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Abstract

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Hannu Laukkanen

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NORMING THE WOLD SENTENCE COPYING TEST

By

CURT OLAND AND KYLE KENISON

A thesis submitted to the faculty of the
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Advisor:

Hannu Laukkanen O.D.

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Abstract

The Wold Sentence Copying Test (WSCT), was normed, for children grades 3-6, for both letter and number copying speed, and for the number of head/eye-movements used to complete both the letter and number sentence. Our study sample consisted of 18 third graders, 13 fourth graders, 17 fifth graders, 16 sixth graders. Results showed an overall significant difference for letter and number copying speed ($p=.0001$), and for head/eye-movements used while copying the letter sentence ($p=.0022$). The number of head/eye-movements used to copy the number sentence decreased for every grade, but not significantly. For the letter sentence there is a significant difference between grades 3 vs. 5, 3 vs. 6, 4 vs. 5, and 4 vs. 6 copying speed, and a significant difference between grades 3 vs. 6 for head/eye-movements, as indicated by the Scheffe F-test. For the number sentence there is a significant difference between grades 3 vs. 5, 3 vs. 6, and 4 vs. 6 for copying speed as indicated by the Scheffe F-test. Head/eye-movements show a decreasing trend as grade level increases. The correlation between letter copying speed and head/eye-movements showed an overall strong negative correlation of $-.706$. The correlation between number copying speed and head/eye-movements showed an overall healthy correlation of $-.657$.

Introduction

In the classroom, a child relies upon his or her copying skills to obtain information and complete assignments. During a copying task, many visual and motor skills are being utilized and integrated. For example, some of these skills include: accurate eye-movements (i.e., saccadic, vergence, and fixational eye movement skills), accommodative response, eye-hand coordination (visual-motor integration), visual processing, visual memory, and fine motor control. If these skills are well developed, utilization of them will be habitual in nature, and the child will expend minimal energy during

a copying task. Vision therapy is often designed to enhance these skills, creating a more efficient visual system. Greater efficiency in harnessing these skills would presumably allow the child to allocate greater attentional resources to processing the incoming information. This ability is very important for tasks such as reading. E.A. Taylor's research(1) has shown, that as a person's reading ability increases, the number of saccadic eye-movements and regressions decrease and the amount of information obtained through each fixation increases. These visual skills are developmental in nature.(2-8)

Valid and reliable diagnostic tests are essential in a vision therapy assessment. The best known clinical test to assess a child's copying skill is the Wold Sentence Copying Test(W SCT). (appendix A).

The WSCT is a quick, easy to administer test, that simulates a classroom task for evaluating a child's copying skills. The test determines a child's equivalent grade level for his or her copying performance. The grade equivalency is based upon the number of letters per minute he or she can copy from a 29 word sentence at the top of a page to blank lines at the bottom of the page. The test is normed for grades 2-8 for copying speed. (see side two of the WSCT, appendix A).

The WSCT consist of 29 words totaling 108 letters with a visual acuity demand of 20/120. The reading level demand for the sentence is equivalent to grade 8, determined by the Fry reading test. The sentence is grammatically correct, but very unpredictable in its flow, which makes it difficult to memorize and therefore does not favor those youngsters with good language or semantic memory skills.

The child is instructed to copy the sentence as quickly and accurately as possible, following a standardized instruction set, which reads as follows: "I want you to copy this sentence down here as quickly as you can. Ready? Go." The amount of time needed to complete the sentence is recorded in seconds. The time in seconds is converted to minutes by dividing it by 60. The product of this conversion is then divided into the total number of letters copied by the child to yield the child's copying speed in letters/minute. The

child's score is compared to the age equivalent norms to see if she/he is copying at, above, or below grade level.

The test usually takes 4-5 minutes to administer and score. The test can be included in a diagnostic test battery or administered as a performance test in evaluating a patient's progress in a vision therapy program.

Clinical indications for administering a copying test include: poor handwriting, poor copying skills, difficulty with copying tasks, especially copying off the board.

The WSCT has some noteworthy advantages and disadvantages. The advantages are: it is quick to administer and is a good screening test. Its disadvantages are: because it is a screening test, numerous variables can affect performance. The published norms have questionable validity.

The "Buros Mental Measurement Yearbook," stated: "no data on validity of norms", for the WSCT.(9) Investigating further, we contacted the originator of the test Dr. Wold to inquire how he normed the test. He told us that he made a sentence up and then borrowed the norms from another test normed in 1917 for copying speed, by A.J. Ayers(9). This raises the question are these norms valid for his sentence and for today's children?

We gathered normative data for the WSCT in a situation that simulated copying from a blackboard. Our sample population consisted of children grades 3-6. Data were gathered for copying speed in letters/min. and the number of head/eye-movements used while copying the sentence. We feel that the validity of a clinical test increases substantially when the testing procedure simulates a real life situation. We believe norming the WSCT in a situation that simulates a child copying from the blackboard, reflects a more "true to life" demand.

In addition we investigated whether substituting numbers for letters would affect copying speed. For this we tested each child under identical conditions with a sentence consisting of 108 numbers, sized and spaced the same as the previously described word sentence. The number sentence presented the same acuity demand as the WSCT. (appendix B)

We hypothesized that copying only numbers, grouped like words, would be slower than copying words, due to language function. Experienced readers rarely look at individual letters in common words, but rather perceive the word as a whole unit or see groups of words in a process called chunking. Because of this chunking process, the number of head/eye-movements used to copy the numbers should be higher than the quantity to copy the words. In addition children who are faster at copying the numbers may require less head/eye-movements to complete the task due to better visual memory.

