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Development and tentative norms for the Stern Fixation test

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Development and tentative norms for the Stern Fixation test

Abstract

The Stern Fixation Test (SFT) was developed to clinically evaluate the eye movement skills involved in reading, with a minimum of symbol recognition required. Two forms of the test were constructed to meet the different letter size, number of words per line, number of lines per paragraph, and number of lines per page for reading material, one designed for grades 1-3 and the other for grades 4 and above.

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DEVELOPMENT AND TENTATIVE NORMS
FOR THE STERN FIXATION TEST

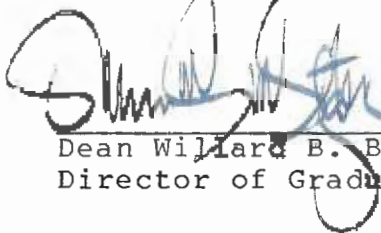
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Submitted in Partial Fulfillment of the
Requirements for a Master of Education
Degree (Visual Function in Learning)

Pacific University, Forest Grove, OR 97116

2 May 1984

Graduate Committee:



Dean Willard B. Bleything, O.D., M.S.
Director of Graduate Studies

date 7 May 1984

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the Stern Fixation Test

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FOR THE STERN FIXATION TEST

Norman S. Stern, O.D., Ph.D.

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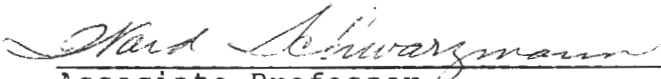
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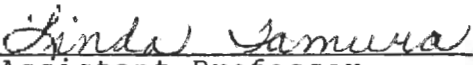
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ABSTRACT

The Stern Fixation Test (SFT) was developed to clinically evaluate the eye movement skills involved in reading, with a minimum of symbol recognition required. Two forms of the test were constructed to meet the different letter size, number of words per line, number of lines per paragraph, and number of lines per page for reading material, one designed for grades 1-3 and the other for grades 4 and above.

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INTRODUCTION

To help diagnose a saccadic eye-movement* problem that may be contributing to a reading problem, a saccadic fixation test is often used. The currently available clinical saccadic fixation tests, the Pierce Saccade Test, the Per Con Saccadic Fixation Test, and the NYSOA K-D Saccade Test, do not reflect the reading task actually encountered in schools.

The purpose of this investigation was to develop and tentatively norm a fixation test that would approximate the visual demands of school reading material.

Review of the Literature

Visually, during reading, the two eyes must accommodate** accurately to keep the print clear and the two eyes must fuse or a double image will result. There is not a continuous sweep of the eyes across the page, but rather the eyes proceed in quick, short movements with pauses interspersed. The eye movements involved in reading are saccadic fixations (used to move from one word to another), regressions (saccades from right to left used to refixate previously viewed material), and return sweeps (saccades from the end of one line to the beginning of the next lower line to be read).

In reading, perfectly, rhythmic eye movements exist only theoretically or possibly when one is reading fluently extremely simple material.² Taylor has found that between the first and sixth grades children fixate at least once per word,³ and thus

*A voluntary shift in fixation from one point to another.

**Ocular focusing adjustments for objects at near distances, involving parasympathetic stimulation of the ciliary muscle.

the evaluation of eye movements involved in reading must include material requiring irregularly spaced small fixations.

Eye movements during reading reflect the sight word recognition, word analysis, and comprehension abilities of the reader, and irregularities are present in the eye movement patterns of both "good" and "poor" readers, particularly when they are attempting to read difficult or unfamiliar material.⁴ Griffin, Walton, and Ives compared a group of inadequate readers* with a group of adequate readers** on measures of saccadic eye movements. Reading and nonreading materials and tasks*** were used as targets for a Reading Eye Camera. On all nonreading and reading tasks inadequate readers tended to make more regressions and fewer forward fixations.⁵ Starnes evaluated the pursuit eye movements of good and poor readers, and found that 90 percent of the good readers had smooth pursuits, while only 40 percent of the poor readers showed this ability.⁶

*Pupils of average or above average intelligence and not diagnosed as severely neurologically or emotionally impaired, the performance of these children in the language arts - e.g. reading, spelling and writing is significantly below their grade placement and general intelligence.

