A DEXTERITY TEST
AS A MEASURE OF FUNCTIONAL SKILL

A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF MASTER OF ARTS

IN THE GRADUATE SCHOOL OF

THE TEXAS WOMAN'S UNIVERSITY

SCHOOL OF OCCUPATIONAL THERAPY

BY

DORIT HAENOSH, B.S., O.T.R.

DENTON, TEXAS

MAY, 1982

DEDICATION

To my mother.

ACKNOWLEDGEMENTS

As with all major projects, one cannot accomplish them alone. This was no exception. This work could not have been completed in time to meet any deadlines if it weren't for Barbara Johnson's MOT, OTR, Mary Beth Laplant's, LPT and Mary Beth Billota's OTR dedicated hours of data collection; Priscilla Nichols's OTR endless patients and endurance in typing and retyping this paper; and Diane Schreiter's creative talent. To all of them--THANK YOU.

I owe thanks to the Occupational Therapy staff at St. Joseph Hospital for being so supportive and understanding, and to the hospital for allowing me the time for this project while I was working full time.

I express special appreciation to Grace Gilkerson, Ed.D. OTR for believing in me. Last, but by no means least, I thank my husband Rob for helping to create an environment where such an undertaking was possible.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

In occupational therapy, specifically in the treatment of patients with injured hands, little attention has been given to developing dexterity screening tests that can be used in a busy patient care clinic. In addition, over the years studies have failed to correlate the results of dexterity with the actual functional ability of a given hand.

In the literature one finds various dexterity and functional tests such as the Physical Capacity Evaluation of Hand Skill (Bell, 1976), An Objective and Standardized Test of Hand Function (Jebsen, 1969), Purdue Pegboard, the O'Connor Finger Dexterity Test, and many others. These tests usually fall into one or several of the following categories:

1. Administration of the test in full takes over ten minutes.

2. The test has been correlated with vocational potential.

3. The test was standardized on a neurological patient population with hemiplegia, closed head injuries, or spinal cord injuries. None of these tests speaks to

the functional capacity as it related to dexterity.

Occupational therapists need a readily available standardized test with realistic time dimensions that can be available to all practicing therapists. Standardization can prove to be valuable due to the growing requirements for documentation in legal and reimbursement cases.

An instrument that will meet the above mentioned need was developed. The dexterity screening test consists of the following components:

1. It takes less than 2 minutes to fully administer.

2. It correlates dexterity with functional performance of the traumatically injured hand.

3. It aids the therapist in determining if dexterity is a problem area of a specific patient and thus facilitate treatment planning.

4. It provides the therapist with standardized documentation of the patient's progressive dexterity and functional abilities.

Statement of the Problem

Is it possible to devise an instrument that allows realistic measurement of manual dexterity in a busy patient care clinic and at the same time provide information about functional hand activity?

Purpose of the Study

The purpose of this study was to determine if a relationship exists between scores on a dexterity test and functional hand activity and to develop an instrument that can be used to provide these results in a short time.

Significance

The significance of this test is the short amount of time required to administer it while providing the following information:

1. The patient's gross and fine three-jaw-chuck prehension in functional activities.

2. A need for further in-depth dexterity testing.

3. A measure of the amount of improvement in the patient's dexterity over time, thus facilitating treatment planning.

Definition of Terms

Dexterity: A factor that involves the use of skillful controlled finger movements to manipulate tiny objects through a small space (Hester, 1976).

Functional prehension: The ability to use a three-jaw-chuck prehension pattern.

A. Gross: manipulation of large objects

B. Fine: manipulation of small objects.

Limitations of the Study

Data collection was performed by several therapists; however, steps to control interrater reliability were implemented. Each participating therapist was taught by this investigator the correct administration of the test and provided with written instructions. Each therapist demonstrated correct use of test prior to beginning collection of data.

Hypotheses

1. There will be no relationship between results of the gross dexterity screening test and the ability to perform tasks requiring a three-jaw-chuck prehension pattern.

2. There will be no relationship between results of the fine dexterity screening test and the ability to perform tasks requiring a three-jaw-chuck prehension pattern.

CHAPTER II

REVIEW OF LITERATURE

The literature review covers several major areas. It begins with a brief overview of the hand's prehensile functions and a discussion of the motor and sensory components of hand function that influence prehension. This is followed by a summary of the most commonly available dexterity tests used in occupational therapy and prevocational testing, including the goal of each test, its validity, reliability, and time required for administration. The review concludes with a statement on standardization of tests.

> The hand is composed of material for touch of great sensitivity and a system of exact machinery of great specialization and refinement--all in a most complex array and condensed into unit weighing less than a pound. With this amazing tool, we implement the desires of the human brain, whether requiring the speed and precision of the fingering hand of a concert violinist or the brute power grasp needed to wield a sledge hammer. (Burton, 1978, p. VII)

The hand may be viewed as having two functional categories. The first function is non-prehensile, which is defined as functions not requiring manual skill, i.e., using the fist as a hammer, or pushing off to a rise from a sitting position. The second function is prehensile, which is defined as power grip and precision handling.

This would include such gross tasks as hammering and opening a jar, and fine tasks such as writing or buttoning. Precision handling or manual dexterity refer to manipulation of objects using the thumb and second and/or third digit (Trombly & Scott, 1977).

Manual dexterity is achieved by integration of sensory, motor, and skeletal components. Moberg (1958) drew a direct relationship between sensibility of the hand and one's ability to use the hand. "A hand that possesses normal sensibility can see even when the subject has his eyes closed" (p. 454). Moberg went on to develop a test called the "Picking Up Test" which allows one to examine the effects of sensibility on functional use of the hand. This test requires the patient to pick up several small objects and place them in a small container, then repeat the task with his eyes closed. The tester then can differentiate between intact motor abilities and no sensibility as opposed to intact motor and normal sensibility.

