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# Adult Norms for the Box and Block Test of Manual Dexterity

(hand evaluation, hand, motor skills, occupational therapy, tests)

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*The Box and Block Test, a test of manual dexterity, has been used by occupational therapists and others to evaluate physically handicapped individuals. Because the test lacked normative data for adults, the results of the test have been interpreted subjectively. The purpose of this study was to develop normative data for adults. Test subjects were 628 Normal adults (310 males and 318 females) from the seven-county Milwaukee area. Data on males and females 20 to 94 years old were divided into 12 age groups. Means, standard deviations, standard error, and low and high scores are reported for each five-year age group. These data will enable clinicians to objectively compare a patient's score to a normal population parameter.*

Occupational therapists are frequently involved with increasing the manual dexterity of their patients. Often, these patients are unable to perform tests of fine manual or finger dexterity, such as the Purdue Pegboard Test or the Crawford Small Parts Dexterity Test. Tests of manual dexterity, such as the Minnesota Rate of Manipulation Test, have limited clinical application because a) they require lengthy administration time, b) a standardized standing position must be used for testing, and c) the tests use normative samples that poorly represent the wide range of clinical patients. Because of the limitations of such standardized tests, therapists often evaluate dexterity subjectively.

The Box and Block Test has been suggested as a measure of gross manual dexterity (1) and as a prevocational test for handicapped people (2). Norms have been collected on adults with neuromuscular involvement (2) and on normal children (7, 8, and 9 years old) (3). Standardized instructions along with reliability and validity data, are reported in the literature (2, 3), but there are no norms for the normal adult population. Therefore, the purpose of this study was to collect normative data for adults.

## Methods

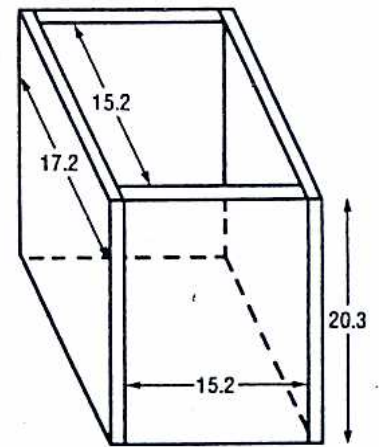
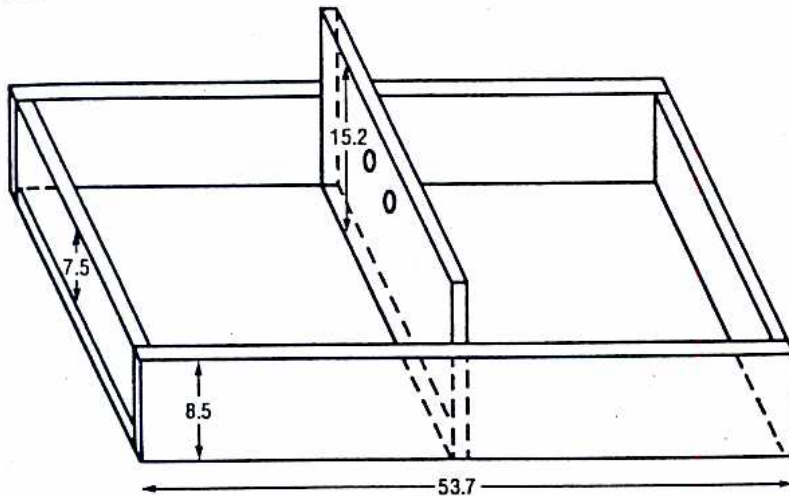
### *Test Description*

The idea for the Box and Block Test originated with A. Jean Ayres and Patricia Holser Buehler. They used a bowl and blocks to evaluate the gross manual dexterity of adults with cerebral palsy. The test was designed to be durable and simple so that it could be used for testing persons with severe dexterity deficits (3). Patricia Holser Buehler and Elizabeth Fuchs changed the test to its present box form and copyrighted it in 1957 (2).