**Pupils who were reading at or above grade level, based on their classroom teachers' evaluations on measures of saccadic eye movements.

***A Picture Card consisting of 25 black ink animal drawings equally spaced five across in five rows. Pictures 6 mm. across were spaced 21 mm. apart (measured from the center of the picture) and in rows of 12 mm. separations, requiring a four-degree eye movement from picture to picture and a 15 degree return sweep. A Dot Card was similar in format to the Picture Card with a 2 mm.-dot substituted for the picture. A Two-Word Card had two words to a row spaced 84 mm. apart (measured from the middle of the words). A Five-Word Card had five words to a row spaced 21 mm. apart, also measured from the center of each word. Words on the Two-Word Card and Five-Word Card were three-letter words from the Dolch Lists.

Flax found that 52 percent of dyslexic children showed gross jerkiness of their eyes during a tracking task versus only 11 percent for the control group.⁷ Gilbert in a study dealing with ocular motor efficiency and its relationship to reading, found a wide range between the upper and lower quartile readers on number of fixations, number of regressions, and the average fixation duration on digit and prose reading.⁸ The frequency of saccades and the average fixation duration are negatively correlated with reading ability (as reading ability increases, the number and duration of fixations decreases) and positively correlated with the difficulty of the reading material (as the reading material increased in difficulty, the number and durations of fixations also increased).^{9,10,11,12} Flax concluded that inaccurate eye movement control can lead to numerous reading "errors" such as omission, substitutions, and loss of place.¹³

The spacing of lines, length of lines, and size of type may vary widely without a great deal of influence on children's reading, according to an extensive study by McNamara, Paterson, and Tinker (1953). Their study showed that type sizes over the range of 8 to 24 points had no effects in the first and lower second grades on reading; in the upper second, 14-point had a slight advantage; in the third grade there was also a small advantage for 14-point, although 10-and 12-point were almost equally good. Likewise, line length or leading showed no consistent results,¹⁴ however adults are more influenced by these factors.¹⁵ Gibson and Levin concluded that "for young children who are reading slowly with a great deal of attention to the details of the text, physical features of the textual display are only peripherally important.

Adults whose reading is practiced and automatic do find certain type sizes and layouts easier to read.¹⁴ The optimal type size for best readability is considered by some to be 11 point type (20/60 Snellen),¹⁴ and others 14 point type (20/80 Snellen).¹⁵ Lower case texts are felt to be more legible than texts printed in all capitals, because of the greater variety of word shapes possible in lower case.¹⁴

In summary, poor eye movements during reading may be related to either vision problems or difficulties with the level of reading task material, and therefore eye movements must only be evaluated on material within the readers ability. The diagnosis of saccadic eye movement problems must include materials which minimize decoding or comprehension factors. The three clinical tests available to evaluate saccadic ability are the Pierce Saccade Test, the PerCon Saccadic Fixation Test, and the NYSOA K-D Saccadic Test.

1. The Pierce Saccade Test;¹⁶

- a. consists of two vertical rows of numbers spaced 8 1/4 inches apart.
- b. The testee calls out the numbers starting with the upper left, then the upper right, then the second upper left, and so on as rapidly as possible.

2. The PerCon Saccadic Fixation Test;¹⁷

- a. Is similar to the Pierce Saccade Test except that the numbers are present in horizontal columns spaced 3/4 inches apart.
- b. The testee calls out the first and last number on each column.

3. The NYSOA K-D Saccade Test;¹⁸

- a. Consists of numbers randomly spaced on horizontal lines. The testee is timed for calling out each letter in the order of right to left, top to bottom line.¹⁸

In summary, the Pierce, Per Con, and NYSOA K-D saccadic tests do not represent the letter size, number of words per line, number of lines per paragraph, and number of lines per page of reading material normally encountered by children and adults, and thus are of limited value in diagnosing if saccadic fixations are contributing to a reading problem.

