Journal of Clinical Neuropsychology
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/ncen18

Normative data for the halstead-reitan neuropsychological tests

Delee Fromm-auch [a] & Lorne T. Yeudall [a]
[a] Alberta Hospital , Edmonton, Alberta
Published online: 04 Jan 2008.

To cite this article: Delee Fromm-auch & Lorne T. Yeudall (1983) Normative data for the halstead-reitan neuropsychological tests, Journal of Clinical Neuropsychology, 5:3, 221-238, DOI: 10.1080/01688638308401171

To link to this article: http://dx.doi.org/10.1080/01688638308401171

Journal of Clinical Neuropsychology
1983, Vol. 5, No. 3, pp. 221-238

0165-0475/83/0503-0221 $3.00

Normative Data for the Halstead-Reitan Neuropsychological Tests

Delee Fromm-Auch and Lorne T. Yeudall
Alberta Hospital, Edmonton, Alberta

ABSTRACT

Normative data from a large neurologically intact, nonpsychiatric adult sample (male = 111, female = 82) are presented. Despite the size limitations in the upper age ranges, these data are consistent with previously published norms. Sex effects are evident, with females appearing weaker and slower than males on motor tests. The higher than average WAIS FSIQ displayed by this normal sample and the previous use of psychiatric patients as control subjects is discussed.

Cut-off scores in the original Halstead publication (1947) were derived from a comparison between normal, non-brain-damaged controls and brain-damaged subjects. Despite the numerous validity studies that have been generated (e.g., Kløve, 1974; Reitan, 1955; Schreiber, Goldman, Kleinman, Goldfader & Snow, 1976; Snow, 1981; Swiercinsky & Leigh, 1979; Tsushima & Wedding, 1979; Vega & Parsons, 1967), few studies have provided normative data from nonpsychiatric, nonneurological adult samples. In the studies that have published such data, several limitations are evident including: a small sample size (Bak & Greene, 1980; Kløve, 1974; Kløve & Lochen, 1974; Matarazzo, Weins, Matarazzo, & Goldstein, 1974; Weins & Matarazzo, 1977); an all, or nearly all, male sample (Kløve, 1974; Matarazzo et al., 1974; Weins & Matarazzo, 1977); and a very low or very high average age (Bak & Greene, 1980; Matarazzo et al., 1974; Weins & Matarazzo, 1977). Since the ultimate purpose of normative observations is to establish a basis for interpretation of performance, adequate normative data are essential for clinical practice.

The present article provides normative data from a large nonpsychiatric,

* The authors are grateful to Don Schopflocher for statistical analysis of the data, to K. Arnott, C. Bolt, B. Croskery, P. Hyatt, and B. Stefanyk for administration of the test battery and to C. Ridenour for manuscript preparation. This research was supported by a grant from the Alberta Mental Health Advisory Council.

[1] Department of Neuropsychology and Research, Alberta Hospital, Edmonton, Box 307, Edmonton, Alberta, Canada, T5J 2J7. Send reprint requests to the first author.

Accepted for publication: January 6, 1983.

nonneurological adult sample on the Halstead-Reitan neuropsychological test battery (HRB), as well as presenting normative data from all previously published studies.

METHOD

Subjects

All subjects (male = 111, female = 82) were volunteers without a psychiatric or neurological history. A small number of these subjects (n = 31) were obtained through posted advertisements in the downtown area of Edmonton. The remainder of the sample was informed about the research through personal contact with department members.

Descriptive variables for this group are presented in Table 1. Handedness was determined by the hand used to write while strength of handedness was determined by the Annett Questionnaire (1970). Intelligence scores were derived from the Wechsler Adult Intelligence Scale (WAIS). Years of education includes technical and university training.

Table 1

Descriptive Variables for the Total Group of Normal Subjects (n = 193)

	Mean	Standard Deviation	Range
% Males	57.5	—	----
% Right Handers	83.4	—	----
Age (years)	25.4	8.2	15-64
Education (years)	14.8	3.0	8-26
VIQ	119.8	9.9	95-143
PIQ	115.6	9.8	89-146
FSIQ	119.1	8.8	98-142

Procedure

Trained technicians tested all subjects using a modified and expanded HRB (Fromm-Auch, Yeudall, & Stefanyk, Note 1). The tests from the HRB were administered according to the instructions by Reitan (Note 2) with one exception - administration of the Tactile Form Recognition Test involved two instead of four trials. Modifications of the battery used by Reitan included substitution of the Language Modalities Test for Aphasia (Wepman & Jones, 1961) for the Aphasia Screening Test.

Each test session involved approximately 5-6 hours of assessment, including a detailed interview to determine factors which may influence neuropsychological or neurological function. All data were manually scored and entered via a computer terminal into a data base.

The mean score, standard deviation, and range were calculated for each test variable (see list in Table 2). The data were stratified by age on all nonmotor variables and stratified by age and sex for motor variables.

