1-1980

A preliminary investigation of norms and relationships for the Stern Fixation Test in the elementary school population

Charles L. Abady
Pacific University

Lynn E. Goodwin
Pacific University

J Steven Larsen
Pacific University

V Chad Nielsen
Pacific University

Keith L. Schindler
Pacific University

See next page for additional authors

A preliminary investigation of norms and relationships for the Stern Fixation Test in the elementary school population

Abstract

The Stern Fixation Test was investigated for its usefulness as a screening test for detecting visual problems associated with reading. Preliminary norms were established based on age and reading level, significant relationships between these norms and subject reading level for certain groups were found, and correlations between Stern Fixation Teat scores and the 21-point examination were found to be of low order. While the Stern Fixation Test cannot be expected to screen for all visual factors involved in reading, it can serve as a useful screening tool for many visual factors related to reading difficulties.

Degree Type

Thesis

Degree Name

Master of Science in Vision Science

Committee Chair

Norman Stern

Subject Categories

Optometry

Author

Charles L. Abady, Lynn E. Goodwin, J Steven Larsen, V Chad Nielsen, Keith L. Schindler, and Dennis M. Wagner

A PRELIMINARY INVESTIGATION OF NORMS AND RELATIONSHIPS FOR THE STERN FIXATION TEST IN THE ELEMENTARY SCHOOL POPULATION

by

Charles L. Abady
Lynn E. Goodwin
J. Steven Larsen
V. Chad Nielsen
Keith L. Schindler
Dennis M. Wagner

Advisor,
Norman Stern O.D., Ph.D.

A paper submitted in partial fulfillment
of the requirements for the Degree of
Doctor of Optometry

Approved _____

_____

Pacific University
College of Optometry
January, 1980

A PRELIMINARY INVESTIGATION OF NORMS AND RELATIONSHIPS FOR THE STERN FIXATION TEST IN THE ELEMENTARY SCHOOL POPULATION

by

Charles L. Abady
Lynn E. Goodwin
J. Steven Larsen
V. Chad Nielsen
Keith L. Schindler
Dennis M. Wagner

Advisor,
Norman Stern O.D., Ph.D.

Midterm Grade 

Final Grade 

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

The authors would like to acknowledge Dr. Norman Stern, creator of the Stern Fixation Test, for his constant support and valuable criticism in compiling this thesis. Additional thanks goes to the Washington County School District with particular gratitude to all the teachers and students without whose cooperation this project would not have been possible.

ABSTRACT

The Stern Fixation Test was investigated for its usefulness as a screening test for detecting visual problems associated with reading. Preliminary norms were established based on age and reading level, significant relationships between these norms and subject reading level for certain groups were found, and correlations between Stern Fixation Test scores and the 21-point examination were found to be of low order. While the Stern Fixation Test cannot be expected to screen for all visual factors involved in reading, it can serve as a useful screening tool for many visual factors related to reading difficulties.

INTRODUCTION

Investigation into the area of reading and reading disability reveals a large number of factors which contribute to reading proficiency. The Stern Fixation Test was developed in an attempt to provide a rapid and easily administered screener to isolate the visual factors which are involved.

Unlike other fixation tests designed to measure saccadic fixation skills, the Stern Fixation Test was designed primarily to screen for visual factors which have been shown to be important for grades one to three, another for grades four to six.

It is assumed that the skills necessary to score well on the Stern Fixation Test are also involved in proficient reading. The review of the literature indicated those skills considered most important to the reading task. Dr. Stern designed his test to isolate those visual factors, and approximate the type of reading material encountered by elementary school children at different grade levels. He determined the print size and letter spacing for the two forms of the Stern Fixation Test (see Appendix) by surveying several basal reader series at the appropriate grade levels. Only the first letter of each word was utilized in constructing the test to approximate the visual task factors involved in reading, while isolating these factors from the other reading task factors such as knowledge of sight words, context clues, phonic analysis, structure analysis as well as the many other factors which will be presented later.

In this study, the Stern Fixation Test was given with a three-fold

purpose in mind: to establish norms based on age and reading level, to investigate the relationship between these norms and subject reading levels, and to explore the relationship between performance on the fixation test and the subject's performance on the 21-point examination as determined by Haynes' normative analysis.

Factors Involved In Reading:

In considering factors involved in reading, a review of the literature will involve what many consider required skills and task factors in learning to read and the development of these skills into the ability to learn from what is read.

Stanchfield[77] considers as essential to successful reading instruction the faculties of auditory discrimination, visual discrimination skills, oral language skills, sound-symbol correspondence skills, motor perceptual skills and efficient listening skills. Oral communication in the language has been cited as another prerequisite skill by Gibson,[31] who identifies three phases of learning in the process of moving from spoken to written language: 1) differentiation of graphic symbols, 2) decoding letters, and 3) using progressively higher-order units of structure. Concerning the effects of graphic characteristics on reading, Vernon[84] does not believe small children below five or six years of age are capable of perceiving and remembering small details of shape and regards auditory perception as a more significant factor at this early stage. There is support for this idea from studies[32] which have shown that spacing of lines, length of lines, and size of type seem to have little influence--within wide limits--on children's reading. Adults are said to be more influenced by these factors, however, and a very thorough treatment of the factors of style, contrast, illumination, spacing and size of type as they relate to the

"visibility" and "readability" is presented by Luckiesh and Moss.[51] It is their feeling that utilization of type size by printers has not been maximized for best comfort in reading. They propose 14 point type as close to optimum standard for type size, for best readability. Others consider 11 point type to be optimal.[32] Lower case texts are claimed to be more legible than texts printed in all capitals, due to greater variety in word shapes possible in lower case.[32]

The identification of both letters and words proceeds by a process of feature analysis, according to Smith,[71] who also presents the basis of three other theories of word recognition: whole word, letter by letter, and identification of letter clusters. He favors the feature analysis theory and proposes that both visual and auditory channels operate by a feature analytic process. Recognition, then, involves a system which makes use of the relative frequency with which "critical features" are combined to form letters, and these letters words, etc.[23] Certain features in a letter, however, have been shown to affect identification differently depending on its context in a word.[5]

In the process of decoding letters to sounds, Gibson writes: "reading entails decoding to speech. Letters are, essentially, an instruction to produce a given speech sound."[31] It is said that children learn early to recognize shapes and sounds of individual letters. A high correlation was found between naming of letters and reading ability.[84] Some of the problems of decoding letters to sounds result from the various sounds associated with a single letter when that letter occurs in different words.[31] Also involved are the arbitrary and unsystematic nature of the associations between printed letter units.[84] The process of reading is not understood such that it can be explained by a theory or model agreeable to all. A

review of several current models is presented by Singer, which try to explain the processes of decoding, comprehending, and subsequent oral or written outputs.[70]

Comprehension of spoken and written language requires the ability to perceive and process higher-order units of structure. Letters have patterns of distinctive features, occurring redundantly, and can be considered as higher-order structures. Words then become still higher-order structures.[32,71] "Relations between distinctive features and events constitutes learning higher-order structure."[32] Gibson believes the smallest units or "chunks" of english which are perceived in a single fixation are "spelling patterns" (having invariant pronunciations) the size and complexity of which increase with development of reading skill.[31]

Prolonged reading effort, according to Luckiesh and Moss, requires good visibility of reading material as well as good readability. "Readability" encompasses factors of strain, tenseness, fatigue, and other psychological and physiological factors.[51] Pre-requisites to reading for comprehension according to Athey include minimal vocabulary, knowledge of grammatical structure to some degree, and certain background information relative to the reading material.[3]

Reading is defined in the practical sense by Guszak as "thinking in response to graphic cues."[37] In analyzing reading comprehension, he presents the different taxonomic models developed by Guilford, Bloom, Sanders, and Barrett. Of these various models, which evaluate comprehension in terms of processes and objectives, Guszak prefers that of Barrett which describes the specific outcomes of reading. These are literal comprehension, reorganization, inferential comprehension (convergent or divergent thinking), evaluation and appreciation. In their chapter, "Learning from

Reading," Gibson and Levin[32] admit that basic research offers more knowledge about recognition of words than about comprehension of sentences and longer passages. They present the main processes involved as: 1) extracting relevant information, 2) assimilation of the information with previous knowledge - fitted into the system in a meaningful way, 3) remembering and retrieving it when desired, 4) making inferences from the text, and the essence of reading them being, 5) the ability to use the information from reading on a new occasion or in a new context.

