COPYING SPEED IN SCHOOL CHILDREN

COMPARISON OF MEANINGFUL AND NON-MEANINGFUL MATERIALS

AND DESK VS. BOARD COPY

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Master's Thesis

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RUNNING HEAD: Copy Speed

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Abstract

The purpose of this study was to develop a measure of children's copying speed (conditions: making X's in boxes, copying unfamiliar alphabet-like figures, writing pronounceable nonsense syllables, and copying grade appropriate paragraphs from the Gray Oral Reading Tests presented as desk copy or board copy) and copy span. Four hundred twenty-five children in grades 2 through 8 were tested. It was found that copy speed and copy span increased with age and grade, that the relative speed of the tasks varied between grades, and that girls were faster than boys on tasks involving alphabet letters. The Copy Speed and Span Test is a reliable measure of children's copy speed and span that should be useful in future research.

Table of Contents

With the advent of computers and photocopiers handwriting appeared to be a skill that would soon become obsolete. Now, however, despite growing use of both machines, we realize that it is unrealistic to imagine a world where one must carry a computer around to jot down notes. Even battery operated machines have a limited range from a source for recharging. A pencil stub and sheet of paper can fit compactly into a pocket or purse, to be used whenever needed. Distributing to students the vast amounts of information currently required while trying to deal with cutbacks in funding, schools are finding that a reversion to the old "copy it off the board" methods can save them money. Handwriting still has a place in our lives. It is also likely that the easier it is for us to get our thoughts written down, the more likely that we will use handwriting regularly. Fast writing seems to be associated with more mature syntactical structure in written work (McAndrew, 1990), something all teachers hope to see their students

develop.

Children who must copy work into their notes must be able to get all the material copied before the board is erased. If they fail, they have incomplete notes and nothing from which to study for examinations. Often children do such poor written work that they are told they must copy it over. Thus they must spend hours of extra time re-copying work. Many children seem to find themselves in this position. Parents and teachers wonder what is wrong.

While a number of investigators have looked at the subject of handwriting speed, there has been little uniformity in conditions of measurement. Some school psychologists have expressed a need for a method of determining a student's level of achievement in handwriting speed. Teachers often describe a student as a "slow writer", but without a scale based on uniform conditions of measurement one cannot make clinically valid interpretations. The conditions of measurement are also important in understanding why one investigator's results may differ from another's results.

The problem of uniform conditions of measurement has been recognized previously in the literature. Ziviani

(1984) examined the methods of previous studies and compared the resulting speeds with her own findings. These speeds are shown in Table 1. It is readily apparent that there are large discrepancies. [All speed scores in this paper have been reported in or transformed to letters per minute (lpm) to facilitate comparison.]

Table 1. Mean Handwriting Speed in Letters/Minute*:

Grade	1912	1954	1961	1984
3	--	40	--	32.60
4	55	50	35.06	34.24
5	64	60	40.65	38.41
6	71	67	49.60	46.18
7	--	74	--	52.15

*Comparison of data from Ayres(1912), Freeman(1954), Groff(1961), Ziviani(1984) given in Ziviani (1984).

Other writers have reported their measurements of copy speed. Sometimes it is reported as an "extra" bit of information in a study that is investigating something else. The copy speeds reported in these studies is summarized in Table 2. Again, discrepancies are apparent.

Table 2. Other Reports of Handwriting Speed

Grade	Klein (1979)	Otto & Rarick (1968)	Jackson (1970)	Zaner-Bloser (1979) [from Reis, 1989]
1		-		25
2	-	-	-	30
3	-	-	-	38
4	35.84	37.6	1-36.55 2-60.16	45
5			1-50.43 2-71.03	60
6	52.26	53.6	1-50.73 2-77.50	67
7	-		-	74
8	77.00		-	-

The importance of measurement conditions can be seen in Jackson's results. Jackson had two conditions: (1) "as well and as rapidly as you can", and (2) "as fast as you can". Lawton & Currie (1980) give sample speed norms which match Freeman's rates but add 80 lpm as a goal for grade 8 students. They give no data about where or how the norms were obtained. Sawyer, Francis & Knight (1992) give the mean for Year 10 pupils as 107.39 lpm with a range from 85 lpm for the all male, low ability band to 122.95 for the mixed sex, high ability band. College students were reported by Gust and Schumacher (1969) to have a mean rate of 126-128 lpm.

These varying speed scores reflect the differences

in conditions and materials employed in the various studies. Table 3 presents a summary of these important factors.

Table 3. Conditions/Materials Used in Writing Speed Studies

Author	n	Model	Location	PracticeType/Amt
Ayres	class	Gettysburg Address	Board	Written/Repeated
Freeman	?	" "	Board	Written/Repeated
Groff	4834	" "	Board	Read/Repeated
Ziviani	575	"cats and dogs"	Desk	None
Klein	194	grade 7 level	Desk	None
Otto & Rarick	240	everyday words	??	??
Jackson	108	.quick brown fox...	??	??
Sawyer,Francis & Knight	50	gov't exam	Desk	None

The wide variation in conditions and materials is evident in Table 3. Some studies had the model on a chalkboard, others on the desk. Copying speed may differ when the material is copied from the board as compared to when it is copied from a paper on the desk. With longer distances for the eye to travel when the material is on the board, there is more chance that distracting stimuli will be encountered. Finding and focusing on a small target on a large background is also likely to increase the time involved. Therefore there are likely to be

differences in copying speed norms between the two tasks.

Practice type and amount are also likely to affect copying speed. Ayres (1912, in Groff, 1961) and Freeman (1954, in Ziviani, 1984) had students practice writing the passage over and over. Groff (1961), in contrast, had the students read the passage without writing it until they knew all the words. Klein (1979) and Sawyer, Francis and Knight (1992) used previously unseen material which would conceivably be closer to what would be encountered in the classroom.

Variation in difficulty levels in the model is also likely to result in differences in copying speeds. The Gettysburg Address is not simple. Yet Ayres' and Freeman's norms are used to evaluate speed when students are given simple material to copy. A phrase such as "cats and dogs" written repeatedly could likely be written from memory after the first time by most students. Thus it is not appropriate to compare speeds obtained from such copy with those obtained when the copy requires continuously looking back at the model.

The test-retest reliability of speed scores, after a period of two months has been reported to be .85

(Mojet, 1991) indicating that performance consistency can be expected. While popular opinion appears to hold that cursive style handwriting is faster than manuscript style (printing), Jackson (1970) found that manuscript style writers in grades 5 and 6 were as fast as cursive style writers. Children's "best" work is better than their fast work (Harris & Herrick, 1963) which implies that they write slower when they know they are being judged on quality. This finding alone may account for the differences in speeds found by different investigators. The emotional quality of the copy chosen does not seem to affect the speed at which the words are written. There was no significant difference between the speed at which pleasant words such as "pretty" or unpleasant words such as "murder" were written in Matlin and Kennedy's (1976) study.

Dyslexics write slower than "normals" (Whitehouse, 1983; Sovik, Arntzen & Thygesen, 1987) though in a copying task their performance was more similar to their age mates than to younger children with the same spelling ability (Martlew, 1992) which would perhaps support a maturational component in copying speed. Hildreth (1947) asserted that maturation appeared to be a dominant factor

in handwriting speed. However, maturation may not be the complete explanation. Simner (1991) reported that children who had many form errors in printing in kindergarten later wrote more slowly than other children. Simner attempted to explain the slower writing as the result of a memory problem (the form fades) or as an organizational problem. Keele and Hawkins' (1982) work appears to support a personal motor speed factor. They found that the rate of repetitive activity is common across different muscle groups and that the rate of wrist, finger or foot tapping is related to and predicts handwriting speed. Greater speed may be related to higher intelligence (Love, 1965; Jackson, 1970; May & Brannin, 1984).

Research on sex differences in handwriting speed strongly suggests that females are faster than males (Burt, 1921 in Bailey, 1988; Groff, 1963 in Andersen, 1965; Klein, 1979; Ziviani, 1984) although Jackson (1970) did not find differences. Judd, Siders, Siders and Atkins (1986) found that grade one boys were as fast as girls in placing dots in circles, but that they were significantly slower at copying symbols. They point out that the literature reports differences between the sexes

in older children and adults in fine motor and visuo-spatial tasks as well (though no direct comparison of the same task is reported). Since writing involves symbol copying, their work seems to support sex differences in handwriting.

Handedness does not seem to make a difference in speed in and of itself (Auzias, 1973; Herron, 1980). Athenes & Guiard (1991) found that speed for left handed subjects was related to hand position and arm position in relation to the page. Left handed "inverters" wrote faster with the arm in a more horizontal position on the page. Left handed non-inverters wrote faster when the arm was more vertical on the page. For right handed subjects, speed did not seem to be affected by the amount of forearm slant on the page.

Other factors may also affect copying speed. Furner (1969) argues that young students must be taught to perceive the stimulus carefully before they can be expected to copy it accurately. Then a child must remember what has been perceived long enough to get it copied. Visual and verbal memory seem to be separate entities (Woodhead & Baddeley, 1981). Young children have greater dependence on visual working memory,

particularly when dealing with visually presented material although they do use phonological memory when working with material presented in the auditory mode. Older children, however, seem to depend more on phonological memory, translating visual material into phonological material which they can then rehearse (Hitch, Halliday, Schaafstal & Schraagen, 1988). The introduction of auditory labels onto the copying task by the experimenter facilitates young children's ability to copy shapes (Stiles, Tada and Whipple, 1990). Berninger, Yates and Lester (1991), working with visual material, suggested that a child uses multiple orthographic codes and that the codes used will change as the child develops skills. How efficiently a child decodes and encodes the stimulus material in copying likely affects speed.

A child must therefore perceive the material to be copied, decode it and then encode it in memory in some way. Other requirements of efficient copying behaviour might be stores of motor programs, kinematic information, and spatial and temporal programs covering the details of which muscles to move to what extent in which direction, how fast or slow, and with how much force in order to accomplish the task (Laszlo and Broderick, 1985; Zimmer

and Engelkamp, 1985).

Copying span (the amount of material that can be clearly recalled immediately after it is no longer available to sight) is almost certainly a factor in copying speed. Mori and Yamada (1988) tested the relative contributions of copying span and copying speed in measuring written language ability in adult students of English as a second language. In their study they found that, while there were exceptions, generally people with short copy spans were poor readers and those with longer copy spans were good readers. Bradley (1983) reported that poor young readers tended to copy letter by letter and normal readers copied by words or phrases which would tend to support Mori and Yamada's findings. Spelling ability might also have been a factor. Rothkopf (1980) suggested that copying span is a function of the information burden of the material. These findings suggest that more attention should be paid to comparing copying span with copying speed in children to see how the two relate.

The findings of these previous studies and the questions raised by differences in their reported copy speeds lead to the following hypotheses in this study.

1. Based on speculation about the possible difficulty of copying tasks with varying degrees of complexity, familiarity, and distance involved it was hypothesized that speed would be greatest for making X's in boxes (a spatial-graphic, largely motor task), followed by writing words from desk copy (a practiced, semantic-lexical-phonological-graphic task with minimum space difference), followed by writing words from board copy (similar to desk copy but with the additional distance variable), followed by writing nonsense words (non-lexical-phonological-graphic task) followed by copying non-meaningful figures (an orthographic task).

2. Based on Furner's supposition that one must perceive the stimulus as a first step, it was hypothesized that the difficulties of perceiving a more distant model might cause copy from a board to be slower than copy from a desk model.

3. It was also hypothesized that, given the greater familiarity level of the material, copy speed would be greater when readability level of material was considerably lower than the students'

grade level.

4. Familiarity as well as the factor of physical maturation led to the hypothesis that copy speed and copy span would increase with age and grade.

5. Because of the time factor involved in looking back at a copy, it was hypothesized that greater copying speed would be expected for word copying (measured by the board task) in subjects with longer copying span (the number of recognizable words that can be written in response to a 5 second exposure to the stimulus material presented on the board) in the copy span task.

6. The findings of previous studies in the literature suggested the hypothesis that females would be faster than males in most tasks.

Method

Subjects

Students enroled in grades 2 through 8 in five elementary schools in and around a Northern Ontario city were approached for testing. The schools were chosen in consultation with a board of education in the district. Special attention was given to trying to use schools that

had students from a range of socio-economic levels. The selection was not a truly random sample, but was based on accessibility. The principals of schools 1, 3, and 4 asked for parental permission forms to be completed.

Poor parental response resulted in only portions of the classes being tested. Principals in the other two schools decided that the content was sufficiently academic and that participants were anonymous and so allowed the testing of entire classes if the classroom teacher agreed. In both of these schools all students of a particular grade were tested, thus assuring a representative sample was obtained. A total of 425 students were tested. As can be expected with such a large number, a few students did not cooperate. In some classes some students reported difficulty reading the overhead. Some students were observed looking at a neighbour's paper during the copy span task. Such students were noted by protocol number and their scores omitted from calculations that might be affected. The number from each grade tested and retained was as shown below:

Grade	Number Tested	Number Retained	Retested (speed)	Retested (span)
2	41	37	12	
3	74	72	10	26
4	63	59	7	
5	65	64	5	
6	32	32	3	
7	81	65	7	
8	69	63	1	20
Total	425	392	45	46

There were approximately equal numbers of male and female subjects overall (for exact numbers see Tables of Means for males and females in Appendices F and G).

Research assistants

One volunteer assistant was available for helping in each large group. The assistant helped to distribute and collect materials, observed for compliance with instructions, observed writing postures, and recorded protocol numbers for distance from the board and problems such as noncompliance. Three assistants were trained and used.

Measures

The Copy Speed and Span Test (CSAS) was constructed in an attempt to provide a uniform means of measuring copy speed and to determine some of the factors which contribute to it (see appendix B). Test forms were constructed to provide space for the five speed tasks and

the span task. They also contained space for students to record information on date, age, birthdate, grade, sex, and hand, eye, and foot preference. If left handed, students were asked whether they write with their hand above (inverted posture) or below their writing. An additional question asked whether the student reads or writes a language that uses different letters than English or French since familiarity with another alphabet might indicate familiarity with the supposedly "non-meaningful" material.

Speed Tests. Five speed tests were devised.

1. X's. The motor (spatial-graphic) task consisted of marking X's in boxes. This task requires two strokes making it a better comparison with alphabet tasks than making dots. It does not require reading skills nor does it tax memory abilities. Therefore it was thought to be a good measure of motor speed.

2. Symbols. The non-verbal task consisted of copying generally unfamiliar symbols from the WordPerfect (1991) extended characters (see test form, Appendix B). These characters are used in other languages or specialized areas and most are similar in complexity (number of strokes or direction changes) to letters, but were

thought to be unfamiliar to most students studying in English in North American schools. For figures such as triangles which could be verbally labelled by most students, the orientation of the symbol still interfered with quick verbal labelling.

3. Nonsense syllables. A list of pronounceable nonsense syllables (see Appendix A) was used to test non-meaningful copying ability.