Statement of Problem

The purpose of this investigation was: 1) To develop a fixation test that approximated the visual acuity, accommodative, and eye movement demands normally encountered by children in grades 1-3 and older children and adults in the 4th grade and above, without requiring comprehension or decoding beyond single letter recognition; and, 2) To establish tentative norms by age and grade.

Materials

Basal readers for the first and fourth grades from The Economy Company, Allyn and Bacon Inc., and the Macmillian Publishing Co., were evaluated for letter size, number of words per line, number of lines per paragraph and number of lines per page (Figure 1 and 2).

Publisher	Letter Size Capital	Snellen Lower Case	Words Per Line	Lines Per Paragraph	Lines Per Page
Economy Co. Allyn & Bacon, Inc.	20/120	20/80	6	3	15
Macmillian Co.	20/150	20/120	6	3	12

Figure 1. Letter size, words per line, lines per paragraph, and lines per page for first grade basal readers.

Publisher	Letter Size Capital	Snellen Lower Case	Words Per Line	Lines Per Paragraph	Lines Per Page
Economy Co. Allyn & Bacon, Inc.	20/100	20/60	9	4	20
Macmillian Co.	20/120	20/80	8	4	22

Figure 2. Letter size, words per line, lines per paragraph, and lines per page for fourth grade basal readers.

The Economy Basal Series¹⁹ was chosen as representative of the group evaluated. It contains two distinct groups of books, those for grades 1-3 and another for grades 4 and above. Those for grades 1-3 have capital type size of 20/120 and lower case type size of 20/80, averaging 6 words per line, 3 lines per paragraph, and 15 lines per page. The books for 4th grade and above have capital type size of 20/100 and lower case type size of 20/60, averaging 9 words per line, 4 lines per paragraph and 20 lines per page. Form 1 of the SFT consists of a representative page from Blue Dilly Dilly, a grade 1, level 6 book of the Economy Co. Basal Readers Program 1975, with only the first letter of each word present, in the position it occupied on the page (Appendix A).¹⁹

Form 2 of the SFT is the first letter of each word from a representative page of Silver Twist, a grade 4, level 11 book of the Economy Basal Readers Program 1975, (Appendix B).¹⁹

Subjects

The subjects consisted of two populations, the first consisting of 285 elementary school children from Washington County, Oregon. The subjects ranged in age from six to 12 years. Of the 285 students, 41 were first graders, 42 second graders, 65 third graders, 42 fourth graders, 50 fifth graders, and 45 sixth graders. The subject population was selected at random without regard to sex, age, or grade level placement. The only qualification required of the subjects was a signed parental permission form (Appendix C).

The second population of subjects was 156 adults, ranging in age between 23 and 34, and consisted of third year optometry students at the Pacific University College of Optometry.

Procedure

The SFT was administered to the above subjects by third year optometry students from Pacific University, in the following manner: The instructions were read verbatim from the recording form (Appendix D & E). Each subject was then given the practice form (Appendix F) of the test and told to begin. The practice run was conducted to alleviate any undue student apprehension, confusion, misunderstanding or misinterpretations of the instructional set. Immediately following the practice run, the SFT was administered, Test 1 to grades one through three, and Test 2 to grades four and above.

The test was timed to the nearest second and errors were recorded on the individualized score sheet. An error was defined as any omission or incorrectly named letter which the subject did not voluntarily correct. A regression received no formal penalty, since the time spent renaming the letter was a self-invoked penalty. Each subject received a numerical score value which was determined in the following manner:

Score = time (in sec) + 2 times the number of errors, for example, a subject who completed the test in 86 seconds while committing four errors would have a score of 94 (score = 86 + (2 x 4)). This score was the value used in all of the calculations and data analysis.