If the above assumptions are true, then the addition of a number copying test to the WSCT may prove to be useful in helping to distinguish between slow copying because of language problems, vs. visual memory vs. visual motor or fine motor problems. It may be useful to compare the ratio of letters to numbers copied per minute and the amount of head/eye-movements necessary for each type of copying. Theoretically there are a minimum of four scenarios that might occur:

1. A child may copy both the letter and number sentence at a normal rate. In this case it is unlikely there are visual/fine motor problems or language problems present that affect copying performance. This child would have a normal letter to number ratio for his/her appropriate grade level.
2. A child may copy the letter sentence at a speed below normal for his/her grade level, but copy the number sentence at a speed that is normal for his/her grade level. This may indicate that the child doesn't have a visual/fine motor problem affecting his copying performance, but might have a learning or language problem that is the cause for the abnormal letter copying speed. This child would have an abnormally low letter to number ratio for the appropriate grade level.
3. A child may copy both the letter and number sentences at a speed that is below grade level. This child could have a visual-motor problem or a fine-motor problem, affecting copying performance. The ratio in this case would be

normal. This case can be classified as a copying automaticity problem. The ratio for the child in scenario 2 with the language problem may be abnormally low because the number copying speed was not affected as much as the letter copying speed. The ratio for the child with the copying automaticity problem is normal because both copying speeds should be affected the same amount.

4. A child may copy the letter sentence at a speed that is normal for his grade level, but copy the number sentence at a speed below grade level. This child would have an abnormally high ratio. This child may have a problem with visual/fine motor control coupled with good language or "chunking" ability.

The interaction of visual-memory function can likely be derived from the number of head and eye-movements necessary to copy both sentences.

The purpose of this paper was not to establish whether these types of cases exist, but rather to investigate the relationship between letter and number copying speed and the quantity of head/eye-movements necessary to copy each. If there is such a relationship, then more research needs to be done to investigate the above assumptions and to possibly enhance the amount and quality of information obtainable from the WSCT.

Our goals for this project were: (1)to generate normative data for the WSCT and compare it to the results previously reported for this test. (2)Administer a parallel test that substituted numbers for letters, and compare copying speed for numbers vs. letters. (3)Gather normative data on the number of head/eye-movements made while copying both letters and numbers.

We hypothesized that:

1. Copying speeds for numbers grouped like words will be slower than copying words.
2. A greater amount of head/eye-movements will occur copying numbers than in copying words.
3. Slower copiers will make more head/eye-movements whether copying letters or numbers than faster copiers.

Methods

The subject pool was obtained through returned informed consent forms given to the parent's of Eagle Creek Elementary school students.(see appendix C) Informed consent forms were circulated to the parents with a request that the form be returned after checking a box that gave their consent for their child's participation. The form also included a box to mark if they did not wish to give their consent. This method of obtaining a study sample resulted in the following groups: eighteen third graders, thirteen fourth graders, seventeen fifth graders, and sixteen sixth graders from Eagle Creek Elementary school. (see appendix D for subject pool information) All of our subjects were from a small logging community, Estacada, Oregon, southeast of Portland.

To simulate copying from a chalkboard, the sentence was placed eye level on an easel 40 cm from the child. The child then copied the sentence from the easel to the paper in the child's lap. For support, a lap desk was used. To insure a comfortable copying position the child's feet were raised to a level that gave their lap a slight upward slope. The examiner sat perpendicular to the student and the easel so that he could easily count the number of head and eye-movements made by the subject. The head/eye-movements that we counted consisted of the vertical movements made from the easel to the paper. We made no differential between head and eye-movements.

Each subject was instructed, from the following standardized set of instructions to print the sentence as quickly and as accurately as possible.

"I'm going to give you a sentence to copy. Print it as accurately and as quickly as you can. I will be measuring how long it takes you to finish. If you make a mistake don't erase it, cross it out and continue on. You may begin when I say, Ready? Go."

The time it took the child to complete the sentence was measured and the number of head/eye-movements made by the

child were counted. Letters per minute copied was calculated from the amount of time it took to complete the test.

The children also copied the sentence of numbers under the same conditions described above, only this time they were given the following instruction set.

"I'm going to give you a sentence of numbers to copy. Print it as accurately and as quickly as you can. I will be measuring how long it takes you to finish. If you make a mistake don't erase it, cross it out and continue on. You may begin when I say, Ready? Go."

To randomize the order of the testing sequence, the examiner tossed a coin prior to testing each child. The toss of the coin determined which sentence would be administered first, with heads representing the letter sentence and tails representing the number sentence.

Our results do not reflect adjustments for copying errors (i.e. spelling and punctuation); however, we did make adjustments for additions and omissions when calculating copying speeds. This was easily done by asking the child in the instructional set to simply cross out any mistakes they make and continue on. Although the instructional set specifically told the children to print the sentence, we did not make any type of adjustment for those who utilized the cursive style of writing while copying the sentence.

Results

RESULTS FOR LETTER COPYING SPEED AND HEAD/EYE-MOVEMENTS

The following table illustrates our results for the mean letter copying speed and the mean number of head and eye-movements used while copying the letter sentence for grades 3-6.

GRADE	N	LETTERS/MINUTE		HEAD & EYE-MOVEMENTS	
		MEAN	S.D.	MEAN	S.D.
3	18	49.22	17.1	28.33	10.0
4	13	53.28	13.6	27.54	7.3
5	17	70.98	16.7	20.41	8.2
6	16	77.77	15.2	18.63	7.7

RESULTS FOR NUMBER COPYING SPEED AND HEAD/EYE-MOVEMENTS

The following table illustrates our results for the mean number copying speed and the mean number of head and eye-movements used while copying the number sentence for grades 3-6.

GRADE	N	NUMBERS/MINUTE		HEAD & EYE-MOVEMENTS	
		MEAN	S.D.	MEAN	S.D.
3	18	36.42	11.3	44.94	3.50
4	13	41.35	12.7	41.85	9.32
5	17	56.54	18.5	36.00	13.8
6	16	61.71	16.9	36.31	14.7

COMPARISON OF LETTER COPYING SPEED BETWEEN GRADES

In comparing grade level to copying speed(letters/min.) the overall data indicate a significant difference(p=.0001). When comparing grade to grade the Scheffe F-Test shows significant differences for grades 3 vs. 5 & 6, and grades 4 vs. 5 & 6. The Scheffe F-Test was used based on our sample size. See following table for results.

