THE EFFECTS OF A STRENTHENING PROGRAM
ON THE FINE-MOTOR ABILITY
OF HANDICAPPED CHILDREN

A THESIS

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS

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IN THE GRADUATE SCHOOL OF THE

TEXAS WOMAN'S UNIVERSITY

SCHOOL OF OCCUPATIONAL THERAPY

BY

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April 14, 1987
Date

To the Provost of the Graduate School:

I am submitting herewith a thesis written by Beverly J. Cogdell entitled "The Effects of a Strengthening Program on the Fine-Motor Ability of Handicapped Children". I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Occupational Therapy.

Nancy Griffin Ed.D.

Nancy Griffin, Ed. D.,
Major Professor

We have read this thesis
and recommend its acceptance:

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Provost of the Graduate School

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It is with honor that I dedicate this endeavor to the children of Dallas Easter Seal Society for Children, to my son Brian, and to my family.

The Effects of a Strengthening Program
On The Fine-Motor Ability
Of Handicapped Children
Beverly J. Cogdell
May, 1987

This study investigated the effects of an upper extremity strengthening program on the fine-motor ability of 24 handicapped children. Five strength measures and four fine-motor tasks were used to collect pretest and posttest data. Results from this investigation revealed that the 2 groups of 12 subjects had no significant difference in the mean pretest fine-motor and strength scores and posttest fine-motor scores. A significant difference was found in their changed fine-motor score and posttest strength scores. This study did not address variables of gender, diagnosis, or severity of disability. Further research was recommended to investigate these variables and the effects of muscle tone, joint alignment and posture.

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CHAPTER I

INTRODUCTION

Ayres (1954) stated that occupational therapists are often concerned with the development of hand function. The pediatric occupational therapist is especially concerned with developing the functional hand skills of children. The components of functional hand skills, Ayres (1954) postulated, include a well coordinated wrist and arm with adequate strength to position the hand properly. In addition to these components, a hierarchy of movements or sequence for development has been well established by many researchers.

Halverston (1931), Gesell (1940), Ayres (1954), and Erhardt (1982), among many others, have documented the developmental sequence of fine-motor skills. Sellars (1983) stated that therapists have been proponents of hand exercise to improve the quality of fine-motor skills. She further related that if a hand is weak and lacks adequate grasp, strengthening exercises are usually administered by the therapist.

There is little empirical data that support the use of strengthening or relaxation exercises to improve the fine-motor ability of handicapped children. What effects do strengthening exercises have on the fine-motor abilities of handicapped children? This question needs to be investigated to validate the use of strengthening exercises and activities in therapy.

Statement of the Problem

This study compared the effects of an upper extremity strengthening exercise program on the fine-motor ability of a group of handicapped children who participated in the program of exercises to a group of handicapped children who did not participate in the upper extremity strengthening program. Few studies are present in the literature that support the premise that strengthening exercises improve the fine-motor ability in handicapped children. Sellars (1983) found no correlation between strength measures and pencil and scissors skills of non-handicapped children. This study measured the effects of a strengthening program on the performance of selected fine-motor tasks in a group of handicapped children.

Statement of the Purpose

The purpose of this study was to investigate the relationship, if any, existing between the strength and fine-motor ability of handicapped children and to investigate whether a strengthening program affected the strength and fine-motor ability of handicapped children. With the lack of empirical data to support or refute the use of strengthening exercises in remedial programs, this study intended to provide information that may assist occupational therapists in planning and developing remedial programs for handicapped children with upper extremity involvement.

Hypotheses

The following hypotheses were tested:

1. There is no significant difference in the mean strength composite scores of handicapped children who participated in an eight week upper extremity strengthening program and those handicapped children who did not participate in the upper extremity strengthening program.

2. There is no significant difference in the mean fine-motor composite scores of handicapped children who did not participate in the upper extremity strengthening

program and those handicapped children who did not participate in the upper extremity strengthening program.

3. There is no significant difference in:

a. the pretest and posttest strength composite scores of handicapped chldren who participated in the upper extremity strengthening program

b. the pretest and posttest fine-motor composite scores of handicapped children who participated in the upper extremity strengthening program.

4. There is no significant difference in:

a. the pretest and posttest strength composite scores of handicapped children who did not participate in the upper extremity strengthening program

b. the pretest and posttest fine-motor composite scores of the handicapped children who did not participate in the upper extremity strengthening program.

Definition of Terms

For the purposes of this study the following terms were defined.

Fine-motor composite scores were derived by summing the fine-motor test items scores and multiplying the summed score by a constant of ten.

Fine-motor skills or _activities_ referred to those tasks which required a controlled muscular contraction of the shoulder, arm and hand resulting in manipulation of objects with one's fingers and hand.

Grasp referred to gripping an object with fingers flexed around the object, thumb opposing the fingers with wrist straight and in neutral forearm supination position.

Handicapped children referred to children ages 24 to 72 months who obtained a composite z score of -1.50 or less and a Developmental Motor Quotient of 78 or less on the _Peabody Developmental Motor Scales_.

Lift referred to the ability to raise a one inch dowel held in pronated hands, from lap to over head with elbows extended. The maximum amount of weight a child raised was determined by grading the weight of the dowel in half pound increments.

Pinch was viewed in three aspects. Lateral pinch referred to the opposition of the thumb and radial aspect of the first and second phalanx of the index finger. Tripod or three-jaw chuck pinch referred to the opposition of the thumb and pads of the index and long finger. Neat pincer grasp referred to the opposition of the thumb and tip of the index finger pad.