Table 2

List of Neuropsychological Test Variables

Test Variables	Tables
Name Writing Speed	
Preferred Hand	4
Nonpreferred Hand	4
Speech-Sounds Perception Test	
Errors	5
Trail Making Test	
Part A Time	6
Part B Time	6
Category Test	
Errors	7
Finger Tapping Speed	
Preferred Hand	8
Nonpreferred Hand	8
Dynamometer	
Preferred Hand	9
Nonpreferred Hand	9
Tactual Performance Test	
Preferred Hand Time	10
Nonpreferred Hand Time	10
Both Hands Time	10
Memory Scores	11
Localization Scores	11
Seashore Rhythm Test	
Errors	12
Tactile Form Recognition	
Preferred Hand Errors	13
Nonpreferred Hand Errors	13
Finger-Tip Number Writing	
Preferred Hand Errors	14
Nonpreferred Hand Errors	14
Face-Hand	
Right Side Errors	15
Left Side Errors	15
Finger Localization	
Preferred Hand Errors	16
Nonpreferred Hand Errors	16

The empirical age groupings were derived by examining the relationship between education and a variety of control variables including age, sex, and verbal and performance IQ (as measured by the WAIS) in a piece-wise regression paradigm. The correlation between education and age (and sex) varied considerably through the range of the education variable.

The age groupings for this study were selected by examining a scatterplot of age and education and choosing points of inflection (see Schaie, 1965). In general, the correlation between age and education was strongly positive and decreasing in magnitude until age 33 when the relationship first ceased to exist and then became increasingly negative.

The decision to stratify by age only was based on the results of Hotelling's T^2 analysis performed on the test variables across the two sexes. Since the only variables which were individually significant were those related to motor functioning (Finger Tapping and Dynamometer), it was decided to collapse across sex in reporting these norms.

In addition to these data, and for comparative purposes, all normative data previously published to our knowledge from the HRB are also presented. Studies with control data from psychiatric patients are not included.

RESULTS AND DISCUSSION

Subjects

The upper age range is restricted in the present sample with only 10 controls in the 41-64 year age range, limiting the normative data to the 15-40 age ranges. The lack of older subjects may be reflective of the type of recruitment, viz., department members are in the younger age ranges and, hence, personal contacts would also most likely be in the under-40 age range.

The high level of education may be artificially raised due to the inclusion of any form of technical or vocational training. Consequently, individuals with high school and 2 years of any vocational training, e.g., plumbing, electrical work, were assigned 14 years of education.

The demographic characteristics of the present sample may also be reflective of the economic situation in Alberta over the past decade. This province, through employment opportunities, has tended to attract this type of individual.

Test Data

Previously published normative data are presented in Table 3. The mean scores, standard deviations and ranges from the present test variables are presented in Tables 4-16. Sex effects were obtained on the motor measures, with females appearing weaker and slower than males.

Two of the sensory tests of Reitan (Note 2) are not presented due to the very low error rates shown by controls. The mean error rate for Visual Inattention is .17 ($SD = .8$) with only 8.3% of the sample making one or more errors. Auditory Perception errors were slightly higher, with a mean of .61 ($SD = 1.1$). A strong age effect was indicated for these data which most likely reflects the effect of aging on peripheral hearing function.

Name-Writing Test. The data for this test are presented in Table 4. No norms have been published to date for adults on this test. The ability to write one's name as quickly as possible does not appear to decrease with age, but rather slightly

Table 3

Published
Normative Data from the Halstead-Reitan Battery

Tests	Halstead (1947) $n = 50$	Vega & Parsons (1967) $n = 50$	Levine & Feirstein (1972) $n = 18$	Kløve (1974) $n = 35$
Category (errors)	37.2	59.4 (26.9)	47.6	42.9
Tactual Performance				
Time	10.6	20.6 (10.4)	15.6	16.1
Memory	8.2	6.6 (1.9)	6.3	6.6
Localization	5.9	2.9 (2.2)	3.6	3.3
Rhythm (errors)	9.1	6.7 (4.2)	5.4	5.8
Speech-Sounds (errors)	10.4	9.5 (6.6)	6.0	8.9
Finger Tapping				
Dominant (number)	54.9	44.6 (9.2)	49.7	47.2
Nondominant	----	----	----	----
WAIS				
VIQ	----	99.8	----	----
PIQ	----	98.8	----	----
FSIQ	----	99.4	----	----
Trail-Making				
Part A (time)	----	----	----	----
Part B (time)	----	----	----	----
Age (years)	----	40.8 (13.1)	44.7	39.4 (11.0)
Education (years)	----	11.1 (3.2)	10.6	10.4 (2.6)
% Males	----	74	100	94

Table 3 (cont.)