4. Desk copy task. Two passages selected from the Gray Oral Reading Tests (GORT, Robinson, 1963) with equivalent reading level were used for each grade (see Appendix A). One of these passages was used for the desk copy task and the other for the board copy task. The difficulty level used in each grade was one level below the grade levels assigned by the GORT. It was anticipated that the choice of reading difficulty level would provide a control on relative difficulty of the task for each grade without making the task too far above slow readers in each grade. The 1963 version was used to avoid exposing current test materials to such a large group of students.

5. Board copy task. This task used the parallel paragraph from the Gray Oral Reading Tests (Robinson, 1963) selected for each grade that was not used in the

desk copy task. This ensured similar difficulty level in the two tasks but eliminated any familiarity effects. In the board task material was presented by overhead projector from approximately 8-10 feet from the screen (actual distances were dictated by physical arrangements in each classroom).

6. Extra. An extra paragraph, not part of the CSAS, with high grade 1/low grade 2 readability (Fry, 1988) written by the experimenter (see Appendix A) was used in the pilot portion of the study (see procedure section) to assess the effects of readability level on copy speed. Students copied this paragraph onto standard notebook paper. This paragraph was given to all students in the pilot portion who were above Grade 3. Because of time constraints only one group of the pilot Grade 3 students copied the low readability level paragraph. (Because the Grade 3 and 4 students were deemed to be too close to the level of the low readability paragraph, and because they greatly outnumbered the older students in the pilot study, it was later decided to analyze only grade 5 and higher protocols in determining the effect of readability level on copy speed.)

Copy Span. The copy span materials consisted of

lines of randomly ordered words taken from the Dolch Word List (Dolch, 1960; see Appendix A) and presented by overhead projector for five seconds. The first two presentations for all grades were one line long and the last two for all grades were two lines long. The third presentation was one line long for lower grades and two lines long for upper grades. Students were given warning before being shown the first two line presentation, and assured that they did not have to worry if they could not read all the words in time. They just needed to remember as many as they could.

Procedure

Approximately two to three weeks prior to the testing in each school that required parental permission, students were told of the experiment and given consent forms to sign and have their parents sign (see Appendix C). Two forms were used as the response rate with the first form was very low.

Pilot Study. A pilot study was conducted using all the students from School 1 whose parents had given permission. Since a ceiling effect was detected with the copy span task as originally designed (sentences), the task was changed to random words from the Dolch Word List

(Dolch, 1960) for the remaining classes.

Test-Retest. Students from School 1 were retested 26 days later to assess test-retest reliability of the speed tests (in which no problems were detected) and to administer the revised copy span measure. (For students in School 1, scores from the first testing were used in speed analyses and from the revised measure for copy span analyses.) Students from grades 3 and 8 in School 5 were retested 14 days later to assess test-retest reliability on the revised copy span measure. For all students retested matching of the original protocol with the retest protocol was done by birthdate and sex. Where there was a duplicate of birthdate and sex within the class, protocols were matched by comparing handwriting style using three independent judges. Teachers did not see the completed forms and the researcher did not have access to names.

Administration. Students first completed the demographic data on the test form and were allowed to use whatever style of writing and whatever writing implement they found most comfortable. Students were instructed to "Write as quickly as possible, but I must be able to read it." It was thought that this would approximate most

closely the classroom copying situations with which comparisons might be made. (See Appendix D for specific wording of instructions for each task.)

All students began with making X's in boxes. The task of making X's was thought to be the easiest task and thus to be suitable as a warm up. One of the complete schools then followed this order:

2. Non-verbal
3. Pronounceable nonsense syllables
4. Board copying task
5. Desk copying task
6. Copy span task

The other complete school did the tasks in the reverse order in order to provide some control for fatigue effects. Where classrooms contained two grades, desk and board copy tasks were run concurrently with one grade doing the desk task and the other the board task.

Stimulus materials for the non-meaningful characters were presented in the test booklet immediately above the square in which they were to be copied. Materials for the nonsense syllables and desk copy were presented on cards on the desk. Board and copy span task materials were prepared ahead (to keep model quality constant) and presented by overhead projector from as close to the same distance as physical conditions permitted for all classes

(approximately 8-10 feet). All verbal materials were typed and made to resemble the original cards from The Gray Oral Reading Test (Robinson, 1963) as closely as possible in size and spacing.

Tests of X's, non-meaningful characters and nonsense syllables were timed for one minute. It was thought that to run these tests for two minutes, while it would have provided a better comparison with the desk and board copy tests, would have caused the test to become unnecessarily long. This might have created boredom and undue fatigue in the student while making teachers less willing to allow access to their classes. Tests of desk and board copying of words were timed for two minutes and the results divided by two to obtain the rate as this longer task more closely resembles classroom handwriting tasks where persevering with speed is important as well as earlier tests of speed such as Groff (1961). Each group of words for the copying span task was exposed for 5 seconds and then removed. Students began to write when the stimulus was removed and were given as long as needed to respond.

In the pilot stage the older classes were given an additional paragraph on a paper on the desk written by

the experimenter using a Fry (1988) readability index rating of high grade 1/low grade 2 difficulty. This additional paragraph was used as the "very easy material" in comparing speeds with grade appropriate material (desk copy task).

The entire class time required was about 30 minutes (testing time about 12 minutes and the remainder for material handling and writing of demographic data). Whenever possible, students were tested in the regular classroom as a class in order to reproduce classroom writing conditions. If too few returned consent forms, those who did were removed to another room for testing in groups of 6 to 8.

Scoring

Scores were the number of letters, symbols, or X's per minute. All letters were counted without reference to quality or spelling. A separate count was made of errors and omissions.

Scoring criteria was as follows:

X's: Every pair of two lines was counted as "1". If one pair of crossed lines was superimposed on another within the same square, credit was given for two letters and one error. An error was counted if

lines did not intersect or have at least minimal evidence of a fourth extension or if neither line was minimally diagonal.

Symbols: Every completed square with a symbol was counted as "1". If parts of the symbol were missing or if it was rotated more than approximately 45 degrees an error was counted. Superimposed symbols counted as two symbols and one error.

Nonsense: Every letter counted as "1". Superimposed letters counted as two letters and one error. Incorrect letters were counted but also counted as errors. Every place where an omission occurred was counted as one omission regardless of the number of letters or words skipped.

Board and Desk: Same as nonsense.

Copy Span: Span was measured by the number of correct words written. For the copy span task any reasonable approximation was accepted and homonyms (words sounding the same but with different spelling and meaning) were counted as correct. No error count was made.

Results

Reliability

Test-Retest. All analyses were done with the SPSS (version 4.0) statistical package. Test-retest reliability was calculated to ascertain whether speeds and spans recorded could be considered as representative scores for a subject. This is considered to be an acceptable method of determining reliability in speed tests (Murphy & Davidshofer, 1988). Reliability was determined by correlations between the first and second testing. The results were all significant at the $p < .01$ level as seen in Table 4:

Table 4. Test-Retest Correlations

Subtest	Pearson's r
X's	.9486
Symbol	.8902
Nonsense	.9689
Desk Copy	.9735
Board Copy	.9521
Copy Span	.8393

According to Murphy and Davidshofer (1988) scores of .95 indicate high reliability while scores of .83 would be in the moderate range. Thus the correlations in Table 4 give us confidence that the further statistical analyses of

scores are meaningful exercises as there is good consistency in handwriting speed and copy span.

Internal. Correlations among the tests were all significant at the p.<.01 level (see Table 5). It will be noted that there is a high degree of correlation between alphabet copy tasks with lower correlations for other tasks.

Table 5. Internal Correlations Among Tests

	Symbols	Nonsense	Desk	Board	Copy Span
X's	.6130	.6922	.6798	.6951	.4545
Symbols		.7431	.7336	.7071	.4745
Nonsense			.9342	.9097	.6186
Desk				.9334	.6545
Board					.6664

Copy Speed

A Manova Profile Analysis (comparing 5 speed tasks by 7 grades including how the profiles for each grade varied) showed that the students of different grades differed significantly, $F(6,385) = 127.42$, $p.<.001$, in speed, and that within each grade there was a significant difference in speed on the various tasks, $Mult.F(4,1540) = 1126.15$, $p.<.001$, as predicted. There was also a significant grade by task interaction, $Mult.F(24,1540) = 22.54$, $p.<.001$, which indicated that the grades did not vary in the same way from task to task.

The anticipated hierarchy of speed tasks (X's, desk, board, nonsense and symbol) held for grades 2 to 4 only. Symbols were slowest for all grades as predicted, but X's went from the fastest in grades 2 to 4, to the second slowest in grades 6-8. Grade 5 appeared to be a transition year (see Table 6).

Table 6. Order of Speed on Tasks by Grade*

Grade	2	3	4	5	6	7	8
X's	1	1	1	3	4	4	4
Desk	2	2	2	1	1	1	1
Board	3	3	3	2	2	2	2
Nonsense	4	4	4	4	3	3	3
Symbol	5	5	5	5	5	5	5

* 1=fastest

A Manova (task by sex) of the entire sample showed no sex difference. A Manova (task by style by sex) was done on all subjects over grade 3 (because cursive is introduced in grade 3 in the area where this study was conducted). This second analysis showed no effect of writing style (manuscript vs. cursive). It was significant however for sex in the older subgroup, Pillais, $F(5,256) = 4.15$, $p<.001$. Univariate tests showed the sex effect to be present on the nonsense, $F(1,256) = 9.98$, $p.<.002$, desk, $F(1,256) = 8.24$, $p.<.004$, and board copy, $F(1,256) = 7.17$, $p.<.008$, tasks only.

Table 7. Correlation of Speed and Errors

Task	Pearson's r	p.*
X's	.2552	.01
Symbol	.2811	.01
Nonsense	.1459	.01
Desk	.2364	.01
Board	.1213	.05

* Probabilities are not Bonferoni corrected.

The number of errors made had a significant positive correlation with the speed scored on the various tasks. As can be seen from Table 7, however, such correlations were low. A Manova analysis done on corrected scores (speed - errors) showed the same patterns as that done on the uncorrected scores. Since uncorrected scores more closely resemble classroom conditions, these were used for means and interpretation. No significant effect of eye or hand dominance or of writing posture was detected.

A one-tailed paired T-test comparing the grade 5 through 8 pilot students on the desk task and the low readability level copy task was significant in the expected direction, $t(27) = -1.96$, $p.<.05$. Students were faster on the easier copy.

Copy speed on the board task was positively correlated with copy span, $r = .6664$, $p.<.01$. A paired

t-test showed the students to be faster on the desk task than the board task, t,391 = 10.28, p.<.001, as predicted. The student's location (front or back) of the classroom was not significant in the board or copy span measures.

Investigation with a stepwise multiple regression showed motor speed (X's) to be the most important factor after age or grade on all other speed tests [symbols, Beta=.364113; nonsense, Beta=.347275; desk, Beta=.327312; board, Beta=.369148].

Copy Span

An Anova comparing the grades on copy span showed that there was a significant difference between them, F(6,380) = 45.79, p.<.001. There was no significant difference between sexes on copy span. A Manova comparing all students whose copy span was below a z-score of -1.00 for their respective grades with those whose copy span z-score was over +1.00 on their performance in the nonsense, desk and board copy showed that copy span was a significant factor in copy speed (with motor speed used as a covariate) on both the desk, F(1,113) = 8.27, p.<.005, and board copy, F(1,113) = 12.99, p.<.001, tasks. It was not significant in the nonsense task.

Discussion

Reliability

Test Retest. The test-retest reliability of all the measures of handwriting copy speed used was higher after 26 days than Mojet (1991) found after two months. A higher correlation is to be expected, not only because correlations generally decline with time, but because, as the results show, there is a strong effect of grade on speed. Thus, after two months, the continuing educational experience should have caused more variation in Mojet's subjects. Test-retest reliabilities in the ranges shown in Table 1 are generally considered acceptable (Murphy & Davidshofer, 1988). Copy span test-retest reliability after 14 days was in the moderate range.

Internal. The internal reliability of the CSAS appears to be good. The alphabet tasks are all highly correlated. The correlations are lower between the X's (motor) and the Copy Span task though these are still significant. This significant correlation may be a result of the effect of maturation on both tasks.

Copy Speed

The findings that speed increases with age and grade

are consistent with Hildreth's (1947) assertion that maturation is a major factor in handwriting speed. Maturation, however, is not sufficient to explain the shift in relative ranking of the speed tasks from X's being fastest in young children to meaningful copying using known words presented as desk copy being fastest for older children. This shift would be more easily explained in terms of a practice effect making the graphic motor pattern stronger or more easily accessible.

The highly significant effect of the motor speed task on all other speed tasks indicates that motor speed is a very important factor. This effect is present even when the effect of age is removed. Keele and Hawkins (1982) found the rate of repetitive activity to be common across muscle groups so it would appear to perhaps be a genetic factor. If it is a natural, inborn factor, then it would imply that some students just cannot write speedily no matter how hard they try. Studies to determine if slow writers can be brought up to the level of fast writers by extra practice, perhaps with special treats for achievement, might be useful. If such a plan succeeded, schools could use it to help slower students improve. If it was shown that it had little effect, then

expectations and pressures on students with slower motor speed could be reduced. An individual measure of motor speed preferably using a different muscle group would help to ensure that students truly fit the description "slow motor speed".

While the student's location in the classroom was not a significant factor in the board or copy span tasks, there was a significant difference in the speed of copying depending on whether the materials were presented on the desk or on the board. Board copy was slower as predicted. This was likely because of the added effort required to focus on a small area within a much larger space at some distance.

Easier material was copied faster than more difficult material as predicted. This may have been because the copy span is related to the information burden of the material as Rothkopf (1980) showed. In this study an attempt was made to keep the information burden constant across grades on desk and board tasks by using materials one level lower than recommended by the GORT (Robinson, 1963) for the grade. Unfortunately no information was available on the reading levels of our students. Thus it is possible that those with high

scores on our speed tests were reading at higher than grade levels, and those with lower scores were reading at lower than grade levels. Love (1965), Jackson (1970), and May and Brannin (1984) found a relationship between greater speed and higher intelligence. It may be that a relationship between speed and intelligence is mediated by the reading level of the student and the difficulty level of the material. This hypothesis would be consistent with the findings of Whitehouse (1983) and Sovik, Arntzen & Thygesen (1987), that dyslexics write slower than "normals".

The problem of the difficulty level of the material is one that surfaces throughout the literature, and seldom appears to have been considered. The studies reviewed earlier that described the test material, apparently all used the same material on all grades tested. In some cases the students were given a time of practice with the material. It would appear that the practice effects helped to overcome the problem of difficulty level. Material difficulty level is clearly an area that needs much more consideration in future research.

The number of errors on each task did correlate

positively with the speed on that task. However, the percentage of students making more than five errors on a test was only 7.3% on the board copy. Other tests had fewer with the lowest being 2.8% on the nonsense syllable test. Some students did seem to focus only on how fast they could write. One grade 8 student was observed to write the board copy task with his eyes focused entirely on the board, making no effort to check his placement on the paper. Amazingly, his copy was largely decipherable.

Of our 425 students, 54 were left handed, 25 using the inverted posture. There were also six students who wrote with right handed inverted posture. In agreement with the findings of Auzias (1973) and Herron (1980), this study found no significant effect of handedness on speed. Checks of the effects of direction of paper tilt and mixed eye-hand dominance failed to find any significant effect on speed either.