Auditory discrimination is the ability to hear similarities and differences among sounds of letters. Tests of auditory discrimination have varied approaches to measurement and show varied correlations.[19] No significant relationship or predictive value for reading ability was found from various auditory discrimination tests for students in the intermediate grade levels.[60,87] Auditory discrimination seems to be more significant at primary reading levels; but, according to Spache, "is not a highly significant factor in reading success at any level or in any population."[76] Other studies[2,18,55] have considered auditory discrimination to be a significant factor in reading for minority or disadvantaged pupils. The need for auditory discrimination training has been advocated for low socioeconomic children. Auditory acuity losses involving high frequencies affect consonant sounds and blends. These children are severely handicapped in learning via the diagraphs. These children tend to fail in the primary grades.[24,41]

Intersensory interjection is the process of translating sensory stimuli from one channel to a response in another channel. Areas considered in testing include audio-visual, visual-auditory, visual-visual, and auditory-auditory.[23] "It has been recognized for some time that the visual, oculomotor, proprioceptive..., and motor systems of the human being are integrated in the interpretation of sensory stimuli. "[19] It has been suggested

that auditory pattern perception might be the most important intersensory factor in reading, as opposed to transposition of stimuli from visual to auditory or vice versa.[79,80] The same researchers consider auditory-visual integration as a temporal-special relationship involving recognition of time sequencing and special sequencing. Spache[75,79] cannot see any justification for the administration of tests to measure intersensory integration since there is not certain knowledge about what is being measured. Children should not, therefore, be labeled as learning disabled due to low scores on such tests.

What is the relationship between intelligence and reading ability? Intelligence involves the ability to deal efficiently with abstractions, to learn and to respond appropriately in new situations. Albert Harris indicates that the correlation between reading and individual verbal intelligence tests, such as the Stanford-Binet, is approximately .60 to .70.[40] The question of whether or not the I.Q. is an accurate prediction of reading ability has traditionally been of special concern to the reading specialist. A moderate to low relationship between I.Q. and later reading ability has been found,[1] as measured by studies of their correlation. A study purported to represent what can be expected in elementary classes in general used the Stanford-Binet I.Q. measure. It showed a positive relationship between reading and I.Q., but also showed a considerable range of reading levels for each I.Q. score. George and Evelyn Spache express the opinion that I.Q.'s are of little value in predicting later reading achievement.[74] Another way of viewing the relationship between reading and intelligence is to examine the correlation between various intellectual abilities and overall or specific areas of reading achievement. Benjamin Harootunian studied the relationship between fourteen intelligence variables, and reading

achievement.[39] Harootunian found the combined coefficient of multiple correlation between reading and the combined variables to be .781.[39]

"The contributing role of neurological defects, such as brain injuries, to school difficulties, has been recognized since before the last century. Such obvious effects as aphasia, cerebral palsy, mental retardation, and motor disturbances, have been dealt with in a number of specialized fields such as neurology, special education, speech pathology, rehabilitative medicine and physical therapy, to mention only a few."[76] Within the past two decades, the emphasis upon brain damage as a possible cause of reading disabilities has broadened tremendously.[30] Brain damage is being accepted as the primary etiological cause for thousands of pupils who not only show none of the classic massive symptoms but who also, neurologically speaking, may not show any real signs of cerebral dysfunction.[76]

Sociocultural factors that affect reading success include a number of areas such as language development, racial or ethnic characteristics, familial relationships, and school relationships as well as socioeconomic status. Negative elements in each of these areas combine to influence the childs ultimate success in the classroom.[9,13,35,38,52,58]

In studies by Holmes and his colleagues,[43] personality and attitudinal factors failed to appear among those variables making a statistically significant contribution to the variance in reading ability. Should we conclude that affective factors make no contribution to reading ability? A survey of the literature[46] immediately belies such a conclusion. The authors of the above studies point out, when the sum of the contribution made by each of the selected variables is computed, approximately two percent of the variance in reading comprehension remains unexplained. They surmise that motivational factors, either stable or temporary, may be operating, but

these factors are other than those measured by personailty tests employed. Practically, the relationship between measured personality variables and reading is usually so tenuous as to prevent their appearance at any level of the analysis. An initial attempt to identify some of the specific personality characteristics related to reading was made in a study by Athey and Holmes.[4] The relationship between reading and personality may be different at different age levels and for different groups.[44] In general, the research literature suggests that good readers tend to have more positive self concepts than poor readers.[49,50,92] Conversely, underachieving readers tend to be characterized by immaturity, impulsivity, and negative feelings concerning themselves and their world.[3]

Wattenburg and Clifford[85] suggest that indices of the sense of personal worth and competence, if used in kindergarten, would add significantly to reading prediction. Variance in reading ability has not been statistically related to factors of personality and attitude according to Holmes, et. al.[43,44] We should not, however, conclude that affective factors make no contribution to reading. Personality tests did not measure motivational factors.

Visual Factors and Reading:

A large and diverse body of literature has been published dealing with the relationship of visual factors and reading problems. In reviewing this literature, it becomes apparent that there is little agreement on the role of visual deficiencies as causes of reading difficulties.

Hyperopia has long been suggested as a possible cause of reading difficulty. Robinson found hyperopia to be significantly more frequent than any other type of refractive error in a study involving thirty cases of reading disability ranging in age from six years nine months to fifteen

years three months.[62] Cole found that 60 percent of poor readers were hyperopic to some degree.[15] Eames' work with a group of poor readers indicated that 43 percent were hyperopic.[21] These and other studies seem to indicate that compared to the normal population, there is a high incidence of hyperopia among poor or retarded readers. Eames and Taylor found myopia to be more prevalent among normal readers.[21] Taylor indicated that from 387 normal readers, 52 percent were myopic while only 28 percent of 100 poor readers manifested myopia.[81]

The relationship of astigmatism to reading difficulty is less well agreed upon. Betts found an incidence of 90 percent in a group of poor readers.[10] Eames, however, found significantly fewer of his poor readers to exhibit astigmatic refractive errors.[21] In a study by Schubert, induced astigmatism was shown to adversely affect the reading ability of 68 percent of a group of college students.[67] Other studies indicate that astigmatism is not in and of itself a differentiating factor.

Anisometropia has long been considered a causitive factor in reading disability. The correction of unequal refractive errors has been shown to allow some students to achieve at a level nearer their potential.[22] The evidence seems to suggest that anisometropia is a more important causal factor in reading disability than more equal refractive errors.

Far point visual acuity levels have not proven to be a significant factor in reading ability. Fendrick's study of poor readers concluded that a statistically significant difference was isolated favoring the good readers.[20] Farris concluded that decreased far visual acuity did not always handicap a child's ability to learn to read.[25]

Binocular incoordination has long been implicated as a factor in poor reading ability. Robinson and Huelsman, in a survey-type study, looked

at the relationship of 59 visual tests to reading ability. The visual tests which most consistently differentiated high from low achievers involved binocular visual performance.[64] Eames found that binocular incoordination at the near point is often associated with reading disability cases.[21] Farris stated that monocular subjects progress more rapidly than binocular subjects in learning to read.[25] Westheimer found no significant difference between similar groups except below the 25th percentile level where several cases of binocular incoordination were noted.[86] Good, in his study involving 30 subjects, concluded that adduction and abduction weaknesses accompany difficulty in learning to read.[34] Witty and Kopel found that 29 percent of poor readers and one percent of good readers exhibited slow or sluggish fusion.[89] Park and Burri found a correlation between reading ability and total duction score at the .647 level.[56] The relationship of the phoric posture to reading ability has long been debated. Park, in a study involving 133 children with some degree of reading difficulty, found phoric measurements greater than four eso or exo in 45 percent. Poor duction measurement, slow recovery ability after diplopia, and convergence insufficiency were associated with over 50 percent of the cases.[57] Spache and Tillman in a study of retarded and non-retarded readers concluded that fusional difficulties are related to reading.[73] It appears from these studies that the ability to maintain single, binocular vision without undue effort and fatigue is an important factor for success in learning to read.

Fixation disparity has been suggested as a possible cause for problems in learning to read. In a study of reading achievement at the college level, Silbiger and Woolf found a significant eso fixation disparity for the reading underachievers but no significant esophoria under dissociated conditions. They concluded that since fixation disparity tests more

closely approximate reading situations than do traditional lateral phoria tests, they should be added to the visual test battery.[90]

Minimum levels of accommodative performance appear necessary for success in learning to read, but conclusive studies dealing with maturation and ability to use and maintain accommodative proficiency levels at the beginning reading age are rare. Nedrow, in a selected group of good and poor readers, found that a battery of accommodative tests revealed a significantly lower accommodative ability in poor readers.[54] A significant relationship was shown between positive relative accommodation and reading difficulty in a group in institutionalized juveniles by Robinson.[61] Solan states that the most frequent visual anomaly in the severely retarded reader is sluggishness of the accommodative response manifesting either insufficiency or inability to change rapidly.[72]

Eye dominance does not seem to be related to reading ability according to studies by Flax and Park.[27,57] Brod and Hamilton, however, suggest that reading capability is much more closely related to eye dominance than to the interrelationship between hand and eye dominance.[12]