Comparison	Mean Difference	Scheffe F Test
GRADE 3 vs. 4	-4.06	.165
GRADE 3 vs. 5	-21.766	5.482*
GRADE 3 vs. 6	-28.554	9.141*
GRADE 4 vs. 5	-17.706	3.057*
GRADE 4 vs. 6	-24.495	5.696*
GRADE 5 vs. 6	-6.789	.503

*Significant at 95%

COMPARISON OF NUMBER COPYING SPEED BETWEEN GRADES

There were significant differences between grade levels in copying speed(numbers/min.)(p=.0001). When comparing grade to grade the Scheffe F-Test shows significant differences for grades 3 vs. 5 & 6, and grades 4 vs. 6. The Scheffe F-Test was used based on our sample size. See following table for results.

Comparison	Mean Difference	Scheffe F Test
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GRADE 3 vs. 4	-4.929	.264
GRADE 3 vs. 5	-20.118	5.095*
GRADE 3 vs. 6	-25.292	7.803*
GRADE 4 vs. 5	-15.188	2.447
GRADE 4 vs. 6	-20.363	4.283*
GRADE 5 vs. 6	-5.174	.318

*Significant at 95%

COMPARISON OF HEAD/EYE-MOVEMENTS BETWEEN GRADES WHILE COPYING LETTERS

The only significant difference in head/eye-movements was between grades 3 vs. 6($p=.0022$). See following table for results.

Comparison	Mean Difference	Scheffe F Test
GRADE 3 vs. 4	.795	.022
GRADE 3 vs. 5	7.922	2.559
GRADE 3 vs. 6	9.708	3.725*
GRADE 4 vs. 5	7.127	1.745
GRADE 4 vs. 6	8.913	2.658
GRADE 5 vs. 6	1.787	.123

*Significant at 95%

COMPARISON OF HEAD/EYE-MOVEMENTS BETWEEN GRADES WHILE COPYING NUMBERS

There were no significant differences in head/eye-movements while copying numbers. Grade to grade comparison shows no significant difference for any of the grades. See following table for results.

Comparison	Mean Difference	Scheffe F Test
GRADE 3 vs. 4	3.098	.131
GRADE 3 vs. 5	8.944	1.265

GRADE 3 vs. 6	8.632	1.141
GRADE 4 vs. 5	5.846	.455
GRADE 4 vs. 6	5.534	.397
GRADE 5 vs. 6	-.312	.001

*Significant at 95%

CORRELATION BETWEEN LETTERS/MIN. VS. HEAD/EYE-MOVEMENTS

The strongest correlation was seen in the third grade(-.811) and in the fifth grade(-.725). For grades 3-6 the correlation was (-.706). See the following table for results. See appendix (E, Fig. 1) for a scatter gram plot of each subjects performance for letter copying speed and the number of head and eye-movements made while copying the letter sentence.

GRADE	N	CORRELATION	R-SQUARED
3	18	-.811	.658
4	13	-.382	.146
5	17	-.725	.526
6	16	-.265	.07
3-6	64	-.706	.499

CORRELATION BETWEEN NUMBERS/MIN. VS. HEAD/EYE-MOVEMENTS

The correlation between the number of numbers per minute copied and the number of head and eye-movements made to copy the sentence for the entire sample population was -.657. Again the strongest correlation was seen in the third grade(-.765) and in the fifth grade(-.762). See the following table for results. See appendix (E, Fig. 2) for a scatter gram plot of each subjects performance for number copying speed and the number of head and eye-movements made while copying the number sentence.

GRADE	N	CORRELATION	R-SQUARED
3	18	-.765	.586
4	13	-.364	.132
5	17	-.762	.581
6	16	-.558	.311
3-6	64	-.657	.432

COMPARISON OF COPYING SPEEDS BETWEEN LETTERS AND NUMBERS FOR EACH GRADE

The paired one tailed t-test shows a high significance between copying speeds of letters and numbers for each grade. See the following table for results.

GRADE	MEAN FOR LETTERS	MEAN FOR NUMBERS	1 TAILED T-TEST p value
3	49.22	36.42	.0001
4	53.28	41.35	.0011
5	70.98	56.54	.0004
6	77.77	61.71	.0001
3-6	62.81	49.00	.0001

CORRELATION BETWEEN COPYING SPEEDS OF LETTERS/MIN. AND NUMBERS/MIN.

The correlation between the copying speeds of letters per minute and numbers per minute for the entire sample population was .818. The strongest correlation was seen in the third grade(.838) and in the fifth grade(.778). See the following table for results. See appendix (E, Fig. 3) for a scatter gram plot of each subject's performance for letter copying speed and number copying speed.

GRADE	N	CORRELATION	R-SQUARED
3	18	.838	.702
4	13	.654	.427
5	17	.667	.444
6	16	.778	.605
3-6	64	.818	.670

COMPARISON OF HEAD/EYE-MOVEMENTS BETWEEN LETTER AND NUMBER COPYING

The paired one tailed t-test shows high significance between the number of head/eye-movements while copying letters vs. numbers for each grade. See the following table for results.

GRADE	MEAN FOR LETTERS	MEAN FOR NUMBERS	1 TAILED T-TEST p value
3	28.33	44.94	.0001
4	27.54	41.85	.0001
5	20.41	36.00	.0001
6	18.63	36.31	.0001
3-6	23.73	39.78	.0001

CORRELATION BETWEEN HEAD/EYE-MOVEMENTS USED FOR LETTER COPYING AND HEAD/EYE-MOVEMENTS USED FOR NUMBER COPYING

The correlation between the number of head/eye-movements for letter copying and the number of head/eye-movements for number copying for our entire sample was .653. The strongest correlation was seen in the fifth grade(.693) and in the sixth grade(.687). See the following table for results. See appendix (E, Fig. 4) for a scatter gram plot of each subject's performance for the number of head and eye-movements made while copying the letter sentence and the number of head and eye-movements made while copying the number sentence.