More recent studies on the subject of sensation of the hand and its functional correlation were done by Dellon (1981) who claimed that the "natural approach to sensory exploration depends upon a continuous movement of the hand or fingertips" (p. 124). Dellon described the relationship of peripheral sensation with the somatosensory cortex. He suggested that Brodmann's area

1, which is located on the rostral surface of the post-central gyrus, receives sensory input from moving touch or finger movements. Brodmann's area 3, located within the sulcus on the postcentral gyrus posterior wall receives input from constant touch and pressure on the hand. Parry (1971) supported the concept that sensation and motor function are so closely related that sensory loss drastically affects power and precision of hand function.

The motor and skeletal aspect of precision pinch was described by Parry as "holding a paintbrush, the thumb is opposed to the index finger which is abducted and rotated and the fingers slightly flexed at all joints and the wrist held in very slight dorsiflexion" (p. 26). Parry continued to explain that the fingertips can adjust the object held. He emphasized the importance of the stability and movement of the metacarpophalangeal joint.

More specifically, precision manipulation is achieved by use of interossei muscles as abductors or adductors of the fingers and the abductor pollicus brevis, opponens pollicis and flexor pollicis brevis for movements requiring turning of objects. Movement away from palm requires only the intrinsics, and movement toward the palm requires only extrinsics (Long, 1970).

Finger dexterity involves the ability to coordinate finger movements while manipulating objects. This includes grasp-release, turning, speed (specifically wrist flexion and finger movements), aiming and placing (Fleishman & Hempel, 1954). More than proximal limb muscles, movement of the hand is more directly controlled by the motor cortex for efficiency and precision (Ayeres, 1974; Granit, 1970).

In summary, the ability to use one's hand in daily activities requires anatomic integrity, mobility, strength, sensibility and coordination (Jebsen, 1969). Normal function of the hand may be affected by injury, disease or birth defects (Burton, 1978). This study tested injured hands, particularly coordination of finger movements as seen in manipulation of small objects and their direct relationship to functional ability.

Acquaintance with the major types of tests, their contributions and limitations is essential for understanding contemporary testing (Anastasi, 1968). Tests found in the literature are either quite lengthy, standardized for prevocational testing, or standardized for neurologically injured patients. The following is a brief review of the major dexterity tests that are primarily used in occupational therapy today.

Jebsen devised the Jebsen Hand Function Test which utilizes several functional tasks to measure a patient's functional capabilities. This test was standardized on both normal population and a patient population (of various diagnoses); however, no correlation to dexterity was made. The tests look at relatively gross hand function (Fess, 1978). The total administration time of the test is 15 minutes.

Cromwell (1960), Willard and Spackman (1978) and Trombly and Scott (1977) discussed the following tests. The Crawford Small Parts Dexterity Test is designed to aid in vocational placement based on individual measure of fine eye-hand coordination and manipulation of small objects. It has high reliability and face validity and takes an average of 15 minutes to administer. Minnesota Rate of Manipulation Test was designed to measure manual dexterity. It is said that best results are attained when one is standing and thus has good balance and eye-hand control. However, studies have been performed with patients in wheelchairs with good results. This test takes approximately 30 to 50 minutes to administer.

Cromwell summarized the following prevocational tests:

1. Bennet Hand Tool Dexterity Test measures tool manipulative skills independent of intellectual factors. It was found to have high reliability and low validity.

2. Box and Block Test measures gross,

nonmanipulative dexterity (pinch) and can be easily and quickly administered. It is given in several 1-minute blocks of time.

Hopkins and Smith (1978) discussed the following commonly used manual dexterity and motor function vocational tests:

1. Purdue Pegboard provides information on fine finger dexterity and coordination, standardized on vocational applicants, students, and veterans (Hunter, 1978). The test takes 12 to 15 minutes to administer and is widely used in occupational therapy and hand rehabilitation clinics. It has face validity and low reliability.

2. Pennsylvania Bi-Manual Work Sample tests finger dexterity of both hands as well as eye-hand coordination and gross arm movements. This test takes approximately 15 minutes to administer and it has good reliability.

Hunter (1978) discussed the O'Connor Dexterity Test as one commonly used with hand injured patients. It measures fine eye-hand coordination. However, it is time-consuming to administer.

Finally, the Physical Capacities Evaluation (PCE) (Bell, 1976) measures general hand skill, fine and gross. It has been standardized on both neurologically injured patients and a normal population. It takes about 30 minutes to fully administer.

Trombly and Scott (1977) reported that most of the above tests, although used in clinical settings, are standardized for prevocational use. These tests are all useful in a variety of settings; however, they do not lend themselves to easy accessibility and use in a busy clinic treating hand-injured patients. The following dexterity test is one that can be easily constructed in any occupational therapy clinic and administered in 1 to 2 minutes. It provides information about dexterity as it directly relates to functional performance with the use of a three-jaw-chuck prehension pattern. This type of information is not provided by any other test as has been seen in the review of the literature.

The final section of this review will briefly discuss test standardization. The meaning of standardized tests, according to Cromwell (1960), is that they are always the same in content, administration, and scoring, and will consistently give the same information every time they are given. Anastasi (1968) defined a psychological test as "an objective standardized measure of a sample of behavior," like other tests where observations are made on a carefully chosen, small sample. She stated that the actual behavior covered by a given test is rarely the goal of testing; it is only the diagnostic or predictive value of the test that is of interest. As in this study, the dexterity test is a predictive measure of functional abilities. As the definition suggests, the test must be standardized to "have uniformity of procedure in administering and scoring." For more than one individual to use a test, controlled conditions are a requirement in all scientific observations so that the scores obtained can be compared. In a test situation, the only independent variable is usually the individual being tested.