Kløve & Lochen (1974)		Matarazzo et al. (1974)	Weins & Matarazzo (1977)	
$n=22$	$n=22$	$n=29$	$n=24$	$n=24$
34.6	45.5	22.8 (19.2)	23.5 (21.3)	22.8 (11.8)
14.0	13.7	9.4 (2.7)	9.7 (3.2)	9.2 (2.4)
7.2	7.5	8.4 (.8)	8.5 (.9)	8.7 (.8)
4.3	5.2	5.3 (2.4)	5.7 (1.7)	6.1 (2.6)
4.3	5.3	2.8 (1.9)	2.5 (2.3)	2.9 (1.8)
—	—	3.8 (1.7)	4.2 (2.6)	3.9 (2.2)
43.0	48.5	54.6 (4.3)	54.0 (4.6)	54.5 (4.0)
—	—	—	48.4 (4.4)	50.0 (4.1)
—	—	118	117.4 (8.4)	116.4 (6.9)
—	—	116	115.4 (10.5)	118.2 (8.6)
109.3 (13.1)	111.9 (15.4)	118	117.5 (8.3)	118.3 (6.8)
—	—	—	23.8 (6.6)	20.5 (4.4)
—	—	—	56.4 (12.8)	51.0 (11.5)
31.6 (16.5)	32.1 (16.4)	24	23.6	24.8
11.1 (2.2)	12.2 (2.6)	14	13.7	14.0
—	—	100	100	100

Table 3 (cont.)

Anthony et al. (1980) $n = 100$	Bak & Greene (1980) $n = 15$	$n = 15$	Fromm-Auch & Yeudall (Present Study) $n = 193$
32.6 (21.8)	—	—	38.3 (17.3)
13.2* (2.5)	14.0 (5.4)	23.1 (10.4)	10.5 (3.2)
7.8 (1.5)	5.3 (1.5)	5.1 (2.0)	8.3 (1.2)
4.6 (2.1)	2.1 (1.5)	1.6 (1.6)	5.7 (2.1)
3.1 (2.7)	4.7 (2.7)	5.4 (3.3)	2.6 (1.9)
5.8 (3.4)	4.9 (2.8)	7.1 (4.3)	4.2 (2.1)
52.6 (9.1)	44.5 (6.7)	38.7 (4.1)	46.3 (6.3)
48.2 (7.6)	40.8 (4.8)	36.3 (5.9)	43.2 (5.4)
113.2 (11.6)	—	—	119.8 (9.9)
112.3 (10.9)	—	—	115.6 (9.8)
113.5 (10.8)	—	—	119.1 (8.8)
—	32.5 (12.6)	41.6 (10.3)	26.3 (7.9)
68.6 (32.7)	81.7 (30.1)	109.0 (38.8)	57.6 (15.5)
38.9 (15.8)	55.6 (4.4)	74.9 (6.1)	25.4 (8.2)
13.3 (2.6)	13.7 (1.9)	14.9 (3.0)	14.8 (3.0)
Not Reported	40	33	57.5

* Extrapolated from Minutes/block

Table 4

Normative Data for the Name-Writing Test in Seconds Stratified by Age

		Preferred Hand			Nonpreferred Hand		
Age	*n*	*M*	*SD*	Range	*M*	*SD*	Range
15-17	30	8.0	2.2	4.8-12.6	23.2	9.2	9.9-44.9
18-23	64	7.7	2.3	2.7-13.0	20.7	9.0	4.0-57.0
24-32	56	7.5	2.6	2.0-13.1	21.6	9.4	7.0-45.0
33-40	18	6.9	2.7	3.2-14.0	19.8	8.2	6.0-39.0
41-64	10	9.0	1.9	5.0-11.0	20.7	6.3	11.0-27.8

improves. Preferred/nonpreferred hand differences also remain the same, with nonpreferred hand times approximately three times greater for the 40-years-olds and under.

The major limitation of this test is the lack of name length standardization. We

are presently deriving indices for this test based on the difference score between the individual hand times (i.e., preferred minus nonpreferred).

Speech-Sounds Perception Test. Previously published norms (see Table 3) from young samples (mid-twenties) are consistent with the present norms in Table 5 (Matarazzo et al., 1974; Weins & Matarazzo, 1977), while older subject samples provide slightly higher mean scores (Anthony, Heaton, & Lehman, 1980; Bak & Greene, 1980; Kløve, 1974; Vega & Parsons, 1967). This trend of a positive relationship between errors and age in these studies is not supported by the present data. However, the sample numbers are small in our older age groups and, therefore, the present results cannot properly address the issue.

Table 5

Normative Data for the Speech Sounds Perception Test in Total Errors Stratified by Age

Age	*n*	*M*	*SD*	Range
15-17	32	4.6	2.4	1-13
18-23	76	4.2	2.0	1-10
24-32	57	4.1	2.2	1-10
33-40	18	3.6	2.0	1-8
41-64	10	4.4	1.8	1-7

Trail Making Test. The mean time taken to complete Part A and Part B increases with age. This has been demonstrated in detail elsewhere and various explanations offered (Goul & Brown, 1970; Lindsey & Coppinger, 1969). In the present data (Table 6), the change appears greater for Part B than A and may be due to task complexity. These norms are comparable to those published earlier (see Table 3) when the mean age in each study is considered. Despite the different age group divisions, these norms are also similar to those obtained by Davies (1968) which are presented in Lezak (1976). Errors on this test were not made.

Category Test. The cut-off point of 50 errors specified by Reitan appears appropriate for all age groups less than 40 years (see Table 7). However, numerous researchers have documented the influence of age on abstractive abilities generally (see Botwinick, 1970, for review) and Category Test performance specifically (Fitzhugh, Fitzhugh & Reitan, 1964; Reed & Reitan, 1963a, 1963b; Reitan, 1954). This age relationship is indicated by previously published norms (Table 3).