GRADE	N	CORRELATION	R-SQUARED
3	18	.583	.340
4	13	.475	.226
5	17	.693	.480
6	16	.687	.473
3-6	64	.653	.427

SUMMARY OF RESULTS

1. Mean copying speed for all grades in our sample exceeded the norms previously reported for the WSCT.

2. Head/eye-movements while copying both letters and numbers appear to modestly decrease with increasing grade level, but not significantly.
3. An ANOVA showed significant copying speed differences for letter copying between grades 3 vs. 5 & 6, and grades 4 vs. 5 & 6. Although the grade 4 mean was greater than the grade 3 mean the difference did not achieve significance. The same is true for the difference between grades 5 and 6.
4. An ANOVA showed significant copying speed differences for number copying between grades 3 vs. 5 & 6, and grades 4 vs. 6. Although the grade 4 mean was greater than the grade 3 mean the difference did not achieve significance. The same is true for the difference between grades 4 and 5 and grades 5 and 6.
5. The number of head and eye-movements used while copying letters differed only between grades 3 vs. 6. There were no differences between grades for number copying.
6. The correlation of head/eye-movements to letter copying speed was $-.706$.
7. The correlation of head/eye-movements to number copying speed was $-.657$.
8. Mean values show that children in all grades copied numbers slower than they did letters. The one tailed t-test shows high significance between the two copying test speeds within each grade.
9. The correlation between copying speed of letters and copying speed of numbers is $.838$.
10. Mean values show that children in all grades make fewer head/eye-movements while copying letters than they do for copying numbers. The one tailed t-test shows high significance between the two copying test speeds within each grade.
11. The correlation between head/eye-movements used for letter copying and head/eye-movements used for number copying is $.653$.

Conclusion

This study demonstrated that:

1. Copying speeds for numbers grouped like words will be slower than copying words, possibly due to language function.
2. A greater amount of head/eye-movements will be seen with children copying numbers vs. copying words.
3. Slower copiers will make more head/eye-movements in completing both the letter and number sentences.

The mean copying speed for letters is 62.81 letters/min. while the mean number copying speed was 49.00 numbers/min. for grades 3-6. This is most likely due to language ability.

Mean head/eye-movements for letter copying is 23.73 and for number copying it is 39.78 for grades 3-6. This is due to language ability and visual memory. When copying the lettered sentence the children are able to rely more upon their language chunking ability and their eidetic visual memory. Therefore they don't need to use as many head/eye-movements to complete the worded sentence as they do to complete the numbered sentence.

Slower copiers tend to make more head/eye-movements in completing both the letter and number sentences. The correlation factors of $-.706$ and $-.657$, respectively, and their corresponding scatter grams, support this conclusion. Faster copiers most likely have better chunking and visual memory abilities, thus lower head/eye-movements.

We recommend that the previously reported norms for the WSCT no longer be used for clinical assessment. Those norms were determined more than 75 years ago with text different than the WSCT. Based on our limited sample, the previous norms seriously underestimate copying speed of the Wold sentence, particularly above grade 4. See following table for results:

<u>GRADE EQUIVALENT</u>	<u>LETTERS/MIN.(A.J. AYERS)</u>	<u>LETTERS/MIN.(KENISON & OLAND)</u>
2	39.7	
3	42.0	49.22
4	45.8	53.28
5	50.5	70.98

6	54.5	77.77
7	58.9	
8	62.8	

Results indicated that letter and number copying speeds appear to be developmental, they increase with age in grades 3-6. Whereas, head/eye-movements do not appear to be developmental, they do seem to be strongly correlated with copying speed. We believe this is because as a person's visual memory ability improves his/her copying speed also increases, and head movements decrease.

Based on the fact that the copying speeds appear to be developmental, further research on the ratio between letter copying speed and number copying speed is needed to clinically evaluate if decreased performance is secondary to learning, visual, or copying automaticity problems.

When copying speed is less than age expected, and the number of head/eye-movements higher than average, the optometrist needs to determine the cause and follow up with eye-movement, visual memory, and visualization skills testing. An excessive number of secondary head movements can be a result of a poor visual memory ability or some other visual problem. If a patient has a poor visual memory the number of head/eye-movements will be large because the amount of information obtained from each fixation will be less than the average, hence yielding decreased copying speed.

Based on our limited sample size and the demographic representation of the subjects, we are unable to generalize these norms to the population as a whole. However we feel that we have added a new and important dimension to the test by norming the actual number of head/eye-movements made by the child. The optometrist can obtain additional valuable information about the child by observing penmanship, sustaining ability, motor overflow, head and eye-movements, and other behaviors during the test. Although, these behavioral observations may be useful, they may be subject to bias and individual interpretation by the clinician. Norming the number of head and eye-movements during copying, will hopefully reduce bias and make the interpretation more objective.

We believe that our research has laid a good foundation for further research which incorporates a larger, more demographically and chronologically diverse population. With a broader and more extensive normative base the WSCT will become a more valuable test, this will allow the practitioner to make a more accurate judgment whether or not a youngster has adequate copying skills and whether the youngster commits a normal amount of head/eye-movement during this task.

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APPENDIX A

Wold Sentence Copying Test

Four men and a jolly boy came out
of the black and pink house quickly to
see the bright violet sun, but the sun
was hidden behind a cloud.

APPENDIX B

APPENDIX C

INFORMED CONSENT FORM
Norming the Wold Sentence Copying Test

Institution:

- A. Title Norming of the Wold Sentence Copying Test
- B. Faculty Advisor Hannu Laukkanen, O.D., Pacific Univ.
(503) 357-6151 ext. 2451
- Principal Investigators Kyle Kenison 359-4756
Curt Oland 359-5077
- C. Location Eagle Creek Elementary
30391 S.W. Hwy. 211
Eagle Creek, OR 97022
- D. Dates of Project January, 1991 to May 1992

1. **Description of project**

This research project is designed to norm the Wold Sentence Copying Test for copying speed and eye and/or head movements used by the child in copying a sentence in a blackboard simulated condition. The project will consist of a pre-test screening and a simple test procedure. The testing procedure will require children to copy printed material from an easel, to a note pad on their laps. We will measure the speed, accuracy, and the number of eye and/or head movements used to complete the sentence. The child's speed will be measured by the use of a stop watch. Their accuracy will be assessed by the number of mistakes made. The number of eye and/or head movements will simply be counted by the investigators administering the test.

