

CORRELATIONS OF THE GRADE LEVEL EQUIVALENT SCORES AMONG THREE READING TESTS

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Abstract

The subjects of this study were grade school students (N=24) with a mean age of 11 years, 4 months. Each was administered the following reading tests in a single session: the Visagraph II™ (Visagraph), the Gray Oral Reading Test (GORT-4), and the Test of Silent Word Reading Fluency (TOSWRF). Grade level equivalent scores were calculated for each test. The goal was to determine the correlations of grade level equivalent reading scores among the three tests.

Pearson Correlation Coefficients were only small to moderate between the Visagraph and the subtests of the GORT-4 and the TOSWRF (range: 0.17 to 0.36). The highest correlations were found between subtests of the GORT-4 and the TOSWRF (range: 0.68 to 0.82).

The Visagraph showed small to moderate correlations with standard measures of oral and silent reading. Although the Visagraph and the TOSWRF both purport to measure silent reading, it appears that each test measures different components of reading. We encourage clinicians to exercise caution when making statements about children's reading level based on their Visagraph grade level equivalent score.

Key Words

grade level equivalent reading score, Gray Oral Reading Test, Test of Silent Word Reading Fluency, Visagraph II™

INTRODUCTION

The role of eye movements in reading ability cannot be disputed. Normal readers acquire information from text through accurate eye movements. Research generally shows that poor readers manifest more fixations and regressions than normal readers.¹⁻³ Technology now affords the clinician with a clinical tool that objectively measures eye movements.

The Visagraph II™^a (Visagraph) quantifies eye movement components such as the number of fixations, regressions, and the duration of fixations.⁴ This instrument objectively measures eye movements while a subject reads a grade appropriate passage. The software program then develops an idealized tracing of the eye movements. Once the subject completes the passage he or she answers 10 comprehension questions. The program then calculates seven parameters which include fixations, regressions, span of recognition, duration of fixation, reading rate, comprehension score and grade equivalent. The Visagraph can be a powerful clinical tool in measuring changes in reading performance in school-aged patients if shown to be reliable and valid.

To date, little is known about the relationship of the Visagraph with other measures of reading. Colby et al⁵ evaluated the validity of the Visagraph using first year optometry students by comparing their performances on the Visagraph to their Optometry Admission Test (OAT) reading comprehension scores. Correlations between the two tests were low and non-significant except for the Visagraph's fixation durations and the comprehension score.⁵

Lack⁶ compared the Visagraph Numbers Test (VGN), a timed scored test, to the Test of New York State Standards which measures students' mastery of English Language Arts (ELA). The most significant correlation was the VGN fixation duration to three of the ELA scores (range: 0.277 to 0.343).⁶ These values, while statistically significant (at the 0.05 level) are small to moderately significant on a clinical level.^{7,8} Although this study measured eye movements in children, the study did not correlate the Visagraph reading paragraph individual measures and grade level equivalent score with the ELA test.

In a study that compared the Visagraph reading paragraphs to standardized reading tests, Solan et al⁹ correlated the individual measures of the Visagraph with the Test of Silent Word Reading Fluency (TOSWRF) in a group of 7th grade readers. The researchers found significant correlations of fluency (as measured by the TOSWRF) with all Visagraph eye movements subscales, except regressions (range: 0.502 to 0.735). However, when groups were separated into "good" and "poor" readers, the results indicated that "poor" readers had a significant correlation between fluency and the Visagraph measures of fixation duration and fixation rate (0.451 and 0.534 respectively). In the group of "good" readers there was no significant correlation between the TOSWRF and any measures on the Visagraph. We felt it would be beneficial to investigate the ability of the Visagraph to predict reading ability in a broader age range of children. In addition, since many clinicians use the grade level equivalent score (GLE) to make decisions regarding reading eye movements, this specific measure would be an important one to investigate. To address the above issue, we investigated the correlations among the reading

scores of the Visagraph, the Gray Oral Reading Test Fourth Edition (GORT-4) and the TOSWRF in a group of school aged children. The GORT-4 and the TOSWRF are widely used by educators to provide an efficient and objective way to clinically assess reading abilities of school-age children. Researchers have also used the GORT-4, written in Standard American English, to monitor improvements in reading skills including speed, accuracy, and comprehension in school aged children between 8-18 years.^{10,11}

METHODS

Subjects

Twenty-four children, ages 8 to 14 years (mean age=11 years, 4 months; SD=1 year, 8 months) were recruited from the clinic population at the Eye Care Center of the Southern California College of Optometry, and from children of College employees. There were 11 females and 13 males; their mean school level was 6th grade (range 3rd to 9th grade). Inclusion criteria were: the ability to read English fluently; no diagnosis of reading disability as reported by parent or legal guardian; best corrected visual acuity of 20/20 at 40 cm, and no neurological, physical or ocular condition that would interfere with accurate recording on the Visagraph.