Cursive style was not found to be any faster than manuscript style in this study when the grade 2 and 3 students were removed. This finding is in agreement with Jackson's (1970) findings. Students were allowed to choose whichever style they preferred. Those who switched styles on different tasks [n=30] were removed

from analyses involving style. In grade 2 all students used manuscript. A few students in Grade 3 chose cursive, but since they were just being introduced to cursive style writing, grade 3 was not included in the analysis of style effects. The lack of difference between styles may support the effect of practice on speed. Whichever style is preferred and used most may be faster.

Sex did not have a significant effect when the entire population was considered. The analysis using just the grade 4 and older students did show a significant effect of sex for those tasks which involved the alphabet letters. This conflicts with the findings of Jackson (1970) who was working with grade 5 and 6 students using copy involving alphabet letters, but agrees with Burt (1921, quoted in Bailey, 1988), Groff (1963, in Andersen, 1965), Klein (1979) and Ziviani (1984) who found females faster.

It is interesting to note that males and females were not significantly different in motor speed in this study. This finding agrees with Judd, Siders, Siders, and Atkins (1986). However they found boys slower at symbol copying than girls, whereas this study found no

significant difference. This apparent contradiction may be because older students were included in the present study. When we examine the means in this study, we find that the boys were slower at symbol copying as Judd et.al. reported, but only through grade 6. They were faster in grades 7 and 8.

When males and females do not differ significantly on motor speed, the difference in copy speed evident in this study especially for alphabet related tasks needs more research. Perhaps the females were more advanced in reading and thus the task was easier for them. Or perhaps the commonly observed preference of girls to "play school" or write letters to pen pals may lead to a significantly increased amount of practice in alphabet usage by the time they reach grade 4. This sex difference is an area for future research that could have important instructional implications.

Another area for investigation is the amount of discrepancy between motor speed and speed on desk or board copy in individual students that would fall within the normal range. Perhaps there are students who are normal in motor speed measures but slow in other measures. If such students were identified perhaps a

test of handwriting speed would be a quick and inexpensive classroom measure for determining which students need referral for further learning ability assessment.

The speed hierarchy was only as predicted for the early grades (2-4). Grade 5 appears to be a transitional year after which a different pattern emerges in the higher grades (6-8). As predicted, copying unfamiliar symbols was the slowest task for all grades. If one believes that the brain creates graphic motor patterns when exposed to a copying task and saves these for future use (Margolin, 1991), then perhaps symbols are slowest because, in contrast to alphabet letters, graphic motor patterns have not yet been created for them.

Contrasting the younger grades with the older on the other four tasks one wonders why there is a shift. The X's task is largely motor speed. The nonsense task uses alphabet without meaning. The desk task uses alphabet with known words and meaningful arrangement. The board task mimics the desk task, but with a distance variable. It seems that while motor speed is initially most important, meaning and then familiarity with the alphabet become increasingly so as a student progresses through

the grades. When one compares the mechanics of making three "X's" as opposed to writing the word "the" one finds that the tasks can be broken into the same number of strokes. For some writers "the" may have more changes of direction. Yet three "X's" seems to require more time. It is possible that a physical motor speed ceiling effect is partly responsible. Figures 1, 2, and 3 (see Appendix E) all show that there seems to be a period from grade 3 to grade 6 when there is almost no increase in speed on the "X's" task. The speed then increases again in grade 7 and 8 for both sexes. In the older grades it would appear that the effect of practice with the alphabet overtakes the effect of motor speed alone, as students have much more practice using words of mixed letters than just writing the letter "X" over and over. Perhaps this practice effect is related to a more defined graphic motor pattern or to a more frequently travelled path to the pattern. In either case, it is clear that those items which are more frequently encountered are written faster. This finding reemphasizes the need for practice to attain speed. As stated earlier, the additional distance variable in the board task likely interferes with perception of the image to be copied.

The additional focusing time thus slows the whole task.

Copy Span

Copy span increased with age and grade. The words used for the copy span task were all very easy words that even the grade 2's should have encountered in their reading. Hulme, Thomson, Muir and Lawrence (1984) showed a strong positive relationship between articulation speed and memory span which increased with age. Perhaps some of this increasing articulation speed and span is responsible for the increased copy span as age increases. However, here again the effect of practice might be an important factor. Older students have been using these words in their reading and writing many more times than younger students making it easier for them to identify them during the 5 second display period. If they could more quickly identify larger units by grouping letters into words, then they would be more likely to copy by words or phrases rather than by letter as Bradley (1983) described. Older students might also have had the advantage of being able to use phonological rehearsal to greater effect as suggested by Hulme et.al. (1984). An alternative explanation might be that younger students, having a slower motor speed, may have suffered more trace

decay while writing the first word or two because more time had elapsed, and thus have forgotten more. Faster students might be able to get more on paper before the trace fades. Simner (1991) suggested that slower writers may have a trace fading problem. Research to discover what determines copy span would be difficult but useful.

Whatever the mechanism determining our measure of copy span, it had a significant effect on copy speed on the board task. It is to be expected that any span effect on speed would be magnified in a task where perception takes more effort. Each look back at the copy would take more time and thus slow the overall effort. In light of the findings that span increases from grade to grade, it would be interesting to see if attempts to teach students to increase their span would be successful. Perhaps teaching younger students to use phonological rehearsal strategies with visual material would increase their span.

The findings of this study support the CSAS as a useful tool for handwriting research. Clearly any test of writing speed must use models that are appropriate for the grade level of the student being tested. Use of only one model for several grades may artificially inflate the

scores of the higher grades or depress those of grades lower than the level of the copy material.

Use of a test such as the CSAS allows one to gather a sample of different kinds of copying ability. The norms and percentile tables provided (see Appendices F and G) are designed to be useful in assisting the professional to diagnose if a student has a writing problem or not. Sometimes an average student in a class of fast writers is unfairly labelled as "slow". If a student has a problem, then the subtests may help to identify the type of problem and suggest remedial action. Various combinations of abilities on subtests may help teachers to identify a student's problem. A combination of a high motor speed (X's) percentile ranking with low alphabet copy scores (nonsense, desk, board) may suggest that a student needs to improve reading skills or may respond more quickly to extra practice. Low scores on motor and alphabet tasks may suggest that a student has a slow motor speed and may not respond as quickly to practice. A student who does well on the desk task, but who is considerably slower on the board task than average, may have a problem with vision or spatial awareness. A student who does poorly on the copy span

task may have a memory problem or may need to be taught how to organize perceptions for easier recall. Comparisons are also possible between meaningful and nonmeaningful copy and between a task requiring visual memory (symbols) and one which can be rehearsed verbally (copy span). Research is needed to verify these possibilities.

The findings of this study that sex is a significant factor from grade 4 onward suggested the need for separate norms for males and females. However, because dividing the sample by sex led to some small cell sizes norms are also provided for the combined sample. Grade norms will most likely be more useful for screening purposes, but if a student is above or below the average age for their grade, then age norms should be used instead.

Summary and Conclusions

Copy speed and span both increase with age and grade. The relative speed of tasks varies with grade. The lower grades went from X's (motor speed) as the fastest task through desk, board, nonsense and symbol.

Higher grades also were slowest at the symbol task, but had desk as the fastest, with board, nonsense and X's (motor speed) following. While some of this is likely a factor of maturation, it was thought that there is also an effect of practice and thus the enhancement of graphic motor program formation and development of new strategies for recalling more text with each look.

Other factors that seem to be involved with copy speed are the distance of the copy, the basic motor speed of the individual, the level of difficulty of the copy material, and, in the higher grades with alphabet related material, sex. Copy span is positively related to copy speed and increases with grade and age.

Further research is needed to determine the cause of speed differences between sexes in the higher grades. Males may write slower because of less informal practice or lower reading levels.

Copy span may be a function of reading level. Research needs to determine if lower copy speed is a function of shorter copy span, or if the measure of copy span is distorted by the lower copy speed.

Children who are slower in copy speed need help. Perhaps speed training would help with increasing speed

in the regular class work in a way similar to an athlete's training for a competition. Perhaps an improvement in motor speed or copy span can be trained. If so, perhaps computer games manufacturers could be persuaded to create games using copy span and handwriting tasks that would be fun and beneficial for slower students. If it can be determined that handwriting copy speed is related to general learning ability then we need to know how it is related. Perhaps the lack of ability slows the writing, or maybe it is the slow writing that causes a deficit in learning. Perhaps a child's need for learning assessment by psychologists can be accurately determined by teachers using a test such as this as a screening device in the classroom.

The Copy Speed and Span Test provides a method of controlling the difficulty level of the copy model. It also provides a means for determining differences between motor speed, meaningful and nonmeaningful copy, near versus distant copy and ability to retain visual material (symbols) versus words which could be pronounced. The norms obtained from this study may be a starting point for further research in this area. Teachers and psychometrists may wish to use this information to devise

new strategies for dealing with children who seem to be slower than their classmates in getting material copied.

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Appendix A: Verbal Stimulus Materials

Gray Oral Reading Tests Selections

GRADE LEVEL	BOARD TASK	DESK TASK
2	A-3	B-3
3	A-4	C-4
4	A-5	C-5
5	B-6	C-6
6	A-7	B-7
7	B-8	C-8
8	A-9	C-9

Low Reading Level Desk Copy

The old man sat on the green grass. He could see a little brown fox on the hill. It was playing with five more little foxes. They all ran around and jumped at each other. Their mother just sat under a tree to see that they didn't get hurt. After a long time they went into their den to go to sleep. Then the old man got up and went home to wash his hands and eat supper.

Words for Copy Span Task

go is make can try come fall see do have help
ran ride stop may said tell jump saw thank

say he of just like on not all big his now

far no here old red fast blue how for many see
both hurt she open me and from or six but full
if our my small by funny in out so as good
over some green down it sat soon away them

the yes your they up play we with her warm him
why been did use at walk then want about

Nonsense syllables

beb dev keb baf caj dap gaj dar faw riz yun jad mev pag
sab wup kos vis mes lel gep cem bav cag mir lar mav gom
mun zad tup suz goj dom wis vid laz jat nij mec det fev
ged cek cew der pif rin zum fov nug nuv rud wub vun puj
zan yat sul yag sar fab maf gan

Appendix B: Test Form

5.

6.

CSAS pages 4 and 1 @45% actual size

TODAY'S DATE ___ ___ ___ SEX F M

BIRTHDATE ___ ___ ___ AGE ___
YEAR MONTH DAY

GRADE ___

WHICH HAND DO YOU WRITE WITH? R L

If you write with your LEFT hand,
where is your hand when you write?

ABOVE or BELOW your writing

WHICH EYE DO YOU USE TO SEE THROUGH A TINY HOLE? R L

WHICH FOOT DO YOU USE TO KICK A BALL? R L

DO YOU READ OR WRITE A LANGUAGE THAT USES DIFFERENT LETTERS THAN ENGLISH OR FRENCH? YES NO

3.

/	\	∩	∂	⊂	⊃	⊆	⊢	⊣	⌠	⟩	⊇

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⊕	ρ	ζ	γ	§	£	Ѫ	Ӿ	Δ	∀	◀	µ

A. ______________________________

B. ______________________________

C. ______________________________

D. ______________________________

E. ______________________________

F. ______________________________

____

G. ______________________________

____

H ______________________________

____

I ______________________________

____

J. ______________________________

CSAS pages 3 and 2 @45% actual size TOP->

Appendix C: Consent Forms

Dear Parent:

In the next few weeks a study will be done at school. The purpose of the study is to find the average speed at which children of a certain age or grade can copy different types of written material. Students will be tested as a class during regular class time for about 20 minutes. Three classes will repeat the tasks later to see if rates are similar over time.

Your child's work will not have any name on it so all will be confidential.

Participation is completely voluntary. We believe the results will create a standard by which parents and teachers can later determine how a child is doing.

If you wish to give permission, please sign the attached form. If you DO NOT want your child to participate, please indicate this by signing the appropriate space on the form. Please return the Consent Form by ________________________________.

If you have any questions, or wish a copy of the final results, please feel free to call the number listed below. Thank you.

Sincerely,
Mrs. W. Bauman
343-8110 (Ask for Psychology)

_ _

PLEASE DETACH AND RETURN TO SCHOOL BEFORE FRIDAY.

☐ I WANT to be part of study.
☐ I DO NOT want to be part of this study.

____
Signature of Student

☐ I give permission for my son/daughter____________ to participate in the study described.

☐ I DO NOT give permission for my son/daughter ____________ ___to participate in the study described.

____
Signature of Parent or Guardian Date

Dear Parent:

In the next few weeks we plan to do a study at school. We would like to test students in their regular class for about 20 minutes. Students will be given activities measuring their muscle speed, ability to copy things that require them to remember what they see or what they can say to themselves, and ability to copy simple material such as they would find in a textbook or on the board. The purpose is to find how quickly children of each age or grade can copy different types of written material and what abilities are the most helpful in copying.

Your child's work will NOT have any name on it. No child will know what score they obtained. Teachers will only get a report where all scores have been added together. Participation is voluntary.

It is important in a study like this to have as many students as possible take part. If only the fast or slow students participate, then teachers will have too high or low expectations of other children in future.

Obtaining this information will enable us to create a modern standard to help teachers and parents know if a particular child needs extra help and practice. It will also help the child to know when he/she has improved to the level of most children in his/her grade.

Please sign this form to give your child permission to be a part of it.

If you DO NOT want your child to participate, please indicate this by signing the appropriate space on the form.

Either way, <u>please return the form this week</u>.

If you have questions, or wish a summary of the final results, please feel free to call the number listed below. Thank you.

Sincerely,

Mrs. W. Bauman
343-8110 (Ask for Psychology)

- -

PLEASE DETACH AND RETURN TO SCHOOL BEFORE FRIDAY.

☐ I give permission for my son/daughter_____
(full name)
to participate in the copy speed study.

☐ I DO NOT give permission for my son/daughter _____
_____ (full name)
to participate in the study described.

_____
Signature of Parent or Guardian Date

Appendix D: Instructions for Tasks

WE WANT TO SEE HOW MUCH YOU CAN COPY IN A SET TIME. WE MADE THE TASKS LONG SO NO ONE WILL BE ABLE TO FINISH. DO NOT START UNTIL I SAY "GO" AND BE SURE TO STOP AS SOON AS I SAY "STOP", EVEN IF YOU ARE IN THE MIDDLE OF A WORD. ON SOME OF THE TASKS YOU WILL BE ABLE TO CHOOSE WHETHER YOU WISH TO PRINT OR WRITE. DO WHAT IS EASIEST FOR YOU. IF YOU MAKE A MISTAKE, DO NOT ERASE. JUST KEEP WORKING. (Allow questions (Q) after each set of instructions. Clarify as much as needed.)

1. FIND NUMBER 1 ON YOUR ANSWER SHEET ON THE FRONT PAGE. JUST BELOW IT YOU WILL SEE MANY SQUARES. WHEN I SAY GO, I WANT YOU TO PUT AN X (NOT A +) IN EACH BOX AS QUICKLY AS YOU CAN. KEEP GOING UNTIL I SAY STOP. YOU WILL HAVE ONE MINUTE. (Q) READY? GO.