Steady, accurate fixations and smooth, regular ocular pursuits and saccades are of obvious importance in the act of reading. Starnes found 90 percent of good readers showed smooth pursuits while only 40 percent of his poor readers could demonstrate this same ability.[78] Flax found that 52 percent of dyslexic children showed gross jerkiness of their eyes during a tracking task whereas only 11 percent of the controls demonstrated such difficulty.[29] In an extensive study dealing with ocular motor efficiency and its relationship to reading, Gilbert 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.[33] A number

of studies have shown that the frequency of saccades and the average fixation duration are negatively correlated with reading ability and positively correlated with the difficulty of the reading material.[48,59,82,83] Flax concluded that inaccurate eye movement control can lead to numerous reading "errors" such as omission, substitutions, and loss of place.[28]

Visual perception as it relates to reading is a widely explored topic in the educational, optometric, and psychological literature. The fact that at least one child in seven is handicapped in his ability to obtain essential reading skills leads many individuals to feel that there is a need for further study into the relationship between vision development, perception, and the reading task. A number of visual perception tests have been developed to assess reading readiness and predict reading achievement. The first references appearing in the literature was early in the 1920's. Efforts to utilize the concepts of perception in the field of reading for diagnostic and predictive purposes is complicated. Perception tests are vulnerable to a multitude of confounding factors including cultural background, maturity, attention, vision, visual skills, meaningfulness, and intelligence.[6,76]

Research and expert opinion have supported the conclusion that visual perception is closely related to early progress in learning to read.[63] Piaget stated that the major developmental task of a child between the ages of three and a half to seven years of age is the establishment of stable and accurate perception. Gray found that there existed a high correlation between competence in reading and academic ability.[36] He further found that this correlation was reduced as an individual progressed through school. He attributed this reduction to the increasing complexity of achievement and its dependency on more factors. Center states that a relationship between

reading performance and perceptual functions might best be shown by a test or tests of perceptual dynamics.[14] Winebrenner felt strongly that the ability to perceive and reproduce form is a necessity for reading.[88] Schorr and Svagr found a significant relationship between visual-perceptual skills and reading comprehension.[66] Coleman found that nine of twenty subjects accounted for more than thirty-three percent of the variability in academic achievement.[16,17] The two basic areas which these subtests outlined were spatial discrimination and pattern reproduction. Lowder concluded that there is a significant relationship between perceptual ability and scholastic achievement.[50] Rosner related I.Q. and perceptual skills to school achievement and found perceptual skill measurements far more closely related to achievement than did I.Q.[65] Sherman evaluated the visual disorders of 50 children diagnosed as "learning disabled." He showed that 75 percent of these children presented deficiencies in visual perceptual-motor skills, form reproduction and visualization.[69] Kane investigated figure-ground in children and concluded it is a fundamental perceptual process and that before information can be stored effectively it must first be ordered into some pattern.[45]

Numerous studies concerned with identification of those kinds of visual perceptual abilities which are the most indicative of reading readiness and achievement have been attempted. Of the various perceptual areas, two that have received considerable attention in the literature because of the predictive power are form reproduction and visual discrimination. These areas encompass a number of subdivisions including spatial relationships, perceptual speed, figure-ground, visual closure, and digit, letter, and word recognition.

de Hirsch found poor performance with word matching, word recognition

and word reproduction to be most predictive of visual skill deficiency in reading disability.[42] Murroughs states that not only digit recognition but also the span and speed of this perceptual process are important for reading readiness and efficient reading ability.[53]

Robinson set out to determine the relationship of the Children's Visual Achievement Forms (Winterhaven) to reading achievement. He found them to be unsatisfactory in predicting reading ability difficulties and pointed out the considerable subjectivity inherent in their scoring.[64]

Beck tested the validity of house drawing as a first grade readiness test. He found it to be unsuitable for selecting potential underachievers because of the low correlation between house-drawing and achievement.[8]

Visual discrimination has been shown to be highly predictive in reading readiness and achievement. Lee et. al. used a visual discrimination task which measured the ability to recognize similarities and differences in letter and word forms in first graders. They found that this type of test correlated better to reading achievement scores than did two intelligence tests.[47] Similarly, Scott evaluated children's kindergarten scores on an experimental visual discrimination test of seriation and later to their second grade reading tests. He found a meaningful relationship between the children's perceptual skills and their success in reading.[68] Barrett, in his review of the literature, studied the relationship between various types of visual discrimination abilities and first grade reading achievement. He reviewed the relative predictive power of visual discrimination of letters, words, geometric designs, pictures, and combinations of these. He found that discrimination of letters and words had a higher predictive relationship than did discrimination of geometric designs and pictures. Additionally, he found no difference in the predictive power

between letter and word discrimination.[6] Zarulia examined the predictive values of three measures of reading readiness to first grade reading achievement. She found letter recognition to have the greatest value for predicting first grade reading success.[91] Barrett found that reading letters and numbers were the single best visual discrimination tasks for predicting first grade reading achievement. He also found that the optimum combination of visual discrimination tasks were reading letters and words, word matching and pattern copying.[7]

In summary, of the visual factors which influence reading ability, the most important seem to be hyperopia, binocular incoordination, anisometropia, accommodative ability, ocular movement and fixation skills, and visual discrimination. Most investigators reviewed agree that visual anomalies should be considered in individual cases. The issue would then seem to be the degree to which reading is affected by visual inefficiency and not whether vision is or is not involved.

Since reading involves a near point visual demand requiring accurate fixations, smooth pursuits, accurate and precise accommodation and convergence, and maintenance of these skills, studies isolating these visual factors and their relationship to the reading act would seem to be in order.

METHODS

Subjects

The subject population consisted of 285 elementary school children from the Washington County School District. 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 with no regard to sex, age, or grade level placement. The only qualification required of the subjects was a signed parental permission form, a copy of which is found in the Appendix.

Methods and Materials

Prior to administration of the test, the teachers were asked to provide the following information: 1) a numbered list of students in the class, and 2) a list with the student's number and reading grade level. The reading grade level was based on standardized testing when available, or the teacher's subjective evaluation. The Stern Fixation Test recording form (see Appendix) identified each student by number only. Only after the administration of the test and the completion of the visual examination, were these findings matched with the student's assigned reading grade level.

The Stern Fixation Test was administered to the above subjects in the following manner. The instructional set was read verbatim from the instruction sheet prepared by Dr. Stern, a copy of which is included in the Appendix. Each child was then asked if he or she had any questions. Each child was then given the practice form of the test and told to begin. The practice run was conducted to alleviate any undue student apprehension, con-

fusion, misunderstanding or misinterpretations of the instructional set. Immediately following this trial run the Stern Fixation Test was administered, form one to grades one through three, and form two to grades four through six.

The test run was timed to the nearest second with a stop watch and errors were recorded on the individualized score sheet. An error was judged as any omission or incorrectly named letter which the child did not correct on his or her own. Such a regression required no formal penalty since the time spent renaming the letter was a self-invoked penalty. Each child 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, graphs, and data analysis.

The subjects were offered a complementary visual examination at the Pacific University Optometric Clinic in Forest Grove. This examination included ocular health, entrance skills (NPC, motilities, cover test, confrontation) and the 21-point evaluation. The results were computer analyzed according to Haynes' normative analysis. The accommodative and convergence subscores were then compared with the Stern Fixation Test scores as z-scores.

RESULTS

Individual Stern Fixation Test Scores are compiled in Appendix A. Figures 1-6 are histograms that clearly illustrate the distribuiton of scores for the Stern Fixation Test by grade. The dashed line represents the mean score for students in a particular grade. These graphs afford the reader the opportunity to visualize the distribution of scores, as well as the variability of the scores about the mean. Uniform labeling of the abscissas allows for comparison of scores among the various grades by vertical inspection.

Tables I and II show results by grade for Test form 1 and Test form 2, respectively. Grade levels are listed as assigned by the teachers, either on grade level or years above or below as designated by (+) or (-). Sample size, means, and standard deviations for each level are found in the second, third, and fourth columns, respectively. For each grade, the mean for on grade level is compared with levels above and below and t values computed. The last column lists the level of significance for values computed. The last column lists the level of significance for these comparisons. It can be observed that a number of these comparisons (15 of 33) showed differences significant at the 0.05 level.

Tables III and IV present means for test forms one and two, respectively, according to age. If a student of a given age category was above or below his or her grade level in reading performance, this is designated as (+) or (-), with the age, respectively. The remaining information is presented as in Tables I and II. It can be noted that of the 15 compari-

sons made in Tables III and IV seven were significantly different at the 0.05 level.

Table V presents a further comparison of the means found in Tables I and II. In this table, comparisons are made between the mean scores of students judged to be at the same reading level but of different grade level. With the exception of one comparison (involving inadequate sample size), no significant difference between groups were found at the 0.05 level. Five out of the eight comparisons were not significantly different even at the 0.07 level.

Table VI demonstrates the relationship between performance on the Stern Fixation Test and the subject's performance on the 21-point examination by Haynes' normative analysis. Accommodation and convergence subscores and Stern Fixation Test raw scores were converted to z-scores for comparison purposes. A summary of these results can be found in Table VII, which presents correlation coefficients for comparison of accommodation and convergence z-scores and Stern Fixation Test z-scores. No significant correlations are apparent from these data.