In order to standardize a test, a representative sample of the type of subjects for whom the test is designed is used. This sample is known as "standardization sample"; it serves to establish the norms. Anastasi continued that "such norms indicate not only the average performance but also the relative frequency of varying degrees of deviation above and below the average." The objective evaluation of a test involves the determination of its reliability and validity. Reliability refers to the consistency of the tests' parameters. Validity simply answers the question, "What is the degree to which the test actually measures what it purports to measure?"

Crombach (1960) defined test as "a systemic procedure for comparing the behavior of two or more persons," and a standardized test as "one in which the procedure, apparatus, and scoring have been fixed so that precisely the same test can be given at different times and places."

Helmstadter (1964) claimed there are four items that must be examined to determine whether a test is a good measuring device:

1. Standardization
2. Reliability
3. Objectivity
4. Validity

This literature review has presented a brief overview of some of the published material concerning dexterity tests and the background in hand prehensile function. The literature offered little actual information concerning prehensile patterns. It did, however, offer an array of dexterity and coordination tests that have been standardized for various purposes. No tests were found that provide information directly linking dexterity with functional ability, or that can be administered in less than 2 minutes.

CHAPTER III

METHODOLOGY

Subjects

A convenience sample of 46 patients with hand injuries was selected from the patient population of two Houston area hand units.

Instrument

The following test materials were chosen on the basis of the manipulative skill one must have to perform the task. As was explained in the literature review, dexterity tests that are commercially available require only a grasp-release prehension pattern, and manipulation of tools, such as screw drivers and pliers. No test, to this investigator's knowledge, actually requires a three-jaw-chuck prehension pattern for its performance. The pegboards chosen for this test specifically demand manipulation of an object with a three-jaw-chuck pinch. A large and small pegboard were used to determine which type of manipulation, fine or gross, has the highest correlation to functional skill. The pegboards used in this test had the following dimensions:

1. Large Pegboard - 20.6 cm by 20.6 cm with 16 pegholes, each measuring 3 cm in depth, placed 5 cm from

each other in four rows of four. In each hole there was a 4 cm long peg that had a 2.4 cm diameter and was marked with a dot on one side.

2. Small Pegboard - 12.4 cm by 12.4 cm with 16 pegholes, each measuring .9 cm in depth, and placed 2.5 cm from each other in four rows of four. In each hole there was a 1.4 cm long peg measuring .5 cm in diameter and marked with a dot on one side (See Figure 1).

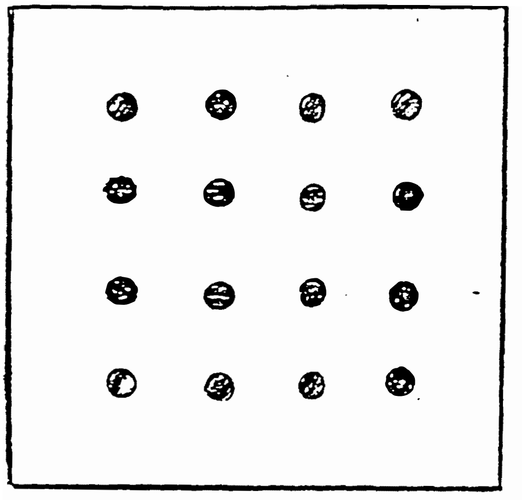
Other equipment used to perform this test included a stopwatch and a functional board that was 29 cm long and 25 cm wide to which were attached four functional tasks (see Figure 2). The functional tasks included:

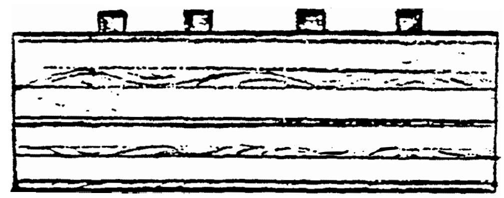
1. A rope that was 49 cm long and 2 mm thick wrapped around two nails that were 9 cm apart. The rope had two free ends measuring 20 cm in length each. The right free end was used for tying by the right hand, and the left rope by the left hand.

2. A screw that was 4 cm long with a nut that was 1 cm wide. For testing, the nut was placed on the board, either on the left or right of the bolt depending on what hand was tested.