Finger Tapping Test. Sex difference were obtained with higher scores (approximately 5 taps) for males than females on both preferred and nonpreferred hand scores

Table 6

Normative Data for the Trail Making Test in Seconds Stratified by Age

		Part A			Part B		
Age	*n*	*M*	*SD*	Range	*M*	*SD*	Range
15-17	32	23.4	5.9	15.2-39.0	47.7	10.4	25.4-81.0
18-23	76	26.7	9.4	12.0-60.1	51.3	14.6	23.3-101.0
24-32	57	24.3	7.6	11.8-46.0	53.2	15.6	29.1-98.0
33-40	18	27.5	8.3	16.0-52.7	62.1	17.5	39.0-111.0
41-64	10	29.7	8.4	16.5-42.0	73.6	19.4	41.9-102.0

Table 7

Normative Data for the Category Test in Total Errors Stratified by Age

Age	*n*	*M*	*SD*	Range
15-17	32	35.8	16.2	16-68
18-23	71	35.9	21.2	9-106
24-32	55	30.5	13.6	10-68
33-40	18	36.3	14.3	11-67
41-64	10	53.0	21.0	29-96

(Table 8). Within each sex, the hand difference (preferred minus nonpreferred) for males is roughly four taps and for females roughly two taps.

The relationship between age and performance appears to be curvilinear for both males and females with the peak of performance in the 33-40 year age range and with a decrease occurring in the 41-64 year age range. Our norms are comparable to most of the previous data on the tapping test. However, a few studies report slightly higher means (Matarazzo et al., 1974; Weins & Matarazzo, 1974).

Dynamometer. Normative data for this test are presented in Table 9. Male hand strength is substantially greater than female hand strength (approximately 17 kilograms), although both sexes show similar preferred-minus-nonpreferred hand differences (2-3 kilograms). These norms are comparable to the only other adult norms available to date (Dodrill, 1978).

Tactual Performance Test. All subjects placed 10 blocks in less than 15 minutes with the preferred, nonpreferred, and both hands. A slight increase in time as a function of age is indicated by the present data for individual and both hand times (Table 10), although the preferred/nonpreferred hand difference for each age

Table 8

Normative Data for the Finger Tapping Test[a] Stratified by Age and Sex

Males

		Preferred Hand			Nonpreferred Hand		
Age	*n*	*M*	*SD*	Range	*M*	*SD*	Range
15-17	17	47.6	5.8	38.0-55.6	43.6	4.9	33.4-51.8
18-23	44	49.5	6.9	26.6-64.6	45.4	6.9	26.8-58.6
24-32	31	50.6	6.6	38.2-66.2	46.0	6.1	28.8-55.0
33-40	12	53.4	5.9	39.0-61.0	49.8	4.7	41.0-57.8
41-64	4	44.4	5.8	35.8-48.2	41.4	3.5	36.6-44.4

Females

Age	*n*	*M*	*SD*	Range	*M*	*SD*	Range
15-17	15	42.7	7.9	30.2-54.0	41.1	6.2	31.6-51.0
18-23	30	43.6	7.5	30.6-65.6	41.2	6.5	32.8-61.8
24-32	25	45.2	6.7	31.0-60.0	40.9	5.7	28.6-53.6
33-40	6	45.8	5.5	40.6-55.6	44.3	4.6	40.6-53.2
41-64	6	40.4	4.8	34.2-48.4	38.6	4.8	32.0-46.6

[a] Average number of taps over five trials.

group remains approximately the same (median = 1.4 minutes). The nonpreferred hand time is roughly 30% less than preferred hand time.

Total hand time in minutes for our control group is comparable to previous data when the mean ages are considered. The mean times for the 15-32 year age ranges are similar to studies with young subjects (Matarazzo et al., 1974; Weins & Matarazzo, 1977); however, the studies with older mean ages have higher total time scores (Kløve, 1974; Kløve & Lochen, 1974; Levine & Feierstein, 1972). The reason for this is not obvious.

Cauthen (1978) published norms on the Tactual Performance Test that were stratified by age and IQ. These data are similar, especially for the higher IQ ranges (123-139). The oldest sample range (50-60 years) in that study produced much higher times than shown by our data; this is most likely due to our small size in the age range of 41-64 years. Hence, our norms for this range are comparable to his 40-49 year age norms.