The box was constructed of 1 cm

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Figure 1  
Construction drawing for box and block test (in cm)



( $\frac{3}{8}$  in.) of plywood. The outside dimensions of the base of the box were 53.7 cm by 25.4 cm (21 $\frac{1}{8}$  in. by 10 in.). The long sides of the box were 53.7 cm by 8.5 cm (21 $\frac{1}{8}$  in. by 3 $\frac{3}{8}$  in.) and were nailed to the 1 cm ( $\frac{3}{8}$  in.) thickness of the base. The short ends, 7.5 cm by 25.4 cm (3 in. by 10 in.), were nailed to the top of the base between the long sides. The box was then divided into two 25.4-cm (10-in.) square compartments by inserting a partition in the center. This partition was 25.4 cm long (10 in.), 15.2 cm (6 in.) high, and 1 cm ( $\frac{3}{8}$  in.) thick. Near the top of the partition, two 2.5-cm (1-in.) holes were drilled for ease in transporting (see Figure 1). A coat of varnish was applied after sanding. Self-adhesive foam cushion was added to the bottom (outside) of the test box to decrease the noise during testing.

The blocks used were 150 colored wooden cubes 2.5 cm (1 in.) square (Special Education Materials Inc, Box 226, Yonkers, NY 10705). The original test used sanded hardwood cubes. For the blocks, a storage box of 1 cm ( $\frac{3}{8}$  in.) of plywood was made with inside dimensions of 15.2 cm (6 in.) square and 20.3 cm (8 in.) high (see Figure 1). This shape facilitated the pouring of the blocks during the test procedure and also allowed for

storing the test box when the test was not in use.

Test procedures were slightly modified for this study. The original instructions called for a 60-second trial period prior to the actual 60-second test. In a preliminary study, subjects complained of boredom and stated that they felt the trial time was redundant especially when testing the nondominant hand. In a recent pilot study of 27 female occupational therapy students (22 to 39 years old), subjects were tested on two separate occasions. Subject scores did not vary significantly with a 60-second trial period vs. a 15-second trial period.

The following test instructions are a slight modification of the original test (2). The test box was placed lengthwise along the edge of a standard-height table. Each subject was seated on a standard-height chair facing the box (see Figure 2). The 150 cubes were in the compartment of the test box on the side where the subject's dominant hand was. The examiner sat facing the subject so she or he could view the blocks being transported. A 15-second trial period preceded the testing. Immediately before testing began, the subjects placed their hands on the sides of the box. On signal, the subject

Figure 2  
Subject taking box and block test



grasped one block at a time with the dominant hand, transported the block over the partition, and released it into the opposite compartment. By use of a digital stop watch (Accusplit Inc, 2290A Ringwood Ave, San Jose, CA 95131), the subject was stopped after one minute. The procedure was then repeated with the nondominant hand. After the actual testing, the examiner counted the blocks before returning them to the com-

partment. If the subject transported two or more blocks at the same time, this was noted and the number was subtracted from the total. No penalty was made if the subjects transported any blocks across the partition and the blocks bounced from the box to the floor or table.

The following directions were read to the subject.

I want to see how quickly you can pick up one block at a time with your right (or left) hand [the examiner pointed to the hand]. Carry it to the other side of the box and drop it. Make sure your fingertips cross the partition. Watch me while I show you how.

The examiner then transported three cubes over the partition in the same direction she or he wanted the subject to move them. After a demonstration the examiner said the following.

If you pick up two blocks at a time, they will count as one. If you drop one on the floor or table after you have carried it across, it will still be counted, so do not waste time picking it up. If you toss the blocks without your fingertips crossing the partition, they will not be counted. Before you start, you will have a chance to practice for 15 seconds. Do you have any questions? Place your hands on the sides of the box. When it is time to start, I will say "ready" and then "go."

The stop watch was started at the word go. When 15 seconds had passed, the examiner said "stop." If mistakes were made during the practice period, they were corrected before the actual testing was begun. On completion of the practice period, the transported cubes were returned to the compartment. The examiner mixed the cubes to assure random distribution.

The examiner continued with the following directions.

This will be the actual test. The instructions are the same. Work as quickly as you can. Ready. [The examiner waited

**Table 1**  
Interrater Reliability for Box and Block Test

	Rater	Mean	SD	SE	Correlation*
Right hand	A	87.89	8.8	1.7	1.000
	B	87.89	8.8	1.7	
Left hand	A	83.59	7.9	1.5	.999
	B	83.56	7.9	1.5	

*N* = 27 females (age 20-39). \* Pearson product-moment correlation between two raters.