This study will be concerned with the performances of children in grades three through eight. Each grade will be represented by a randomly chosen population of thirty children. These populations will be selected from the children who have returned their signed consent forms. Therefore, even though you have elected to volunteer your child for participation in this study he or she may not be chosen.

2. **Description of risk**

The test procedure is designed to mimic a common everyday classroom copying task. The only difference being that instead of copying from the blackboard, the child will copy from an easel, 40cm. from the child. The procedure should require not more than 5 minutes per child. During the pretest screening each eye will be covered with a standard occluder for visual acuity measurement and polaroid glasses will be put on the child to measure depth perception ability, in accordance with normal

optometric procedures. This could possibly result in trauma to the eye.

3. Descriptions of benefits

This study is designed to establish two sets of norms for a test that can be used to measure 1) paper/pencil copying speed thereby coupling visual-motor integration, eye movement, and accommodative skills, and 2) the number of eye and/or head movements used during the copying task thereby giving some indication of visual memory. By detecting potential problems early there is a better chance for more effective intervention and remediation.

The parents of any of the children, who are selected to participate in the study, will be contacted by the investigators if their child should happen to fail any of the visual screening criteria used in this study. These screening criteria do not constitute a full Pacific University visual screening, nor do they substitute for a comprehensive visual examination.

4. Alternatives advantageous to subjects

Not applicable

5. Confidentiality of records

The records of this project will be maintained in a confidential manner between the investigators and the appropriate school personnel such that no name-identifiable information will be released.

6. Compensation and medical care

If you are injured in this study, it is possible that you will not receive compensation or medical care from Pacific University, the investigators, or any organization associated with the project. However, all responsible care will be used to prevent injury.

7. Offer to answer any inquiries

The investigators will be happy to answer any questions you may have at any time during the study. If you are not satisfied with the answers you receive, please call Dr. James Peterson at 357-0442.

During your participation in the project you are not a Pacific University clinic patient or client for the purpose of the research and all questions should be directed to the researchers and/or the faculty advisor who will be solely responsible for any treatment (except for an emergency). You will not be receiving complete eye, vision or health care as a result of participation in the project;

therefore you will need to maintain your regular program of eye, vision, and health care.

8. Freedom to withdraw

You are free to withdraw your consent and discontinue participation in this project at any time without prejudice to you.

Subjects printed name _____

Parent's signed _____ Date _____

Address _____ Phone _____

City _____ State _____ Zip _____

Name and address of a person not living with you who will always know your address:

APPENDIX D

SUBJECT POOL INFORMATION

SUBJECT NUMBER	SEX	GRADE	D.O.B.	AGE	COPYING SPEED IN	NUMBER OF HEAD & EYE-MOVEMENTS	NUMBER COPYING SPEED	NUMBER OF HEAD & EYE-MOVEMENTS
					LETTERS/MIN	USED TO COPY LETTERS	IN NUMBERS/MINUTE	USED TO COPY NUMBERS
1	F	3	5/21/83	9.00	33.75	34	23.26	57
2	M	3	4/21/83	9.01	40.99	32	30.80	51
3	F	3	5/11/83	9.01	28.33	38	22.16	75
4	F	3	5/1/83	9.01	74.16	13	62.26	12
5	M	3	5/27/83	9.00	44.69	33	36.24	58
6	M	3	8/28/83	8.09	28.58	52	30.00	49
7	F	3	11/11/82	9.06	54.96	20	48.64	24
8	F	3	7/31/83	8.10	44.49	29	31.07	38
9	F	3	5/12/82	10.00	86.05	15	60.54	26
10	F	3	2/5/83	9.04	52.38	35	38.33	37
11	M	3	5/18/83	9.00	38.86	35	36.95	41
12	F	3	4/4/83	9.02	33.43	36	26.14	58
13	F	3	3/26/83	9.02	55.93	20	35.97	50
14	F	3	6/14/83	8.11	60.00	14	28.32	39
15	M	3	4/4/83	9.02	23.28	30	27.35	38
16	M	3	11/22/82	9.06	58.42	26	37.72	53
17	F	3	12/21/82	9.05	58.92	28	36.54	55
18	M	3	3/26/83	9.02	68.66	20	43.31	48
1	M	4	12/31/81	10.05	58.30	29	61.73	34
2	F	4	12/13/80	11.06	78.07	31	72.13	41
3	F	4	6/13/82	9.11	50.92	16	42.05	25
4	F	4	9/19/81	10.08	68.75	28	40.94	39
5	F	4	5/18/81	11.00	48.09	35	34.29	45
6	M	4	5/21/82	10.00	51.56	35	34.21	61
7	F	4	12/21/81	10.05	30.93	41	36.25	39
8	M	4	1/29/82	10.04	45.10	27	27.08	45
9	F	4	9/16/82	9.08	74.32	15	40.59	35
10	M	4	10/17/82	9.07	41.63	25	36.70	34
11	M	4	3/25/82	10.02	52.32	23	40.88	47
12	M	4	3/15/82	10.02	51.84	25	44.03	45
13	M	4	7/12/82	9.10	40.75	28	26.69	54
1	F	5	1/31/81	11.04	83.54	12	90.42	11
2	F	5	2/11/81	11.04	79.02	14	50.41	37
3	F	5	7/16/80	11.10	66.00	21	48.79	42
4	M	5	3/1/81	11.03	79.02	11	57.02	29
5	F	5	9/20/80	11.08	53.11	29	45.42	40
6	F	5	7/17/81	10.10	82.22	23	77.80	29
7	M	5	5/11/81	11.00	42.86	33	29.73	65
8	M	5	4/14/80	12.01	86.40	15	99.80	15
9	F	5	3/17/81	11.02	61.12	17	42.39	32
10	M	5	6/1/81	11.00	68.66	28	62.49	28
11	F	5	11/9/80	11.07	68.94	18	48.78	51
12	F	5	4/14/81	11.01	68.40	11	46.29	24
13	M	5	7/8/81	10.11	105.48	9	54.68	27
14	M	5	3/2/81	11.03	44.19	29	41.34	48
15	M	5	12/25/80	11.05	88.42	24	69.74	42
16	F	5	8/1/81	10.10	75.75	18	55.12	40
17	M	5	1/28/81	11.04	53.55	35	40.96	52
1	F	6	4/11/80	12.02	74.51	18	58.96	40
2	M	6	4/15/80	12.02	85.82	18	67.39	39
3	M	6	1/9/80	12.05	67.50	20	39.30	33
4	F	6	1/12/80	12.05	93.91	10	82.96	39
5	F	6	9/9/80	11.08	84.29	17	97.55	7
6	F	6	7/20/79	12.10	61.71	19	43.50	49
7	F	6	5/29/80	12.00	82.78	29	70.85	40
8	M	6	2/15/80	12.04	48.70	37	41.55	67
9	M	6	7/21/80	11.10	77.86	18	64.75	34
10	F	6	7/24/80	11.10	60.55	16	55.57	41
11	M	6	10/14/79	12.08	76.24	16	54.57	41
12	F	6	8/3/80	11.10	88.77	27	55.70	44
13	F	6	4/14/80	12.01	87.57	19	64.88	36
14	F	6	4/10/80	12.01	102.86	20	76.42	39
15	F	6	9/26/80	11.08	94.41	6	76.63	4
16	M	6	3/19/79	13.02	56.84	8	36.85	28