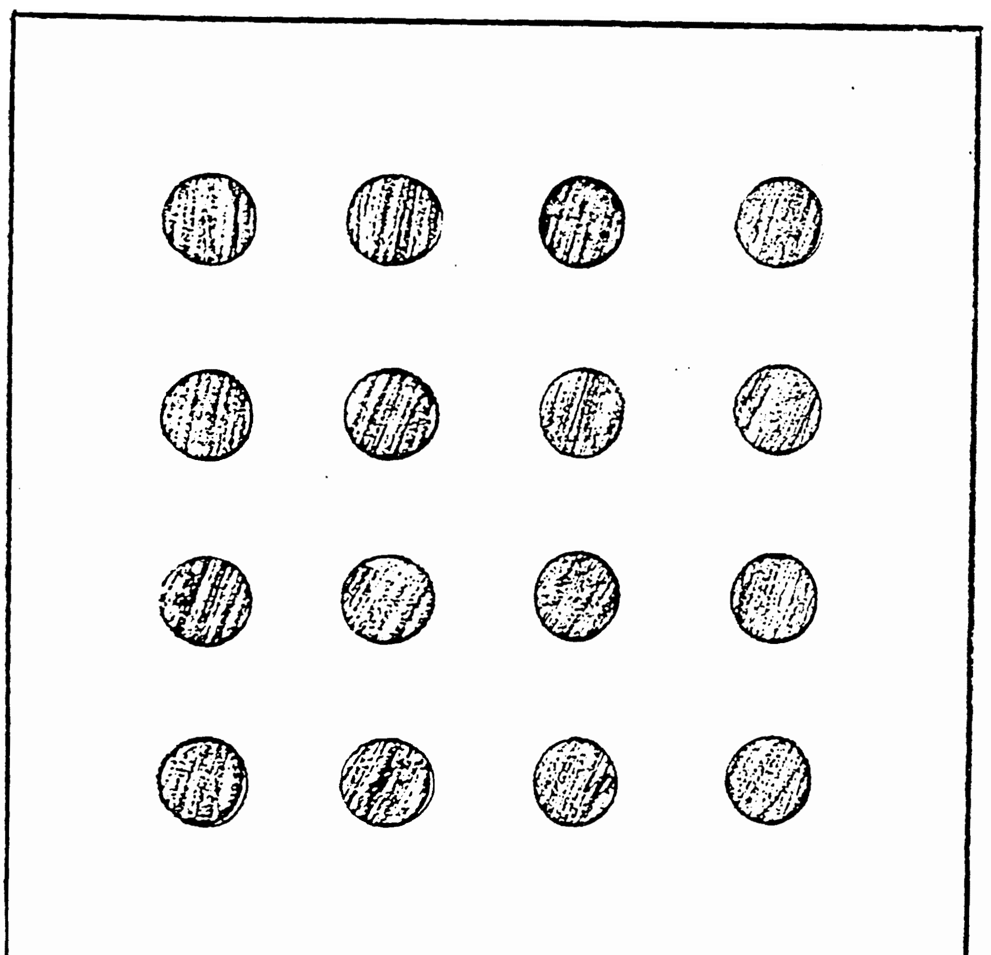
3. A button of 1 cm diameter. The button was on the right and button hole on the left.

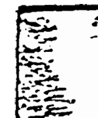
4. A weave pattern consisting of six pieces of yarn 5 cm long placed 2 cm apart and glued to the board.