DISTRIBUTION OF SCORES FOR THE SFT BY GRADE

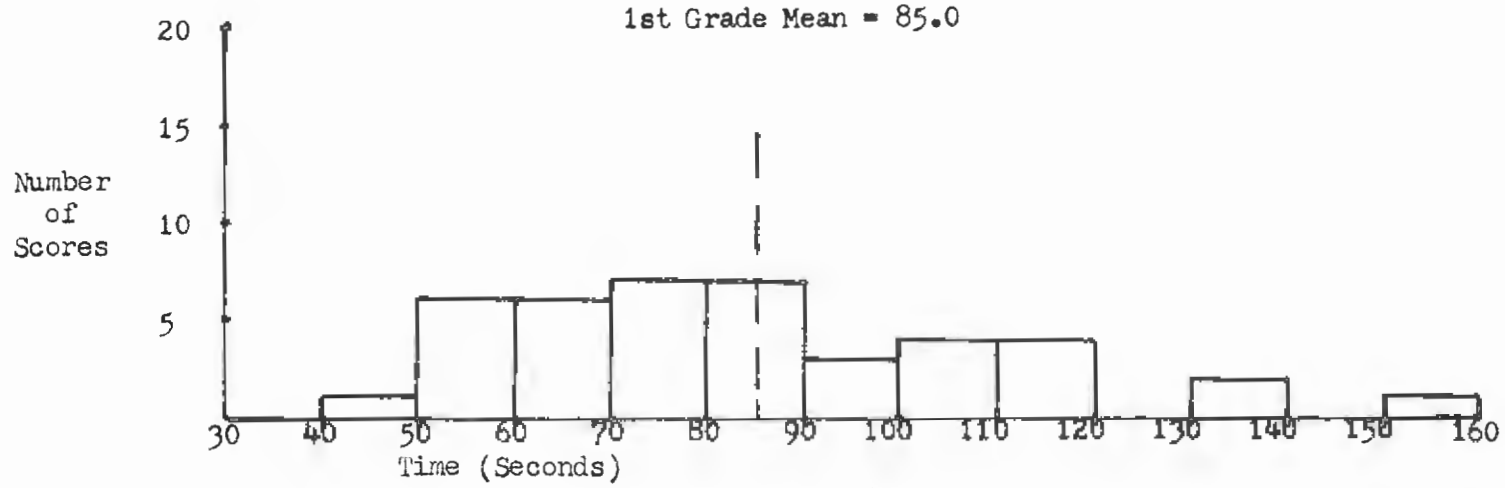

FIGURE 1

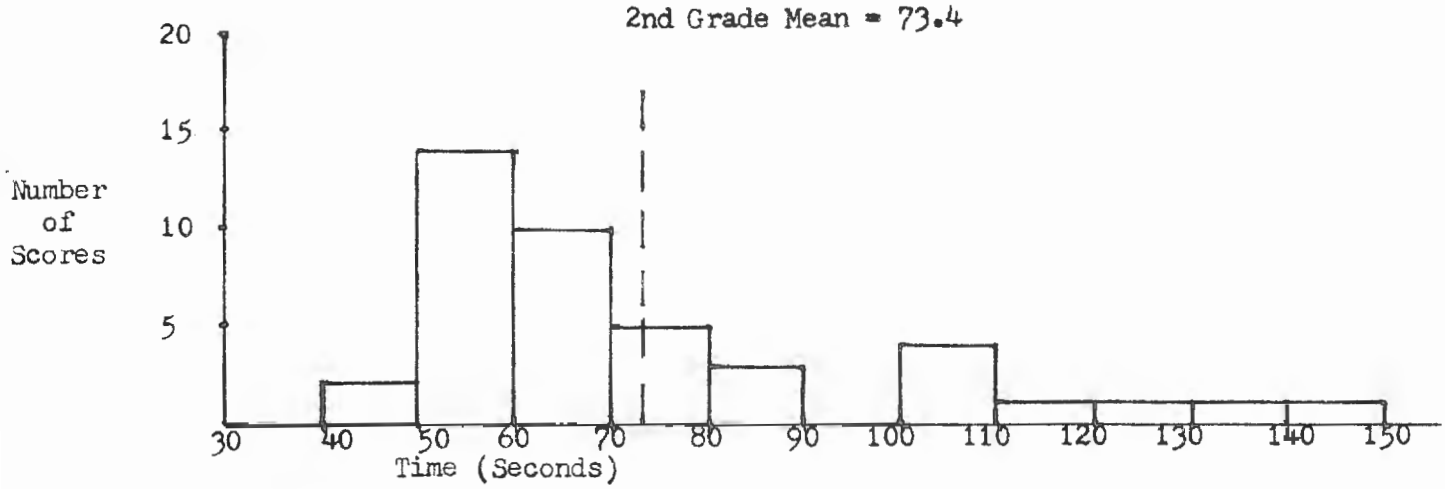

FIGURE 2

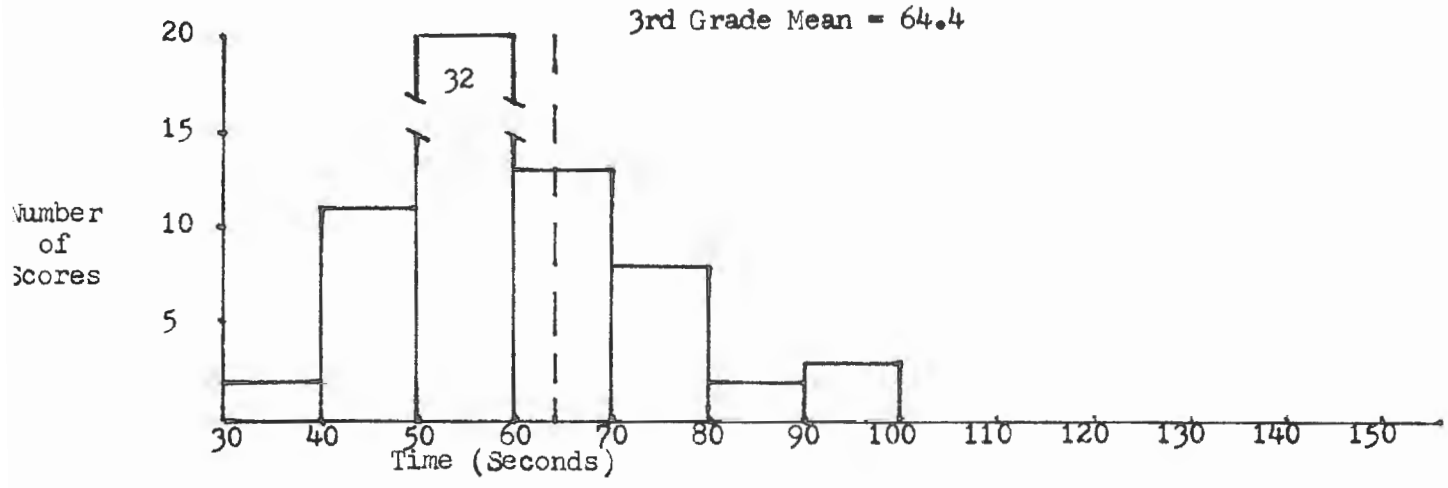

FIGURE 3

DISTRIBUTION OF SCORES FOR THE SFT BY GRADE

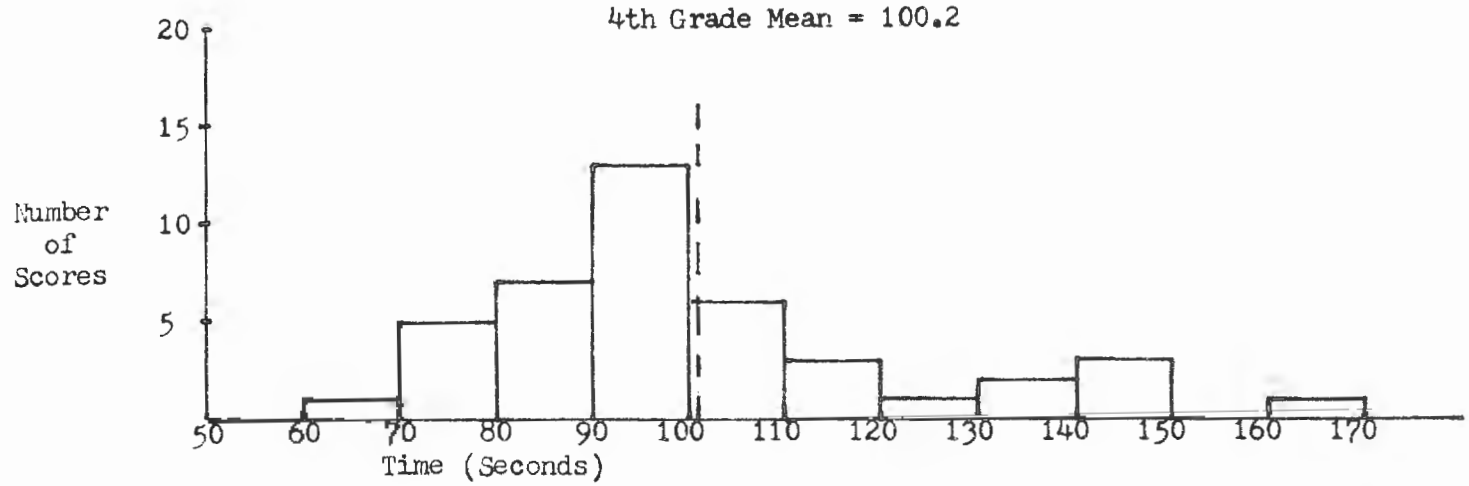

FIGURE 4

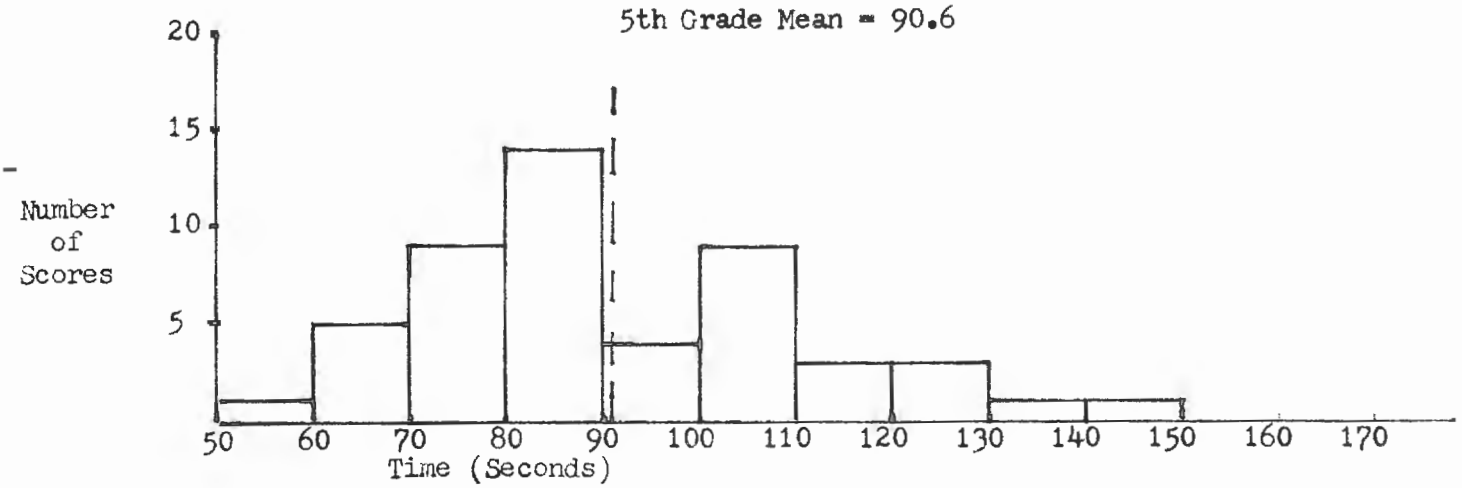

FIGURE 5

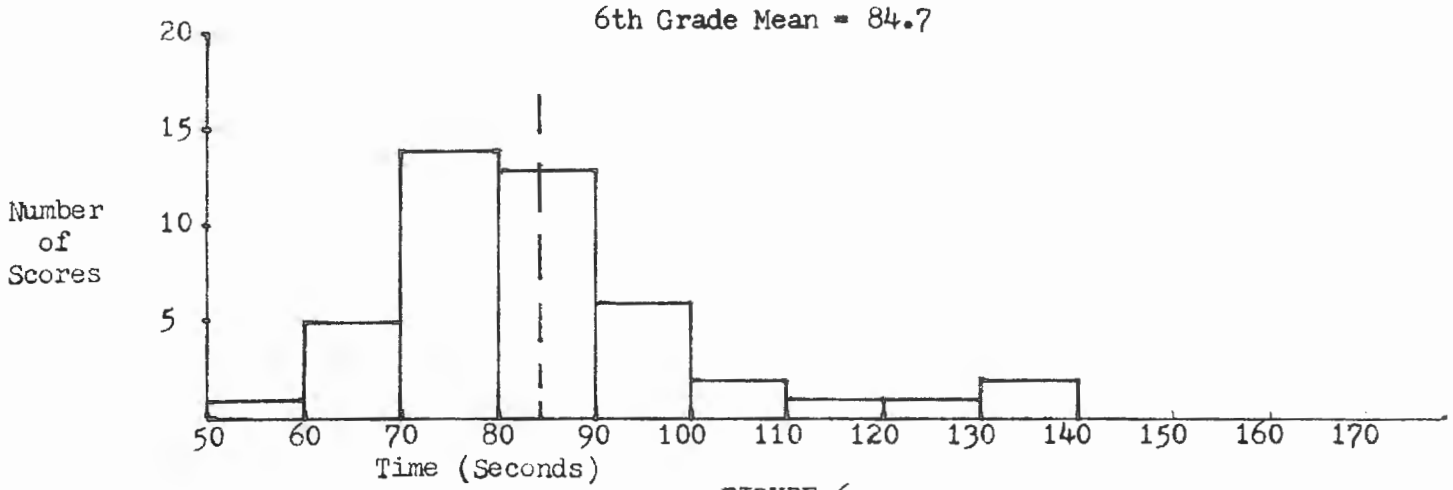

FIGURE 6

STERN FIXATION TEST MEANS BY GRADE: TEST 1				COMPARISON OF MEANS WITH "ON GRADE" MEANS		
GRADE	N	MEAN	SD	df	t-VALUE	*SIG. LEVEL
1 -½	4	101.5	29.73	24	-1.28	0.25
ON 1	22	86.18	20.77	--	-----	-----
1 +½	4	100.25	15.5	24	-1.282	0.25
1 +1	11	71.36	29.87	31	1.666	0.10
1 +1, +½	15	79.07	29.38	35	0.864	0.25
2 -1, -½	9	87.55	30.50	37	-2.085	0.025
2 -1	6	82.67	29.84	34	-1.359	0.10
2 -½	3	97.33	35.80	31	-2.076	0.025
ON 2	30	68.7	21.59	--	-----	-----
2 +1	2	93	18.38	30	-1.55	0.10
2 +1, +½	3	78.67	28.02	31	-0.746	0.25
3 -2, -1	19	66.26	13.45	46	-2.22	0.025
3 -2	6	62.67	12.96	33	-0.841	0.25
3 -1	13	67.92	13.86	40	-2.42	0.01
ON 3	29	58.59	10.39	--	-----	-----