APPENDIX E

FIGURE 1.

LETTERS/MIN. VS. HEAD MOVEMENTS

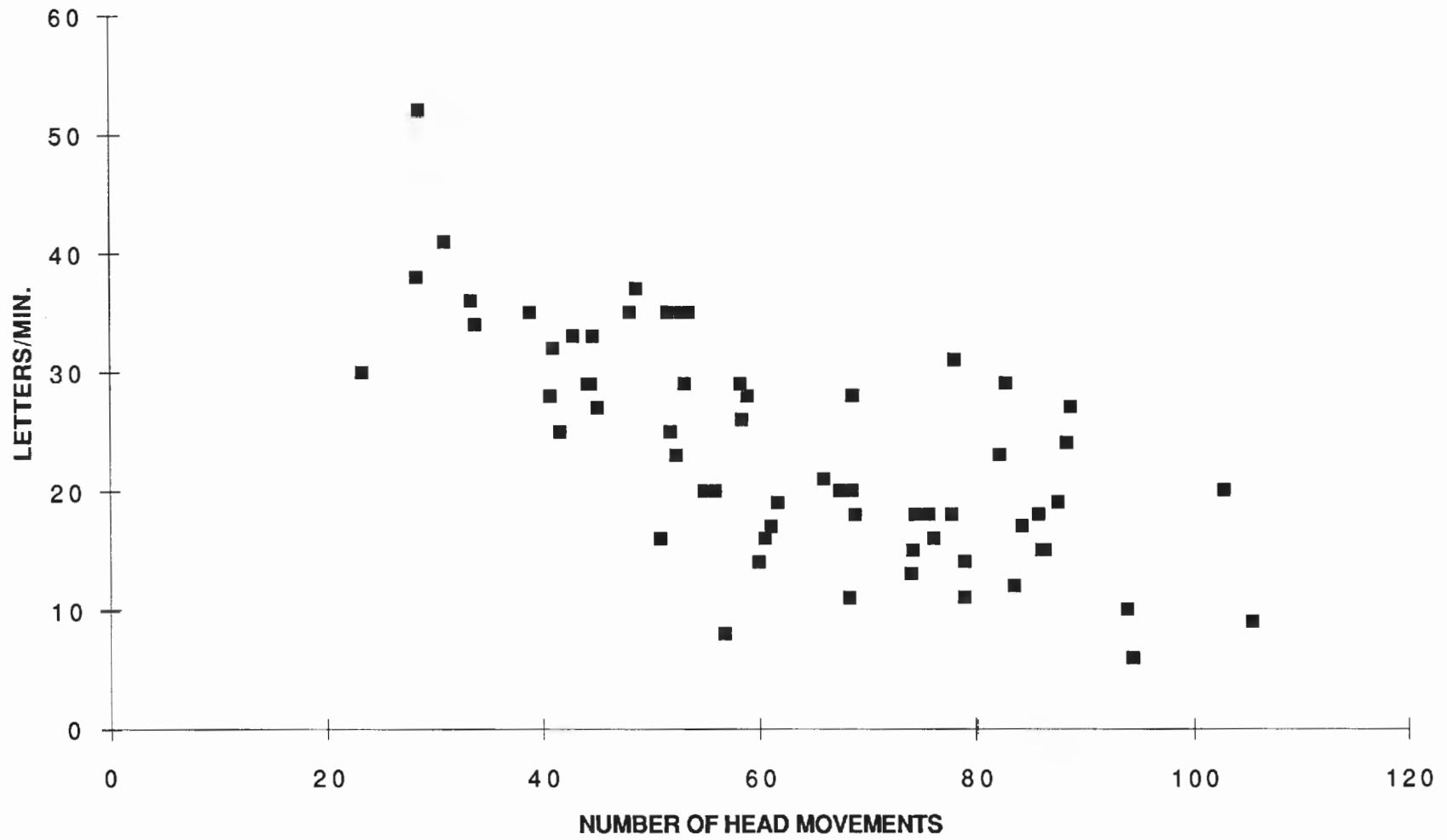


FIGURE 2.