**Table 2**  
Characteristics of Subjects: Age, Sex, and Hand Dominance

Age, yr	Males		Dominance		Females		Dominance	
	<i>N</i>	Mean Age	Right	Left	<i>N</i>	Mean Age	Right	Left
20-24	29	21.7	26	3	26	22.4	26	0
25-29	27	27.4	21	6	27	26.6	25	2
30-34	27	32.1	24	3	26	32.1	23	3
35-39	25	37.3	24	1	25	36.4	17	8
40-44	26	41.5	22	4	31	42.3	30	1
45-49	28	47.1	28	0	25	47.1	25	0
50-54	25	51.9	25	0	25	51.9	22	3
55-59	21	57.1	21	0	25	56.5	25	0
60-64	24	62.1	22	2	25	62.4	24	1
65-69	27	66.7	27	0	28	67.3	25	3
70-74	26	72.0	23	3	29	71.8	28	1
75+	25	78.9	25	0	26	78.8	25	1
Total	310		288	22	318		295	23

3 seconds.] Go. [After 1 minute] Stop. [Counting was recorded as described above.] Now you are to do the same thing with your left (or right) hand. First you can practice. Put your hands on the sides of the box as before. Pick up one block at a time with your hand, and drop it on the other side of the box. Ready. [The examiner waited 3 sec.] Go. [After 15 sec] Stop.

The transported blocks were returned to the compartment as described above.

This will be the actual test. The instructions are the same. Work as quickly as you can. Ready. [The examiner waited 3 sec.] Go. [After 1 min] Stop.

The score was the number of blocks carried from one compartment to the other in one minute.

#### Reliability & Validity

Test-retest reliability at six-month intervals has been reported as rho coefficients of .937 and .976 for the left and right hands, respectively (2). For the current study, interrater reliability was established during a pilot study. This was accomplished by having separate raters score the same subject's performance independently. A

very high correlation ( $r = 1.000$  and .999, right and left hands, respectively) was found between raters A and B using the Pearson correlation coefficient (see Table 1).

Validity of the Box and Block Test has been established in previous studies (2) by correlating the Box and Block Test with the Minnesota Rate of Manipulation Test-Placing with a result of  $r = .91$ . The Box and Block test also correlated highly with the General Aptitude Test Battery, part 10 ( $r = .86$ ). Based on Cromwell's (2) data, the test appeared to discriminate between a normal population and a handicapped population.

#### Subjects

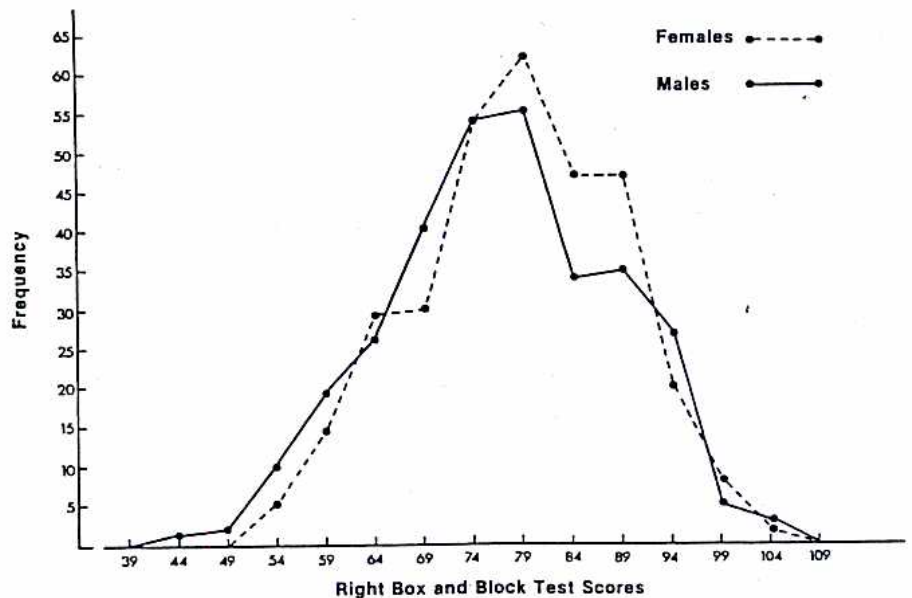
The study included 628 volunteers (310 males and 318 females) 20 to 94 years old. Subjects were solicited at shopping centers, fairs, senior citizen centers, a rehabilitation center (staff), and a university. All sites were within the seven-county Milwaukee area, which includes urban, suburban, and rural areas. It was therefore assumed that a broad range of socioeco-