Small Pegboard





Large Pegboard

Scale: 1/2 cm = 1 cm

Figure 1 - Small and Large Pegboard

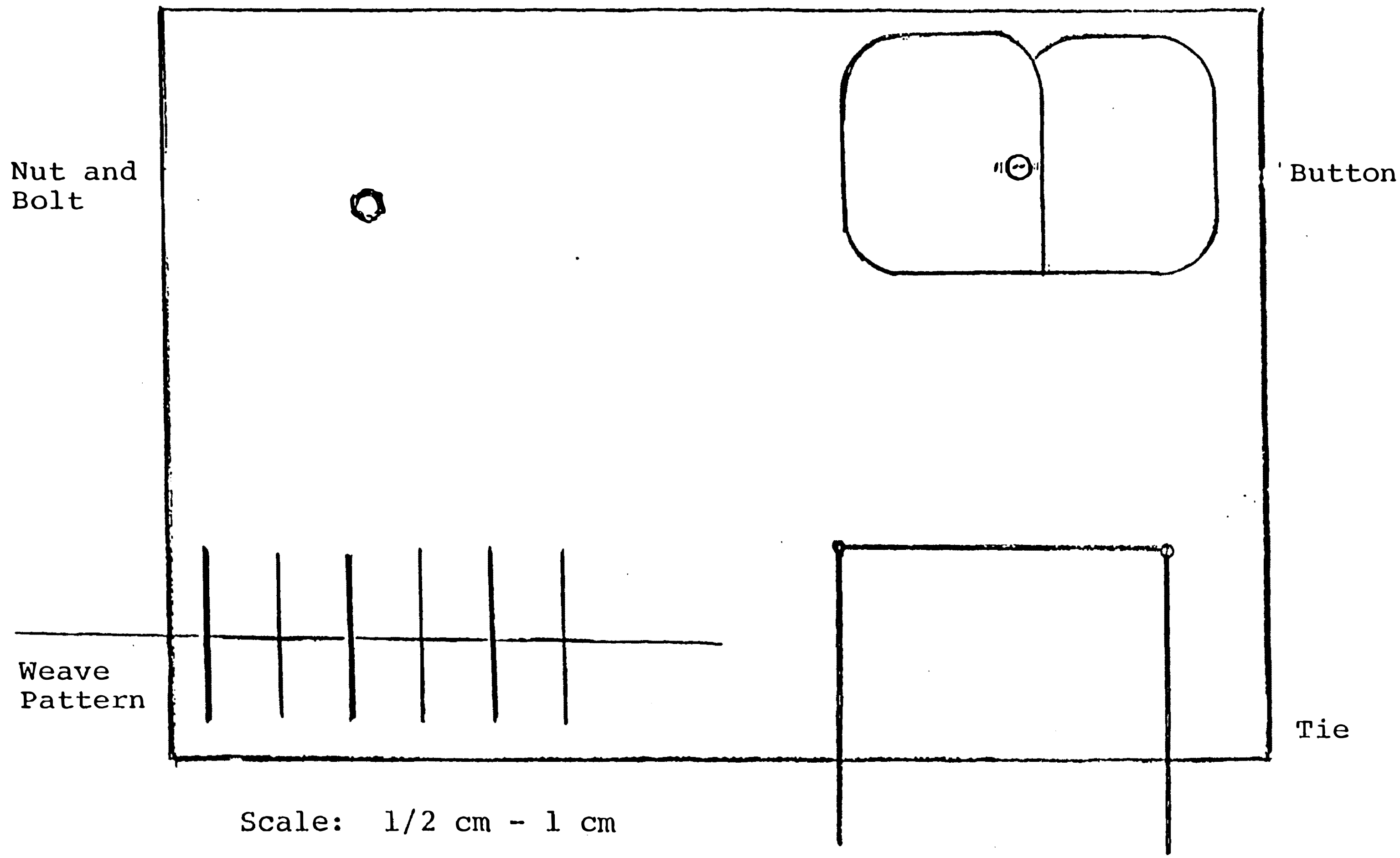


Figure 2 - Functional Task Board

The patient wove a 20 cm piece of yarn that was knotted at one end, under/over each of the six stationary pieces. Yard was woven from right to left with right hand, and left to right with left hand.

Procedure

The patient being tested was comfortably seated at a table of functional height. Pegboards, one at a time, were placed 10 centimeters from the edge of the table. Pegboards were at the patient's midline. Testing began with the noninjured hand followed by the injured hand. Following the pegboard tests all patients performed the functional activities on the board with their injured hand.

Patient Instruction

"Please turn the pegs over as fast as possible starting with your noninjured hand. You will start with the top of the opposite side of the board (demonstrated) and go in the shortest direction (demonstrated). When turning the pegs do not turn your hand at any time to face the ceiling or place the peg down to touch the board. (Four pegs were demonstrated to the patients). Please practice turning these pegs back. You will be timed to see how fast it will take you to turn all the pegs over." These instructions were given separately for each pegboard test. The large pegboard was given to the patient followed by the small one.

The patient was then asked to perform the following on the Functional Tasks Board with their injured hand only:

1. Unbutton and button. There was one demonstration, and no trials. Patient was to complete tasks in less than 15 seconds.

2. Tie a bow. The patient was shown one-handed tying and allowed two trials. Patient was to complete task in less than 5 seconds.

3. Screw and unscrew with the use of thumb and index and middle fingers. Patient was instructed to screw nut until it was flush with bolt. There was a demonstration. Patient was to complete task in less than 10 seconds.

4. Weaving. The patient was asked to weave a length of yarn 10 cm long in and out. There was one demonstration and no trials. Patient was to complete task in 10 seconds.

Scoring

The score was the amount of time it took to turn over all the pegs on each board. Timing was begun when the patient began to turn the pegs and ended when all pegs were turned on each individual pegboard test. There were 5 additional seconds added each time the patient either turned his hand up (supinated) or touched the board with a peg. If a peg was dropped, 10 seconds were added to the score. Time was stopped until the peg was retrieved; peg was put back in its preturned position. Tester recorded any unusual hand patterns during testing for therapeutic reference at a later date. Patients who did not complete or perform the test due to acute physical problems such as pain, swelling, or open wounds were given an automatic score of 200. This score was derived by adding an arbitrary 50 to the highest score, which was 150.

The functional tasks were scored as "able to perform" or "unable to perform"; this was done on the basis of both correct completion and the amount of time it took to accomplish the task. Scores along with age, sex, dominance and occupation were recorded on a score sheet (see Figure 3).

Functional Categories

When all the testing was completed the scores on the pegboard tests were compared with a single score on the functional task test (see Table 1). Range of the scores in seconds were correlated to functional ability. The functional categories were as follows:

Age _____ Sex _____ Occupation __________________________

Dominance _________ Hand Injured ______

Type of injury ____

<u>Time for completion of peg tests</u>

Large pegs: Right _______ Small pegs: Right ______

Left ________ Left _______

<u>Performance of functional tasks</u>

	<u>Able</u>	<u>Unable</u>
Button	_____	_____
Tie	_____	_____
Screw	_____	_____
Weave	_____	_____

Figure 3 - Score sheet for data collection

Table 1

Range of Dexterity Test Scores Compared With a Single Functional Score

	Dexterity Time in Seconds			
	Gross		Fine	
Functional Level	DI[a]	NDI[b]	DI	NDI
Functional	16-25	18-27	30-35	33-39
Moderately Functional	26-31	28-45	38-56	40-60
Minimally Functional	35-50	46-55	57-95	61-100
Nonfunctional	>50	>55	>95	>100

[a]Dominant injured hands

[b]Nondominant injured hands

1. Nonfunctional = performed one or fewer tasks.
2. Minimally functional = performed two out of four tasks.
3. Moderately functional = performed three out of four tasks.
4. Functional = performed all tasks.

Statistics

All statistical tabulations were done two times, once for each pegboard test. The statistical analysis was performed on all four groups of hands being tested. The groups are injured dominant hands and injured nondominant hands, noninjured dominant hands and noninjured nondominant hands. Each patient tested fell into two of these groups, since both hands were tested. In all the hypothesis testing, the .05 level of probability was utilized. Following are the statistical tests used:

1. Spearman Rank Correlation Coefficient with time of manipulation of the dexterity test, with the injured hands, as one variable and ability to perform the functional tasks, with the injured hands, as the second variable. There were two tests for each of the two pegboards, one test for each of the two groups of hands tested. There were a total of four tests for the two pegboards. This provided information about the correlation of dexterity to total hand skill.

2. A Rank Biserial Coefficient was determined by assessing each specific functional task and its relationship to time on the dexterity test. There are four functional tasks and two groups of hands tested (injured only); thus for each pegboard, eight tests were performed.