NUMBER/MIN. VS. HEAD MOVEMENTS

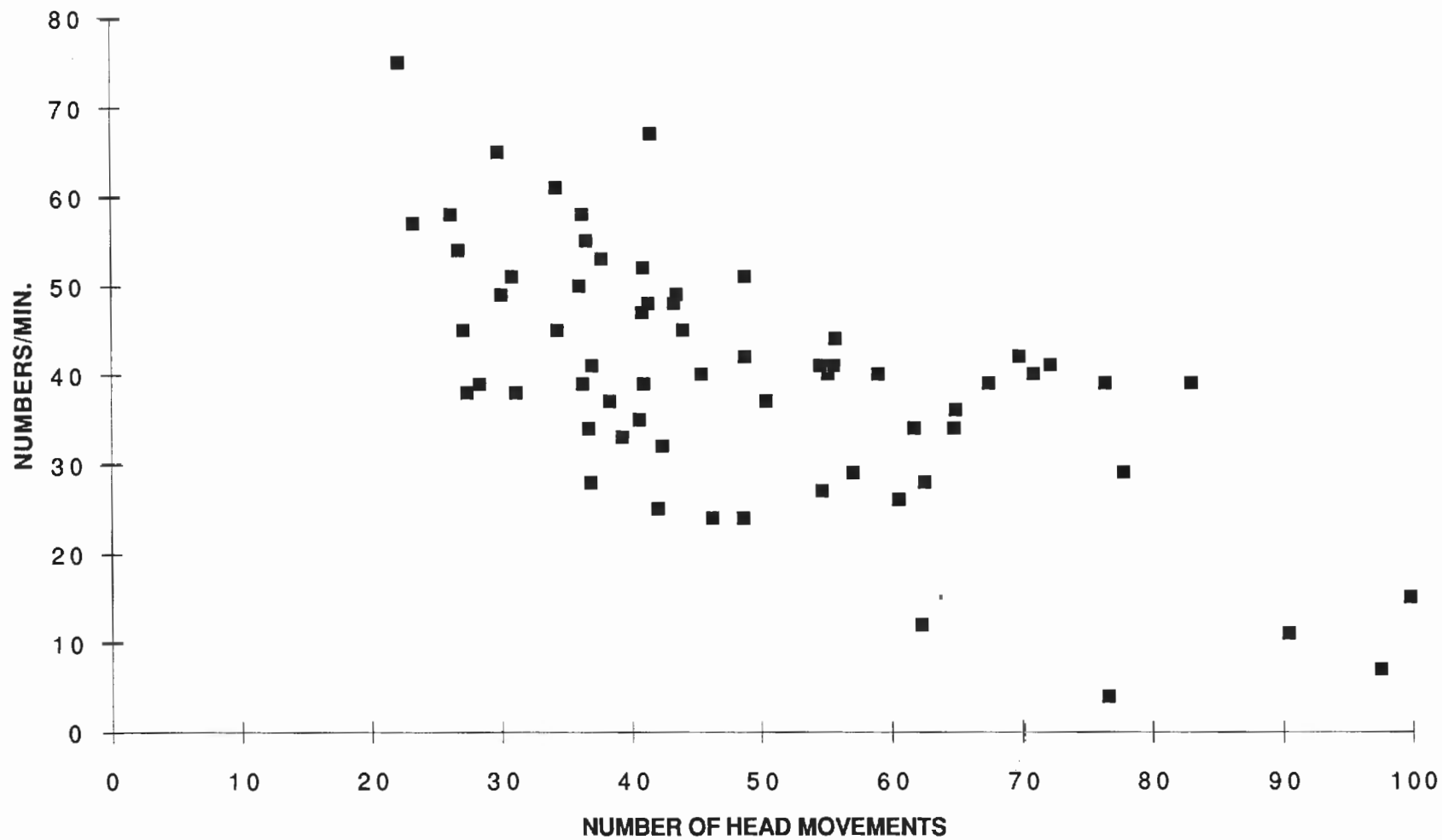


FIGURE 3.

LETTERS/MIN. VS. NUMBERS/MIN.