Location and Memory scores (Table 11) are comparable to those of others, with the characteristic lower Location score (approximately 2-3 block difference). The norms from our laboratory are comparable to those in Table 3 for Memory, but slightly higher for Localization. The much lowered scores were obtained from

Table 9

Normative Data for the Dynamometer[a] Stratified by Age and Sex

Males

		Preferred Hand			Nonpreferred Hand		
Age	*n*	*M*	*SD*	Range	*M*	*SD*	Range
15-17	17	38.0	8.4	22.2-51.0	35.8	9.6	21.0-57.5
18-23	43	49.7	9.7	30.0-71.2	46.6	9.9	26.7-73.0
24-32	31	51.8	8.1	37.0-65.5	49.6	7.2	30.5-66.0
33-40	12	52.9	8.3	41.0-67.0	51.2	7.9	36.2-62.5
41-64	4	44.5	10.9	30.5-57.0	47.9	11.9	32.0-58.7

Females

Age	*n*	*M*	*SD*	Range	*M*	*SD*	Range
15-17	15	28.1	5.0	21.0-37.5	26.3	5.2	17.8-33.5
18-23	29	28.8	7.8	8.5-43.8	26.4	6.2	13.5-38.0
24-32	24	34.4	9.2	20.5-64.7	30.2	6.8	20.5-49.5
33-40	6	27.7	3.2	23.0-31.5	28.6	3.1	25.2-33.5
41-64	6	28.0	6.2	18.7-37.5	24.1	6.8	16.7-36.5

[a] Kilogram average of two trials.

older age samples (Bak & Greene, 1980; Kløve, 1974; Levine & Feirstein, 1972; Vega & Parsons, 1967).

Seashore Rhythm Test. The data presented in Table 12 are similar to previously published error scores, with the exception of three studies that present slightly higher error means (Kløve, 1974; Kløve & Lochen, 1974; Levine & Feirstein, 1972). These samples ranged in age from 32-45 years. The lower error scores in the present data may therefore be due to the sample size limitation in the upper age ranges.

Tactile Form Recognition. This test was devised by Reitan (Note 2) and requires tactile identification of geometric shapes (i.e., circle, square, cross, triangle). The total number of incorrect responses and total time for the trial for each hand are recorded. The test administration has been modified slightly so the preferred hand is tested first. Only one trial per hand is given unless an error occurs, then an additional trial for each hand is administered.

Published norms are unavailable for this test. Our data in Table 13 show very low error rates, with only one person producing an error in each of the first three age groups.

Table 10

Normative Data for the Tactual Performance Test[a] in Minutes Stratified by Age

		Preferred Hand			Nonpreferred Hand		
Age	*n*	*M*	*SD*	Range	*M*	*SD*	Range
15-17	32	4.6	1.2	2.6- 6.8	3.3	1.2	1.1- 6.4
18-23	74	5.1	2.2	1.9-13.5	3.5	1.6	1.1-10.8
24-32	56	4.5	1.8	1.7- 9.5	3.1	1.1	1.5- 7.1
33-40	18	4.9	1.7	1.9- 9.0	3.7	1.0	2.2- 5.9
41-64	10	5.6	1.5	4.0- 9.0	4.2	1.6	2.4- 8.1

		Both Hands			Total Time		
Age	*n*	*M*	*SD*	Range	*M*	*SD*	Range
15-17	32	1.7	.5	.8-3.3	9.5	2.1	4.7-14.1
18-23	74	2.1	1.3	.4-9.3	10.6	4.5	4.2-29.1
24-32	56	1.8	.8	.5-4.6	9.4	3.0	3.8-18.8
33-40	18	2.3	.8	1.4-4.4	10.9	2.9	5.9-19.4
41-64	10	2.5	1.2	1.4-5.5	12.2	3.6	8.3-20.6

[a] All subjects placed 10 blocks in less than 15 minutes with the preferred, nonpreferred, and both hands.

Table 11

Normative Data for the Tactual Performance Test in Total Correct Blocks Stratified by Age

		Localization			Memory		
Age	*n*	*M*	*SD*	Range	*M*	*SD*	Range
15-17	32	6.8	2.5	1-10	8.9	1.0	6-10
18-23	74	5.7	2.1	1-10	8.2	1.3	4-10
24-32	57	5.5	1.8	2-9	8.3	1.1	6-10
33-40	18	5.6	2.2	1-9	8.6	1.1	6-10
41-64	10	4.9	1.8	2-7	7.7	1.3	6-9

Total time for the four trials per hand reveals a slight increase with age. The mean hand difference across the age groups is 1.5 seconds or approximately a 20% reduction in nonpreferred hand time.

Finger-Tip Number Writing. Normative data for this test have not been published

Table 12

Normative Data for the Seashore Rhythm Test in Total Errors Stratified by Age

Age	*n*	*M*	*SD*	Range
15-17	32	2.1	1.4	0-5
18-23	75	2.5	2.1	0-9
24-32	57	2.4	1.9	0-9
33-40	18	2.3	2.1	0-8
41-64	10	3.9	2.1	1-6

Table 13

Normative Data for the tactile Form Recognition Test in Total Errors and Time in Seconds Stratified by Age

Errors

		Preferred Hand			Nonpreferred Hand		
Age	*n*	*M*	*SD*	Range	*M*	*SD*	Range
15-17	32	.06	.24	0-1	.03	.18	0-1
18-23	54	.02	.14	0-1	.19	.14	0-1
24-32	47	.02	.15	0-1	.02	.15	0-1
33-40	18	0	0	0	0	0	0
41-64	10	0	0	0	0	0	0

Time in Seconds		Preferred Hand			Nonpreferred Hand		
15-17	32	5.5	2.2	3-12	4.7	2.2	2-11
18-23	54	7.9	4.0	3-22	6.5	2.6	2-14
24-32	47	7.8	3.9	2-23	5.3	1.9	2-9
33-40	18	7.9	2.9	3-13	6.0	2.3	2-11
41-64	10	8.5	4.3	3-16	6.1	1.9	3-8

to date. The average mean error score for the preferred hand is approximately 2, with a lowered nonpreferred hand score of slightly greater than one (see Table 14).