economic and occupational groups had been obtained. Subjects were divided into 12 age groups with each group covering a five-year interval except for the group of people 75 years old and older. The distribution of the sample by age, sex, and hand dominance is presented in Table 2. The average sample size for each age group is 26.2. All subjects 20 to 59 years old were free from disease or injury that could affect their upper extremity dexterity. Subjects 60 years old and older had the following less stringent criteria: a) had no acute pain in their arms and hands, b) had been out of hospital for at least six months (e.g., after a heart attack or any surgery), and c) maintained a normal life-style (i.e., subject had not restricted activity level because of a health problem). The rationale for these less stringent criteria is that people of this age group often have some chronic health problems (4). Consequently, persons with degenerative joint disease not currently experiencing pain and maintaining a normal life-style were included in the study.

#### Procedures

This study was part of our larger study on hand strength and dexterity (5, 6). A brief interview preceded all the testing procedures to determine if subjects met the above criteria. Hand dominance was determined by asking subjects, "Are you right or left-handed?" If subjects responded that they were ambidextrous, dominance was based on their writing hand. The Nine-Hole Peg Test, a test of fine manual or finger dexterity, was administered prior to the Box and Block Test. Four tests of hand strength were administered following the two dexterity tests. The hand strength tests were administered

**Figure 3**  
Frequency polygons for female and male right box and block test scores



**Table 3**  
Average Performance of Normal Males on the Box and Block Test (number of cubes transferred in 1 minute)

Age, yr	Hand	Mean	SD	SE	Low	High
20-24	R	88.2	8.8	1.6	70	105
	L	86.4	8.5	1.6	70	102
25-29	R	85.0	7.5	1.4	71	95
	L	84.1	7.1	1.4	69	100
30-34	R	81.9	9.0	1.7	68	96
	L	81.3	8.1	1.6	69	99
35-39	R	81.9	9.5	1.9	64	104
	L	79.8	9.7	1.9	56	97
40-44	R	83.0	8.1	1.6	69	101
	L	80.0	8.8	1.7	59	93
45-49	R	76.9	9.2	1.7	61	93
	L	75.8	7.8	1.5	60	88
50-54	R	79.0	9.7	1.9	62	106
	L	77.0	9.2	1.8	60	97
55-59	R	75.2	11.9	2.6	45	97
	L	73.8	10.5	2.3	43	94
60-64	R	71.3	8.8	1.8	52	84
	L	70.5	8.1	1.6	47	82
65-69	R	68.4	7.1	1.4	55	80
	L	67.4	7.8	1.5	48	86
70-74	R	66.3	9.2	1.8	50	86
	L	64.3	9.8	1.9	45	84
75+	R	63.0	7.1	1.4	47	75
	L	61.3	8.4	1.7	46	74
All male subjects	R	76.9	11.6	.66	45	106
	L	75.4	11.4	.65	43	102

R, right; L, left.

later to avoid having fatigue affect the dexterity test scores.

#### Results

To assess whether the data collected represented a normally dis-

tributed sample, frequency polygons were drawn (see Figure 3) that show a relatively normal curve for males and females. Descriptive data for each age group are reported for males (see Table 3) and

females (see Table 4). When all male scores were compared with all female scores, it was found that the differences between males and females were relatively small (females scored slightly better than males). However, there were larger differences within specific age groups (age 45-49 and age 60-64). Therefore, male and female scores are reported separately.

For right-hand-dominant male and female subjects at each age group, the average for the right hand was greater than that for the left hand. For left-hand-dominant male subjects, in five out of seven age groups, the average left-hand score was greater than the average right-hand score. In contrast, for left-hand-dominant female subjects, the average left-hand score was greater than the right-hand score in only three out of nine age groups. When all age groups are combined and compared (see Table 5), there is clearly little functional difference between the mean scores of right- and left-hand-dominant subjects. For this reason and the fact that left-hand-dominant subjects made up only 7% of the sample, the normative data presented in Tables 3 and 4 are the combination of both right- and left-hand-dominant subjects. In general, the highest scores were achieved by the youngest group (age 20-24) and the lowest scores were achieved by the oldest group (age 75+). With a few exceptions, there was a gradual decrease in scores with age.