Strength referred to the force that a muscle group exerted against a resistance in one maximum effort. (Wells, 1972)

Strength composite score was derived by summing the individual strength item scores, right upper extremity score and left upper extremity score plus Lift score to obtain a total score.

Upper extremity strengthening program referred to the eight week series of exercises provided two times weekly. Resistance was increased when a child could complete ten repetitions of each exercise.

Limitations

Subjects were limited to children enrolled in an occupational therapy program at the Dallas Easter Seal Society for Children during the fall 1985 semester. These children had diagnoses of cerebral palsy, spinal bifida, and developmental delay. All subjects had no greater than 15 percent limitation of passive range of motion of the shoulders, elbows, wrists, and hands, bilaterally. Children had to attend 16 to 20 possible exercise sessions during the eight week program to be included in this study.

Assumptions

The first assumption was that all subjects would be able to follow simple one or two step instructions with repeated demonstrations.

The second assumption was that all subjects would be positioned in a sitting posture which would maximize normal muscle tone and provide thoracic stability and support as needed.

With the acceptable subject criteria of a significant delay in fine-motor ability set at -1.50 standard deviations on the Peabody Developmental Motor Scale, the third assumption was that neither gender nor diagnoses would make a difference in the fine-motor ability or strength of handicapped children.

CHAPTER II

REVIEW OF THE LITERATURE

Recent literature regarding the relationship of strength and fine-motor ability for the handicapped child appears to be non-existent. Most of the literature available attemps to provide normative data for both strength and fine-motor ability, separately.

Trombly (1977) referred to Kellor's articles for norms to aid in the assessment of hand function. Kellor (1971; 1977) attempted to provide protocols for assessing dexterity and hand strength. Kellor (1971) studied 250 men and women between the ages of 20 to 80 years of age. The results of this study confirmed the premise that men have stronger grip strength than women and also revealed that women lose their dexterity at a slower rate than men.

Swanson (1978) utilized the hydraulic dynamometer and electronic pinch meter to assess the grasp and pinch strength of 100 adults between the ages of 20 and 60 years of age. Her norms differed from Kellor's norms. This may be attributed to differing instrumentation.

The lack of a consistent protocol for assessing hand strength was the subject of Smith and Benge's (1985) survey. They surveyed the literature, occupational therapy clinical settings and occupational therapy educational programs in an attempt to begin the standardization process of hand function assessment terminology and protocols. Their study revealed a wide variety of terms and methodology for determining hand function. This lack of consistency is particularly evident when assessment of children's hand function is attempted. Sellars (1983), Ager, Olivett, and Johnson (1984), Morris, Vaughan, and Vaccaro (1982) each used differing methods to determine hand function in the children they studied. Sellars (1983) found no significant relationship between the hand strength and pencil and scissors skills of 49 non-handicapped children. Lateral pinch and grip strength were measured with a pinch gauge and dynamometer, respectively. A visual-motor subtest of the Bruninks-Oseretsky Motor Proficiency Test requiring cutting, tracing, and drawing shapes was used. Although no significant correlation was found between strength and these pencil and scissors skills, the two strength measures of grip and lateral pinch correlated highly ($p= 0.05$).

Ager, Olivett, and Johnson (1984) studied 474 children ages 5 to 12 years of age to establish normative data for grasp and pinch strength. Using the Jamar dynamometer and the Preston pinch gauge, their results appeared to indicate an increase in pinch and grasp strength as chronological age and development increased. Boys were found to be consistently stronger than girls across the age ranges, though not at a significant level.

Morris, Vaughan, and Vaccaro (1982) compared the muscle tone and strength of 28 children with Down's syndrome and 33 normal children 4 to 17 years of age. Grip strength measured by a hand dynamometer was employed as the strength measure. The Lafayette knee reflex apparatus and a five point rating scale were employed to measure muscle tone. Their results indicated that Down's syndrome children had more irregular patellar reflex responses than normal children. Down's syndrome subjects were also found to have lower muscle tone and lower grip strength when compared to normal subjects.

CHAPTER III

METHODOLOGY

Approval

Approval to conduct this investigation, which was a portion of a study being conducted by the Occupational Therapy Department of the Dallas Easter Seal Society for Children, was granted by the Administrative staff, Director of Occupational Therapy, and Human Rights Committee of Dallas Easter Seal Society for Children. Dallas Easter Seal Society approved permission forms were completed by each child's parent(s) or guardian during the fall semester conferences, August, 1985. See Appendix A; B.

Subjects

Subjects for this study were clients of the Dallas Easter Seal Society for Children's Occupational Therapy Department. Each child was between the ages of 24 to 72 months and met the following criteria: (a) consent form signed by parent or guardian on file in medical record. See Appendix B. (b) had no greater than a 15 per cent limitation of passive range of motion as determined by individual child's therapist according to goniometer measurements of shoulders elbows, wrists and fingers, bilaterally; (c) had the ability to understand and follow one or two step instructions as determined by each child's therapist; (d) attended at least sixteen of twenty possible exercise sessions.

Twenty-four subjects met the above criteria and were randomly assigned to either the experimental group or the control group. Ten subjects in the experimental group completed the exercise program while nine subjects in the control group completed their regular therapy program during the fall semester of 1985. All five of the subjects who did not complete either of the therapy programs had excessive absences due to illness.

The range of ages of the experimental group was 33 to 68 months with a mean of 49.5 months and standard deviation of 11.33 months. The control group's range of ages was 29 months to 68 months with a mean of 51.0 months and standard deviation of 13.84 months. No significant difference was found between the mean ages of the two groups.