Finger Localization. This test is a modified version of the Finger Agnosia (Reitan, Note 2) and Finger Localization tests (Benton, 1955). The subject is required to identify, without visual guidance, fingers touched by the examiner. For each of the 11 subtests the preferred hand is tested first, a single finger stimulation trial is followed by a double finger stimulation trial and a different response is required of

Table 14

Normative Data for Finger-Tip Number Writing Test in Total Errors Stratified by Age

		Preferred Hand			Nonpreferred Hand		
Age	*n*	*M*	*SD*	Range	*M*	*SD*	Range
15-17	32	1.3	1.7	0-7	1.2	1.1	0-4
18-23	69	2.3	2.4	0-10	1.9	2.1	0-9
24-32	54	1.3	1.8	0-7	.94	1.3	0-5
33-40	18	2.4	2.3	0-10	1.3	1.0	0-3
41-64	8	2.5	2.5	0-7	1.1	1.6	0-4

the subject. Depending upon the subtest, the subject is told to identify the finger or fingers either by: (1) pointing, (2) naming, (3) indicating the finger on the hand of the examiner, or (4) indicating the number of the finger on a drawing. A total error score summed across all subtests is obtained. The maximum number of errors possible is 150. (A more detailed description of administration can be obtained from the authors).

No normative observations have been published on this test to date. Interhand differences are not evident in the data presented in Table 15. More detailed analysis of these data involving subtypes of responses and double versus single finger stimulation will be presented in a later publication.

Face-Hand. This is a combined version of the tactile portion of the Sensory Imperception (Reitan, Note 2) and Face-Hand (Green & Fink, 1954) tests. With closed eyes, the subject is requested to verbally identify the body side and area touched by the examiner. Four areas are lightly touched with either a finger or pencil tip: right cheek, left cheek, right hand, and left hand. Double, simultaneous

Table 15

Normative Data for the Finger Localization Test[a] in Total Errors Per Hand Stratified by Age

		Preferred Hand			Nonpreferred Hand		
Age	*n*	*M*	*SD*	Range	*M*	*SD*	Range
15-17	32	2.8	2.3	0.9	3.1	2.2	0.8
18-23	76	2.8	2.7	0-12	3.0	3.3	0-20
24-32	54	2.3	2.4	0-10	2.8	2.4	0-9
33-40	18	2.4	2.6	0-9	2.5	3.2	0-14
41-64	10	2.9	1.8	0-7	3.7	2.6	0-8

[a] Modified version of test.

stimulations are performed. (A more detailed description of administration can be obtained from the authors). A summed error score is obtained.

Very few errors are made by normal controls on this test as shown in Table 16. Right/left side differences in errors are not evident.

Table 16

Normative Data for the Face-Hand Test[a] in Total Errors Per Side Stratified by Age

		Right Side			Left Side		
Age	*n*	*M*	*SD*	Range	*M*	*SD*	Range
15-17	32	.16	.45	0-2	.22	.49	0-2
18-23	68	.07	.26	0-1	.12	.37	0-2
24-32	55	.13	.58	0-4	.09	.44	0-3
33-40	18	.17	.38	0-1	.17	.71	0-3
41-64	10	.10	.32	0-1	.40	.52	0-1

[a] Modified version of the test

DISCUSSION

The normative data presented in this paper are consistent with previously published norms and reflect differential effects of age and occasionally sex on test performance. Age effects were evident on measures of perceptual-motor functions (Trail Making and Tactual Performance Tests) and abstraction (Halstead Category Test). Despite the size limitation in the upper age ranges of the present sample, the age trends are consistent with previous data (Reed & Reitan, 1963a, 1963b; Reitan, Note 2).

Females were weaker (Dynamometer) and slower (Finger Tapping) than males on motor tasks. Sex effects on motor performance have not been investigated in the previous literature due to the preponderance of males within most samples. As a consequence of such division, these norms tend to be more conservative than those used by most neuropsychologists. The motor differences appear reflective of physical size factors since these effects were not revealed in tests of perceptual-motor speed, viz., Trail Making and Tactual Performance Tests.

The present data for the sensory-perceptual tests within the HRB indicate that normal subjects make few errors. This suggests that a small number of errors, particularly if unilateral, is pathognomonic. Golden, Osmon, Moses, and Berg (1981) suggest that lateralized dysfunction is not indicated unless there is a difference of three or more errors.

