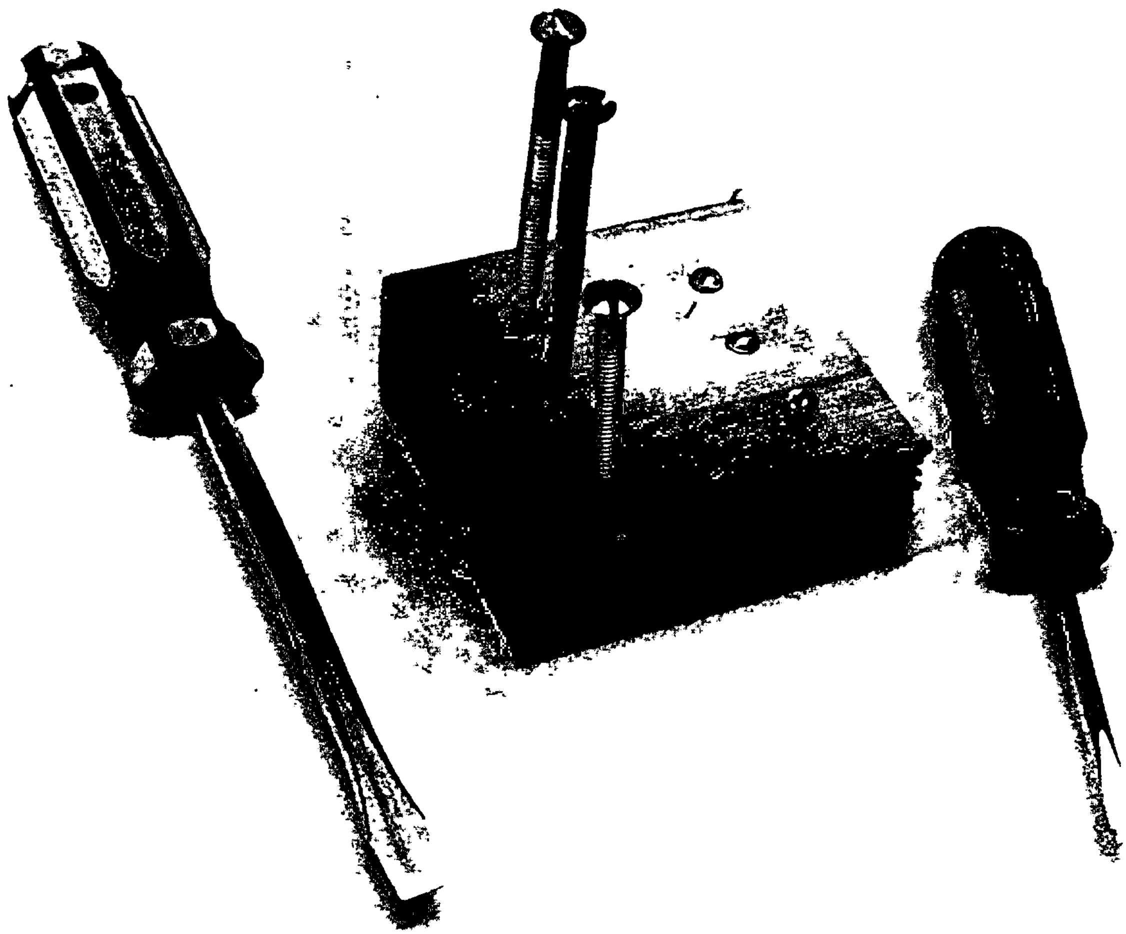
1. Objectives:
   a. To develop fine finger-hand coordination.
   b. To lengthen the subject's attention span.
   c. To develop integration between physical and perceptual functions.
   d. To develop utilization of the tactile-kinesthetic sensations.
2. Materials:

   A board four by four inches and one inch thick. Holes are bored into the board to receive screws of different diameter. A large and small screwdriver with screws are provided.
3. Subject Matter:

   Manual dexterity, discrimination of size.
4. Procedure:

   Place a screw in one of the holes in the board. Demonstrate turning the screw in the board with utilization of the screwdriver. Have the subject manipulate the other screws. Proceed to more difficult presentations.