Results

Figure 3 presents the mean and standard deviation for the SFT Form 1, by age and grade level for children reading on grade level.

Figure 4 shows the mean and standard deviation for the SFT Form 2 by age and grade level for children reading on grade level.

Figure 5 shows the mean and standard deviation for college educated adults on Form 2 of the SFT.

STERN FIXATION TEST FORM 1 MEANS BY AGE:				STERN FIXATION TEST FORM 1 MEANS BY GRADE:			
AGE	N	MEAN	SD	GRADE	N	MEAN	SD
6	11	95	18.08	1	22	86.18	20.77
7	26	74.12	19.00	2	30	68.7	21.59
8	31	60.61	10.28	3	29	58.59	10.39
9	15	60.27	25.42				

Figure 3

Means and Standard Deviations for children reading on grade level for the Stern Fixation Test Form 1 (grades 1-3).

STERN FIXATION TEST FORM 2 MEANS BY AGE:				STERN FIXATION TEST FORM 2 MEANS BY GRADE:			
AGE	N	MEAN	SD	GRADE	N	MEAN	SD
9	8	110	18.35	4	15	103.87	18.76
10	18	95.5	17.86	5	14	95.29	22.03
11	12	100.25	22.68	6	15	87.6	14.92
12	12	86.17	16.11				

Figure 4

Means and Standard Deviations for children reading on grade level for the Stern Fixation Test Form 2 (grades 4 and above).

STERN FIXATION TEST FORM 2

AGES	N	MEAN	SD
23-34	156	54.20	8.56

Figure 5

Means and Standard Deviations for college educated adults for the Stern Fixation Test Form 2.

Discussion and Summary

Mean and standard deviations for the SFT Forms 1 and 2 are presented in figures 3-5. Normal behavior for this test is defined as within one standard deviation on either side of the mean.

The SFT can be used to help diagnose individuals with eye movement problems that may be contributing to sustained reading difficulties. An individual with reading difficulties (after a complete vision exam to rule out any visual problems of eye-health, visual acuity, refractive error, accommodation, and fusion) could then be given the SFT. If he/she scored below one standard deviation of the mean, this would indicate either a saccadic eye movement problem or difficulty in recognizing and calling out the names of the alphabet. Individual alphabet letters could then be presented singly, in an untimed situation to determine if they could be recognized and named. If they could, then a saccadic fixation

problem could be diagnosed. The SFT recording form can be analyzed for patterns of errors, i.e., are there consistent errors on return sweeps to the next line, in the middle of each line, or on the right or left side of each line.

In summary, the SFT may be used clinically to evaluate eye movements approximating those required in reading. If an individual scores poorly on the SFT, he/she should be evaluated to determine if the inefficiency was due to inadequate eye movements or symbol recognition. Informally the SFT may be used monocularly (one eye alone) to compare the relative abilities of an individual's two eyes to fixate accurately and as a pre- and post-test to measure the effects of a lens prescription change or visual therapy.

Limitations

The tentative norms presented are based on small sample sizes of populations that may not represent the general population. Different investigators were used in norming the test, and there is the possibility of an inter tester variation which might effect the norm results. Further research should include test-retest reliability for the same tester and different testers, norms for different populations, and to determine objective pre- and post-test changes on the effect of visual therapy.

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Appendix A

O n R F l B W
H r a t r
H w l f f

S R F c t a f
H w a n f c
S h w t t c h

C c w t c
T c w s l t t f
c o

R F s t f
H w a
R F r a f a h c
H r b t B W

R F d n r t t c h
H s i t w

Appendix B

J W h s a h d d o t r
S t c b h h t a s L
a t h c i e T i s c
o o t m
J s h h a g s t t.
s O h w r h w f a a
t w l w a f c m r t
T e h o t m b o f J
c t h h
W h r t t o t s J s h
h a s i s T s w c
d o o h i t s o t m
A J d n t m h h t d
i s o w b t a l s t b c
r o o t c o s
S J s a T i s h
l l b t o b f o o t h
i t m T a c o f f

April 1979

Dear Parent:

Your child's class has been specially selected to participate this school year in the gathering of base line data for an eye fixation test. The test is the Stern Fixation Test, and was developed by Norman Stern, O.D., Ph.D., of the Pacific University College of Optometry, Forest Grove, Oregon.