## Discussion

The normative data collected on the Box and Block Test are consistent with other tests of manual dexterity. In general, females scored slightly better than males (7), dexterity decreased with age

**Table 4**

Average Performance of Normal Females on the Box and Block Test (number of cubes transferred in 1 min)

Age, yr	Hand	Mean	SD	SE	Low	High
20-24	R	88.0	8.3	1.6	67	103
	L	83.4	7.9	1.6	66	99
25-29	R	86.0	7.4	1.4	63	96
	L	80.9	6.4	1.2	63	93
30-34	R	85.2	7.4	1.5	75	101
	L	80.2	5.6	1.1	66	92
35-39	R	84.8	6.1	1.2	71	95
	L	83.5	6.1	1.2	72	97
40-44	R	81.1	8.2	1.5	60	97
	L	79.7	8.8	1.6	57	97
45-49	R	82.1	7.5	1.5	68	99
	L	78.3	7.6	1.5	59	91
50-54	R	77.7	10.7	2.1	57	98
	L	74.3	9.9	2.0	53	93
55-59	R	74.7	8.9	1.8	56	94
	L	73.6	7.8	1.6	54	85
60-64	R	76.1	6.9	1.4	63	95
	L	73.6	6.4	1.4	62	86
65-69	R	72.0	6.2	1.2	60	82
	L	71.3	7.7	1.4	61	89
70-74	R	68.6	7.0	1.3	53	80
	L	68.3	7.0	1.3	51	81
75+	R	65.0	7.1	1.4	52	79
	L	63.6	7.4	1.5	51	81
All female subjects	R	78.4	10.4	.58	52	103
	L	75.8	9.5	.53	51	99

R, right; L, left.

**Table 5**

A Comparison of Right-Hand Dominant and Left-Hand Dominant Subjects on the Box and Block Test

Hand	Subject Dominance	N	Mean	SD	SE
<b>Males</b>					
Right	Right dominant	288	76.8	11.5	.68
	Left dominant	22	78.2	13.5	2.87
Left	Right dominant	288	75.1	11.1	.65
	Left dominant	22	78.9	15.3	3.26
<b>Females</b>					
Right	Right dominant	295	78.5	10.4	.61
	Left dominant	23	76.9	9.2	1.92
Left	Right dominant	295	75.9	9.5	.55
	Left dominant	23	75.7	9.4	1.95

(8), right-hand-dominant subjects scored best with their right hands, and left-hand-dominant subjects had mixed results (5).

When these normative data are compared with data for adults with neuromuscular conditions (best hand, 57.1; worst hand, 38.0) (2), it appears that the Box and Block Test does discriminate between normal and handicapped adults. Because limited data were reported in Cromwell's book (2), further study is needed to confirm this conclusion. In addition, normative data for children and adolescents

(age 10-19) are needed because this test is appropriate for these ages also.

Advantages of the Box and Block Test include that it can be easily constructed in most occupational therapy clinics at a reasonable cost and that blocks are readily available commercially if the occupational therapy clinic does not have them. Because of the simplicity of the test, it is appropriate for evaluating the dexterity of individuals with low intelligence and/or limited manual dexterity. It can be administered more quickly than a

comparable test (i.e., the Minnesota Rate of Manipulation Test). The fact that the test is administered in a sitting rather than in a standing position is an advantage because many patients are not able to stand or find standing difficult. Now that normative data are available for both sexes at a wide age span, the test is more useful in therapy clinics than are many standardized tests having normative data only for the working populations.

One disadvantage of the test was the noise during data collection. This noise could be distracting to other patients in a busy clinic. However, considering the relatively short time needed to administer the test (2-3 min), this disadvantage should not present insurmountable problems for most clinics.

### Conclusion

The Box and Block Test is a simple, low-cost, and efficient test

of gross manual dexterity. We recommend it as a test to evaluate adult individuals with suspected impairment in manual dexterity. These individuals' scores can now be compared with the normative data collected in this study, and a more objective interpretation can be made of each person's level of impairment. The test can also be used to evaluate the effectiveness of treatment programs designed to improve gross manual dexterity.

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