Table 1

Ages

Group	N	$\bar{x}$	s	*t*	p
Exp.	10	49.50	11.33	-0.26	p=0.80
Control	9	51.00	13.38		

Taken from the subjects' most recent fine-motor assessment with the Peabody Developmental Motor Scale, the Developmental Motor Quotients range of scores for the experimental group was 65 to 77 points with a mean of 69.10 and standard deviation of 5.08 points. The Developmental Motor Quotient range of scores for the control group was 65 points to 78 points with a mean of 67.89 points and standard deviation of 5.73 points. No significant difference was found between the mean motor quotient scores of the two groups. See Table 2.

Table 2

Developmental Motor Quotients

Group	N	$\bar{x}$	s	t	p
Exp.	10	69.10	5.09	0.49	p= 0.63
Control	9	67.89	5.73		

Analysis of the age data and fine-motor Development Motor Quotient data revealed that there was no significant difference in the experimental and control groups with regard to age and fine-motor ability.

Diagnoses of the nineteen subjects completing the study included the general categories of developmental delay and cerebral palsy. The experimental group included 2 subjects with a diagnosis of developmental delay and the following types of cerebral palsy: 3 spastic right hemiplegia (SRH), 1 rigid quadraplegia (RQ), 2 mixed (Mix), 1 ataxic (At), and 1 athetoid (Ax). The control group included 2 subjects with a diagnosis of developmental delay and the following types of cerebral palsy: 2 spastic diplegia (SD), 3 spastic right hemiplegia (SRH), and 1 spastic quadraplegia (SQ). See Table 3.

Table 3

Diagnoses

Group	DD	SD	SRH	S/RQ	At/Ax	Mix
Exp.	2	0	3	1	2	2
Control	3	2	3	1	0	0

Procedures

Test Procedures

One week prior to the initiation of the upper extremity strengthening exercise program, all subjects were administered a pretest of strength and fine-motor items. Strength items included gross grasp, three pinch measures and lifting a weighted dowel. The Jamar dynamometer and Preston pinch gauge were used to obtain hand and finger strength in half pound increments. A one inch in diameter dowel, 36 inches long with weights attached by Velcro® to its center was used to measure gross shoulder and arm strength. Fine-motor tasks included four timed items: placing pegs in a pegboard, stringing one inch beads, drawing vertical lines and cutting along a six inch line.

Each subject was positioned in an optimal sitting posture with feet flat on a surface and thoracic support provided as needed. The pretest items were obtained in the following manner:

1. Strength measures were obtained with the subject's arms at sides and elbows flexed 90°.

2. To perform gross-grasp, each subject's arm was held in neutral supination-pronation. The subject was allowed three trials with the highest trial score being recorded on the Pre/Posttest Data Sheet. See Appendix C.

3. Three pinch strength measures were obtained with forearms pronated and pinch gauge held by the researcher. The highest response of 3 trials was recorded for each tripod, lateral, and pincer grasp.

Strength composite score was derived by assigning 1 point to each pound grasped, pinched or lifted. Credit was also given to the nearest quarter pound. The sum of right upper extremity score, left upper extremity score plus lift were recorded on the Pre/Posttest Study Data Sheet. See Appendix C.

Fine-motor test scores were obtained with each subject seated at the end of a 17 inch table with both upper extremities on the table top. All fine-motor test items were initially demonstrated prior to trial and initial trial was timed for 30 seconds. The score obtained on the initial trial was recorded on the data sheet.

The third fine-motor item presented was drawing vertical lines with a red felt-tip pen on a rectangular target. An adapted version of the Miller Assessment for Preschoolers "Cage" test item was used. See Appendix E. The subject was instructed to pretend that the rectangles on the paper were monkey cages at the zoo. The smaller rectangle at the top of the page was used as a trial. Each subject was instructed to place the pen at the top of the cage and stop at the bottom of the cage. Physical guidance was provided by the researcher on 2 "bars" with verbal guidance used with the remaining vertical strokes. The subject was then instructed to draw bars on the big monkey cage, starting at the top of the cage and stopping on the bottom of the cage. Verbal encouragement and start/stop reminders were given twice during the 30 seconds. The vertical strokes made by the subject were scored in the following manner: 1 point for each stroke within 20° of vertical, 2 quality points if strokes were drawn within 1/2 inch of the target area, 1 quality point if the strokes were within 1 inch of the top or bottom of the target, and 0 quality points if the vertical strokes fell outside the one inch scoring boundary. The sum of the vertical strokes plus the quality points were recorded on the data sheet.

The final fine-motor test item presented was cutting a

6 inch line with Easy-grip or loop handled scissors, obtained from Cole Supply. This item was adapted from the Peabody Developmental Motor Scales fine-motor section. The subject was instructed to cut the line. If a subject was unable to hold the paper to be cut, minimal physical assistance was provided by the examiner. The number of inches cut along the black line was recorded on the data sheet. Distance to the nearest 1/4 inch was credited.

The fine-motor score points were totaled in the following manner:

Pegs: 1 peg = 1 point

Vertical Lines: 1 line = 1 point plus quality point(s)

Beads: 1 bead = 1 point

Cutting: 1 inch = 1 point; partial credit given for fraction of inch to nearest quarter inch

Fine-motor composite score: total number of score points multiplied by a constant of 10.

Following the collection of baseline data, the experimental group participated in a strengthening exercise program, twice weekly, for 8 weeks. Each subject's therapist attended a training session on the proper performance of exercises. The control group subjects participated in their regular occupational therapy.