5. Illustration: Screwdriver Manipulation



APPENDIX B

TRAINING SCHEDULE

TRAINING SCHEDULE

DATE	MANUAL DEXTERITY TASKS
5/2/74	Pegs and Holes Task Bean Placement Task Tracing Outlines Task Nut and Bolt Board Task,
5/6/74	Bean Threading Task Bean Placement Task Gluing Cut-Outs Task Screwdriver Task
5/7/74	Dressing Techniques and Shoe Lacing Task Knot Untying Task Lids and Containers Task Pegs and Holes Task
5/8/74	Nut and Bolt Board Task Bead Threading Task Screwdriver Task Tracing Outlines Task
5/9/74	Knot Untying Task Pegs and Holes Task Dressing Techniques and Shoe Lacing Task Lids and Containers Task
5/13/74	Bean Placement Task Gluing Cut-Outs Task Tracing Outlines Task Nut and Bolt Board Task
5/14/74	Bead Threading Task Screwdriver Task Dressing Techniques and Shoe Lacing Task Knot Untying Task
5/15/74	Pegs and Holes Task Lids and Containers Task Nut and Bolt Board Task Tracing Outlines Task
5/16/74	Bean Placement Task Gluing Cut-Outs Task Bead Threading Task Knot Untying Task

TRAINING SCHEDULE (cont.)

DATE	MANUAL DEXTERITY TASKS
5/20/74	Dressing Techniques and Shoe Lacing Task Pegs and Holes Task Screwdriver Task Nut and Bolt Board
5/21/74	Tracing Outlines Task Gluing Cut-Outs Task Lids and Containers Bean Placement Task
5/22/74	Nut and Bolt Board Task Bead Threading Task Pegs and Holes Task Screwdriver Task
5/23/74	Bean Placement Task Lids and Containers Task Gluing Cut-Outs Task Dressing Techniques and Shoe Lacing Task
5/27/74	Tracing Outlines Task Nut and Bolt Board Task Knot Untying Task Bead Threading Task
5/28/74	Pegs and Holes Task Lids and Containers Task Screwdriver Task Gluing Cut-Outs Task
5/29/74	Bead Threading Task Bean Placement Task Knot Untying Task Dressing Techniques and Shoe Lacing Task
5/30/74	Tracing Outlines Task Screwdriver Task Pegs and Holes Task Nut and Bolt Board Task
6/3/74	Bead Threading Task Gluing Cut-Outs Task Dressing Techniques and Shoe Lacing Task Knot Untying Task

TRAINING SCHEDULE (cont.)

DATE	MANUAL DEXTERITY TASKS
6/4/74	Lids and Containers Task Pegs and Holes Task Bean Placement Task Tracing Outlines Task
6/5/74	Knot Untying Task Dressing Techniques and Shoe Lacing Task Gluing Cut-Outs Task Screwdriver Task
6/6/74	Bead Threading Task Bean Placement Task Tracing Outlines Task Pegs and Holes Task

APPENDIX C

SAMPLE TASK SHEET

Sample Task Sheet

Name______________________Task________________Date_____

Comments:

A. Overall Performance

4 - Successful

3 - Performs with slight difficulty

2 - Performs with extreme difficulty

1 - Cannot perform task

B. Preferred Hand Performance

4 - Successful

3 - Performs with slight difficulty

2 - Performs with extreme difficulty

1 - Cannot perform task

C. Non-Preferred Hand Performance

4 - Successful

3 - Performs with slight difficulty

2 - Performs with extreme difficulty

1 - Cannot perform task

D. Performance with Both Hands

4 - Successful

3 - Performs with slight difficulty

2 - Performs with extreme difficulty

1 - Cannot perform task with both hands

E. Consistency

3 - Always consistent with performance

2 - Will be consistent when reminded

1 - Never consistent; pattern always changes

SAMPLE TASK SHEET (cont.)

F. Speed of Performance

Time:

G. Behavior

4 - Good

3 - Listens and performs; but will easily be distracted

2 - Listens and performs occasionally

1 - Non-compliant

H. Additional Comments