2. NOW TURN THE PAGE. YOU WILL SEE MANY BOXES. THE TOP ONES HAVE A FIGURE IN THEM AND THE BOTTOM ONES ARE EMPTY. YOU ARE TO LOOK AT THE FIGURE IN THE TOP BOX AND MAKE ONE LIKE IT IN THE BOTTOM BOX. WHEN I SAY "GO" START AT THE FIRST BOX AND WORK AS QUICKLY AS YOU CAN ACROSS THE ROW WITHOUT SKIPPING ANY. WHEN YOU FINISH ONE ROW GO ON TO THE NEXT UNTIL I TELL YOU TO STOP. YOU WILL HAVE ONE MINUTE. (Q) READY? GO.

3. FIND 3 ON YOUR ANSWER BOOKLET. YOU WILL SEE SOME EMPTY LINES. NOW LOOK AT THE CARD YOU HAVE ON YOUR DESK. IT HAS MANY NONSENSE WORDS ON IT. THIS TIME WHEN I SAY "GO" YOU ARE TO COPY AS MANY OF THE NONSENSE WORDS AS YOU CAN ONTO THE LINES BY THE 3 ON YOUR ANSWER SHEET. WORK AS QUICKLY AS YOU CAN, BUT I MUST BE ABLE TO READ IT. YOU WILL HAVE ONE MINUTE. (Q) READY? GO.

4. FIND 4 ON YOUR ANSWER BOOKLET. AGAIN YOU WILL SEE SOME EMPTY LINES. WHEN I SAY GO, YOU ARE TO COPY THE STORY YOU WILL SEE ON THE SCREEN. WORK AS QUICKLY AS YOU CAN, BUT I MUST BE ABLE TO READ IT. YOU WILL HAVE TWO MINUTES. (Q) CAN EVERYONE SEE THE SCREEN? READY? (Turn on overhead) GO.

5. FIND 5 ON THE BACK PAGE OF YOUR ANSWER SHEET. THERE ARE SOME EMPTY LINES. DO NOT TURN THE CARD OVER UNTIL I TELL YOU. WHEN I SAY "GO", YOU WILL HAVE TWO MINUTES TO COPY THE STORY FROM THE CARD ON YOUR DESK. WORK AS QUICKLY AS YOU CAN BUT I MUST BE ABLE TO READ IT. (Q) NOW TURN THE CARD RIGHT SIDE UP. READY? GO.

6. I AM GOING TO SHOW YOU SOME LINES OF WORDS ON THE SCREEN. THEY ARE ALL WORDS THAT YOU HAVE SEEN IN YOUR READING. I WILL SHOW THEM TO YOU FOR ONLY 5 SECONDS SO YOU MUST LOOK CAREFULLY ALL THE TIME. THEN I WILL COVER THEM, AND YOU WILL WRITE AS MUCH AS YOU CAN OF WHAT YOU SAW. DON'T WORRY IF YOU ARE UNSURE OF HOW TO SPELL THE WORD. JUST WRITE DOWN AS MUCH AS YOU CAN. THIS IS TO SEE HOW MUCH <u>YOU</u> REMEMBER SO DO NOT LOOK AT YOUR FRIEND'S PAPER. DO NOT BEGIN WRITING UNTIL I COVER THE SENTENCE AND SAY "GO". (Q) CAN EVERYONE SEE THE SCREEN? NOW LOOK CAREFULLY. (Turn on overhead.
After 5 seconds cover sample.) GO. (Repeat NOW LOOK CAREFULLY.....GO for each sentence) Wait for everyone to finish.
(Before showing the first two line sample say) this TIME YOU WILL SEE TWO LINES OF WORDS. MOST PEOPLE CAN NOT EVEN READ THEM ALL IN 5 SECONDS. DON'T WORRY ABOUT IT. JUST REMEMBER AS MANY AS YOU CAN.

<u>EXTRA PARAGRAPH FOR PILOT</u>
YOU HAVE AN EXTRA PIECE OF PAPER ON YOUR DESK. IT HAS A NUMBER ON IT THE SAME AS THE NUMBER ON YOUR ANSWER SHEET. WHEN I SAY GO, YOU ARE TO COPY THE STORY FROM THIS PAPER (show) ONTO THAT PAPER. WORK AS QUICKLY AS YOU CAN, BUT I MUST BE ABLE TO READ IT. YOU WILL HAVE TWO MINUTES. IF YOU FINISH EARLY, TRY TO COPY THE FIRST PART AGAIN. (Q) READY? GO.

Appendix E: Graphs

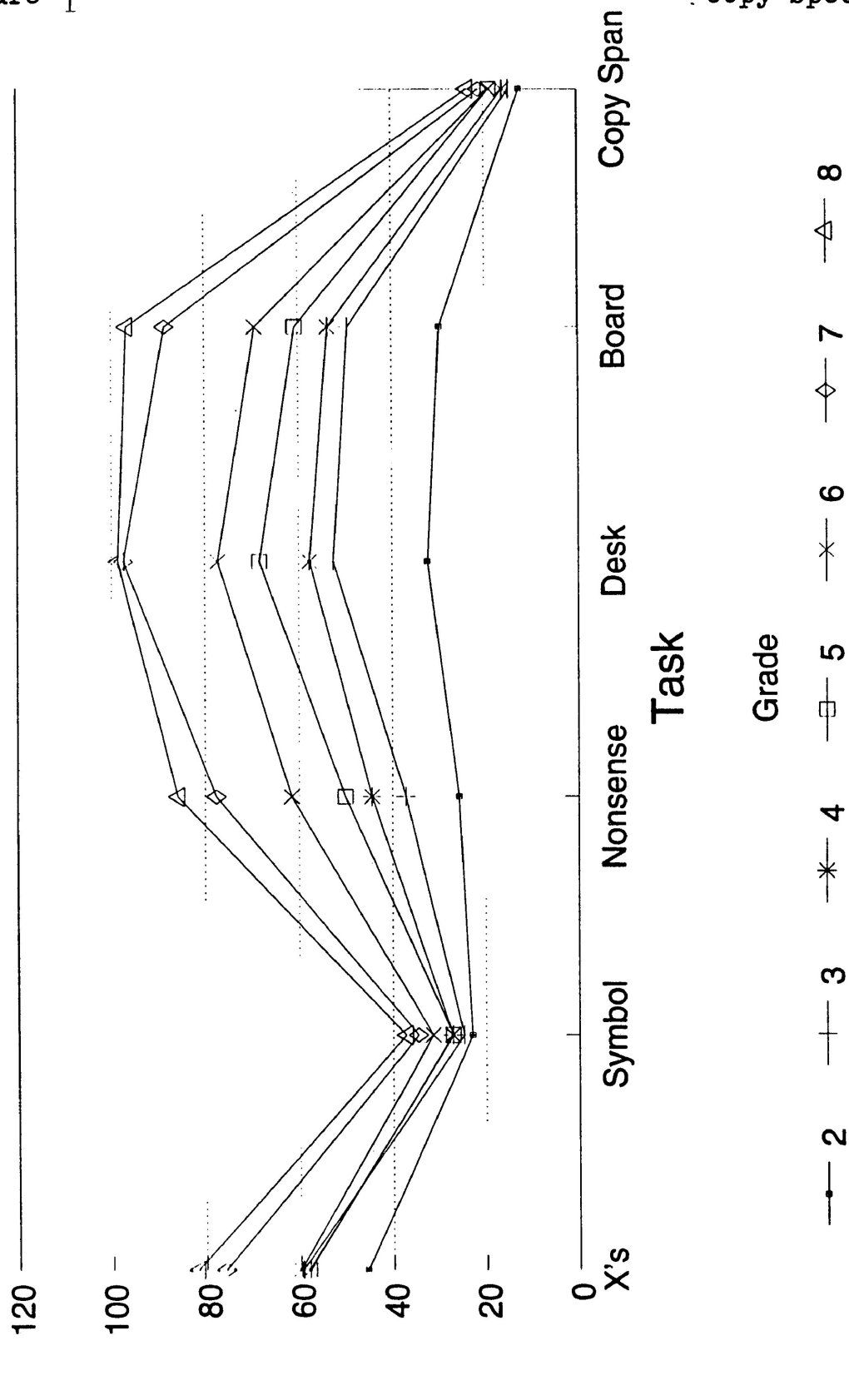

Grade Performances by Task
120
100
80
60
40
20
0
X's
Symbol
Nonsense
Desk
Board
Copy Span
Task
Grade
2
3
4
5
6
7
8
Speed in letters/min. Span in words/min.

Figure 2

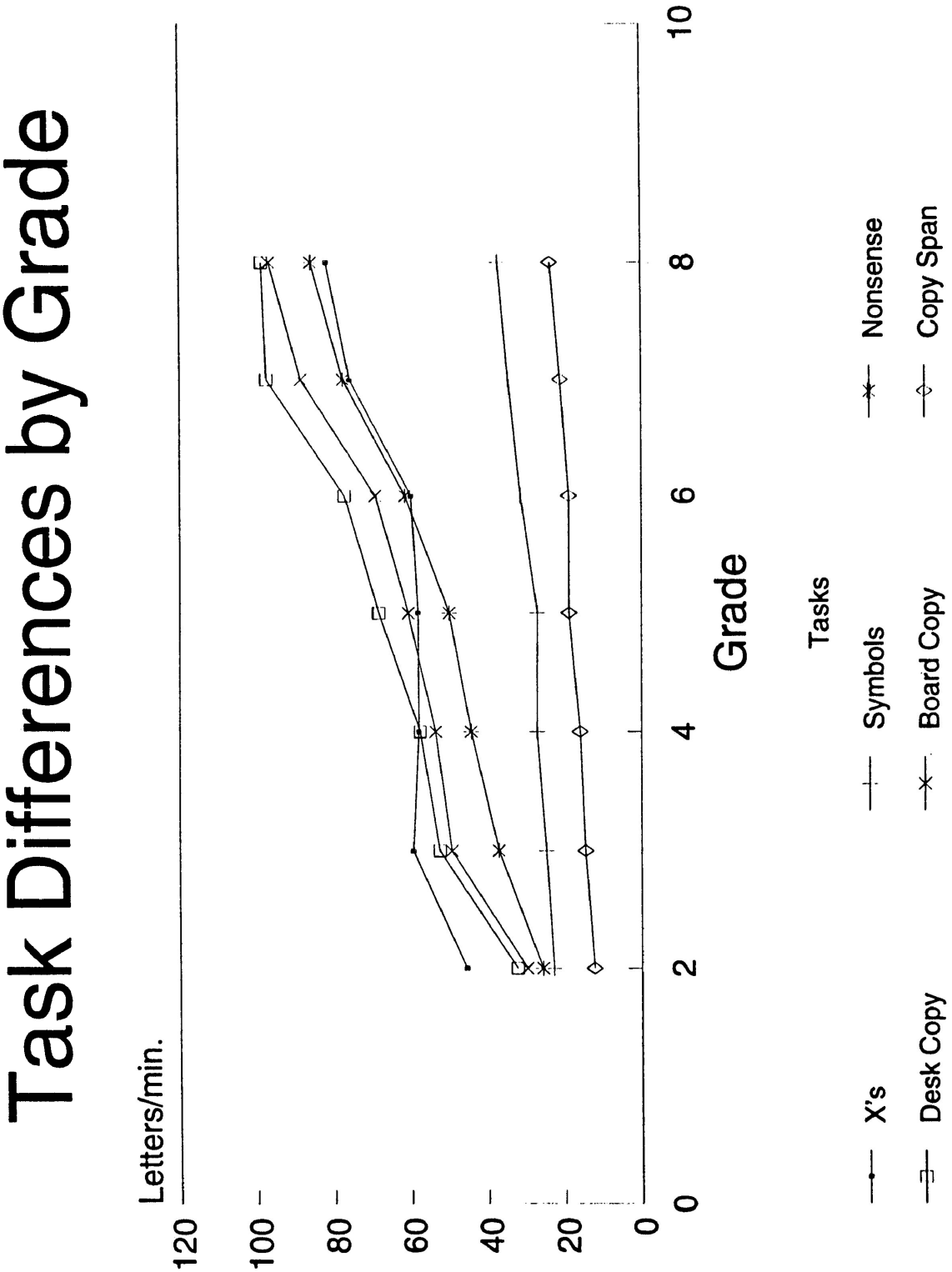
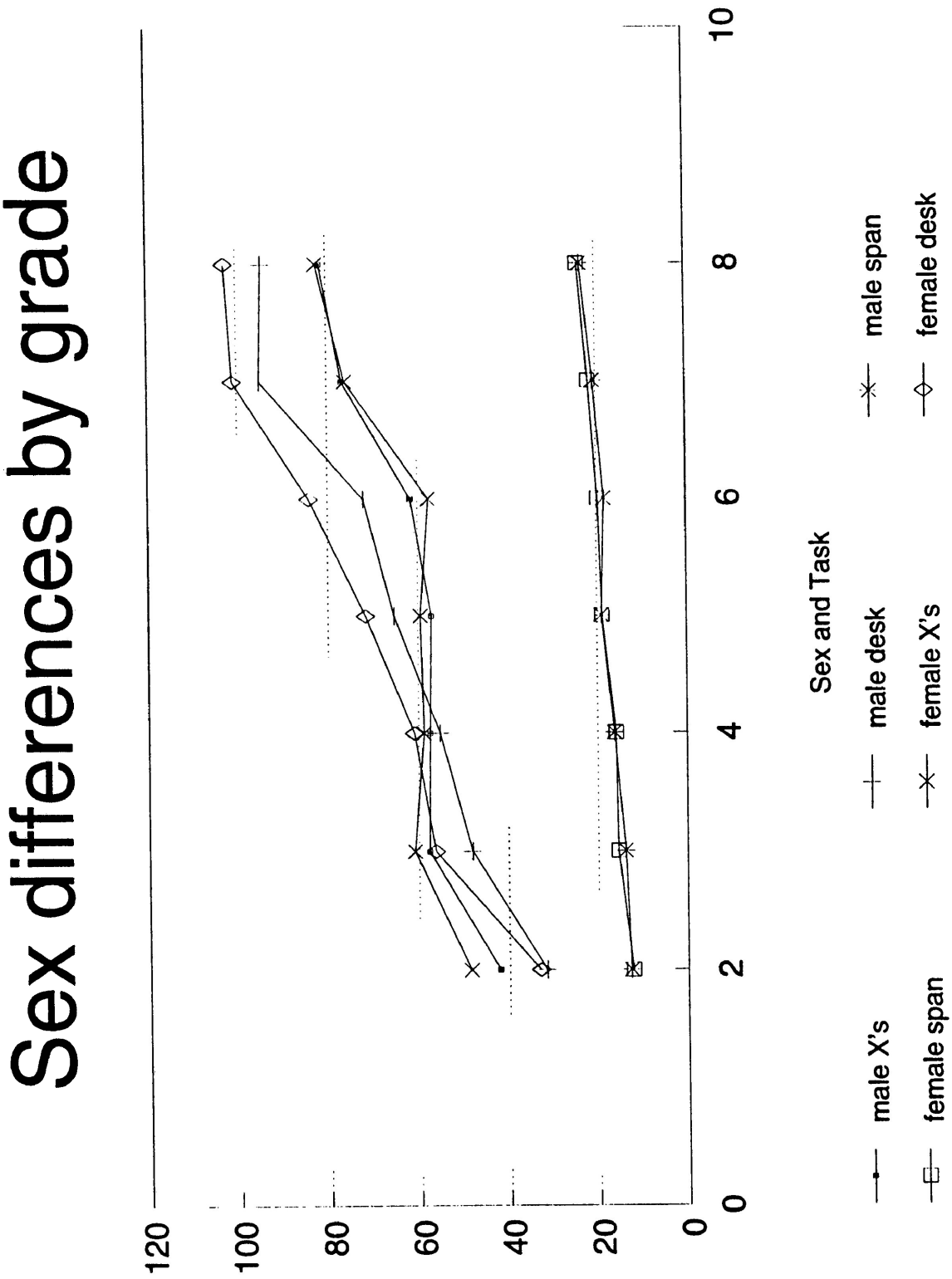