3. Mann-Whitney U test between the times for injured dominant vs. noninjured dominant and injured nondominant vs. noninjured nondominant. There were two tests for each pegboard, thus a total of four tests. This provided

a reference list on dexterity versus function between the four separate groups.

4. The mean scores of all four groups of hands were tabulated and compared to the functional level.

CHAPTER IV

RESULTS AND DISCUSSION

A total of 46 hand-injured patients were tested to determine if a relationship exists between two separate dexterity pegboard tests and the use of a three-jaw-chuck prehension pattern in selected functional activities. The patients represented nine occupational backgrounds and 20 types of hand injuries. (See Table 2.)

A convenience sample of patients who were seen in two Houston area hand rehabilitation units over a three-week period were tested. This study placed no limitations on the type of hand injuries that were tested.

The patients who participated in this study included 35 males ranging in age from 14 to 57 with a mean age of 35 and 11 females ranging from ages 22 to 70 with a mean age of 37. Each patient fell into one of the categories of injured dominant hand and noninjured nondominant hand or injured nondominant hand and noninjured dominant hand.

The patient group was comprised of 28 injured dominant hands and 18 injured nondominant hands. Two occupational therapists and one physical therapist helped in data collection. They were individually instructed in the testing procedure by the investigator, presented with

Table 2

Distribution of Subjects By
Occupation And Diagnosis

Diagnosis	Occupations									
	Machinist	Mechanic	Truck Driver	Heavy Labor	Light Labor	Paper Work	Nursing	Housewife	Electrician	N
Soft Tis. Lac	3			1	3					7
Digital Amp.	2				1					3
Wrist Fx.	1		1		1	1				4
Cross Finger Flap	1			2						3
Crush		3		2					1	6
Phalanx Fx.		1				1				2
Boxer Fx.			1							1
Printgun Inj.			1							1
Flex Tendon	1	1	1		1					4
Deglove-Thumb				1						1
Bennett Fx.				1						1
Median N				1		1	1			3
R.A.								2		2
Burn								1		1
Edema				1						1
Reimplant-dig					1					1
Forearm Fx.						1				1
Steals						1		1		2
MC Fx.	1									1
Joint Fx.	1									1
N	10	5	4	9	7	5	1	4	1	46

written instructions of the procedure, and observed while actually performing the test. All this was done prior to commencing data collection.

Testing time for each patient lasted between 3-5 minutes. Each patient was asked to perform the dexterity pegboard tests starting with the noninjured, then the injured, hand on the large pegboard; this was repeated on the small pegboard. Finally the patient was instructed to perform the four functional tasks with his injured hand.

All 46 patients were considered in the final tabulation. Patients who were unable to perform the dexterity tests were awarded a score of 200 on each test. This is an arbitrary number selected by adding 50 to the highest score achieved by the patients. In this test the desired score is a low score. The dexterity test scores have an inverse relationship with the functional tasks scores.

Following the data collection, several statistical tabulations were performed. In all hypothesis testing, the .05 level of probability was used. The mean scores were determined for the large and small dexterity pegboard tests. These means represent four separate categories which included dominant injured hands, nondominant injured hands, noninjured dominant, and noninjured nondominant hands. The scores were compared to the respective functional levels. For example, all dominant injured hands that received a score of three on the functional tasks were considered as one group, and their mean scores on the dexterity pegboard tests were tabulated. (See Table 3.) These means demonstrated an inverse relationship between scores on the dexterity test and functional level. The lower the score on the dexterity tests, which indicates the amount of time it took to complete the test, the better the score. A high score on the functional test, which has a range of 0 - 4, indicated good performance. There were four tasks on the functional test, each a dichotomous variable, as patients either accomplished or did not accomplish each task. These means presented a gross indication that the dexterity test scores can be used as functional indicators.

The Spearman Rank Correlation Coefficient was used to determine if a relationship exists between three-jaw-chuck prehension in functional activities and dexterity. Subjects with either dominant or nondominant injured hands were used for this correlation. The scores on both the large pegboard and small pegboard, respectively, were correlated with a single score on the functional test which was determined by the number of "able to perform" each patient had on the four functional tasks. The results of these four tests are shown in Table 4.

Table 3

Mean Dexterity Scores Compared With
a Single Functional Score

Functional Category	Large Pegboard				Small Pegboard			
	DI[a]	NDI[b]	DNI[c]	NDNI[d]	DI	NDI	DNI	NDNI
0[e]	101	145			178	161		
1[f]	85	57			115	109		
2	38	43			92	60		
3	29	43			39	35		
4	21	21	23	23	32	36	29	29
N	28	18	28	18	28	18	28	18

[a]DI = Dominant injured hand

[b]NDI - Nondominant injured hand

[c]DNI = Dominant noninjured hand

[d]NDNI = Nondominant noninjured hand

e and f both are considered as one nonfunctional level.

Table 4

Spearman Rank Correlation Coefficient
Between Time on the Dexterity Tests
and Functional Ability

	T_s	Shared Variability	Sig.
DTML[a]	-.64	.42	.001
DTMS[b]	-.44	.19	.009
NDTML[c]	-.63	.40	.002
NDTMS[d]	-.59	.34	.004

[a]DTNL - Dominant injured hand time on the large peg test.

[b]DTMS - Dominant injured hand time on the small peg test.

[c]NDTML - Nondominant injured hand time on the large peg test.

[d]NDTMS - Nondominant injured hand time on the small peg tests.