Informed consent was obtained from each subject's parent or legal guardian, and assent was obtained from each subject. The College's Institutional Review Board approved the study's protocol

Procedures

Each subject was administered the Visagraph, GORT-4^b, and TOSWRF^b according to standardized instructions. The subject was given a one-minute rest period between each test. Testing was performed in an environment that was free from distractions, well ventilated, and comfortable. Parents did not accompany the subjects into the testing area. The order of test presentation was random. All testing was done in a single session over no more than a 45 minute period.

Visagraph

The San Diego Quick Assessment¹² was used to obtain the subject's independent or instructional reading level. This test uses lists of 10 single words at each grade level. The subject is instructed to read the lists of words. Words are scored as correct if they are read within 2 seconds. To determine the subject's starting reading level, we used the highest grade where the subject correctly read at least nine out of

10 words correctly. This grade level was used for the Visagraph testing.

After reviewing the Visagraph procedure with the subject, he or she was comfortably seated with an approximate viewing distance of 40 cm from the reading material which was placed on a 30-degree slant board. Text was positioned below the subject's horizontal line of sight to simulate a more natural reading position. Proper positioning of the Visagraph goggles was obtained for each subject by placing the goggles over the subject's habitual near correction and centering on the pupils through each aperture as the subject viewed a near target. Paragraphs were randomly selected from the 10 paragraphs available for each grade level and no paragraph was repeated. Subjects were instructed to silently read a paragraph at the predetermined grade level and answer 10 comprehension questions. The subject must have answered seven questions correctly on the comprehension section for the data to be considered valid. The Visagraph testing was administered according to the procedures described in the Visagraph user's manual.⁴ Three trials, with a one minute break in between each trial, were completed on each subject. We then averaged the latter two trials for the child's score. Since a standard score is not available for the Visagraph data, we chose to use the GLE score for our data analysis. The GLE is automatically calculated by the Visagraph program and this number was used for the data analysis. The Visagraph program calculates the GLE by using a relative efficiency formula ($\text{Rate (wpm)} / (\text{Fixations per 100 words} + \text{Regression per 100 words})$) and then the relative efficiency score is compared with the Taylor norms to determine a GLE score.⁴

Gray Oral Reading Test – Fourth Edition (GORT-4)

The administration of the GORT-4 began by opening the Student Book to the first passage to be read by the subject. A stopwatch was ready and the following script was read, "I want you to read some stories out loud to me. Read them as quickly as you can and as well as you can. Before you read each story, I will tell you something about it. Then I'll give you the book I want you to read from. When I say 'begin,' start reading out loud. When you have finished, I will ask you some questions about what you have read. Let's start now." After the subject completed reading the passage, the following instructions were said, "I want you to an-

swer some questions based on what you have read. I will read each question and the possible answers out loud, and I want you to follow along as I read. When I have finished reading each question, tell me which one you think is the right answer. Listen carefully and follow along in your book." The time it took the subject to read the story was recorded. The test was scored according to the guidelines in the GORT-4 Examiner's Manual.¹³ Scores for each subject's rate, accuracy, fluency and comprehension were converted to a GLE score to allow for comparison to the Visagraph.

Test of Silent Word Reading Fluency (TOSWRF)

The subject was presented with a row of words that were ordered by reading difficulty and with no spaces between the words (e.g., dimhowfigblue). Subjects were given three minutes to draw a line between the boundaries of as many words as possible (e.g., dim/how/fig/blue). The TOSWRF was scored according to the Examiner's Manual.⁸ The raw score was converted to a GLE score to allow for comparison to the Visagraph.

RESULTS

Data Analysis

The study investigated the associations among the three reading tests. Measuring associations between two reading assessments typically involves the use of simple correlations between tests being administered. One problem that arose in our data analysis was that the Visagraph normative tables do not use standard scores for the individual measures. This makes comparison across a range of ages difficult. To overcome this problem we used the GLE scores for the Visagraph, GORT-4, and TOSWRF when calculating the correlations. We used the Pearson Correlation Coefficient to determine the associations among the three reading tests. Besides determining the statistical significance for correlation values we also chose to use a system developed by Hopkins¹³ and used by the authors of the TOSWRF.⁸ It classifies correlations as follows; 0.0 to 0.1 very small, 0.1 to 0.3 small, 0.3-0.5 moderate, 0.5 to 0.7 large, 0.7 to 0.9 very large, 0.9 to 1.0 nearly perfect. We felt this approach would offer more clinical relevance when interpreting the results.