Task Differences by Grade
Letters/min.
120
100
80
60
40
20
0
0
2
4
6
8
10
Grade
Tasks
X's
Symbols
Nonsense
Desk Copy
Board Copy
Copy Span

Figure 3

Copy Speed 70



Appendix F: Tables of Means and Percentiles by GRADE

TABLE OF MEANS BY GRADE (entire population)

Gr.	n		X's	Symbols	Nonsense	Desk	Board	Copy Span	Extra	(n)
2	34*	mean	45.51	22.97	25.76	32.37	29.81	12.46		
		s.d.	11.88	4.94	7.49	7.96	8.98	5.01		
3	72	mean	59.43	24.81	37.17	52.53	49.38	14.72		
		s.d.	13.66	6.25	10.06	13.47	12.77	3.90		
4	58*	mean	58.00	27.25	44.36	57.63	53.64	16.07	57.88	(8)
		s.d.	12.03	5.00	11.12	12.17	12.19	3.68	6.25	
5	63*	mean	58.19	27.13	50.05	68.36	60.73	18.91	67.33	(6)
		s.d.	10.48	5.18	12.80	15.11	13.97	3.91	13.92	
6	32	mean	59.97	31.44	61.56	77.27	69.25	18.91	71.17	(3)
		s.d.	14.22	6.73	18.00	16.38	15.26	4.54	17.18	
	65	mean	75.88	34.60	77.62	97.45	88.55	21.12	113.00	(7)
		s.d.	15.77	5.86	21.85	21.68	23.45	4.13	27.48	
8	63	mean	81.87	37.24	85.86	98.63	96.72	23.68	128.00	(1)
		s.d.	14.35	6.63	18.77	19.63	21.85	4.42		

*n for copy span. Add 3 for gr.2 speed tests, 1 for other grades marked.

TABLE OF MEANS BY GRADE (FEMALES)

Gr.	n		X's	Symbols	Nonsense	Desk	Board	CopySpan
2	18*	mean	48.50	24.65	26.05	33.00	31.13	12.26
		s.d.	13.45	4.53	8.89	8.60	9.77	5.66
3	39	mean	60.92	26.08	39.62	56.27	52.91	15.46
		s.d.	12.29	6.53	9.89	13.39	12.75	4.44
4	25	mean	58.80	27.80	49.16	60.92	56.26	15.88
		s.d.	11.01	5.66	10.79	13.71	13.70	2.82
5	31	mean	59.45	27.00	52.26	71.61	60.74	18.81
		s.d.	10.40	4.87	14.33	16.46	13.54	3.52
6	12	mean	57.58	32.00	70.42	84.17	73.46	19.75
		s.d.	16.08	7.08	10.67	12.47	12.75	3.55
7	33	mean	76.03	34.30	80.70	101.03	92.02	21.73
		s.d.	19.25	6.98	26.80	24.47	27.42	4.12
8	32	mean	82.28	36.28	88.94	102.72	102.05	23.97
		s.d.	13.54	5.86	14.54	14.66	18.79	3.93

*n for copy span. Add 2 for speed tests,

TABLE OF MEANS BY GRADE (MALES)

Gr.	n		X's	Symbols	Nonsense	Desk	Board	CopySpan
2	16*	mean	42.00	21.00	25.41	31.62	28.27	12.69
		s.d.	8.86	4.78	5.65	7.33	7.96	4.33
3	33	mean	57.67	23.30	34.27	48.11	45.21	13.85
		s.d.	15.12	5.62	9.61	12.35	11.64	2.98
4	33*	mean	57.41	26.85	40.82	55.21	51.71	16.21
		s.d.	12.86	4.51	10.11	10.45	10.75	4.26
5	32*	mean	57.00	27.24	47.97	65.30	60.73	19.00
		s.d.	10.58	5.53	11.00	13.26	14.57	4.30
6	19	mean	61.58	30.47	55.26	72.05	65.32	18.32
		s.d.	13.55	6.23	19.59	17.09	15.52	5.19
7	31	mean	76.68	35.07	75.68	95.00	86.15	20.65
		s.d.	10.24	4.50	13.46	16.89	17.27	4.10
8	31	mean	81.45	38.23	82.68	94.40	91.23	23.39
		s.d.	15.35	7.31	22.12	23.20	23.67	4.92

*n for copy span. Add 1 for speed tests.

PERCENTILE RANKS FOR SCORES (Total Population)

MOTOR SPEED (X's)

Grades

%ile		2	3	4	5	6	7	8	%ile
	n	37	72	59	64	32	65	63	
95		71	82	79	80	85	99	103	95
90		59	75	72	71	79	93	100	90
85		57	72	71	68	75	91	98	85
80		54	70	69	66	73	87	94	80
75		51	66	66	62	69	86	92	75
70		50	63	64	61	65	83	91	70
65		48	62	62	60	64	82	91	65
60		47	60	60	60	61	81	88	60
55		44	59	60	59	60	80	86	55
50		42	57	60	59	60	78	83	50
45		41	57	58	58	60	75	81	45
40		41	56	57	56	58	74	80	40
35		40	54	55	56	58	73	78	35
30		40	53	53	55	57	72	73	30
25		40	53	51	54	56	71	69	25
20		38	52	47	51	51	68	67	20
15		35	51	44	49	44	63	66	15
10		31	46	41	45	39	51	63	10
5		29	38	35	39	27	45	58	5

PERCENTILE RANKS FOR SCORES (Total Population)

SYMBOLS

Grades

%ile	2	3	4	5	6	7	8	%ile
n	37	72	59	64	32	65	63	
95	32	35	36	35	44	44	45	95
90	30	33	35	35	41	41	44	90
85	29	32	33	33	39	40	43	85
80	27	31	32	32	38	39	42	80
75	26	30	31	31	38	38	42	75
70	24	28	31	30	36	37	41	70
65	24	27	30	30	35	37	40	65
60	23	25	28	28	32	36	39	60
55	23	24	27	28	32	36	39	55
50	23	24	26	27	31	36	38	50
45	22	23	25	25	30	35	37	45
40	22	23	25	25	29	34	36	40
35	21	23	24	24	29	33	35	35
30	21	23	24	24	27	33	34	30
25	20	22	24	24	26	32	33	25
20	19	22	24	23	25	31	32	20
15	18	20	23	23	23	30	30	15
10	17	18	22	21	22	25	28	10
5	14	12	21	17	21	21	24	5

PERCENTILE RANKS FOR SCORES (Total Population)

NONSENSE SYLLABLES

Grades

%ile		2	3	4	5	6	7	8	%ile
	n	37	72	59	64	32	65	63	
95		38	56	63	78	91	125	116	95
90		36	48	61	65	88	104	112	90
85		35	48	59	63	79	96	108	85
80		32	45	54	63	75	93	102	80
75		30	44	52	60	75	90	97	75
70		30	42	51	57	74	84	94	70
65		28	41	49	56	71	84	92	65
60		27	39	48	51	69	81	90	60
55		26	39	45	50	69	78	87	55
50		24	36	43	48	64	75	84	50
45		24	36	42	46	59	72	82	45
40		24	33	39	43	55	72	81	40
35		24	33	39	42	54	69	80	35
30		23	33	38	42	49	67	78	30
25		23	30	37	39	47	67	73	25
20		20	30	36	39	46	62	72	20
15		18	28	33	36	42	57	67	15
10		15	24	30	36	32	53	65	10
5		13	18	26	32	30	38	52	5

PERCENTILE RANKS FOR SCORES (Total Population)

DESK COPY

Grades

%ile		2	3	4	5	6	7	8	%ile
	n	37	72	59	64	32	65	63	
95		47	75	79	97	105	137	129	95
90		43	72	74	88	101	128	124	90
85		42	67	70	85	94	122	120	85
80		40	64	67	84	90	115	115	80
75		38	62	66	80	89	111	109	75
70		36	60	65	79	88	107	108	70
65		36	57	63	74	87	103	107	65
60		35	56	61	72	84	100	105	60
55		34	55	59	70	83	97	98	55
50		33	53	57	69	82	95	98	50
45		31	51	57	65	74	90	97	45
40		30	49	56	62	70	90	94	40
35		27	48	54	60	66	89	90	35
30		27	45	52	57	64	87	88	30
25		27	44	49	55	63	82	88	25
20		26	42	46	54	63	80	86	20
15		24	39	43	50	60	78	78	15
10		21	36	41	50	58	73	70	10
5		18	26	38	49	46	61	66	5

PERCENTILE RANKS FOR SCORES (Total Population)

BOARD COPY

Grades

%ile		2	3	4	5	6	7	8	%ile
	n	37	72	59	64	32	65	63	
95		48	70	78	84	96	133	139	95
90		44	66	69	77	90	122	121	90
85		40	65	68	74	88	110	118	85
80		39	60	66	72	85	108	112	80
75		35	59	63	71	82	104	110	75
70		32	58	60	69	78	98	108	70
65		32	55	58	69	76	93	103	65
60		31	53	58	68	74	92	100	60
55		30	52	55	65	72	91	98	55
50		29	50	55	61	69	91	96	50
45		28	47	50	60	63	88	94	45
40		27	47	48	55	62	84	92	40
35		26	44	47	54	60	80	89	35
30		25	43	47	51	59	77	89	30
25		24	42	45	51	56	72	85	25
20		22	38	42	48	55	69	80	20
15		22	35	41	47	54	65	76	15
10		19	29	37	42	50	56	68	10
5		15	26	35	39	46	49	56	5

PERCENTILE RANKS FOR SCORES (Total Population)

COPY SPAN

Grades

%ile		2	3	4	5	6	7	8	%ile
	n	34	72	58	63	32	65	63	
95		22	22	23	25	28	30	30	95
90		19	21	21	24	25	26	29	90
85		17	19	20	23	24	25	28	85
80		17	17	19	23	23	24	28	80
75		16	16	19	22	23	23	27	75
70		15	16	18	21	20	22	27	70
65		14	15	18	21	20	22	27	65
60		13	15	17	20	20	22	26	60
55		12	15	17	20	19	21	25	55
50		12	14	16	19	19	21	24	50
45		11	14	16	19	18	21	23	45
40		11	13	15	18	17	20	23	40
35		11	13	14	16	16	20	22	35
30		11	12	14	16	16	19	22	30
25		10	12	14	15	16	19	20	25
20		10	12	13	15	16	18	20	20
15		8	11	12	15	14	17	18	15
10		4	11	11	14	13	16	17	10
5		4	9	9	13	12	14	15	5

PERCENTILE RANKS FOR SCORES (FEMALES)

MOTOR SPEED (X's)

Grades

%ile	2	3	4	5	6	7	8	%ile
n	20	39	25	31	12	33	32	
95	85	85	77	84	.	106	102	95
90	68	80	72	74	76	95	100	90
85	58	74	71	69	75	94	99	85
80	58	72	69	67	74	91	98	80
75	56	71	68	63	73	90	92	75
70	54	65	64	62	70	86	92	70
65	51	63	64	62	65	83	90	65
60	50	60	61	60	61	82	87	60
55	49	58	60	60	60	81	84	55
50	47	57	60	59	60	80	83	50
45	45	56	60	58	60	78	80	45
40	43	55	58	58	58	74	80	40
35	42	54	55	56	56	73	79	35
30	41	53	53	56	53	70	74	30
25	40	53	52	54	46	69	68	25
20	40	52	51	52	41	63	67	20
15	37	52	45	50	36	51	67	15
10	33	47	44	48	28	46	64	10
5	24	46	34	40	.	36	59	5

PERCENTILE RANKS FOR SCORES (FEMALES)

SYMBOLS

Grades

%ile	2	3	4	5	6	7	8	%ile
n	20	39	25	31	12	33	32	
95	35	36	36	37	.	46	44	95
90	32	35	35	32	43	44	44	90
85	31	33	33	32	39	42	42	85
80	28	32	33	31	38	39	42	80
75	27	32	32	30	38	39	42	75
70	27	31	31	30	36	37	41	70
65	26	30	31	30	35	37	40	65
60	25	30	31	29	34	36	39	60
55	24	27	30	28	32	36	38	55
50	24	24	30	27	32	35	36	50
45	23	24	27	25	31	34	35	45
40	22	24	26	25	31	34	35	40
35	22	23	24	24	30	34	34	35
30	22	23	24	24	28	33	33	30
25	21	22	24	24	25	32	32	25
20	21	22	22	23	23	30	31	20
15	21	22	22	23	23	24	29	15
10	20	18	22	22	22	22	29	10
5	17	12	15	17	.	20	24	5

PERCENTILE RANKS FOR SCORES (FEMALES)

NONSENSE SYLLABLES

Grades

%ile	2	3	4	5	6	7	8	%ile
n	20	39	25	31	12	33	32	
95	42	60	66	81	.	137	118	95
90	38	51	63	78	88	121	111	90
85	38	48	63	67	87	107	103	85
80	36	47	61	64	80	102	102	80
75	33	45	60	63	75	97	99	75
70	31	45	59	61	75	93	96	70
65	30	42	54	57	74	93	94	65
60	27	42	52	57	73	86	92	60
55	24	42	50	51	71	83	90	55
50	24	40	49	50	70	78	87	50
45	24	39	48	46	69	70	87	45
40	24	36	44	45	69	69	85	40
35	24	36	43	42	69	69	83	35
30	24	33	40	42	68	67	81	30
25	23	33	39	39	62	65	80	25
20	19	30	39	39	58	59	76	20
15	15	30	39	38	56	55	72	15
10	13	30	37	36	55	46	68	10
5	8	24	30	35	.	33	64	5

PERCENTILE RANKS FOR SCORES (FEMALES)

DESK COPY

Grades

%ile	2	3	4	5	6	7	8	%ile
n	20	39	25	31	12	33	32	
95	48	80	89	102	.	148	129	95
90	45	73	80	95	102	137	126	90
85	43	72	75	88	100	130	121	85
80	41	68	74	86	94	125	116	80
75	40	67	72	84	90	121	109	75
70	39	64	67	82	90	114	109	70
65	38	63	65	80	90	110	108	65
60	35	59	65	79	89	105	107	60
55	34	57	63	78	87	99	107	55
50	32	56	63	74	86	96	105	50
45	31	55	58	70	84	91	98	45
40	30	54	56	67	84	90	98	40
35	29	51	56	62	83	89	97	35
30	27	49	53	56	81	87	96	30
25	27	46	50	55	76	84	93	25
20	26	42	47	54	70	80	88	20
15	23	42	44	53	63	77	87	15
10	21	39	42	50	63	72	85	10
5	16	33	39	48	.	61	75	5