3 +1	11	49.27	7.03	38	2.733	0.005
3 +2	6	47	7.56	33	2.579	0.01
3 +2, +1	17	48.47	7.07	44	3.552	0.005

TABLE I

*Significance level for a directional test

STERN FIXATION TEST MEANS BY GRADE: TEST 2				COMPARISON OF MEANS WITH "ON GRADE" MEANS		
GRADE	N	MEAN	SD	df	t-VALUE	*SIG. LEVEL
4 -2, -1	9	119.22	26.99	22	-1.647	0.10
4 -2	2	132.5	50.20	15	-1.707	0.10
4 -1	7	115.43	21.82	20	-1.280	0.25
ON 4	15	103.87	18.76	--	-----	-----
4 +1	15	90.07	15.06	28	2.221	0.025
4 +2	3	75.67	1.53	16	2.539	0.025
4 +2, +1	18	87.67	14.75	31	2.777	0.005
5 -2, -1	13	101.38	19.62	25	-0.757	0.25
5 -2	9	106.56	19.44	21	-1.251	0.25
5 -1	4	89.75	16.46	16	0.463	>0.25
ON 5	14	95.29	22.03	--	-----	-----
5 +1	9	87.33	17.71	21	0.908	0.25
5 +2	14	78.14	13.37	26	2.489	0.01
5 +2, +1	23	81.74	15.51	35	2.195	0.025
6 -2, -1	10	97.3	20.56	23	-1.370	0.10
6 -2	5	102	26.60	18	-1.534	0.10
6 -1	5	92.6	13.72	18	-0.660	>0.25
ON 6	15	87.6	14.92	--	-----	-----
6 +1	12	79.08	5.87	25	1.860	0.05
6 +2	8	72	13.05	21	2.49	0.025
6 +2, +1	20	76.25	9.76	33	2.719	0.01