Correlations

The mean GLEs and standard deviations for the Visagraph, GORT-4, and TOSWRF are listed in Table 1. Pearson Correlation

Table 1. Average Grade Level Equivalent Score: Visagraph, GORT-4, and TOSWRF

Test	Mean	Std. Dev.
Visagraph	4.59	3.0
GORT Rate	6.46	2.20
GORT Accuracy	5.80	2.30
GORT Fluency	5.75	2.24
GORT Comprehension	6.50	2.20
TOSWRF	6.64	2.38

Table 2. Pearson Correlation (r-value) for Visagraph, GORT-4, and TOSWRF

Test	Visagraph	GORT Rate	GORT Accuracy	GORT Fluency	GORT Comprehension
GORT Rate	0.26 (p=0.222)				
GORT Accuracy	0.32 (p=0.131)	0.89 (p=<0.001)			
GORT Fluency	0.36 (p=0.081)	0.86 (p=<0.001)	0.86 (p=<0.001)		
GORT Comprehension	0.17 (p=0.434)	0.84 (p=<0.001)	0.82 (p=<0.001)	0.67 (p=<0.001)	
TOSWRF	0.36 (p=0.089)	0.86 (p=<0.001)	0.75 (p=<0.001)	0.82 (p=<0.001)	0.68 (p=<0.001)

Coefficients were calculated for the grade level equivalent scores for the 3 reading tests (see Table 2).

The TOSWRF had a moderate correlation with the Visagraph, with an r-value of 0.36. However, this finding was not statistically significant (p=0.089). The Visagraph GLE had a low to moderate correlation on all four measures of the GORT-4. The r-value was 0.26 (p=0.222) for GORT rate, 0.32 (p=0.131) for GORT accuracy, 0.36 (p=0.081) for GORT fluency and 0.17 (p=0.434) for GORT comprehension. In contrast to the low to moderate correlations between the Visagraph and the GORT-4 and TOSWRF, the correlations between the GORT-4 and TOSWRF were large to very large (0.68 to 0.86) and all these correlations were statistically significant (p=<.0001).

DISCUSSION

Our aim was to determine associations among the Visagraph and the GORT-4 and the TOSWRF. The Pearson Correlation Coefficients showed small to moderate correlations between the Visagraph and the GORT-4 and TOSWRF.

Our results showed a lower correlation between the Visagraph and TOSWRF than other reading tests that have been correlated with the TOSWRF. The correlations between the TOSWRF and other standardized measures of reading fluency showed moderate to very large correlation coefficients that ranged from 0.42 to 0.78.⁸ In contrast, the Visagraph had only a moderate correlation to the TOSWRF

(r-value=0.36). This result is surprising given that both measures are designed to assess silent reading fluency. Perhaps correlations would be higher for individual measures of the Visagraph, such as fixations, when compared to the TOSWRF. However, the lack of a standardized scoring system for the Visagraph makes this analysis difficult.

The same pattern was seen for oral reading, where higher correlations were found between the GORT-4 and other standardized reading tests than for the GORT-4 and Visagraph. The GORT-4 and Gray Diagnostic Reading Test and the Gray Silent Reading Test showed moderate to very large correlation coefficients ranging from 0.41 to 0.74.¹³ In contrast, the Visagraph had only a small to moderate correlation with an r-value that ranged from 0.17 to 0.36.

One notable finding was the high correlation between the GORT-4 subtests and TOSWRF. The correlations were large to very large ranging from 0.67 to 0.89. Although both are reading tests, the TOSWRF only assesses the identification of individual words using a perceptual motor response. On the other hand, the GORT-4 measures oral reading of a story with comprehension questions. However, both tests measure reading fluency or the ability to rapidly identify words either visually or orally. Previous studies using oral and silent reading rates have shown significant correlations between these two components¹⁴ and this might be why these two tests are highly correlated.

The correlations we found between the Visagraph and the TOSWRF are lower than those found by Solan et al.⁹ They found correlations that ranged from small to very large for the total group of 7th graders. However, the correlations between individual measures of the Visagraph and the TOSWRF for the group of good readers ranged from 0.052 to 0.299.⁹ These values are more consistent with our results using GLE scores. Thus, both our study and Solan et al found that when testing a group of good readers, correlations between the Visagraph and the TOSWRF are small to moderate. It would have been interesting to correlate the individual eye movement measures with the GORT-4 and TOSWRF. However,

standard scores were not available from the Visagraph to compare to the standard scores on the GORT-4 or TOSWRF. Hence the only comparable measure was the GLE score on the Visagraph. We recommend that the Visagraph normative data be updated. The current normative data is from 1960^{4,15} and neither the standard deviations nor the standard error of measurements for the individual measures for each grade were reported.

In conclusion, the Visagraph was not a valid indicator of reading fluency when compared to the GORT-4 or the TOSWRF, as performed on children ages 8 to 14 years. The Visagraph does provide value in establishing a baseline level of fine saccadic eye movements in children 8 to 14 years old. However, we encourage clinicians to exercise caution when making statements about children's reading level based on their Visagraph performance and use the results of the Visagraph only in the context of reading eye movements.

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