PERCENTILE RANKS FOR SCORES (FEMALES)

BOARD COPY

Grades

%ile	2	3	4	5	6	7	8	%ile
n	20	39	25	31	12	33	32	
95	50	73	80	88	.	143	138	95
90	46	70	78	75	89	132	120	90
85	43	69	72	72	86	124	118	85
80	40	65	68	72	85	120	116	80
75	39	65	67	71	84	110	111	75
70	38	60	66	70	83	109	110	70
65	35	59	65	69	81	105	109	65
60	33	58	61	68	79	94	106	60
55	31	55	59	65	78	91	103	55
50	31	54	58	60	77	91	103	50
45	30	53	54	59	75	86	99	45
40	29	49	49	54	71	82	97	40
35	28	47	47	51	69	78	95	35
30	24	44	45	51	67	72	94	30
25	22	43	43	50	63	71	93	25
20	22	43	42	48	60	68	91	20
15	20	38	42	46	56	65	88	15
10	17	36	41	42	51	56	75	10
5	16	34	34	39	.	49	68	5

PERCENTILE RANKS FOR SCORES (FEMALES)

COPY SPAN

Grades

%ile	2	3	4	5	6	7	8	%ile
n	18	39	25	31	12	33	32	
95	.	23	21	24	.	33	30	95
90	18	22	20	23	24	27	29	90
85	17	21	20	23	24	26	28	85
80	17	20	18	23	24	24	28	80
75	16	17	18	22	24	23	27	75
70	14	16	18	21	23	22	27	70
65	14	16	17	21	22	22	26	65
60	14	16	17	20	21	21	25	60
55	13	15	16	20	20	21	24	55
50	13	15	15	19	20	21	24	50
45	12	14	15	19	20	21	23	45
40	12	14	14	18	18	20	23	40
35	11	13	14	17	18	20	23	35
30	10	13	14	16	17	20	22	30
25	9	12	14	15	16	20	22	25
20	7	12	13	15	16	19	21	20
15	5	12	13	15	16	19	20	15
10	4	11	13	14	15	18	18	10
5	.	8	11	13	.	15	16	5

PERCENTILE RANKS FOR SCORES (MALES)

MOTOR SPEED (X's)

Grades

%ile		2	3	4	5	6	7	8	%ile
	n	17	33	34	33	19	31	31	
95		.	87	83	76	.	95	105	95
90		56	72	73	71	84	89	102	90
85		51	69	72	68	80	87	96	85
80		49	67	70	64	73	85	93	80
75		48	65	65	61	67	84	92	75
70		44	63	63	60	65	82	91	70
65		42	61	61	60	65	82	91	65
60		41	60	60	60	63	79	89	60
55		41	59	60	59	60	78	87	55
50		40	57	59	58	60	77	85	50
45		40	57	58	57	60	75	81	45
40		40	57	55	56	59	74	79	40
35		39	55	55	55	58	73	74	35
30		39	53	53	55	57	73	72	30
25		38	52	48	53	57	72	70	25
20		34	51	44	50	56	71	68	20
15		31	46	41	45	47	69	65	15
10		31	37	40	41	44	60	62	10
5		.	26	34	35	.	55	49	5

PERCENTILE RANKS FOR SCORES (MALES)

SYMBOLS

Grades

%ile	2	3	4	5	6	7	8	%ile
n	17	33	34	33	19	31	41	
95	.	32	37	36	.	41	53	95
90	30	31	34	35	40	41	45	90
85	26	30	32	35	38	39	44	85
80	24	27	31	33	38	39	43	80
75	24	27	29	32	36	38	43	75
70	23	26	29	31	35	37	41	70
65	23	24	27	30	32	37	41	65
60	23	23	27	28	32	37	40	60
55	22	23	26	28	30	36	39	55
50	21	23	25	27	30	36	39	50
45	20	23	25	26	29	36	38	45
40	19	23	25	25	28	35	38	40
35	19	23	24	24	27	33	37	35
30	18	22	24	24	27	33	36	30
25	18	22	24	24	26	33	34	25
20	18	22	24	23	25	31	33	20
15	16	19	23	22	24	31	31	15
10	14	17	23	19	22	30	27	10
5	.	9	21	17	.	24	24	5

PERCENTILE RANKS FOR SCORES (MALES)

NONSENSE SYLLABLES

Grades

%ile	2	3	4	5	6	7	8	%ile
n	17	33	34	33	19	31	31	
95	.	51	59	67	.	104	124	95
90	34	48	54	63	90	91	114	90
85	31	47	52	61	79	88	110	85
80	30	42	51	60	75	85	106	80
75	30	39	48	59	72	84	96	75
70	28	39	47	55	65	82	91	70
65	27	36	45	51	63	81	89	65
60	27	36	43	51	55	78	82	60
55	27	36	42	48	54	76	81	55
50	26	34	41	48	49	75	81	50
45	24	33	39	46	48	73	79	45
40	24	33	37	43	47	72	78	40
35	23	33	37	42	46	72	76	35
30	23	30	35	41	45	70	71	30
25	23	29	34	39	42	67	69	25
20	20	26	33	37	36	65	67	20
15	18	23	30	36	30	62	64	15
10	17	19	27	32	30	57	52	10
5	.	17	24	31	.	53	42	5

PERCENTILE RANKS FOR SCORES (MALES)

DESK COPY

Grades

%ile	2	3	4	5	6	7	8	%ile
n	17	33	34	33	19	31	31	
95	.	68	71	91	.	131	145	95
90	43	62	69	85	102	117	124	90
85	39	60	66	80	89	112	121	85
80	37	60	65	79	88	108	115	80
75	36	57	64	72	87	107	109	75
70	36	55	62	72	83	102	102	70
65	35	54	59	71	83	101	98	65
60	34	53	59	70	72	100	97	60
55	34	51	57	67	70	97	95	55
50	34	49	57	65	66	95	91	50
45	31	48	56	62	65	91	89	45
40	28	46	55	61	65	89	88	40
35	27	45	52	59	63	89	88	35
30	27	44	51	57	63	86	86	30
25	26	42	48	55	61	83	79	25
20	26	36	44	51	60	80	70	20
15	24	36	41	50	57	79	68	15
10	21	27	39	50	46	78	66	10
5	.	23	36	46	.	61	59	5

PERCENTILE RANKS FOR SCORES (MALES)

BOARD COPY

Grades

%ile		2	3	4	5	6	7	8	%ile
	n	17	33	34	33	19	31	31	
95		.	63	70	87	.	115	144	95
90		42	61	68	79	90	108	122	90
85		35	59	63	74	88	104	121	85
80		32	55	61	74	77	98	110	80
75		32	53	59	70	75	97	107	75
70		31	52	58	69	74	93	98	70
65		30	52	57	68	72	92	96	65
60		29	50	55	66	64	92	94	60
55		28	48	55	64	63	91	90	55
50		27	47	52	61	61	91	89	50
45		26	46	50	60	60	89	88	45
40		26	44	48	57	60	87	87	40
35		26	42	47	54	56	82	83	35
30		25	40	47	54	56	81	81	30
25		25	38	45	51	54	77	78	25
20		24	29	42	48	54	70	72	20
15		22	29	37	47	51	67	66	15
10		20	27	36	41	49	58	56	10
5		.	25	34	31	.	49	50	5

PERCENTILE RANKS FOR SCORES (MALES)

COPY SPAN

Grades

%ile	2	3	4	5	6	7	8	%ile
n	16	33	33	32	19	31	31	
95	.	21	23	25	.	29	29	95
90	20	19	23	25	26	26	29	90
85	18	18	20	24	26	24	28	85
80	18	15	20	23	23	24	28	80
75	17	15	19	23	20	24	27	75
70	16	15	19	22	19	22	27	70
65	12	15	19	21	19	22	27	65
60	11	14	18	20	19	22	27	60
55	11	14	17	20	19	21	26	55
50	11	13	17	19	17	21	25	50
45	11	13	16	19	16	20	24	45
40	11	13	16	18	16	19	23	40
35	11	12	14	16	16	19	20	35
30	11	12	14	16	16	19	20	30
25	10	12	13	15	15	18	19	25
20	10	12	12	15	14	17	17	20
15	10	11	11	15	13	17	17	15
10	8	11	9	14	13	15	15	10
5	.	9	9	11	.	13	15	5

Appendix G: Tables of Means and Percentiles by AGE

TABLE OF MEANS BY AGE (entire population)

Age	n		X's	Symbol	Nonsense	Desk	Board	CopySpan
7.5	26*	mean	45.75	23.29	26.61	32.64	29.95	12.46
		s.d.	12.01	4.00	7.56	8.43	8.94	5.30
8.0	21*	mean	54.14	23.59	32.27	45.07	43.55	14.41
		s.d.	12.94	6.64	11.39	15.65	15.94	4.31
8.5	39	mean	58.41	24.05	36.41	51.13	48.39	14.46
		s.d.	15.07	6.88	9.72	12.80	12.81	4.09
9.0	33	mean	55.85	25.61	39.94	54.71	48.50	15.09
		s.d.	10.41	4.03	11.90	15.83	13.86	3.94
9.5	30*	mean	61.52	27.84	43.32	58.11	54.73	16.57
		s.d.	13.88	4.47	10.82	10.55	11.49	3.00
10.0	23	mean	58.39	28.52	50.00	64.72	59.72	16.70
		s.d.	10.81	5.73	11.18	12.80	9.28	4.16
10.5	30*	mean	56.68	28.26	49.16	67.13	59.63	19.03
		s.d.	10.81	4.68	11.79	14.42	13.36	3.84
11.0	32	mean	59.44	25.91	52.28	68.83	62.53	19.22
		s.d.	9.75	6.19	15.91	16.10	14.81	4.07
11.5	16	mean	57.25	32.06	59.69	74.59	66.94	17.94
		s.d.	17.27	6.51	19.26	18.42	19.47	5.08
12.0	15	mean	72.13	32.53	69.07	85.20	75.37	20.40
		s.d.	15.12	6.66	17.45	18.05	15.79	5.01
12.5	33	mean	75.64	35.06	78.79	99.15	90.39	21.58
		s.d.	13.00	3.95	18.58	17.90	18.51	4.53
13.0	33	mean	77.64	35.03	79.97	97.62	89.64	20.76
		s.d.	16.94	7.00	24.18	23.82	27.90	3.91
13.5	33	mean	78.67	35.76	81.64	92.76	92.29	23.24
		s.d.	16.03	6.59	21.62	20.01	22.54	4.17
14+	23	mean	85.39	39.52	89.83	107.41	103.63	24.52
		s.d.	13.44	6.81	17.15	17.83	20.45	4.57

*n for copy span. For speed tests, add 2 at age 7.5, 1 for other marked ages.

TABLE OF MEANS BY AGE (FEMALES)

Age	n		X's	Symbol	Nonsense	Desk	Board	CopySpan
7.5	15*	mean	49.38	24.19	27.63	33.34	31.22	12.48
		s.d.	12.46	3.27	8.29	8.63	8.62	5.82
8.0	11*	mean	57.58	26.17	33.75	47.63	46.79	14.60
		s.d.	15.68	7.36	14.74	17.86	18.02	5.28
8.5	20	mean	59.40	24.95	37.60	53.25	50.23	14.85
		s.d.	10.36	6.85	9.69	12.04	13.34	4.67
9.0	15	mean	54.60	26.47	43.53	60.57	51.37	16.20
		s.d.	11.73	4.93	9.12	15.21	12.93	3.88
9.5	14	mean	66.21	29.00	47.64	60.36	58.71	16.14
		s.d.	13.74	4.64	11.49	12.56	11.95	2.74
10.0	11	mean	57.55	27.82	55.00	69.41	63.14	16.46
		s.d.	7.87	6.06	11.96	13.56	9.18	3.01
10.5	16	mean	57.31	27.75	51.00	69.91	59.41	19.13
		s.d.	9.51	3.84	12.70	16.05	12.66	3.70
11.0	14	mean	59.21	27.64	59.50	75.71	66.64	19.86
		s.d.	11.60	7.38	17.94	16.88	14.37	2.80
11.5±	3	mean	49.00	27.67	56.67	72.67	59.83	17.33
		s.d.	25.52	4.16	13.65	15.02	23.18	5.13
12.0	11	mean	75.36	33.64	74.73	89.68	78.09	19.18
		s.d.	15.62	6.99	13.34	16.20	16.25	3.71
12.5	16	mean	77.75	34.38	81.38	101.03	92.09	22.75
		s.d.	13.03	4.29	20.78	16.87	20.82	5.34
13.0	16	mean	77.63	35.69	84.63	104.25	98.59	22.56
		s.d.	22.79	8.52	30.25	28.74	31.00	2.71
13.5	16	mean	79.50	35.19	89.81	102.81	100.84	22.63
		s.d.	16.69	7.26	22.90	20.11	27.04	4.06
14+	12	mean	80.33	36.83	84.25	102.42	101.67	24.67
		s.d.	14.68	5.24	11.01	10.97	13.49	4.42

*n for copy span. Add 1 for speed tests.
±Use caution with these means due to small n.

TABLE OF MEANS BY AGE (MALES)

Age	n		X's	Symbol	Nonsense	Desk	Board	CopySpan
7.5	11*	mean	40.92	22.08	25.25	31.71	28.25	12.46
		s.d.	9.90	4.68	6.57	8.45	9.45	4.78
8.0	10	mean	50.00	20.50	30.50	42.00	39.65	14.20
		s.d.	7.45	4.14	5.58	12.74	12.85	3.19
8.5	19	mean	57.37	23.11	35.16	48.90	46.45	14.05
		s.d.	19.07	6.96	9.85	13.50	12.28	3.46
9.0	18	mean	56.89	24.89	36.94	49.83	46.11	14.17
		s.d.	9.38	3.07	13.30	15.02	14.52	3.85
9.5	17	mean	57.65	26.88	39.77	56.27	51.44	16.94
		s.d.	13.14	4.21	9.07	8.50	10.29	3.26
10.0	12	mean	59.17	29.17	45.42	60.42	56.58	16.92
		s.d.	13.27	5.59	8.50	10.89	8.57	5.13
10.5	15	mean	56.00	28.80	47.20	64.17	59.87	18.93
		s.d.	12.35	5.53	10.82	12.30	14.51	4.12
11.0	18	mean	59.61	24.56	46.67	63.47	59.33	18.72
		s.d.	8.39	4.88	11.81	13.61	14.73	4.86
11.5	12	mean	59.25	32.25	59.17	73.50	66.50	17.92
		s.d.	16.29	6.20	21.17	19.66	18.48	5.47
12.0±	4	mean	63.25	29.50	53.50	72.88	67.88	23.75
		s.d.	10.53	5.26	19.67	19.19	13.49	7.14
12.5	16	mean	75.38	36.06	78.88	100.00	91.31	20.75
		s.d.	11.28	3.42	13.24	16.37	13.30	3.32
13.0	17	mean	77.65	34.41	75.59	91.38	81.21	19.06
		s.d.	9.31	5.40	16.42	16.58	22.36	4.16
13.5	17	mean	77.88	36.29	73.94	83.29	84.24	23.82
		s.d.	15.86	6.06	17.71	15.01	13.75	4.31
14+	11	mean	90.91	42.46	95.91	112.86	105.77	24.36
		s.d.	9.81	7.33	20.87	22.45	26.64	4.95

*n for copy span. Add 1 for speed tests.
±Use caution with these means due to small n.