TABLE II

*Significance level for a directional test

STERN FIXATION TEST MEANS BY AGE: TEST 1				COMPARISON OF MEANS WITH "ON AGE" MEANS		
AGE	N	MEAN	SD	df	t-VALUE	*SIG. LEVEL
ON 6	11	95	18.08	--	-----	-----
+6	6	81.5	24.24	15	1.308	0.25
-7	3	84.67	27.15	27	-0.877	0.25
ON 7	26	74.12	19.00	--	-----	-----
+7	12	76.83	31.08	36	-0.333	>0.25
-8	8	80.62	28.86	37	-3.235	0.005
ON 8	31	60.61	10.28	--	-----	-----
+8	6	51	9.34	35	2.123	0.025
-9	8	66.62	9.97	21	-0.674	>0.25
ON 9	15	60.27	25.42	--	-----	-----
+9	13	48.77	7.36	26	1.571	0.10

TABLE III

*Significance level for a directional test

STERN FIXATION TEST MEANS BY AGE: TEST 2				COMPARISON OF MEANS WITH "ON AGE" MEANS		
AGE	N	MEAN	SD	df	t-VALUE	*SIG. LEVEL
-9	4	131	30.52	10	-1.511	0.10
ON 9	8	110	18.35	--	-----	-----
+9	12	85.75	13.26	18	3.44	0.005
-10	9	109	20.43	25	-1.766	0.05
ON 10	18	95.5	17.86	--	-----	-----
+10	18	84.89	16.35	34	1.859	0.05
-11	11	100.73	18.56	21	-0.055	>0.25
ON 11	12	100.25	22.68	--	-----	-----
+ 11	18	79.89	13.66	28	3.077	0.005
-12	9	97.67	19.95	19	-1.462	0.10
ON 12	12	86.17	16.11	--	-----	-----
+12	12	75.42	11.59	22	1.876	0.05

TABLE IV

*Significance level for a directional test

COMPARISON OF MEANS

FROM TABLES I AND II

TEST I

Comparing	df	t-scores	Significance Level
1 + 1 (71.4) with ON 2 (68.7)	39	0.33	0.7
2 - 1 (82.7) with ON 1 (86.2)	26	-0.33	0.7
2 + 1 (93.0) with ON 3 (58.6)	29	4.37	0.001
3 - 1 (67.9) with ON 2 (68.7)	41	-0.12	0.9

TEST II

Comparing	df	t-scores	Significance Level
4 + 1 (90.1) with ON 5 (95.3)	27	-0.75	0.4
5 - 1 (89.7) with ON 4 (103.9)	17	-1.38	0.10
5 + 1 (87.3) with ON 6 (87.6)	22	-0.04	0.25
6 - 1 (92.6) with ON 5 (95.3)	17	-0.25	0.25

TABLE V

RELATIONSHIP BETWEEN PERFORMANCE
ON THE SFT AND THE SUBJECT'S PERFORMANCE
ON THE 21-POINT EXAMINATION BY HAYNES NORMATIVE ANALYSIS

	SUBJECTS	ACCOM. SUBSCORE	ACCOM. Z-SCORE	CONV. SUBSCORE	CONV. Z-SCORE	SFT RAW SCORE	SFT Z-SCORE
TEST 1	W.P.	27.8	0.1433	33.3	-0.8115	72	+0.7167
	L.J.	26.4	0.5892	18.3	1.4510	53	-0.0346
	K.C.	25	-0.3025	20.8	-0.4344	104	-1.2999
	J.B.	26.4	0.1433	27.5	0.5762	114	-1.6953
	A.S.	28.5	0.9251	28.3	0.7014	44	1.0726
	K.W.	23.5	-0.7803	17.9	-0.8718	62	0.3608
	J.B.	30	1.2898	28.7	0.7647	69	0.0840
	L.M.	20	-1.8949	14.6	-1.3695	81	-0.3905
TEST 2	C.K.	24.3	0.1262	23.3	2.0242	87	0.3743
	T.B.	25	0.2897	18.7	0.7930	88	0.2839
	J.S.	25	0.2897	12.5	-0.8871	64	2.4539
	C.C.	29.2	1.2710	16.2	0.1210	79	1.0976
	K.G.	16.4	-1.7196	13.3	-0.6639	89	0.1935
	A.D.	22.1	-0.3878	16.7	0.2339	101	-0.8915
	S.D.	19.3	-1.0421	11.6	-1.1102	91	0.0127
	T.I.	27.1	0.7897	11.6	-1.1102	97	-0.5298
	T.M.	19.3	-1.0421	12.1	-0.9946	99	-0.7107
	M.G.	29.3	1.2944	15.8	0.0080	104	-1.1628
	L.M.	26.4	0.6168	16.2	0.1210	96	-0.4394
	S.P.	24.2	0.1028	17.5	0.4570	85	0.5552
	L.M.	17.2	-1.5327	13.3	-0.6720	107	-1.4340
	B.M.	27.8	0.9439	22.1	1.6936	89	0.1935

TABLE VI

CORRELATION COEFFICIENT FOR COMPARISON OF
HAYNES' NORMATIVE ANALYSIS VS. STERN FIXATION TEST SCORES

COMPARISON		CORRELATION COEFFICIENT
[illegible] SUBSCORES VS. STERN FIXATION TEST SCORES	8	.2676
[illegible] SUBSCORES VS. STERN [illegible]ION TEST SCORES	8	.0009
[illegible] SUBSCORES VS. STERN [illegible]ATION TEST SCORES	14	.2491
[illegible] SUBSCORES VS. STERN [illegible]ATION TEST SCORES	14	.1049

TABLE VII

DISCUSSION

The principal objective of this research was to establish norms for the Stern Fixation Test on an elementary school population. Inspection of figures one through six demonstrates general trends toward improvement of performance with grade level. Although the differences lack statistical significance due to limited sample size, the investigators feel that further investigation might establish significance. With the establishment of significant norms the Stern Fixation Test would be a valuable tool for both teacher and clinician in screening for visual factors affecting reading.

In investigating the relationship between Stern Fixation Test means and subject reading levels (tables 1-5) many instances of significant relationships are apparent. In most instances where there was no significance at the 0.05 level, sample sizes were small. The many instances where significance was found do support the value of the SFT in predicting reading problems which involve visual factors. Whereas we would expect good readers to score well on the SFT, it does not necessarily follow that poor readers would score poorly. The SFT can thus serve to distinguish poor readers with visual problems from those with other underlying causes. The data supports this in that 11 of 17 groups in grades one to six judged to be above grade level in reading were significantly faster on the SFT than those on grade level group. In contrast, only four of 16 groups in grades one to six judged to be below grade level in reading were significantly slower on the SFT than those on grade level group.

The question arose as to whether those judged to be at equal reading

level would in fact show comparable performance on the SFT. As illustrated in Table V, such a relationship is supported by the fact that five of eight comparisons were not significantly different even at the 0.70 level.

The relationship was explored between performance on the SFT and the 21-point examination. As seen in Tables VI and VII, the correlation here was of a low order.

In summary, the poor reader who scores poorly on the SFT should be referred for a complete visual evaluation, as it is likely that visual factors are contributing to the problem. However, the SFT cannot serve to screen for all visual factors involved in reading. Thus, a poor reader who scores well on the SFT might yet have significant visual problems influencing reading. With further investigation extending the SFT to larger populations, it will become a tool of value for screening visual factors as they relate to reading difficulties.

BIBLIOGRAPHY

1. Ames, L. B. and R. N. Walker, "Prediction of Later Reading Ability from Kindergarten Rorschach and I.Q. Scores," Journal of Educational Psychology, 55(1964): 309-313.

2. Arnold, R. D. and A. H. Wist, "Auditory Discrimination Abilities of Disadvantaged Anglo- and Mexican-American Children," Elementary School Journal, 70(March 1970): 295-299.

3. Athey, I., in Theoretical Models and Processes of Reading, ed. by H. Singer and R. B. Ruddell, International Reading Association, Newark, Delaware, 1971, p. 102.

4. Athey, I. and J. A. Holmes, "Reading Success and Personality Characteristics in Junior High School Students," Berkeley: University of California Press, 1969.

5. Baron, J., in Basic Processes in Reading: Perception and Comprehension, ed. by D. Laberge and S. J. Samuels, Lawrence Erlbaum Assoc., Hillsdale, N. J., 1977, p. 178.

6. Barret, T. C., "The Relationship Between Measures of Pre-Reading Visual Discrimination and First Grade Reading Achievements: A Review of the Literature," Reading Research Quarterly, 1(Fall), 1965, p. 51-76.

7. Barrett, T. C., "Visual Discrimination Tasks as Predictors of First Grade Reading Achievement," The Reading Teacher, 18(4): 276-282, 1965.

8. Beck, H. S., and R. C. Beck, "The House-Drawing Test as a Predictor of First Grade Achievement," Journal of Experimental Education, 29: 197-200, 1960.

9. Bell, D. B., R. D. Lewis and R. F. Anderson, "Some Personality and Motivational Factors in Reading Retardation," Journal of Educational Research, 65(Jan. 1972): 229-233.

10. Betts, Emmett A., The Prevention and Correction of Reading Difficulties, Row, Peterson and Co., Evanston, Ill., p. 156, 1936.

11. Bond, G. L. and M. A. Tinker, Reading Difficulties: Their Diagnosis and Correction, 2nd Edition, Appleton-Century-Crofts, New York, N.Y., 1967, pp. 83-84.