Exercise protocol

The strengthening exercises included four categories: Theraband exercises, weighted blocks, free weights, and Theraplast exercises. Resistance was increased as the subject obtained 10 repetitions of each exercise. The strengthening exercises were performed in the following manner:

Stacking weighted blocks - Each subject was seated at a table with feet flat on a surface; thoracic support was provided as needed. Twelve 2 inch hollow plastic blocks were used. Two ounce scrolls of lead were added to the blocks. A maximum of 8 ounces could be added to the blocks. Blocks were placed at the subject's midline and the subject was allowed to stack with either hand. The number of blocks stacked and the weight of each was recorded on the Daily Data Sheet. See Appendix D.

Theraband - Subject remained seated but moved from the table. Subjects held Theraband in pronated hands, elbows flexed, with hands at nipple-line height and pulled into abduction. Theraband was available in two levels of resistance, coded yellow for the first level and red for second level of resistance. Knots were tied at the end of 18 inch lengths of Theraband to aid in holding. Subject's beginning level of resistance was determined by presenting the knots at 18 inch intervals. If the subject could pull Theraband 10 repetitions from the starting position of pronated hands, flexed elbows and hands at nipple-line height to an end position of pronated hands, extended elbows at nipple-line height, the next level of resistance was used. None of the subjects could stretch the Theraband at the lowest resistance level 10 repetitions on the initial trial. As a subject got stronger, he or she progressed to segments with knots at 12 inch and 6 inch intervals. Upon completion of a 6 inch interval, the subject was moved to the next color level of resistance. When the subject completed the 6 inch level with the red Theraband, the Theraband was doubled and knotted at the 18 inch width. The sequence of knot interval was repeated with the doubled Theraband. Color of Theraband and number of repetitions were recorded on the daily data sheet by the subject's therapist. See Appendix D.

Arm Curls - Arm curls were accomplished with dumbells and Velcro® wrist weights. The subjects remained seated in optimum sitting posture with arms at sides. Therapists ensured that each subject maintained proper body alignment and that each subject moved through full elbow range of motion with each repetition. Two pound iron dumbells were used initially to obtain a baseline level. If a subject could not hold the dumbell, Velcro® wrist weights were straped in the subject's palms. When a subject could perform 10 repetitions, at a given weight, resistance was increased by 1/2 pound increments. The amount of weight and number of repetitions were recorded on the daily data sheet. See Appendix D.

Lift - A 1 inch by 36 inch dowel with weights attached to its center was used for subjects to lift from their lap to above their heads. With the subject in optimim sitting position, the dowel was grasped in pronated hands, shoulder width apart. The number of repetitions and amount of weight on the dowel was recorded on the daily data sheet. As 10 repetitions at a given weight were achieved weight was increased by 1/2 pound increments and recorded on the daily data sheet. See Appendix D.

Theraplast exercises - Theraplast exercises included 3 exercises: squeezing, rolling and pinching the Theraplast. Five color and number coded levels of resistance was available in the Theraplast. Squeezing the Theraplast involved the therapist presenting a cylinder shaped piece of Theraplast approximately 1 1/4 inch by 3 1/2 inches. The subject was instructed to "Squeeze" the Theraplast: with each squeeze, the Theraplast was rotated in the subject's hand. When a subject was able to make a series of ten 0.5 centimeter indentations with each hand, the next level of resistance was offered. Following Squeeze, the subject was instructed to roll the Theraplast to make a "snake". Each subject was shown how to roll the Theraplast with both hands from fingertips to heel of hand in a forward pushing motion only. When a subject could roll the Theraplast forward 10 times with all fingers in contact, the next level of Theraplast resistance was used.

Once the Theraplast was rolled out, the subject was instructed to pinch the snake. When the subject could pinch a 1.0 centimeter indentation in the Theraplast, 10 times with the index finger and thumb of each hand, the next level of resistance was utilized. The color of Theraplast and number of 1.0 centimeter pinches were recorded on the daily data sheet. See Appendix D.

During the week following completion of the eight week exercise program, posttest data identical to pretest was obtained and recorded on the same Study Data Sheet used for the pretest data. See Appendix C. Data from the study were analyzed using the Interactive Statistical Programs, N group and paired, available through the Texas Woman's University computer bank. An acceptable confidence level of 0.05 was set for the purposes of this study.

CHAPTER IV

RESULTS

Nineteen of the 24 subjects completed this eight week study, attending a minimum of 16 of 20 therapy sessions. Identical pretest and posttest measurements were obtained by the same examiner from each group, experimental and control. Using the data obtained the four hypotheses were tested.

Pretest strength composite scores for the control group ranged from 30.75 pounds to 67.90 pounds with a mean of 40.89 pounds and a standard deviation of 13.31 pounds. The experimental group pretest strength composite scores ranged from 26.75 pounds to 65.25 pounds with a mean of 39.17 pounds and standard deviation of 12.19 pounds. No significant difference was found between the two groups in their pretest strength composite scores ($p = 0.71$). See Table 4.

Table 4

Comparison of Pretest Strength scores by Group

Group	N	$\bar{x}$	s	*t*	p
Exp.	10	39.17	12.19	-0.37	p = 0.71
Control	9	40.89	13.31		

The posttest strength composite scores of the two groups did not support the first hypothesis. Posttest strength composite scores of the experimental group ranged from 41.25 pounds to 78.00 pounds with a mean of 53.47 pounds. The control group posttest strength composite scores ranged from 23.50 pounds to 64.00 pounds with a mean of 40.51 pounds. The mean difference of the two groups was 12.95 pounds with a pooled standard deviation of 12.14 pounds. Posttest strength composite scores of the control and experimental groups were found to be significantly different ($p = 0.033$). See Table 5.