Preferred/nonpreferred hand differences have generally not been published for many of the motor and sensory tests within the HRB. Most clinicians use generally accepted percentages such as a 10% better dominant hand performance on Finger

Tapping and a 30% decrease in time from the dominant to nondominant hand performance on the Tactual Performance Test (Golden et al., 1981). The hand difference on Tactual Performance is supported by the present data. However, the hand difference generally accepted for Finger Tapping is displayed only by the males. The females show a hand difference of approximately 5%. Thus, neuropsychologists using the present cut-off points and the generally accepted hand differences would classify most female subjects as impaired, with a possible preferred hand weakness.

The Full Scale IQ (FSIQ) as assessed by the Wechsler Scales for the present sample was 119. This is within the high normal range of function and is comparable to the FSIQ of other normal samples (Anthony et al., 1980; Matarazzo et al., 1974; Weins & Matarazzo, 1977). A possible explanation for these higher than average IQ scores in the normal samples is that deletion of pathological samples from the distribution (e.g., mental retardates, individuals with neurological disorders or minimal brain damage) raises the group mean of normals. Researchers have also reported this effect in normal children and adolescent samples (Yeudall, Fromm-Auch, & Davies, 1982; Spreen, Note 3).

Inclusion of psychiatric patients in control groups has occurred in numerous neuropsychological studies (e.g., Prigatano & Parsons, 1976; Reitan, 1955; Snow, 1981; Swiercinsky, 1978). This assumes that psychiatric patients display "functional" disorders rather than "organic" disorders, an assumption which does not appear valid, especially for schizophrenic groups (see Heaton, Baade, & Johnson, 1976 for review). Numerous techniques, both neuropsychological test measurement and neurological assessment techniques, have provided evidence for central nervous system abnormalities in the major psychiatric psychoses (Flor-Henry, 1976; Snow, 1981; Weinberger, Bigelow, Kleinman, Klein, Rosenblatt, & Wyatt, 1980; Weinberger, Torrey, Neophytides, & Wyatt, 1979; Weinberger & Wyatt, 1980; Yeudall & Fromm-Auch, 1979; Yozawitz, Bruder, Sutton, Sharpe, Gurland, Fleiss, & Costa, 1979). As a result of this practice, many of the cut-off points employed by clinical neuropsychologists may be excessively conservative and consequently produce a high rate of false negatives.

REFERENCE NOTES

1. Fromm-Auch, D., Yeudall, L. T., & Stefanyk, W. *Manual for the Administration of the AHE Neuropsychological Test Battery.* Unpublished Manuscript, 1978.
2. Reitan, R. M. *Manual for Administration of Neuropsychological Test Batteries for Adults and Children.* Unpublished Manuscript, Indianapolis, 1969.
3. Spreen, O. Personal Communication, June 7, 1982.

REFERENCES

Annett, M. A classification of hand preference by association analysis. *British Journal of Psychology,* 1970, *61,* 303-321.

Anthony, W. Z., Heaton, R. K., & Lehman, R. A. W. An attempt to cross-validate two actuarial systems for neuropsychological test interpretation. *Journal of Consulting and Clinical Psychology,* 1980, *48,* 317-326.

Bak, J. S., & Greene, R. L. Changes in neuropsychological functioning in an aging population. *Journal of Consulting and Clinical Psychology,* 1980, *48,* 395-399.

Benton, A. L. Right-left discrimination and finger localization in defective children. *Archives of Neurology and Psychiatry,* 1955, *74,* 583-589.

Botwinick, J. Geropsychology. *Annual Review of Psychology,* 1970, *21,* 239-246.

Cauthen, N. Normative data for the Tactual Performance Test. *Journal of Clinical Psychology,* 1978, *34,* 345-365.

Davies, A. The influence of age on Trail Making Test performance. *Journal of Clinical Psychology,* 1968, *24,* 96-98.

Dodrill, C. B. The hand dynamometer as a neuropsychological measure. *Journal of Consulting and Clinical Psychology,* 1978, *46,* 1432-1435.

Fitzhugh, K. B., Fitzhugh, L. C., & Reitan, R. M. Influence of age upon measures of problem solving and experimental background in subjects with longstanding cerebral dysfunction. *Journal of Gerontology,* 1964, *19,* 132-134.

Flor-Henry, P. Lateralized temporal-limbic dysfunction and psychopathology. *Annals of the New York Academy of Sciences,* 1976, *280,* 777-795.

Golden, C. J., Osmon, D. C., Moses, J. A., Berg, R. A. *Interpretation of the Halstead-Reitan Neuropsychological Test Battery: A casebook approach.* New York: Grune & Stratton, 1981.

Goul, W. R., & Brown, M. Effects of age and intelligence on Trail Making Test performance and validity. *Perceptual and Motor Skills,* 1970, *30,* 319-326.

Green, M., & Fink, M. Standardization of the Face-Hand Test. *Neurology,* 1954, *4,* 211-217.

Halstead, W. C. *Brain and intelligence: A quantitative study of the frontal lobes.* Chicago: University of Chicago Press, 1947.

Heaton, R., Baade, L., & Johnson, K. Neuropsychological test results associated with psychiatric disorders in adults. *Psychological Bulletin,* 1978, *85,* 141-162.