PERCENTILE RANKS FOR SCORES (Total Population)

MOTOR SPEED

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	28	22	39	33	31	23	31	32	16	15	33	33	33	23	
%ile															%ile
95	77	79	85	74	89	83	77	76	.	.	96	100	104	106	95
90	59	73	74	71	80	73	73	70	82	95	91	95	99	102	90
85	57	71	71	69	73	70	63	68	77	83	88	92	95	100	85
80	55	65	67	67	72	69	62	67	74	81	86	91	92	100	80
75	52	62	65	62	70	64	60	66	71	80	85	91	91	98	75
70	50	60	64	60	68	62	60	65	65	80	84	89	90	92	70
65	50	59	63	59	64	61	60	63	63	79	82	87	86	92	65
60	48	56	61	57	64	60	59	60	61	78	81	84	83	91	60
55	44	54	59	57	62	60	58	60	59	76	78	82	83	89	55
50	42	54	58	55	60	58	58	60	58	74	75	80	80	87	50
45	41	53	57	54	60	57	57	60	57	69	74	78	80	85	45
40	41	52	56	53	60	55	56	59	57	64	73	75	77	83	40
35	40	51	55	52	58	54	56	59	56	61	73	73	74	81	35
30	40	47	53	52	56	53	55	56	49	60	71	73	69	80	30
25	39	45	53	50	55	51	52	55	47	59	71	71	68	73	25
20	37	42	52	47	52	50	50	54	42	58	69	69	66	69	20
15	33	40	47	46	45	46	45	48	34	57	63	63	63	67	15
10	31	40	40	45	42	42	43	43	28	56	54	55	55	66	10
5	30	26	31	34	36	40	31	39	.	.	45	39	43	61	5

PERCENTILE RANKS FOR SCORES (Total Population)

SYMBOLS

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	28	22	39	33	31	23	31	32	16	15	33	33	33	23	
%ile															%ile
95	31	36	35	34	35	39	36	38	.	.	41	46	44	58	95
90	30	34	32	32	35	34	35	35	42	43	40	44	44	47	90
85	28	32	31	31	33	33	34	35	40	41	39	41	43	45	85
80	27	31	30	30	33	33	33	31	39	39	38	40	42	44	80
75	27	28	30	30	32	32	31	31	38	37	38	40	42	43	75
70	24	27	28	27	31	32	30	28	38	36	37	39	41	42	70
65	24	24	26	26	31	31	30	27	35	35	37	38	40	42	65
60	24	24	25	25	29	31	30	26	33	34	36	37	39	41	60
55	23	23	24	24	27	30	30	25	32	33	36	37	38	39	55
50	23	23	24	24	26	29	28	25	32	33	36	36	36	39	50
45	23	22	23	24	25	28	27	24	31	32	35	36	36	38	45
40	22	22	23	23	25	28	27	24	30	30	35	35	34	38	40
35	21	22	23	23	25	27	26	24	29	29	34	34	33	37	35
30	21	22	22	23	24	27	25	23	28	29	33	33	32	35	30
25	21	19	22	23	24	25	24	22	26	27	33	32	32	35	25
20	20	18	22	23	24	24	23	21	24	25	32	31	31	34	20
15	19	17	18	22	24	24	23	19	24	24	31	25	27	33	15
10	19	14	12	22	23	21	22	17	24	23	30	22	25	31	10
5	16	12	10	20	22	13	20	17	.	.	26	20	22	29	5

PERCENTILE RANKS FOR SCORES (Total Population)

NONSENSE SYLLABLES

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	28	22	39	33	31	23	31	32	16	15	33	33	33	23	
%ile															%ile
95	40	55	57	61	63	76	70	83	.	.	122	134	118	133	95
90	38	49	48	57	61	65	64	75	91	91	106	112	112	112	90
85	36	45	45	51	60	63	63	74	82	87	93	102	108	108	85
80	34	41	42	49	54	61	61	69	75	86	91	97	102	103	80
75	33	39	42	48	52	57	60	65	74	84	87	95	98	102	75
70	30	36	42	47	49	54	58	63	72	82	84	90	96	94	70
65	29	36	39	45	45	52	55	58	69	79	84	90	88	93	65
60	28	36	39	43	44	51	52	51	66	75	82	83	83	91	60
55	27	34	36	42	43	50	51	48	64	70	79	81	81	90	55
50	24	33	36	42	39	49	48	48	61	69	76	79	81	90	50
45	24	32	34	40	39	49	46	48	57	69	75	76	81	87	45
40	24	30	33	39	39	48	43	45	53	69	72	72	78	86	40
35	24	27	33	36	37	45	42	45	49	64	72	69	75	82	35
30	24	26	33	33	37	42	42	43	46	56	70	67	72	79	30
25	24	23	30	30	34	42	39	39	43	55	68	63	68	78	25
20	21	23	30	30	33	39	38	36	42	54	65	59	66	73	20
15	17	20	27	26	33	38	36	36	37	52	63	55	65	71	15
10	15	18	24	22	31	37	36	33	30	43	59	52	49	69	10
5	13	10	18	18	27	31	30	31	.	.	47	39	36	64	5

PERCENTILE RANKS FOR SCORES (Total Population)

DESK COPY

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	28	22	39	33	31	23	31	32	16	15	33	33	33	23	
%ile															%ile
95	48	78	73	90	77	86	93	97	.	.	138	145	128	153	95
90	45	70	67	82	73	80	87	90	98	111	127	133	126	132	90
85	42	65	63	72	68	79	84	86	92	103	115	124	114	124	85
80	41	58	62	67	66	79	81	84	90	101	114	119	109	122	80
75	39	55	60	65	66	75	80	84	89	100	111	113	108	120	75
70	38	51	59	60	65	74	75	82	88	98	107	107	107	118	70
65	37	50	57	58	63	73	72	78	87	97	104	103	100	110	65
60	35	49	57	56	63	70	71	72	83	93	102	99	97	108	60
55	34	47	55	55	60	66	68	70	83	87	99	98	95	107	55
50	32	44	54	52	57	63	65	70	77	86	96	98	90	107	50
45	31	42	53	51	57	60	65	66	71	82	93	95	89	103	45
40	30	37	49	49	56	60	63	63	70	79	91	89	88	97	40
35	28	36	46	47	56	59	61	60	64	76	90	86	88	97	35
30	27	34	45	44	53	59	57	57	64	73	90	81	86	97	30
25	26	33	43	43	52	57	56	52	61	65	89	80	74	96	25
20	25	31	42	41	48	55	54	50	60	65	88	79	70	90	20
15	24	27	39	39	45	54	53	50	54	63	84	77	69	88	15
10	21	27	28	37	43	46	50	49	44	62	79	63	67	87	10
5	17	22	26	32	38	37	44	46	.	.	70	61	60	86	5

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PERCENTILE RANKS FOR SCORES (Total Population)

BOARD COPY

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	28	22	39	33	31	23	31	32	16	15	33	33	33	23	
%ile															%ile
95	47	72	70	75	78	79	83	91	.	.	121	143	136	144	95
90	43	68	66	71	73	73	77	82	96	101	111	132	119	135	90
85	40	63	64	68	68	69	74	78	91	93	109	122	111	121	85
80	39	58	61	60	66	67	72	75	88	88	106	122	109	119	80
75	38	55	59	57	63	66	70	72	83	88	104	106	106	118	75
70	33	55	58	53	61	65	69	70	77	86	102	99	102	115	70
65	32	50	53	53	60	62	68	69	75	82	98	94	98	111	65
60	31	49	52	52	58	60	65	68	74	79	94	93	97	110	60
55	30	45	50	50	55	59	64	68	73	78	91	92	95	108	55
50	29	44	47	47	55	59	60	63	68	72	91	91	92	107	50
45	28	43	47	47	50	58	55	60	62	71	91	88	89	97	45
40	27	37	46	45	48	58	54	59	60	70	90	81	88	94	40
35	26	34	44	42	48	58	52	55	56	67	87	72	85	94	35
30	25	31	43	40	47	58	51	54	56	63	85	70	81	93	30
25	23	30	42	38	46	56	51	52	50	62	82	69	77	92	25
20	22	28	38	36	45	53	48	50	45	61	78	65	74	88	20
15	22	25	34	32	43	50	46	47	41	60	76	59	69	85	15
10	20	23	27	30	41	47	40	43	40	55	60	52	65	79	10
5	13	17	26	27	37	40	35	35	.	.	47	50	53	60	5

Copy Speed 101

PERCENTILE RANKS FOR SCORES (Total Population)

COPY SPAN

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	26	21	39	33	30	23	30	32	16	15	33	33	33	23	
%ile															%ile
95	24	23	21	23	22	25	25	25	.	.	33	27	29	30	95
90	20	21	21	22	20	23	25	24	25	28	27	26	29	30	90
85	17	19	19	20	19	22	23	24	23	25	27	25	28	29	85
80	17	18	16	20	19	20	23	23	22	24	26	24	27	29	80
75	17	18	16	18	19	19	23	22	20	24	24	23	27	28	75
70	14	17	15	17	18	19	22	21	20	24	24	23	27	28	70
65	14	16	15	16	18	18	20	21	19	23	22	22	25	27	65
60	12	15	15	15	18	16	20	21	19	22	21	22	25	27	60
55	12	15	15	15	17	16	20	20	19	21	21	22	24	27	55
50	12	14	14	14	17	16	19	20	18	21	21	22	23	26	50
45	11	14	14	14	17	16	19	20	17	20	20	21	23	26	45
40	11	14	13	13	16	15	18	18	16	18	20	21	22	25	40
35	11	13	13	13	15	15	18	18	16	17	20	19	22	23	35
30	10	12	12	12	14	14	16	16	15	16	19	19	20	22	30
25	10	11	12	12	14	14	16	16	14	16	19	19	20	20	25
20	10	11	12	12	14	14	15	15	13	15	18	18	20	18	20
15	7	10	11	11	14	13	15	15	13	14	17	15	19	18	15
10	4	9	10	11	13	11	14	14	12	14	16	15	19	17	10
5	3	5	8	9	11	9	12	11	.	.	15	13	14	16	5

Copy Speed 102

PERCENTILE RANKS FOR SCORES (FEMALES)

MOTOR SPEED (X's)

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	16	12	20	15	14	11	16	14	3	11	16	16	16	12	
%ile															%ile
95	.	.	84	.	.	.	.	.		.	.	.	.	.	95
90	66	78	74	74	90	69	71	77		106	93	100	101	100	90
85	58	73	72	71	80	69	65	69		90	90	96	99	100	85
80	57	72	70	68	79	67	62	68	.	83	89	95	96	99	80
75	56	71	66	63	74	64	62	67	.	81	88	94	92	97	75
70	55	69	64	57	72	62	62	65	70	80	86	92	91	93	70
65	52	66	60	55	70	60	60	62	64	80	86	91	86	88	65
60	50	62	59	55	66	60	60	60	59	79	84	91	84	84	60
55	50	60	58	54	65	59	59	60	53	78	82	88	83	82	55
50	49	59	58	53	63	58	59	60	48	76	81	84	82	81	50
45	46	56	56	52	62	56	57	59	43	75	78	81	80	78	45
40	44	54	56	52	60	54	56	59	38	73	77	79	79	71	40
35	42	53	55	52	60	53	56	58	34	69	75	73	74	68	35
30	42	52	53	51	60	52	56	57	29	65	73	71	69	67	30
25	41	49	53	46	59	51	55	53	.	61	71	70	67	67	25
20	40	44	52	46	58	51	52	48	.	60	66	58	65	66	20
15	39	39	51	45	53	50	48	44		59	63	49	60	65	15
10	36	29	47	38	48	45	41	40		55	57	39	53	62	10
5	.	.	40	.	.	.	.	.		.	.	.	.	.	5

PERCENTILE RANKS FOR SCORES (FEMALES)

SYMBOLS

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	16	12	20	15	14	11	16	14	3	11	16	16	16	12	
%ile															%ile
95	.	.	36	.	.	.	.	.		.	.	.	.	.	95
90	29	36	35	34	35	33	33	39		44	40	46	44	43	90
85	27	35	32	33	35	32	31	37		43	39	45	43	42	85
80	27	33	31	32	33	32	31	35	.	41	38	44	43	42	80
75	27	32	31	31	33	32	30	35	.	39	37	42	42	42	75
70	27	32	30	31	33	31	30	34	31	37	37	40	42	42	70
65	25	31	29	30	32	31	30	32	30	36	36	39	39	41	65
60	24	30	26	28	32	31	30	31	30	35	36	39	38	40	60
55	24	28	24	25	31	31	29	27	29	34	35	38	37	37	55
50	24	26	24	24	31	30	28	25	29	33	35	38	35	36	50
45	23	24	23	24	29	29	27	25	28	33	35	37	34	35	45
40	23	24	23	23	26	29	27	24	27	33	34	36	33	35	40
35	22	23	22	23	26	28	26	24	25	32	34	35	32	35	35
30	22	22	22	23	25	26	25	24	24	31	34	34	31	34	30
25	21	22	22	22	24	24	24	23	.	29	33	33	31	33	25
20	21	20	22	22	24	24	23	23	.	26	31	27	30	31	20
15	21	17	19	22	23	22	23	19		24	29	22	26	29	15
10	21	14	13	21	23	14	23	17		22	26	20	22	29	10
5	.	.	10	.		.	.	.		.	.	.	.	.	5

PERCENTILE RANKS FOR SCORES (FEMALES)

NONSENSE SYLLABLES

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	16	12	20	15	14	11	16	14	3	11	16	16	16	12	
%ile															%ile
95	.	.	65	.	.	.	.	.		.	.	.	.	.	95
90	39	55	48	61	62	76	68	85		94	115	134	118	100	90
85	38	51	45	56	61	69	64	80		89	105	118	114	94	85
80	37	47	45	50	60	65	64	75	.	87	98	106	110	93	80
75	36	45	42	47	60	63	62	75	.	87	93	101	107	92	75
70	34	45	42	45	57	63	60	75	67	85	92	98	103	90	70
65	30	42	42	45	54	62	59	73	65	83	84	97	102	90	65
60	29	38	42	45	52	58	57	69	63	82	84	94	100	89	60
55	26	36	39	44	51	55	52	65	61	77	82	91	97	87	55
50	24	36	36	42	50	51	48	60	59	70	80	86	95	87	50
45	24	32	34	40	47	50	44	55	56	69	76	82	92	86	45
40	24	32	33	40	43	50	43	50	52	69	71	79	86	82	40
35	24	27	33	40	40	49	42	49	49	69	69	69	84	80	35
30	24	22	31	39	39	49	42	47	45	69	69	67	79	78	30
25	24	19	30	39	39	49	40	44	.	69	67	62	74	75	25
20	24	18	30	37	37	43	38	39	.	61	64	57	68	73	20
15	20	18	30	34	34	39	37	37		56	60	49	66	72	15
10	14	11	25	31	30	39	36	35		54	55	39	55	66	10
5	.	.	24	.	.	.	.	.		.	.	.	.	.	5