Table 5

Comparison of Posttest Strength Scores by Group

Group	N	$\bar{x}$	s	t	p
Exp.	10	53.47	11.27	2.32	p = 0.03
Control	9	40.51	13.06		

Pretest fine-motor composite scores of the experimental group ranged from 90 to 300 points with a mean of 143.50 points and a standard deviation of 66.59 points. The control group pretest fine-motor composite scores ranged from 50 to 300 points with a mean of 164.72 points and a standard deviation of 83.09 points. The average difference in the pretest fine-motor composite scores of the two groups equaled -21.22 with a pooled standard deviation of 116.73. Statistically no significant difference was found between the two groups. See Table 6.

Table 6

Comparison of Pretest Fine-motor Scores by Group

Group	N	$\bar{x}$	s	t	p
Exp.	10	143.50	66.59	-0.40	p = 0.69
Control	9	164.72	83.09		

The posttest fine-motor composite scores of the experimental group ranged from 90 to 240 points with a mean of 204.00 points. Control group posttest fine-motor composite scores ranged from 110 to 340 points with a mean of 168.06 points. The mean difference of the two groups was 35.94 points with a pooled standard deviation of 80.64 points. Once again the data failed to reach a significance level of 0.05 ($p = 0.35$). The second hypothesis, there is no significant difference in the mean fine-motor composite scores of the two groups, was upheld. See Table 7.

Table 7

Comparison of Posttest Fine-motor Scores by Group

Group	N	$\bar{x}$	s	t	p
Group	10	204	72.76	0.97	p = 0.34
Control	9	168.06	88.67		

Part A of the third hypothesis, there is no significant difference in the pretest and posttest strength composite scores of the experimental group was not supported. A mean difference of 14.30 pounds was revealed. The experimental group's pretest and posttest strength composite scores were found to be significantly different ($p<0.001$). Following the exercise program the experimental group had higher strength composite scores. See Table 8.

Table 8

Comparison of Pretest and Posttest Strength Scores of Experimental Group

Test	N	$\bar{x}$	s_e	I	p
Pre	10	39.17	1.58	-9.07	$p < 0.001$
Post	10	53.47			

Part B of the third hypotheses, no significant difference in the pretest and posttest fine-motor composite scores of the experimental group, was not supported. The average difference between the pretest and posttest fine-motor composite scores equaled 60.50 points. Following the exercise program, the experimental group demonstrated a significant increase in their fine-motor composite scores. The pretest and posttest fine-motor composite scores of the experimental group were found to be significantly different ($p < 0.001$). See Table 9.

Table 9

Comparison of Pretest and Posttest Fine-motor Scores,

Experimental Group

Test	N	$\bar{x}$	s_e	I	p
Pre	10	143.50	4.74	-12.76	$p<0.001$
Post	10	204.00			

Further examination of the raw scores of each group revealed that all subjects in the experimental group gained in fine-motor composite points while 4 of 9 control group subjects decreased in fine-motor composite points and 5 of the control group subjects increased slightly in fine-motor composite score points. See Appendix F. The mean change in scores of the experimental group was 60.50 points and the mean change in scores of the control group was 3.33 points. The mean difference in the changed fine-motor scores of the two groups equaled 57.17 points with a pooled standard deviation of 29.68 points. While the mean posttest fine-motor composite scores of the control and experimental groups were not significantly different, their mean change in scores were significantly different ($p< 0.001$). Experimental group subjects had significantly higher change fine-motor composite scores than the control group subjects. See Appendix F.

See Table 10.

Table 10

Comparison of Change Scores by Group

Group	N	$\bar{x}$	s	t	p
Exp.	10	60.50	14.99	4.19	$p < 0.001$
Control	10	3.33	40.23		

The fourth hypothesis, there is no significant difference in the pretest and posttest fine-motor composite scores and strength composite scores of the control group, was supported in both instances. The mean difference in the pretest and posttest strength composite scores of the control group equaled 0.37. No significant difference was found between the pretest and posttest strength composite scores of the control group ($p < 0.83$). Without the benefit of a strengthening program the control group experienced no significant change in the strength composite score. See Table 11.

Table 11

Comparison of Pretest and Posttest Strength Scores, Control Group

Test	N	$\bar{x}$	s_e	I	p
Pre	10	40.89	1.65	0.23	$p < 0.83$
Post	10	40.51			

The mean difference in the pre and posttest fine-motor composite scores of the control group equaled -3.33. A significance level of less than 0.810 was reached, indicating that no significant difference existed between the pre and posttest fine-motor composite scores of the control group. The control group subjects experienced no significant increase in their fine-motor composite scores. See Table 12.

Table 12

Comparison of Pretest and Posttest Fine-motor Scores of Control Group

Test	N	$\bar{x}$	s_e	I	p
Pre	9	164.72	13.41	-0.25	$p < 0.81$
Post	9	168.06			

At the conclusion of this study, the occupational therapists of Dallas Easter Seal Society for Children decided to extend the study with modifications in the procedures. For ethical reasons, subjects in the control group who continued in occupational therapy during the spring 1986 semester were given the opportunity to participate in an upper extremity strengthening program. The control group subjects became the extended study experimental group. A memorandum regarding the completion of this study and the schedule for the additional study was sent to the Director of Occupational Therapy. See Appendix G. For further information and the results of this additional study, see Appendices H, I, and J.

Chapter V

Summary and Conclusions

No significant difference was found in the pretest fine-motor composite or strength composite scores of the control and experimental groups. Following the eight week exercise program, a significant difference was found in the posttest strength composite scores of the two groups with the experimental group's mean score beign higher ($p= 0.03$). The means of the posttest fine-motor composite scores of the experimental and control groups were not found to be significantly different. When reviewing the change in the fine-motor composite scores , however, the two groups were found to be significantly different ($p< 0.001$) with the experimental group's mean score again being higher.