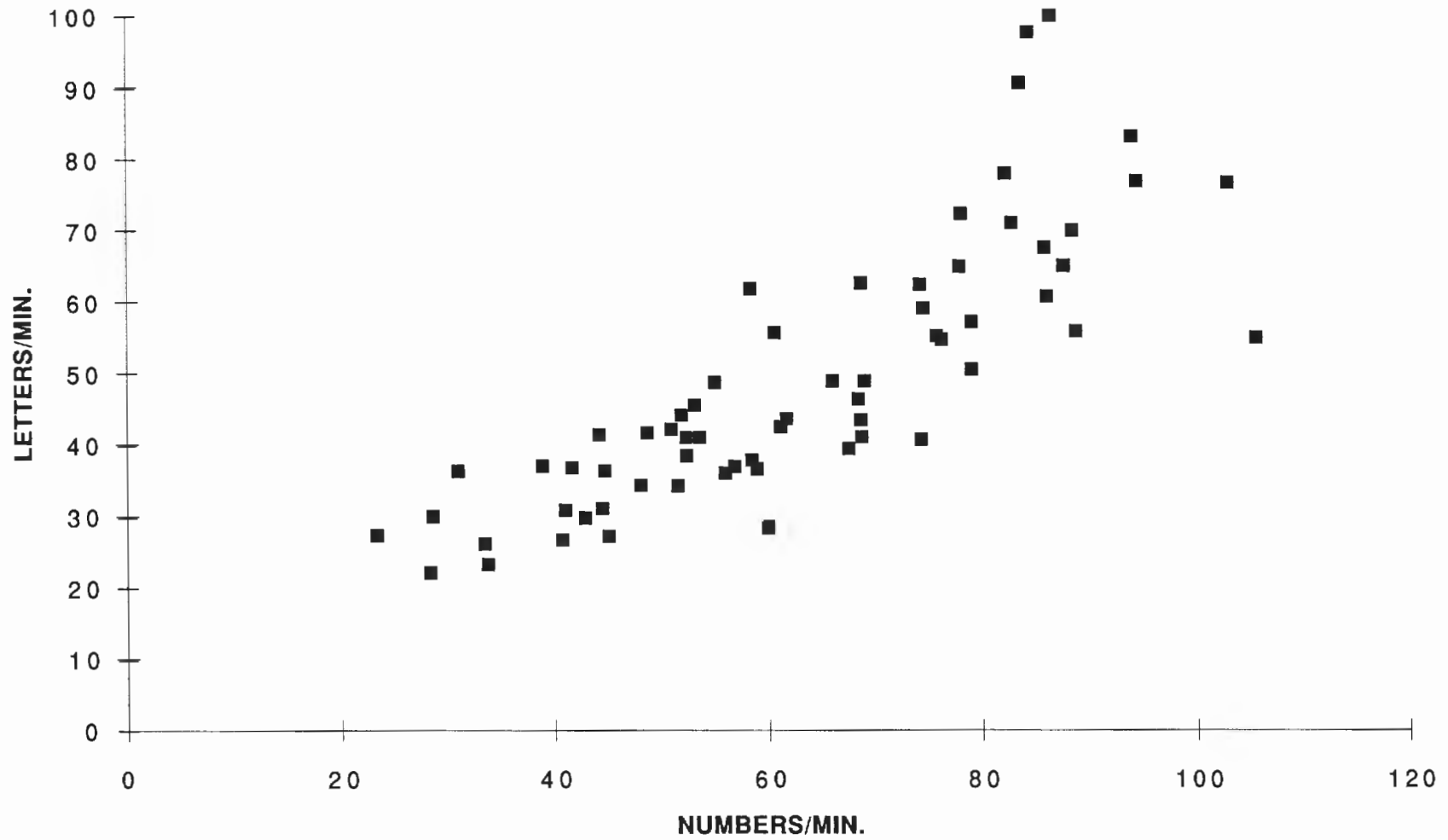
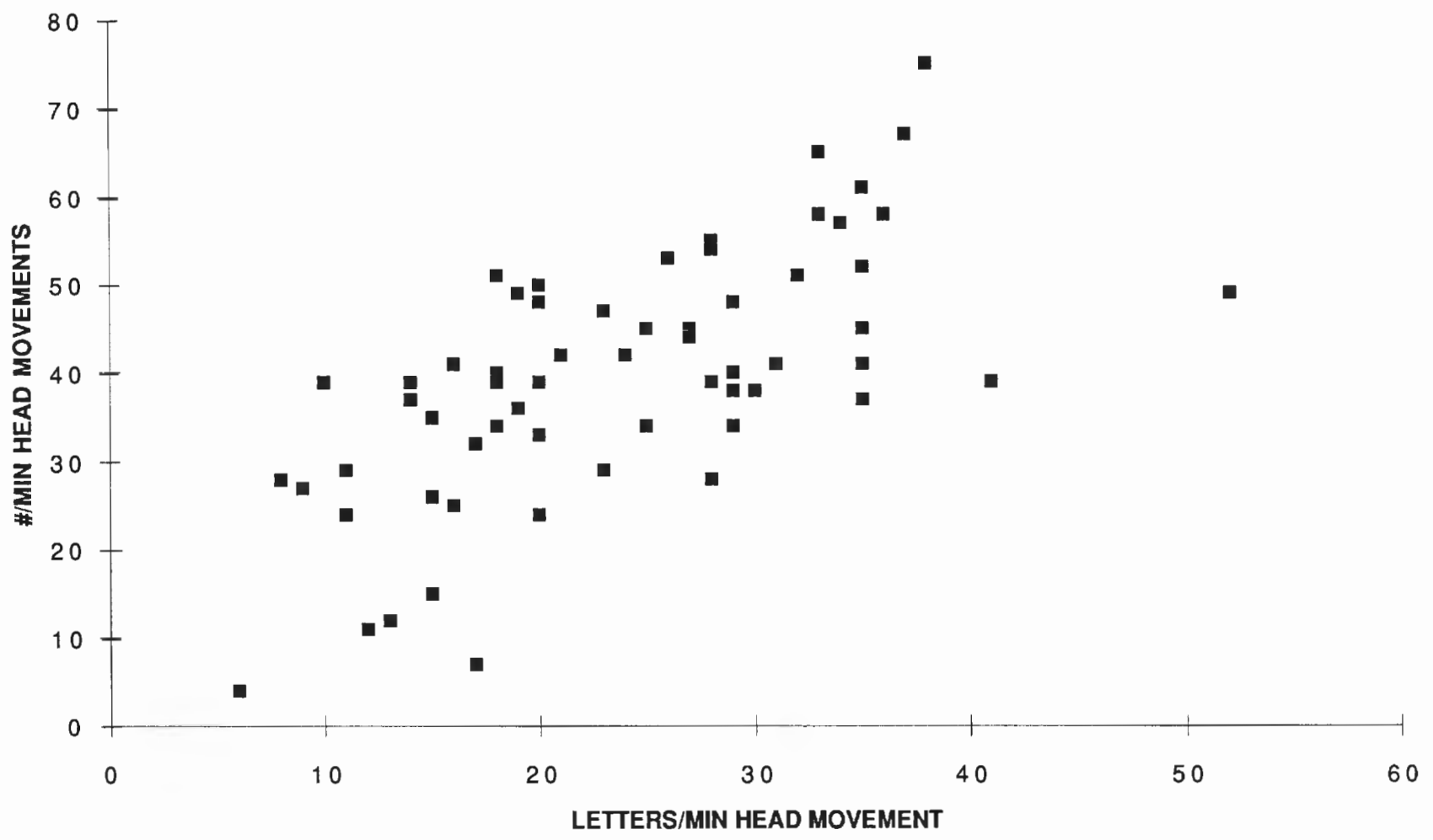


FIGURE 4.

LETTERS/MIN. HEAD MOVEMENTS VS. #/MIN HEAD MOVEMENTS



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The children from Eagle Creek Elementary who participated in the study, and their parents for their open-mindedness in allowing their children the opportunity to participate in an optometry research project.

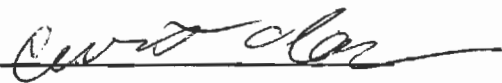
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Curt Oland received his bachelor's degree, in Biology, from Mayville State University in Mayville, North Dakota. He is currently working on his Doctor of Optometry degree at Pacific University in Forest Grove, Oregon. Upon graduating, in May of 1993, he hopes to practice optometry for Public Health Services in the state of Alaska.

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SIGNATURE PAGE

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