12. Brod, Nathon and Hamilton, David, "Monocular-Binocular Coordination vs. Hand-Eye Dominance as a Factor in Reading Performance," American Journal of Optometry and the Archives of American Academy of Optometry, 48(1): 123-128, January, 1971.

13. Carter, T. P., "Cultural Content for Linguistically Different Learners," Elementary English, 48(Febr. 1971): 162-175.

14. Center, B., "Perceptual Functions in Reading Problems," Optometric Weekly, Vol. 45, 1954, pp. 311-312.

15. Cole, Luella, The Improvement of Reading, Farrar and Rinehart, New York, N.Y., p. 28, 1938.

16. Coleman, H., "The West Warwick Visual Perception Study," Journal of the American Optometric Association, Vol. 43(4, 5), April, 1972, pp. 452-462, May, 1972, pp. 532-543.

17. Coleman, H., "Visual Perception and Reading Dysfunction," Journal of Learning Disabilities, Professional Press, February, 1968.

18. Duetsch, C. P., "Auditory Discrimination and Learning Social Factors," Merrill-Palmer Quarterly of Behavior and Development, 10(July 1964): 277-296.

19. Dykstra, R., "Auditory Discrimination Abilities and Beginning Reading Achievement," Reading Research Quarterly, 1(Spring 1966): 5-34.

20. Eames, Thomas A., "A Comparison of Ocular Characteristics of Unselected and Reading Disability Groups," Journal of Educational Research, 25: 211-215, March, 1932.

21. Eames, Thomas H., "A Frequency Study of Physical Handicaps in Reading Disability and Unselected Groups," Journal of Experimental Education, 29: 1-5, September, 1935.

22. Eames, Thomas A., "The Effect of Anisometropia of Reading Achievement," American Journal of Optometry and Archives of American Academy of Optometry, 30: 635, December, 1953.

23. Estes, W. K., in Basic Processes in Reading: Perception and Comprehension, ed. by D. Laberge and S. J. Samuels, Lawrence Erlbaum Assoc., Hillsdale, N. J., 1977, pp. 2-5.

24. Evans, J. R., "Auditory and Auditory-Visual Integration Skills as they Relate to Reading," Reading Teacher, 22(April 1969): 625-629.

25. Farris, L. P., "Visual Defects as Factors Influencing Achievement in Reading," Journal of Experimental Education, 5: 59, September, 1936.

26. Fendrick, Paul, "Visual Characteristics of Poor Readers," Teacher's College Contributions to Education, No. 656, Teacher's College, Columbia University, 1935.

27. Flax, Nathan, "The Clinical Significance of Dominance," American Journal of Optometry and Archives of American Academy of Optometry, 43: 566, September, 1966.

28. Flax, Nathan, "The Contribution of Visual Problems to Learning Disability," Journal of the American Optometric Association, October, 1970.

29. Flax, Nathan, "The Eye and Learning Disabilities," Journal of the American Optometric Association, Vol. 43, No. 6, June, 1972.

30. Fry, E., "Do it Yourself Terminology Generation," Journal of Reading, 11(March 1968): 428.

31. Gibson, E. J., "Learning to Read," Science, 148(1965): 1066-1072.

32. Gibson, E. J., and H. Levin, The Psychology of Reading, The MIT Press, Cambridge, Mass., 1975, pp. 168-188, 21-22, 392-397.

33. Gilbert, L. C., "Functional Motor Efficiency of the Eyes and its Relation to Reading," Publications in Education, University of California Press, 11(3): 159-232, 1953.

34. Good, G. H., "Relationship of Fusion Weakness to Reading Disability," Journal of Experimental Education, 8: 115-121, September, 1939.

35. Gordon, E. W., "Introduction Education of Socially Disadvantaged Children," Review of Educational Research, 40(February 1970): 1-12.

36. Gray, W. S., "Summary of Reading Investigations," Journal of Education Research, 40(1947): 413-414.

37. Guszak, F. J., "Reading: Comprehension Skills," in Reading Foundations and Instructional Strategies, ed. by P. Lamb and R. Arnold, Wadsworth Publishing Co. Inc., Belmont, Ca., 1976, pp. 363-399.

38. Hansen, H. S., "The Impact of the Home Literary Environment on Reading Attitude," Elementary English, 46(January 1969): 17-24.

39. Harootunian, B., "Intellectual Abilities and Reading Achievement," The Elementary School Journal, 66(1966): 386-392.

40. Harris, A. J., "Intellectual and Perceptual Development," in Readings on Reading Instruction, ed. by A. J. Harris, David McKay, New York, New York, 1963, pp. 47-52.

41. Henry, S., "Childrens Audiograms in Relation to Reading Achievement," Pedagogical Seminary and Journal of Genetic Psychology, 70 (June 1947): 211-213; 71(September 1947): 3-63.

42. de Hirsch, Katrina, et al., Predicting Reading Failure, Harper and Row, 19 .

43. Holmes, J. A., "Factors Underlying Major Reading Disabilities at the College Level," Genetic Psychology Monographs, 49(1954): 3-95.

44. Holmes, J. A., "Personality Characteristics of the Disabled Reader," Journal of Developmental Reading, 4(1961): 111-122.

45. Kane, Martin, "Perception: The Phenomenon of Figure-Ground," American Optometric Association Journal, 44(2), February, 1973.

46. Kling, M., "Power of Reading through Interfacilitation of the Content Areas," in New Frontiers in College Adult Reading, ed. by G. S. Schick and M. M. May, Milwaukee: National Reading Conference, 1966, pp. 147-156.

47. Lee, J. M., Clark, W., and Lee, D., "Measuring Reading Readiness," Elementary School Journal, 30: 656-666, 1939.

48. Leisman, G., and Schwartz, J., Oculomotor Function and Information Processing: Implications for the Learning Process, U.S. Department of Health, Education, and Welfare, National Institute of Education, Educational Resources Information Center, Washington, D.C., Document Identification: ED 106 752/ CS 001 770., 1975.

49. Lockhart, H. M., "Personality and Reading Readiness," Illinois School Research, 2(1965): 9-11.

50. Lowder, R. G., Perceptual Ability and School Achievement, Winter Haven, Florida, Winter Haven Lion's Club, 1967.

51. Luckiesh, M. and R. K. Moss, Reading as a Visual Task, D. Van Nostrand Co. Inc., New York, 1942, pp. 4-5, 126-153, 5-7.

52. Morris, J. M., Standards and Progress in Reading, Slough, Bucks: National Foundation for Educational Research in England and Wales, 1966.

53. Murroughs, M. S., Q. O., T. R., "Vision in Reading," Optometric Weekly, March 24, 1960.

54. Nedrow, J. L., "A Comparitive Study of Accommodative Performance in a Selected Group of Good and Poor Readers," Unpublished Master of Science Dissertation, Pacific University, Forest Grove, OR, 1970.

55. Oakland, T. D., "Auditory Discrimination and Socio-Economic Status as Correlates of Reading Disability," Journal of Learning Disabilities, 2(June 1969): 326-329.

56. Park, G. E., and Burri, C., "Effect of Eye Abnormalities on Reading Difficulty," Journal of Educational Psychology, 34: 426, October, 1943.

57. Park, G. E., "Reading Difficulty (Dyslexia) from the Ophthalmic Point of View," American Journal of Ophthalmology, 31: 28-34, January, 1948.

58. Powers, J. M., et. al., "A Research Note on the Self Perception of Youth," American Educational Research Journal, 4(November 1971): 665-670.

59. Poynter, H. L., Oculomotor Functions in Reading Disability, A dissertation presented to the Faculty of the Graduate School, Pacific University, 1979.

60. Reynolds, M. C., "A Study of the Relationships Between Auditory Characteristics and Specific Silent Reading Abilities," Journal of Educational Research, 46(February 1953): 439-449.

61. Robinson, B., "A Study of Visual Function in Institutionalized Juveniles who are Demonstrated Underachieving Readers," American Journal of Optometry and Archives of American Academy of Optometry, 50(2): 113-116, 1973.

62. Robinson, H. M., Why Pupils Fail in Reading, University of Chicago Press, Chicago, 1946.

63. Robinson, Helen, et. al., "An Evaluation of the Children's Visual Achievement Forms at Grade One," American Journal of Optometry and Archives of American Academy of Optometry, 35: 515-525, 1958.

64. Robinson, Helen M., and Huelsman, Charles B. Jr., "Visual Efficiency and Progress in Learning to Read," Clinical Studies in Reading II, University of Chicago Press, Chicago, p. 62, 1953.

65. Rosner, Jerome, "School Achievement as Related to I.Q. and Perceptual Skills: A Comparison of Predictors," American Optometric Association Journal, 44(2), February, 1973.

66. Schorr, R. and J. Svagr, "Relationship of Perceptual and Visual Skills with Reading Accuracy and Comprehension," Journal of the American Optometric Association, July, 1966.