PERCENTILE RANKS FOR SCORES (FEMALES)

DESK COPY

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	16	12	20	15	14	11	16	14	3	11	16	16	16	12	
%ile															%ile
95	.	.	72	.	.	.	.	.		.	.	.	.	.	95
90	46	77	70	87	78	86	92	96		118	131	145	128	121	90
85	43	73	67	82	74	82	87	90		107	120	136	128	120	85
80	41	67	65	77	74	80	86	90	.	102	114	133	126	113	80
75	40	61	62	72	69	79	84	86	.	100	113	129	121	108	75
70	39	56	60	68	67	79	81	84	85	99	109	124	114	108	70
65	39	53	59	65	66	78	81	84	80	98	107	122	110	107	65
60	36	51	58	61	66	75	79	84	75	97	104	110	109	107	60
55	33	49	57	56	64	74	72	84	70	93	99	102	108	105	55
50	32	46	56	56	63	74	66	83	65	87	95	99	107	101	50
45	31	43	54	56	62	72	63	80	64	86	93	98	106	97	45
40	30	42	51	54	57	70	60	76	64	85	92	96	104	97	40
35	30	39	47	53	56	66	57	72	64	82	90	89	96	97	35
30	28	35	45	51	54	62	56	71	64	80	90	88	88	96	30
25	27	34	43	50	51	59	55	65	.	77	89	82	86	96	25
20	26	31	42	48	47	56	54	50	.	75	88	78	80	93	20
15	24	27	40	46	44	51	54	50		72	88	70	74	88	15
10	21	23	39	42	40	44	52	48		65	84	61	70	87	10
5	.	.	27	.	.	.	.	.		.	.	.	.	.	5

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PERCENTILE RANKS FOR SCORES (FEMALES)

BOARD COPY

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	16	12	20	15	14	11	16	14	3	11	16	16	16	12	
%ile															%ile
95	.	.	70	.	.	.	.	.		.	.	.	.	.	95
90	44	71	69	74	78	79	77	87		105	121	143	136	119	90
85	41	69	68	69	75	73	74	82		98	115	137	121	118	85
80	40	67	64	63	68	70	73	78	.	93	111	132	119	117	80
75	39	63	63	59	68	68	71	76	.	89	108	124	115	115	75
70	38	58	59	58	66	67	69	74	79	87	104	120	111	112	70
65	35	56	57	55	64	66	66	72	73	85	103	109	110	110	65
60	32	54	54	53	62	66	65	71	68	80	100	104	109	109	60
55	31	51	52	52	61	65	62	70	62	79	94	100	105	107	55
50	31	47	48	49	60	65	58	69	57	79	91	96	103	101	50
45	30	44	47	47	59	62	54	69	53	75	90	92	101	94	45
40	29	43	45	47	58	60	51	69	49	71	88	91	97	94	40
35	28	40	43	45	53	59	51	68	46	71	85	90	96	93	35
30	28	35	43	42	50	58	51	60	42	71	85	73	96	92	30
25	23	34	41	42	47	58	50	50	.	70	80	69	80	92	25
20	22	29	38	41	45	57	48	50	.	65	77	67	72	91	20
15	21	21	36	38	44	54	46	47		59	71	62	67	88	15
10	19	18	34	34	42	48	42	44		52	58	56	61	81	10
5	.	.	23	.	.	.	.	.		.	.	.	.	.	5

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PERCENTILE RANKS FOR SCORES (FEMALES)

COPY SPAN

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	15	11	20	15	14	11	16	14	3	11	16	16	16	12	
%ile															%ile
95	.	.	29	.	.	.	.	.		.	.	.	.	.	95
90	21	23	21	22	21	22	24	24		24	33	27	28	30	90
85	17	21	20	22	20	21	23	24		24	30	26	27	30	85
80	17	20	17	21	18	20	23	22	.	24	27	25	27	29	80
75	17	19	16	20	18	19	23	21	.	23	27	24	26	29	75
70	15	17	16	18	18	17	22	21	22	22	26	23	25	28	70
65	14	16	16	17	18	16	21	21	20	21	24	23	24	27	65
60	14	15	15	17	17	16	20	21	19	21	22	23	23	27	60
55	13	15	15	16	17	16	20	20	17	21	21	22	23	26	55
50	12	14	15	16	17	16	20	20	16	20	21	22	23	26	50
45	12	14	14	15	16	15	19	20	15	18	21	22	23	25	45
40	12	14	13	14	15	15	19	20	15	17	20	22	22	23	40
35	11	14	13	14	14	15	18	20	14	16	20	22	22	23	35
30	10	13	12	13	14	15	17	19	14	16	20	21	20	22	30
25	10	11	12	13	14	14	16	18	.	16	20	21	19	21	25
20	8	10	12	12	13	14	14	17	.	15	19	20	19	19	20
15	5	8	11	12	13	14	14	16		15	19	20	19	18	15
10	3	5	8	12	13	13	14	15		14	17	19	17	18	10
5	.	.	8	.	.	.	.	.		.	.	.	.	.	5

Copy Speed 108

PERCENTILE RANKS FOR SCORES (MALES)

MOTOR SPEED (X's)

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	12	10	19	18	17	12	15	18	12	4	16	17	17	11	
%ile															%ile
95	.	.	.	.	.	.	.	.	.		.	.	.	.	95
90	61	61	80	69	74	81	77	70	84		91	90	97	106	90
85	51	60	71	68	71	74	68	68	80	.	85	89	94	104	85
80	49	58	67	67	70	72	60	67	76	.	84	88	92	102	80
75	47	55	65	62	67	70	60	66	71	74	84	86	91	100	75
70	42	54	64	60	64	63	60	65	66	69	82	85	89	95	70
65	40	54	63	60	63	62	59	64	64	64	80	83	85	92	65
60	40	53	63	59	61	62	58	61	62	59	76	81	83	92	60
55	40	52	61	58	60	60	58	60	60	59	74	78	82	92	55
50	40	52	60	58	60	59	58	60	59	59	74	78	80	91	50
45	39	51	57	57	57	58	57	60	57	58	73	75	77	90	45
40	39	48	56	57	55	56	56	60	57	58	73	74	77	89	40
35	38	45	55	55	55	55	54	58	57	58	72	73	72	87	35
30	36	43	53	51	54	54	52	56	55	58	71	73	69	86	30
25	32	42	52	50	49	50	50	55	49	57	71	72	68	85	25
20	31	41	41	49	43	45	46	55	43	.	70	69	66	83	20
15	31	41	35	47	42	40	44	52	38		65	64	61	79	15
10	30	40	31	45	39	40	37	44	32		57	63	51	75	10
5	.	.	.	.	.	.	.	.	.		.	.	.	.	5

PERCENTILE RANKS FOR SCORES (MALES)

SYMBOLS

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	12	10	19	18	17	12	15	18	12	4	16	17	17	11	
%ile															%ile
95	.	.	.	.	.	.	.	.	.		.	.	.	.	95
90	30	27	31	30	35	39	36	31	41		41	41	43	58	90
85	30	24	30	29	33	35	35	30	40	.	40	40	43	51	85
80	26	23	30	27	31	34	35	28	39	.	39	39	42	47	80
75	24	23	27	27	30	33	34	28	38	35	39	39	41	45	75
70	24	23	26	26	28	33	33	27	38	33	38	38	41	45	70
65	23	22	26	25	27	32	32	26	36	31	37	37	40	45	65
60	23	22	25	24	26	30	31	25	34	29	37	36	40	43	60
55	23	22	24	24	25	28	30	25	32	29	37	36	39	41	55
50	22	22	23	24	25	28	30	25	32	28	37	36	37	39	50
45	21	22	23	24	25	28	28	24	32	28	36	35	36	39	45
40	20	20	23	23	25	27	27	24	30	27	36	34	36	39	40
35	20	19	23	23	24	27	26	23	29	27	35	34	35	38	35
30	19	18	23	23	24	27	25	22	28	26	33	32	33	38	30
25	19	18	22	23	24	26	24	21	26	26	33	31	33	38	25
20	19	17	19	23	24	25	23	19	25	.	33	31	30	38	20
15	18	15	16	23	24	24	22	19	24		32	29	27	37	15
10	15	13	11	22	23	21	20	17	24		31	24	26	34	10
5	.	.	.	.	.		.	.	.		.	.	.	.	5

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PERCENTILE RANKS FOR SCORES (MALES)

NONSENSE SYLLABLES

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	12	10	19	18	17	12	15	18	12	4	16	17	17	11	
%ile															%ile
95	.	.	.	.	.	.	.	.	.		.	.	.	.	95
90	35	39	48	57	56	58	62	66	93		99	100	99	133	90
85	34	37	48	52	48	54	61	63	90		89	92	86	119	85
80	32	36	42	49	45	53	59	61	81	.	87	90	81	112	80
75	30	35	39	48	45	52	55	53	74	72	86	87	81	109	75
70	29	34	39	48	44	52	54	49	72	67	84	83	81	108	70
65	28	33	39	44	42	50	52	48	68	61	84	80	81	107	65
60	27	33	36	42	39	48	51	48	65	55	80	79	81	103	60
55	27	33	36	42	39	48	50	47	63	54	77	78	81	98	55
50	26	32	36	39	38	46	48	46	59	53	76	75	78	93	50
45	24	30	34	33	37	43	48	45	53	52	75	72	75	91	45
40	24	28	33	30	37	42	44	44	50	51	74	72	73	88	40
35	23	27	33	30	35	42	42	42	48	46	72	69	69	85	35
30	22	26	33	29	34	42	41	38	46	41	72	66	67	82	30
25	19	25	28	25	34	38	39	36	43	35	72	63	67	78	25
20	18	24	27	23	33	37	37	35	37	.	69	58	61	73	20
15	17	23	24	21	32	37	34	33	30		65	55	51	70	15
10	16	23	18	19	30	32	30	32	30		63	53	43	69	10
5	.	.	.	.	.	.	.	.	.		.	.	.	.	5

Copy Speed 111

PERCENTILE RANKS FOR SCORES (MALES)

DESK COPY

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	12	10	19	18	17	12	15	18	12	4	16	17	17	11	
%ile															%ile
95	.	.	.	.	.	.	.	.	.		.	.	.	.	95
90	45	64	63	69	67	77	81	87	102		130	117	101	153	90
85	42	59	62	67	65	74	77	81	90		120	111	98	141	85
80	39	54	60	61	65	71	72	74	88	.	114	108	97	132	80
75	37	51	60	58	64	68	72	70	88	92	110	105	94	125	75
70	37	49	57	58	62	64	71	70	87	83	106	101	91	124	70
65	36	48	56	54	60	62	71	67	84	74	103	99	89	123	65
60	35	47	54	52	59	60	70	64	83	65	102	97	89	121	60
55	34	45	53	50	57	60	67	63	83	65	100	96	88	116	55
50	33	40	53	47	57	60	65	62	77	65	98	95	88	111	50
45	30	35	49	45	56	59	65	60	71	65	95	87	88	108	45
40	28	35	48	43	56	59	64	58	70	65	92	84	88	105	40
35	27	34	46	42	54	58	62	57	66	64	90	81	76	99	35
30	26	34	45	41	52	57	60	55	60	63	90	79	70	94	30
25	25	32	43	40	51	56	57	50	60	62	89	79	69	91	25
20	23	28	37	38	48	55	52	50	54	.	86	79	68	89	20
15	21	27	28	36	45	53	50	49	46		82	75	65	87	15
10	19	27	27	34	43	41	44	48	41		80	65	61	86	10
5	.	.	.	.	.	.	.	.	.		.	.	.	.	5

Copy Speed 112

PERCENTILE RANKS FOR SCORES (MALES)

BOARD COPY

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	12	10	19	18	17	12	15	18	12	4	16	17	17	11	
%ile															%ile
95	.	.	.	.	.	.	.	.	.		.	.	.	.	95
90	46	59	62	70	69	71	80	80	98		109	122	100	144	90
85	41	56	61	68	64	64	75	75	90		107	106	97	144	85
80	36	54	59	58	62	62	71	69	82	.	105	96	95	135	80
75	32	52	58	53	58	60	69	68	76	82	102	93	93	122	75
70	32	49	52	53	55	59	69	66	75	76	97	93	91	121	70
65	30	47	52	52	55	59	69	62	74	69	97	91	90	119	65
60	28	45	50	51	54	58	67	60	73	63	93	88	89	113	60
55	27	44	49	48	50	58	65	60	72	63	92	87	88	109	55
50	26	38	47	47	48	58	63	59	68	62	91	82	88	107	50
45	26	31	47	44	48	58	57	57	63	62	91	81	85	101	45
40	26	31	46	39	47	58	54	55	61	61	90	74	83	97	40
35	25	30	45	38	47	56	54	54	58	61	90	70	82	95	35
30	25	29	42	37	46	54	54	54	55	60	88	69	79	92	30
25	23	28	42	32	45	51	52	53	50	60	84	65	77	88	25
20	22	27	29	31	44	50	48	50	46	.	81	57	74	84	20
15	21	26	27	29	41	48	40	46	42		79	51	69	76	15
10	14	25	27	28	37	41	35	38	41		71	50	64	60	10
5	.	.	.	.	.	.	.	.	.		.	.	.	.	5

Copy Speed 113

PERCENTILE RANKS FOR SCORES (MALES)

COPY SPAN

Age

	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14+	
n	11	10	19	18	16	12	14	18	12	4	16	17	17	11	
%ile															%ile
95	.	.	.	.	.	.	.	.	.		.	.	.	.	95
90	21	18	21	20	21	25	25	25	29		26	25	29	29	90
85	19	18	19	20	19	23	25	24	23	.	25	24	28	29	85
80	18	18	16	18	19	22	23	24	21	.	24	24	28	29	80
75	17	18	15	16	19	21	23	23	20	30	24	23	28	28	75
70	14	17	15	15	19	19	22	22	19	29	22	22	27	27	70
65	12	16	15	15	19	19	20	21	19	27	22	22	27	27	65
60	11	16	15	14	18	19	20	21	19	26	21	21	27	27	60
55	11	15	14	14	18	17	19	20	19	26	21	19	25	27	55
50	11	14	14	14	18	17	19	19	18	25	21	19	25	27	50
45	11	13	13	13	17	16	19	17	17	25	20	19	23	26	45
40	11	12	13	12	17	15	18	16	16	24	19	18	22	26	40
35	11	12	12	12	16	15	17	16	16	22	19	17	21	24	35
30	11	11	12	12	15	14	16	16	15	19	19	16	20	22	30
25	10	11	12	12	14	13	16	15	14	17	18	15	20	18	25
20	10	11	11	11	14	12	15	15	13	.	17	15	20	17	20
15	9	11	11	11	14	11	15	14	13		17	15	20	17	15
10	5	10	10	9	13	10	13	12	11		17	13	18	16	10
5	.	.	.	.	.	.	.	.	.		.	.	.	.	5