Although the mean posttest fine-motor composite scores of the two groups were not found to be significantly different, the change in individual scores indicated a significant difference in the posttest scores of the subjects who participated in the upper extremity strengthening program. All subjects in the experimental group improved their fine-motor composite scores following an upper extremity strengthening program. When comparing the experimental group's pretest and posttest performance, both the posttest fine-motor composite scores ($p < 0.001$) and strength composite scores ($p < 0.001$) were found to be significantly higher than the pretest scores. The control group subjects demonstrated no significant change in either their fine-motor composite scores or strength composite scores. The control group subjects also had no significant difference in their change fine-motor composite scores. Following the eight week upper extremity strengthening program, all subjects in the experimental group demonstrated an increase in their fine-motor ability and upper extremity strength while subjects in the control group demonstrated no significant change in their fine-motor ability or strength. From the data obtained, it appears that an upper extremity strengthening program positively affects both strength and fine-motor ability of these these handicapped children.

The positive effects of the strengthening program on fine-motor ability of handicapped children is supported by the significant difference in the pretest and posttest fine-motor composite scores of the experimental group. Comparison of the change scores in the two groups also supports the positive effects of the strengthening program. Occupational therapists appear to have a valid basis for including strengthening activities in the therapeutic programs of handicapped children designed to improve fine-motor ability and activities of daily living which require upper extremity function. While the data obtained in this study appears to support the inclusion of strengthening exercises in therapy, further research is indicated with larger subject populations to validate these findings.

Further research should include the variables of gender, age, diagnoses, and severity of disability which were not addressed by this study. While the limited number of subjects precluded this type of analysis, further investigation with these variables would be a helpful addition to the body of knowledge available to occupational therapist developing therapeutic programs for handicapped children. With problems of posture, muscle tone, and joint alignment that children with cerebral palsy encounter, further research regarding these problems' effects on strength and fine-motor ability would also be beneficial.

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APPENDIX A

Letter of Approval

EASTER SEAL SOCIETY
FOR CHILDREN
Formerly Dallas Society For Crippled Children

Sharon Kozak, OTR/L
Director Occupational Therapy
Dallas Easter Seal Society for Children
5701 Maple Avenue
Dallas, Texas 75235

October 2, 1985

Beverly Cogdell, OTR/L
Dallas Easter Seal Society for Children
5701 Maple Avenue
Dallas, Texas 75235

Dear Ms. Cogdell,

This is to inform you that the Program Committee of the Dallas Easter Seal Society for Children has met in the role of the Human Rights Committee to review your thesis study relating to upper extremity strength and fine motor ability.

In reviewing your proposal and following the general guidelines as discussed with Dr. Griffin, TWU Advisor outlining considerations in the Human Rights Review, the committee voted unanimously to allow the study to proceed. The committee met, reviewed and voted 9/18/85.

Sincerely,

Sharon Kozak, OTr/L
Director, Occupational Therapy Department

DALLAS EASTER SEAL SOCIETY FOR CHILDREN
5701 Maple Avenue at Inwood
Dallas, Texas 75235 Phone: 214-358-5261

TRINITY EASTER SEAL SOCIETY FOR CHILDREN
Professional Plaza I, One Medical Pkwy., Suite 109
Dallas, Texas 75234 Phone 214-484-0033

APPENDIX B

Study Participation Permission Form

EASTER SEAL SOCIETY
FOR CHILDREN
Formerly Dallas Society For Crippled Children

STUDY PARTICIPATION PERMISSION

I ____________________ agree to allow my child ______________
Parent/Guardian

to participate in the O.T. study examining the relationship of strengthening activities and fine-motor ability.

I understand that my child s name and other identifying information will be held in strictest confidence.

I also understand that I may withdraw my child's participation at any time.

____
Witness

____
Parent/Guardian

____
Date

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APPENDIX C

Study Data Sheet

STUDY DATA SHEET

NAME:______________________ PDMS:LMS:_________ SUBJECT NUMBER:____

STRENGTH SKILLS	PRETEST		POST-TEST	
	rt	lft	rt	lft
Gross grasp				
Pinch				
Pincer				
Lateral				
Tripod				
Lift				
FINE-MOTOR SKILLS	**PRETEST**		**POST-TEST**	
# pegs in 30 sec.				
# vert. line in "				
# 1"beads in "				
Cut 6" line in "				
Composite Score				

APPENDIX D

Daily Data Sheet

DAILY DATA SHEET

Date:

Name:__________

1. Stack Block *stack all																				
2. Theraband note color *,**,***																				
3. Arm curls * (biceps) **																				
4. Lift (shoulders) *,**																				
5. Theraplast note color *,**,***																				
Squeeze																				
Roll snake																				
Pinch snake																				

* criteria to move to next level- 10 reps.
** increase wt. by ½ lb increments
*** record - # reps/blocks, wt. color/# resistance level

APPENDIX E

Cage Test Form

practice
R L

item
R L

APPENDIX F

Change in Fine-motor Composite Scores

Change in Fine-motor Composite Scores

Experimental n=10		Control n=9	
Subject	Points	Subject	Points
01	60	21	-10
02	65	22	40
03	60	23	10
04	70	24	55
05	30	25	20
06	70	26	20
07	80	27	-10
08	70	28	-85
09	60	29	-10
10	40		
Total	605.00		30
Mean	60.5		3.33
Median	62.5		10
St. Dev.	14.9907		40.23
SEM	4.74		13.41

Mean difference	57.1667
Pooled St. Dev.	29.6772
T-test	$t(17) = 4.19$
P Value	$p < 0.001$

APPENDIX G

Memorandum

EASTER SEAL SOCIETY
FOR CHILDREN
Formerly Dallas Society For Crippled Children

MEMO

DATE: February 13, 1986
TO: Sharon Kozak, Director Occupational Therapy
FROM: Beverly J. Cogdell, OTR
RE: Status Report of O.T. Research Project

Please be advised that Part I of the Occupational Therapy Research Project has been completed with 10/12 children completing the exercise program. A preliminary review of the pre-post test data appears favorable to our hypothese. At the present time, I am awaiting confirmation of a password and account to use the TWU computer bank to analyze our data in detail.