The dominant injured hands scores on the large pegboard tests as related to function showed a negative correlation with functional ability of .64 (P = .001) with a shared variability of .42. Dominant injured hands scores on the small pegboard tests showed a negative correlation with functional ability of -.44 (P = .009) and a shdred variability of .19. Nondominant injured hands scores on the large pegboard test and a single score on the functional tests showed a negative correlation of

−.63 (P = .002) with a shared variability of .40. Nondominant injured hands scores on the small pegboard test and a single score on the functional tests showed a negative correlation of −.59 (P = .004) with a shared variability of .34.

The Spearman Rank Correlation Coefficient indicated that there is a statistically significant inverse relationship between the dexterity pegboard tests and functional ability, with the large pegboard test being a stronger indicator than the small pegboard. This inverse relationship clarified that the faster time of manipulation of either of the pegboard tests correlates with a high ability to perform the functional tasks. The significance of each of the obtained r_s was determined by computing the t associated with those values, then referring to the t table for a one-tailed test at the .05 level. (See Table 5.)

Table 5

Values of the t Test

df	t Test Scores	
	DTML	DTMS
28	4.29	2.5
	NDTNL	NDTMS
18	3.26	4.9

The Rank Biserial Correlation was utilized to determine whether a relationship exists between each of the four individual functional tasks of buttoning, tying, screwing a screw, and weaving each of which was scored as "unable to perform" or "able to perform" and the dominant and nondominant injured hands ranked scores on both the large and small pegboard tests. These resulted in eight tests for each dexterity pegboard, thus 16 total tests. The patients were divided into a group of 18 nondominant injured hands and a group of 28 dominant injured. (See Table 6.)

Table 6

Rank Biserial Correlation Coefficient Data Representing Scores on the Dexterity Tests and Each Functional Task

	Dominant Injured Hands				Nondominant Injured Hands			
Functional Tasks	Large Peg Test		Small Peg Test		Large Peg Test		Small Peg Test	
	r	[a]r^2	r	r^2	r	r^2	r	[a]r^2
Button	.514	26	.328	11	.436	.19	.41	17
Tie	.203	41	.440	19	.110	.012	.429	18
Screw	.605	37	.365	13	.021	.0044	-0.1	.01
Weave	.649	41	.438	19	.351	.12	.476	23
N	28		28		18		18	

[a]r^2 Indicates shared variability between the functional task and the score of the pegboard test.

Glass's (1966) equation for computing R_{rb} was used. This equation is not recommended if many ties occur in the scores. In this study, it was felt that there were not enough ties to negate the use of this equation. The Rank Biserial indicated that:

1. The large pegboard test when used with the dominant injured hand shared the highest shared variability with the functional tasks.

2. The large pegboard is a better indicator of functional skill than the small pegboard.

The Mann-Whitney U test was used to determine if there was a significant difference between scores of injured dominant hands on the large pegboard test and noninjured dominant hands scores on the large pegboard test (P = .0007). Scores of injured versus noninjured dominant hands on the small peg test were also significant (P = .0001) as were scores of injured versus noninjured nondominant hands on the large pegs (P = .0020). (See Table 7). Finally, scores of injured versus noninjured nondominant hands on the small peg test showed a significance level of P = .0062. For all of the above tabulations the time of completion of each dexterity test was used as the score.

The statistical analysis showed a modest relationship between manipulation of the pegboard tests and functional

Table 7

Mann-Whitney U Test of Injured Versus Noninjured Hands Scores on the Large and Small Dexterity Tests

	Dominant Hands				Nondominant Hands			
	Large Pegs		Small Pegs		Large Pegs		Small Pegs	
	I[a]	NI[b]	I	NI	I	NI	I	NI
N	28	18	28	18	18	28	18	28
$\bar{R}$	28.84	15.19	29.59	14.03	31.11	18.61	30.25	19.16
U	102.5		81.5		115.0		130.5	
W	273.5		252.5		360.0		544.5	
Z	-3.37		-3.84		-3.088		-2.738	
2 tailed P	.0007		.0001		.0020		.0062	

[a]I = Injured hands

[b]NI = Noninjured hands

skill. Some factors influencing these results were:

1. The dexterity pegboard tests required new skill while the functional tasks are familiar and automatic.

2. Patients' intelligence levels were reflected in their ability to follow instructions correctly.

Results from this study indicated that a relationship does exist between scores on the dexterity tests and functional ability with the use of a three-jaw-chuck prehension pattern. It further showed that the gross dexterity test had a higher statistical significance as a functional indicator than the fine dexterity test.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

The purposes of this study were to (1) determine if a relationship exists between scores on two dexterity tests and functional hand skill and (2) develop a screening instrument that can provide information on both function and dexterity in a short period of time.

To determine dexterity a large and a small pegboard were designed. The pegboards were tested independently of each other for their potential use as functional indicators.

Hand function was defined as performance of activities requiring a three-jaw-chuck prehension pattern. To test function a board with a button, a screw, string for tying, and a weaving pattern was used. Each patient was asked to perform all four tasks with his injured hand within a given time period. It was assumed that the noninjured hands would be able to perform all the functional tasks within the given parameters. There were 46 patients with hand injuries representing 28 injured dominant hands and 18 injured nondominant hands.

The results from the study were presented as raw data, means, Spearman Rank Correlation Coefficient scores, Rank Biserial Correlation scores and Mann-Whitney U test scores, and as descriptive analyses. The hypotheses were:

1. There will be no relationship between results of the gross dexterity screening test and the ability to perform tasks requiring a three-jaw-chuck prehension pattern.

2. There will be no relationship between results of the fine dexterity screening test and the ability to perform tasks requiring a three-jaw-chuck prehension patterns.

Results of this investigation may have been influenced by several factors. The pegboard tests, both fine and gross, represented a new learned activity requring sophisticated perceptual function and cognition to accomplish. The functional tasks were familiar to the patient and represented activities that are performed daily. These tasks however did require the patient to perform them with one hand instead of the usual two, and a number of the patients performed them with their nondominant hands.