Kløve, H. Validation studies in adult clinical neuropsychology. In R. Reitan & L. Davison (Eds.) *Clinical neuropsychology: Current status and applications.* New York: Wiley, 1974.

Kløve, H., & Lochen, D. Data published in R. Reitan & L. Davison (Eds.) *Clinical neuropsychology: Current status and applications.* New York: Wiley, 1974.

Levine, J., & Feirstein, A. Differences in test performance between brain-damaged, schizophrenic and medical patients. *Journal of Consulting and Clinical Psychology,* 1972, *39,* 508-511.

Lezak, M. *Neuropsychological assessment.* London: Oxford Press, 1976.

Lindsey, B. A., & Coppinger, N. W. Age-related deficits in simple capabilities and their consequences for Trail Making performance. *Journal of Clinical Psychology,* 1969, *25,* 156-159.

Matarazzo, J. D., Weins, A. N., Matarazzo, R. G., & Goldstein, S. G. Psychometric and clinical test-retest reliability of the Halstead impairment index in a sample of healthy, young, normal men. *Journal of Nervous and Mental Disease,* 1974, *158,* 37-49.

Prigatano, G. P., & Parsons, O. Relationship of age and education to Halstead test performance in different patient populations. *Journal of Consulting and Clinical Neuropsychology,* 1976, *44,* 527-533.

Reed, H. B. C., & Reitan, R. M. A comparison of the effects of the normal aging process with the effects of organic brain-damage on adaptive abilities. *Journal of Gerontology,* 1963, *18,*

Reed, H. B. C., & Reitan, R. M. Changes in psychological test performance associated with the normal aging process. *Journal of Gerontology,* 1963, *18,* 271-274. (b)

Reitan, R. M. The distribution according to age of psychologic measures dependent upon organic brain function. *Journal of Gerontology,* 1954, *10,* 339-340.

Reitan, R. M. Investigation of the validity of Halstead's measures of biological intelligence. *Archives of Neurology and Psychiatry,* 1955, *73,* 28-35.

Schaie, K. W. A general model for the study of developmental problems. *Psychological Bulletin,* 1965, *64,* 92-107.

Schreiber, D. J., Goldman, H., Kleinman, K. M., Goldfader, P., & Snow, M. The relationship between independent neuropsychological and neurological detection and localization of cerebral impairment. *Journal of Nervous and Mental Disease,* 1976, *162,* 360-365.

Snow, W. G. A comparison of frequency of abnormal results in neuropsychological vs. neurodiagnostic procedures. *Journal of Clinical Psychology,* 1981, *37,* 22-28.

Swiercinsky, D. *Manual for the Adult Neuropsychological Evaluation.* Springfield, Illinois: C. C. Thomas, 1978.

Swiercinsky, D., & Leigh, G. Comparison of neuropsychological data in the diagnosis of brain impairment with computerized tomography and other neurological procedures. *Journal of Clinical Psychology,* 1979, *35,* 242-246.

Tsushima, W. T., & Wedding, D. A comparison of the Halstead-Reitan neuropsychological battery and computerized tomography in the identification of brain disorder. *Journal of Nervous and Mental Disease,* 1979, *167,* 704-707.

Vega, A., & Parsons, O. A. Cross-validation of the Halstead-Reitan tests for brain damage. *Journal of Consulting Psychology,* 1967, *31,* 619-625.

Weinberger, D. R., Torrey, E. F., Neophytides, A. N., & Wyatt, R. J. Structural abnormalities in the cerebral cortex of chronic schizophrenic patients. *Archives General Psychiatry,* 1979, *36,* 935-939.

Weinberger, D. R., Bigelow, L. B., Kleinman, J. E., Klein, S. T., Rosenblatt, J. E., & Wyatt, R. J. Cerebral ventricular enlargement in chronic schizophrenia. *Archives General Psychiatry,* 1980, *37,* 11-13.

Weinberger, D. R., & Wyatt, R. J. Schizophrenia and cerebral atrophy. *The Lancet,* 1980, *1,* 1129-1130.

Weins, A. N., & Matarazzo, J. D. WAIS and MMPI correlates of the Halstead-Reitan Neuropsychological battery in normal male subjects. *Journal of Nervous and Mental Disease,* 1977, *164,* 112-121.

Wepman, J., & Jones, L. *Studies in aphasia: An approach to testing.* Chicago: University of Chicago, Educational Industry Service, 1961.

Yeudall, L. T., & Fromm-Auch, D. Neuropsychological impairments in various psychopathological populations. In J. Gruzelier & P. Flor-Henry (Eds.), *Hemispheric asymmetries of function in psychopathology.* New York: Elsevier/North Holland Biomedical Press, 1979.

Yeudall, L. T., Fromm-Auch, D., & Davies, P. Neuropsychological impairment of persistent delinquency. *Journal of Nervous and Mental Disease,* 1982, *170,* 257-265.

Yozawitz, A., Bruder, G., Sutton, S., Sharpe, L., Gurland, B., Fleiss, J., & Costa, L. Dichotic perception: Evidence for right hemisphere dysfunction. *British Journal of Psychiatry,* 1979, *135,* 224-237.