The expected dates for Part II duration is March 10 through May 2. Prior to this time, all children in the study will need to be retested with the pre-test.

Please feel free to contact me if you need any further information.

Beverly J. Cogdell, OTR/L

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APPENDIX H

Additional Study

Additional Study

An additional study similar to the study presented in this thesis was conducted by the occupational therapists at the Dallas Easter Seal Society for Children to afford the control group subjects the opportunity to participate in an upper extremity strengthening program. Subjects in the control group who continued in occupational therapy during the spring 1986 semester became the extended study experimental group. Eight of the nine subjects continued in therapy during the spring session. These subjects acted as their own control group for reviewing the effect of time and modifications in the exercise program. The following hypotheses were added to the current study:

5. There will be no significant difference in the pretest strength composite scores of the control group and the extended study experimental group.

6. There will be no significant difference in the posttest strength composite scores of the control group and the extended study experimental group.

7. There will be no significant difference in the pretest fine-motor composite scores of the control group and the extended study experimental group.

8. There will be no significant difference in the

posttest fine-motor scores of the control group and the extended study experimental group.

9. There will be no significant difference in the pretest and posttest strength composite scores of the extended experimental group.

10. There will be no significant difference in the pretest and posttest fine-motor scores of the extended study experimental group.

11. There will be no significant difference in the change fine-motor scores of the extended study group and the control group.

The modifications in the exercise program included the omission of the following exercises: Theraband exercises and Theraplast exercises. These exercises were omitted due to the length of time to instruct and the necessity to assist the subjects either verbally or physically. All other exercises were performed as in the initial study. An adaptation of the weighted dowels was also made to provide more ease of execution and uniformity of presentation. Six one inch plastic pipes with closed ends, increasing in 1/2 pound increments from 1 pound to 3 1/2 pounds were used in place of the dowels. If a subject surpassed the 3 1/2 pounds limit, wrist weights were attached at the center of the pipe as with the dowel in the earlier study.

Eight of the nine subjects continued therapy during the spring semester and completed the modified exercise program. Each of the subjects participated in the exercise program twice weekly for eight weeks. From the data obtained, the additional hypotheses were tested.

The fifth hypothesis, there is no significant difference in the pretest strength composite scores of the control and extended study experimental groups was upheld. The mean difference of these two groups was -7.11 with a pooled standard deviation of 14.19. This group of subjects demonstrated no change in their strength levels from their two pretest dates, September to January. See Table 13.

Table 13

Comparison of Pretest Strength Scores by Group

Group	N	$\bar{x}$	s	*t*	p
Control	9	40.89	13.31	-7.11	p = 0.32
Extended	8	48.00	15.12		

The sixth hypothesis, there is no significant difference in the posttest strength composite scores of the control and extended experimental groups, was not supported. The mean difference of the two groups was -30.39 with a pooled standard deviation of 15.32. The difference in the control group's posttest strength composite scores and the extended study experimental group's posttest strength composite socres exceeded the acceptable confidence level of 0.05 ($p < 0.001$). See Table 14.

Table 14

Comparison of Posttest Strength Scores by Group

Group	N	$\bar{x}$	s	*t*	p
Control	9	40.51	13.06	-4.08	$p < 0.001$
Extended	8	70.96	17.54		

The seventh hypotheses, there is no significant difference in the pretest fine-motor composite scores of the two groups, was supported. The mean difference between the two groups' pretest fine-motor composite scores was -3.40. A significance level of 0.95 was obtained. Again this group of subjects demonstrated no significant change in their pretest fine-motor composite scores. The subjects demonstrated no significant change in their pretest fine-motor composite scores, even though they participated from September to January in occupational therapy programs which did not include specific strengthening exercises. See Table 15.

Table 15

Comparison of Pretest Fine-motor Scores by Group

Group	N	$\bar{x}$	s	*t*	p
Control	9	164.72	83.09	-0.07	p = 0.95
Extended	8	168.13	117.17		

The eighth hypothesis, there is no significant difference in the posttest fine-motor scores of the control group and extended study experimental group obtained a confidence level of 0.59. The mean difference of the two groups was -95.07 with a pooled standard deviation of 95.55. Although the acceptable confidence level of 0.05 was not obtained with this small population, it is anticipated that the results might have been significant with a larger subject population. See Table 16.

Table 16

Comparison of Posttest Fine-motor Scores by Group

Group	N	$\bar{x}$	s	$\underline{t}$	p
Control	9	168.06	88.67	-2.05	p = 0.059
Extended	8	263.13	102.85		

The ninth hypotheses, there is no significant difference in the pretest and posttest strength composite scores of the extended study experimental group was not supported. The average difference in the pretest and posttest scores was -22.91. The difference in the pretest and posttest scores reached a confidence level of less than 0.001. This group of subjects significantly increased their strength composite scores following the modified exercise programs. See Table 17.