Factors such as learned activity versus an automatic one and the use of one hand for a two-handed tast may have impacted the results of this study. Sensation, which was discussed in depth in the review of literature, was another aspect that influenced the outcome of this study. However, minimal correlation between dexterity and function was established in the course of this work, enough to support beginning establishment of norms for a dexterity test that will provide functional information. Based on the findings of this study, the first hypothesis that there will be no relationship between results on the gross dexterity screening test and the ability to perform tasks requiring a three-jaw-chuck prehension pattern was rejected ($P < .05$). The second hypothesis stating that there will be no relationship between results on the fine dexterity screening test and the ability to perform tasks requiring a three-jaw-chuck prehension pattern was as well rejected ($P < .05$).

This investigation has provided the clinician with a brief screening test that can be used in a busy clinic. Total time for administering the test is 16-150 seconds depending on the patient's ability. The screening test to date has been tested on a small population, but appears to indicate that the clinician may test dexterity and thereby estimate the patient's functional level.

The dexterity test can be used as an aid in treatment planning by administering it to the patient at given intervals of time, thus measuring improvement in dexterity. Dexterity testing is usually conducted in clinical settings by utilization of involved, time-consuming, prevocational evaluations. Three-jaw-chuck prehension in functional evaluation has been traditionally based upon observation and kinesiologic knowledge. The use of a dexterity test to determine functional three-jaw-chuck prehension in the manner described has not been used prior to this study.

Recommendations for Further Study

It is recommended that this study be replicated in other clinical areas to broaden the data base and to establish reliability and validity. It is further recommended that the following more specific studies be conducted:

1. Collection of data on a normal population to establish norms on the dexterity test

2. Duplication of the study on a specific patient population; for example, specific hand injuries, neurological disorders, and various pediatric complications

3. Establishment of norms on various age groups with use of the dexterity test only

4. Comparison of results of this test to other similar tests

5. Replication of the study, revising the functional tasks to incorporate a larger spectrum of activities

6. Replication of the study to establish norms for sensation and perception

The findings of this study indicated several variables in need of control if study is to be replicated in future investigations.

1. The population selected for this study did not discriminate between dominant and nondominant injured hands. Since the statistical analyses were all based on either dominant or nondominant hands, a larger number in each category would have been preferred.

2. This study, since it accepted a convenience sample, did not control for type of hand injuries that were accepted. Limiting the type of injury may allow better control of data analysis.

3. Manipulation of the pegs improved as patients proceeded to turn the pegs from top to bottom. No allowance was made for the "learned" activity in this study. Allowing the patients to perform each peg test several times and averaging the scores of each should increase the test validity.

REFERENCES

American Society for Surgery of the Hand. The hand examination and diagnosis. Aurora, Colo: Author, 1978.

Anastasi, A. Psychological testing (3rd ed.). London: Macmillan, 1968.

Ayres, J. A. Ontogenetic principles in the development of arm and hand function. In J. A. Ayres (Ed.), The development of sensory integrative theory and practice: A collection of works of A. Jean Ayres. Dubuque, Iowa: Kendall Hunt Publishing Company, 1974.

Bell, E., Jurek, K., & Wilson, T. Hand skill measurement: A gauge for treatment. American Journal of Occupational Therapy, 1976, 30 (2), 82-86.

Crombach, L. J. Essentials of psychological testing (2nd ed.). New York: Harper and Brothers, 1960.

Dellon, A. L. Evaluation of sensibility and re-education of sensation in the hand. Baltimore: Williams and Wilkins, 1981.

Fess, E. E., Harmon, K. S., Strickland, J. W., & Steichen, J. B. Evaluation of the hand by objective measurement. In J. M. Hunter, L. H. Schneider, & J. A. Bell (Eds.), Rehabilitation of the hand. St. Louis: C. V. Mosby Co., 1978.

Fleishman, E. A., & Hempel, W. E. A factor analysis of dexterity tests. Personnel Psychology, 1954, 7, 15-32.

Granit, R. The basis of motor control. New York: Academic Press, 1970.

Helmstadter, G. C. Principles of psychological measurement. New York: Meredith, 1964.

Hopkins, H. L., & Smith, H. D. Willard and Spackman's Occupational Therapy (2nd ed.). Philadelphia: J. B. Lippincott Co., 1978.

Jebsen, R. H., Taylor, N., Trieschmann, R. B., & Noward, L. A. An objective and standardized test of hand function. Archives of Physical Medicine and Rehabilitation, June 1969, pp. 311-319.

Kellor, M., Frost, J., & Silberberg, N. Hand strength and dexterity norms for clinical use, age and sex comparisons, American Journal of Occupational Therapy, 1971, 25, 77-83.

Long, C., Conrad, P. W., Hall, E. A., & Furler, S. L. Intrinsic-extrinsic muscle control of the hand in power grip and precision handling. The Journal of Bone and Joint Surgery, 1970, 52-A(5), 853-867.

Moberg, E. Objective methods for determining the functional value of sensibility in the hand. The Journal of Bone and Joinr Surgery, 1958, 40B, 454-476.

Parry, W. Rehabilitation of the hand (3rd ed.). Boston: Butterworths, 1973.

Smith, D. A. The Box and Block Test: Normative data for 7, 8, and 9 year old children. Unpublished master's thesis, University of Southern California, 1961.

Trombly, C. A., & Scott, A. D. Occupational therapy for physical dysfunction. Baltimore: Williams and Wilkins, 1977.