67. Schubert, Delwyn and Walton, Howard N., "Effects of Induced Astigmatism," The Reading Teacher, p. 547-551, March, 1968.

68. Scott, Ralph, "Perceptual Readiness as a Predictor of Success in Reading," The Reading Teacher, Vol. 22, October, 1968.

69. Sherman, A., "Relating Vision Disorders to Learning Disability," Journal of the American Optometric Association, 44(2): 140-141, February, 1973.

70. Singer, H., "Theoretical Models of Reading," Journal of Communication, 19(June 1969): 134-156.

71. Smith, F., Understanding Reading - A Psycholinguistic Analysis of Reading and Learning to Read, Holt, Rinehart, and Winston, Inc., New York, New York, 1971. pp. 105-151.

72. Solan, Harold A., "Some Physiological Correlates of Dyslexia," American Journal of Optometry and Archives of American Academy of Optometry, 43: 3, January, 1966.

73. Spache, G., and Tillman, C., "A Comparison of the Visual Profiles of Retarded and Non-Retarded Readers," Journal of Developmental Reading, 1962.

74. Spache, G. and E. Spache, Reading in the Elementary School, 2nd edition, Boston: Allyn and Bacon, 1969.

75. Spache, G. D., Diagnosing and Correcting Reading Disabilities, Boston: Allyn and Bacon, Inc., 1976, pp. 57-64, 64-67.

76. Spache, G. D., Investigation the Issues of Reading Disabilities, Boston: Allyn and Bacon, Inc., 1975, pp. 92-93, 102.

77. Stanchfield, J. M., "The Development of Pre-Reading Skills in an Experimental Kindergarten Program," Elementary School Journal, 71(8): 438-439, May, 1971.

78. Starnes, David R., "Visual Abilities vs. Reading Abilities," Journal of the American Optometric Association, 1969.

79. Sterritt, G. M. and M. Rudnick, "Auditory and Visual Rhythm Perception in Relation to Reading Ability in Fourth Grade Boys," Perceptual and Motor Skills, 22(1966): 859-864.

80. Sterritt, G. M., V. E. Martin, and M. Rudnick, "Sequential Pattern Perception and Reading," in Reading Disability and Perception, G. D. Spache, Editor, Proceeding International Reading Association, 13(3): 61-71, 1969.

81. Taylor, Earl A., Controlled Reading, University of Chicago Press, Chicago, p. 101-112, 1237.

82. Taylor, S. E., Frackerpohl, H., and Pettee, J. L., "Grade Level Norms for the Components of the Fundamental Reading Skill," EDL Research and Information Bulletin, No. 3, 1960.

83. Tinker, M. A., "Fixation Pause Duration in Reading," Journal of Educational Research, 44: 471-479, 1951.

84. Vernon, M. D., Backwardness in Reading - A Study of its Nature and Origin, Cambridge University Press, London, 1957, pp. 25-30, 187.

85. Wattenburg, W. W., and C. Clifford, "Relation of Self-Concepts to Beginning Achievement in Reading," Child Development, 35(1964): 461-467.

86. Westheimer, Gerald, "The Effect of Spectacle Lenses and Accommodation on the Depth of Focus of the Eye," American Journal of Optometry and Archives of American Academy of Optometry, 30: 513, 1953.

87. Wheeler, L. R. and V. D. Wheeler, "A Study of the Relationship of Auditory Discrimination to Silent Reading Abilities," Journal of Educational Research, 48(1954): 103-113.

88. Winebrenner, M. R., "The Visually Inadequate Child," Optometric Weekly, 1951(42): 1553-1560.

89. Witty, Paul and Kopel, David, "Factors Associated with the Etiology of Reading Disability," Journal of Educational Research, 29: 449-459, February, 1936.

90. Woolf, Daniel and Silbiger, Francene, "Fixation Disparity and Reading Achievement at the College Level," American Journal of Optometry and Archives of American Academy of Optometry, 45: 734-742, November, 1968.

91. Zarulia, E., "Objective and Subjective Evaluation at Grade One," The Reading Teacher, 22(1), October, 1968.

92. Zimmerman, I. L. and G. N. Allebrand, "Personality Characteristics and Attitudes Toward Achievement of Good and Poor Readers," Journal of Educational Research, 59(1965): 28-30.

87. Wheeler, L. R. and V. D. Wheeler, "A Study of the Relationship of Auditory Discrimination to Silent Reading Abilities," Journal of Educational Research, 48(1954): 103-113.

88. Winebrenner, M. R., "The Visually Inadequate Child," Optometric Weekly, 1951(42): 1553-1560.

89. Witty, Paul and Kopel, David, "Factors Associated with the Etiology of Reading Disability," Journal of Educational Research, 29: 449-459, February, 1936.

90. Woolf, Daniel and Silbiger, Francene, "Fixation Disparity and Reading Achievement at the College Level," American Journal of Optometry and Archives of American Academy of Optometry, 45: 734-742, November, 1968.

91. Zarulia, E., "Objective and Subjective Evaluation at Grade One," The Reading Teacher, 22(1), October, 1968.

92. Zimmerman, I. L. and G. N. Allebrand, "Personality Characteristics and Attitudes Toward Achievement of Good and Poor Readers," Journal of Educational Research, 59(1965): 28-30.

APPENDIX A

STERN FIXATION TEST RAW DATA

(test scores in seconds)

Grade 1.

62, 67, 54, 156, 73, 54, 49, 57, 86, 64, 63, 104, 114, 105, 78,
58, 54, 84, 78, 65, 90, 74, 87, 99, 89, 109, 77, 115, 136, 58,
82, 63, 104, 89, 78, 111, 96, 82, 72, 116, 136

Grade 2.

106, 80, 50, 57, 52, 52, 104, 58, 46, 63, 56, 62, 58, 89, 58,
69, 68, 70, 72, 53, 114, 79, 70, 67, 50, 59, 56, 49, 148, 65,
86, 69, 62, 106, 128, 58, 131, 108, 56, 68, 70

Grade 3.

59, 42, 47, 37, 46, 51, 44, 50, 52, 58, 39, 44, 41, 62, 53, 48, 59, 73, 70,
51, 62, 56, 66, 62, 57, 51, 53, 54, 71, 42, 66, 62, 41, 58, 72, 57, 66, 58,
72, 58, 51, 60, 66, 52, 50, 58, 58, 53, 59, 59, 55, 44, 93, 81, 73, 70, 58,
62, 84, 51, 91, 62, 94, 55, 59, 71, 84, 52, 60, 49, 60,

Grade 4.

77, 76, 74, 73, 90, 102, 85, 98, 84, 60, 102, 99, 92, 126, 77,
86, 90, 87, 101, 131, 94, 101, 97, 95, 84, 82, 103, 92, 99, 134,
92,147, 106, 88, 91, 141, 110, 118, 116, 144, 97, 168

Grade 5.

76, 75, 71, 69, 80, 80, 53, 83, 63, 75, 104, 102, 84, 79, 100, 85, 90,
110, 84, 85, 61, 62, 109, 106, 88, 91, 126, 70, 77, 143, 117, 85, 89,
107, 87, 84, 64, 94, 80, 111, 74, 102, 104, 86, 96, 136, 124, 107, 77, 127

Grade 6.

78, 75, 71, 61, 66, 70, 56, 99, 86, 76, 70, 87, 78, 78, 85, 79, 83,
68, 79, 80, 75, 94, 84, 69, 124, 71, 93, 67, 110, 89, 90, 85, 86, 86,
90, 103, 72, 107, 89, 92, 86, 130, 83, 132, 79

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

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

Stern Fixation Test Form 1 (grades1-3)

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 I s t b c
r o o t c. o s
S J s a T i s h
l I b t o b f o o t h
i t m T a c o f f

Stern Fixation Test Form 2 (grades 4 and up)

Norman Stern OD,PhD

APPENDIX B

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 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

S t c b h h t a s L
a t h e 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".
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 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

Recording Form 2 (grades 4 and up)

APPENDIX G

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 H

May 1979

Dear Parent,

The second part of the Stern Fixation Test Study will consist of a complete vision examination and analysis at the Pacific University College of Optometry Clinic. There will be no cost to you for your child's examination.

Upon your request the examination findings will be made available to you or your eye-care practitioner. Should you wish to use Pacific University Clinics, any additional services or materials beyond the vision examination and analysis will be available to your child at normal clinic fees.

Please call 357-6151 ext. 208 or 640-1731 or 1732 to set up an appointment for your child's vision examination. At the time of the examination please bring the following completed form to show your child's participation in the study. Appointments for this study will only be made until August 24, 1979.

Stern Fixation Test Study

Child's Name_____

Child's grade as of May 1979_____

Child's teacher as of May 1979_____

I give my permission for the Pacific University College of Optometry Clinic to release the vision examination findings of my child to Dr. N. Stern, or one of his research assistants, for their analysis and study.

_____

Parent's signature and relationship to chil