The test consists of the child reading out loud letters from a test sheet, while being timed. The test will take only a few minutes of your child's time.

There are no known risks involved to your child, other than those he might encounter during his normal reading in school. Your child's name will not be recorded on the answer sheet and therefore will not be identified in any way as a result of this project.

When sufficient data has been gathered for this test, it will allow us to screen children for potential visual problems that might interfere with reading.

Dr. Stern will be happy to answer any questions that you may have at any time during the course of the study.

You are free to withdraw your consent and to discontinue participation of your child in this project at any time without question.

We are very grateful for your permission to allow your child to help us in this project.

Child's name _____

I have read and understand the above.

Parent's signature _____ Date _____
(Relationship to child: Mother, Father, Guardian)

Appendix I.
Stern Fixation Test
Recording Form 1 (grades 1-3)

O n R F l B W
H r a t r
H w l f f

S R F c t a f
H w a n f c
S h w t t c h

C c w t c
T c w s l t t f
c o

R F s t f
H w a
R F r a f a h c
H r b t B W

R F d n r t t c h
H s i t w

Instructions:

1. "When I say Go, I want you to read each letter out loud as fast and as accurately as you can. Read them in the same order as you would sentences." You may not point with your finger at the letters.
2. Show the example card and have the child read all of the letters. Let the child hold the test at any distance they desire. When the child has finished reading the example card, ask him if there are any questions, if not say "Ready...GO".
3. Start timing as soon as you say GO and continue until they have read the last letter.
4. Mark each error on the above copy of the test by drawing a line through it. Each skipped letter is an error, and if a whole line is skipped, mark a check by it and count each letter in that line as an error.

Scoring:

Record the total time in seconds to complete the test:

Record double the total of all the errors on the test: ADD _____

Add the time and errors together for the Score:

Name _____ Sex: M F

Age _____ Birthdate _____ Grade in school _____

Wearing glasses during test: Yes No Date of last eye exam _____

Have glasses ever been prescribed in the past: Yes No

Reading level: _____ on grade level, _____ months above grade level,
_____ months below grade level

Appendix E

J W h s a h d d o t r
 S t c b h h t a s L
 a t h c i e T i s c
 o o t m
 J s h h a g s t t.
 .s O h w r h w f a a
 t w l w a f c m r t
 T e h o t m b o f J
 c t h h
 W h r t t o t s J s h
 h a s i s T s w c
 d o o h i t s o t m
 A J d n t m h h t d
 i s o w b t a l s t b c
 r o o t c o s
 S J s a T i s h
 l l b t o b f o o t h
 i t m T a c o f f

Instructions:

1. "When I say Go, I want you to read each letter out loud as fast and as accurately as you can. Read them in the same order as you would sentences." You may not point with your finger at the letters.
2. Show the example card and have the child read all of the letters. Let the child hold the test at any distance they desire. When the child has finished reading the example card, ask him if there are any questions, if not say "Ready...GO".
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Scoring:

Record the total time in seconds to complete the test:

Record double the total of all the errors on the test: ADD _____

Add the time and errors together for the Score:

Name _____ Sex: M F

Age _____ Birthdate _____ Grade in school _____

Wearing glasses during test: Yes No Date of last eye exam _____

Have glasses ever been prescribed in the past: Yes No

Reading level: _____ on grade level, _____ months above grade level,
 _____ months below grade level

Appendix F
Example Card
Stern Fixation Test

J w i t p

C a p b J s
H s H t b

T t t h i
H m t b

J g b
J h t b
T r a t b
H g i

T a J h f