Table 17

Comparison of Pretest and Posttest Strength Scores, Extended Study Experimental Group

Test	N	$\bar{x}$	s_e	I	p
Pre	8	48	3.00	-7.64	$p < 0.001$
Post	8	70.90			

The tenth hypothesis, there is no significant difference in the pretest and posttest fine-motor scores of the extended study experimental group was not upheld. The average difference in the pretest and posttest fine-motor composite scores obtained a probability level of less than 0.001. Following the modified upper extremity strengthening program, this group of subjects demonstrated a significant increase in their fine-motor composite score. See Table 18.

Table 18

Comparison of Pretest and Posttest Fine-motor Scores, Extended Study Experimental Group

Test	N	$\bar{x}$	s_e	I	p
Pre	8	168.13	10.00	-9.50	$p<0.001$
Post	8	263.13			

The final hypotheses, there is no significant difference in the fine-motor composite change scores of the control group and the extended study experimental group, was not supported. The mean difference in the two group's change scores was -91.67 with a pooled standard deviation of 35.17. The difference in the two groups obtained a probability level of less than 0.001. See Table 19.

Table 19

Comparison of Fine-motor Change Scores of the Control and the Extended Study Experimental Groups

Group	n	$\bar{x}$	s	*t*	p
Control	9	3.33	40.23	-5.36	$p < 0.001$
Ext. Exp	8	95.00	28.28		

Summary and Conclusions

This group of eight subjects experienced a significant increase in both their fine-motor composite scores and strength composite scores following the modified upper extremity strengthening program. They also experienced no significant difference in their pretest fine-motor composite scores and pretest strength composite scores. The change in fine-motor composite scores was found to be significantly higher than their original change scores without a strengthening program. From this data one may conclude that without specific strengthening exercises or activities included in the therapeutic programs, these handicapped children would not effectively improve in either strength or fine-motor ability.

The omission of Theraband and Theraplast exercises did not appear to have any negative effect on the results of this investigation. The effects of time appeared to not significantly change the fine-motor ability or strength of these handicapped children. Therapeutic programs provided during the initial study, which did not include specific strengthening exercises or activities, did not appear to significantly increase strength and fine-motor ability of these subjects. It may be concluded that the modified exercise program positively effected the fine-motor ability and strength of these handicapped children.

Based on the data presented, the inclusion of the modified upper extremity strengthening program may be as beneficial as the original program. When time constraints limit the inclusion of an extensive strengthening program, the modified program may be the one of choice. The average range of time to complete the modified program was 10 to 15 minutes while the original program averaged 20 to 25 minutes. Further investigations with larger populations may help to delineate additional advantages and disadvantages of these two programs.

Due to the small population size of this study, the effects of gender, diagnosis, and severity of disability were not investigated. The effects of these variables and normative studies investigating standard strength measures in preschool children would assist occupational therapists in developing appropriate therapeutic programs.

APPENDIX I

Change Raw Scores of Extended Study

Change in Fine-motor Composite Scores

Extended Study Experimental Group

n=8

Subject Number	Points
21	120
22	60
23	70
24	90
25	130
26	70
27	90
28	130
Mean	95.00
Median	90.00
St. Dev.	28.2843
SEM	10.00

Compared to Changed Fine-motor Composite Scores of Control

Mean difference	-91.6667
Pooled St. Dev.	35.1663
T-test	-5.36
P value	$p < 0.001$

APPENDIX J

Raw Scores

Raw Scores

Experimental Group

n=10

Number	Strength		Fine-motor	
	Pre	Post	Pre	Post
01	31.75	41.25	140	200
02	65.25	78.00	95	160
03	52.00	66.50	90	150
04	37.00	46.40	300	370
05	36.25	55.50	160	190
06	27.25	49.00	160	230
07	35.75	44.75	130	210
08	47.40	56.75	170	240
09	32.25	50.00	140	200
10	26.75	46.50	50	90
Total	391.65	534.65	1435	2040
Mean	39.165	53.465	143.50	204
Median	36.00	53.465	140	200
St. Dev	12.1871	11.2661	66.5854	72.7553
SEM	3.8539	3.5627	21.0561	23.0072

Raw Scores

Control Group

n=9

Number	Strength		Fine-motor	
	Pre	Post	Pre	Post
21	33.90	33.90	190	180
22	52.00	60.00	300	340
23	67.90	64.00	180	190
24	23.25	23.50	110	165
25	30.75	36.25	50	70
26	40.90	39.75	150	170
27	45.00	37.50	57.50	47.50
28	31.80	32.75	195	110
29	42.50	37.00	250	240
Total	368	364.65	1482.50	1512.50

Mean	40.8889	40.5167	164.7222	168.0556
Median	40.90	37.00	180.00	170.00
St. dev.	13.3132	13.0623	83.0892	88.6688
SEM	4.4377	4.3541	27.6964	29.5563

Raw Scores

Extended Study Experimental Group

n = 8

Number	Strength		Fine-motor	
	Pre	Post	Pre	Post
21	48.00	76.50	230	350
22	71.50	99.00	400	460
23	67.50	88.25	220	290
24	27.50	44.50	100	190
25	33.50	67.25	65	195
26	48.50	56.75	190	260
27	43.00	60.50	50	140
28	44.50	74.50	90	220
Total	384	567.50	1345	2105
Mean	48	70.3063	168.125	263.125
Median	46.25	70.8750	145	240
St. Dev.	15.1209	17.5402	117.1671	102.85
SEM	5.3461	5.3461	41.4248	36.3630