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Dedicated to the pioneering work of my father Earl A. Taylor who created an awareness of the need for reading performance efficiency and the basic reading processes he termed the Fundamental Reading Skill. His contribution toward the creation of the Ophthalmograph, the first portable binocular eye-movement recording device, and his research involving Controlled Reading with the Metronoscope, the first widely used reading training device, stand as significant landmarks in the field of reading development and improvement.

Stanford E. Taylor
OVERVIEW

Why Record Eye-Movements
Reading is a complex process, involving close interaction among the visual/functional, perceptual and cognitive functions. A reader’s eyes coordinate as they move along the lines of print in a left-to-right fashion, pausing three to five times per second to perceive words or word-parts that are continuously added up into thought units. The reader interprets what is read in light of his/her experiential background, associates information and projects beyond it in terms of association, judgments, applications and conclusions. Through the use of the Visagraph™ III Eye-Movement Recording System, an evaluation of a student’s Fundamental Reading Process or fluency in reading can be made.

Through the recording and analysis of a subject’s eye-movements, or oculomotor activity, a teacher of reading or a reading diagnostician can make direct objective evaluations concerning a reader’s efficiency and indirect judgment about his/her effectiveness and can use this information in prescribing a program of reading fluency development to remedy or correct deficiencies in visual functioning, perception and cognition. As reading improves during fluency development training, the Visagraph™ III findings can be used in conjunction with teacher evaluations and standardized tests to measure changes in both the efficiency and effectiveness of the total reading process.

There are three basic reasons why a Visagraph™ III appraisal should be administered to the majority, or preferably, to the entire student body.

1. Visagraph™ III is a tremendous motivator for students. As they view the simulation of their reading and understand what skills can make them more fluent readers, they will gain confidence that they can succeed.
2. Students who have visual/functional problems will be detected. Without this examination, many students may go through school with undetected vision problems that can affect their learning and life in general.
3. The data and findings derived from the Visagraph™ III appraisal can truly qualify a student for the reading tasks s/he will be called upon to perform. In many cases, poor visual, perceptual and information processing skills may be misinterpreted as laziness, lack of ability or personality disorders.

Who Can Record
Any teacher can, within a short interval of time, learn to use the Visagraph™ III Eye-Movement Recording System and interpret its findings. This Implementation Guide will provide you with the essential instructions you will need to get started, and the
Visagraph™ III Resource Guide will provide additional information, explanations and pedagogical references. Beyond this, your continued use of the Visagraph™ III will expand your insights as to student findings, allow you to successfully appraise reading efficiency and make judgments as to when/whether certain indicators warrant referrals to a vision specialist for further diagnosis.

Should you desire, you can request a Visagraph™ III Examination form from Taylor Associates. The successful completion of the examination will confirm your basic competency in the interpretation of Visagraph™ III findings.

Who to Record
Every student deserves a Visagraph™ III examination!

After review of all appraisals, the students who should be exported to a Reading Plus® course of study are those whose Grade Level Equivalent (GLE) is less than grade level and/or whose reading rate is less than the 35% minimum goal rate for a given grade level.

Many schools will also use the Visagraph™ III as a screening technique to ensure that students’ fluency in reading is up to par as they advance to more demanding study requirements. The most critical points in determining when eye-movement recording should be used are as follows:

- **Grade 3** - to ensure that students possess a reasonable level of reading efficiency as preparation for the more extensive and complex test-type reading and study activities they will encounter in the intermediate grades.

  A reasonable goal at this point would be a reading rate equal to or in excess of 180 words per minute with commensurate efficiency in terms of oculo-motor characteristics.

- **Grade 6** – to ensure that students’ reading efficiency levels are sufficient to prepare them for the more extensive reading study and research tasks they will face at the secondary level. Furthermore, high levels of reading fluency are essential for truly effective skimming and scanning activities which students should engage in at the secondary level to be truly effective in their studies.

  A desirable goal at this point would be a reading rate in excess of 270 words per minute with accompanying efficiency in terms of oculomotor characteristics.
• **Grade 11 (college bound)** – again to ensure that students who are college bound are prepared for the more extensive reading tasks they will encounter in their advanced studies.

A reading rate deemed suitable for the amount of assigned reading at the college level would seem to be 400-500 words per minute with accompanying appropriate oculo-motor efficiency.

• **Adults (any level)** – to determine that adults possess the reading efficiency necessary to perform their job responsibilities. Once a survey of reading level needs has been conducted, eye-movement recording can be employed to determine whether an individual’s reading efficiency is sufficient or in accord with that reading level expectation.

### When to Record

The Visagraph™ III provides an objective measure of a student’s reading grade level efficiency. We recommend that all students who will be working within Reading Plus® be tested with the Visagraph™ III before beginning the Reading Plus® course to establish an entry level measure that can be compared to a recording generated after the student has improved reading skills through Reading Plus®. Our recommendation is that at least three Visagraph™ III appraisals be administered to each student: Entry, Interim and Exit.

- **Entry** - Should be administered after a student has been entered into Reading Plus® Management and has completed an RPA™ assessment. RPA™ will determine the student’s assigned reading level and will automatically select an appropriate Visagraph ™ III reading/test level selection for the student. If RPA™ is not available, teachers can manually select an appropriate test selection for the student’s recording. See *Generating Recordings* section for details.

- **Interim** - We recommend that students be recorded after completing the Phase I of their Reading Plus® course. (See Reading Plus® Implementation Guide for details on course phases.) This provides teachers a basis to assess the improvements gained through the use of the Reading Plus® fluency development programs. Depending on the amount of progress a student is making, several interim recordings may be needed.

- **Exit** - After the student has reached the goals set at the outset of the Reading Plus® course, we recommend that an exit recording be administered to document the fundamental changes that have been made in a student’s reading process. Follow up exit recordings may be made to document the lasting changes that have been made through the use of Reading Plus®.
GETTING STARTED

Accessing Visagraph™ III
There are two options for entering into the Visagraph™ III application:

- Reading Plus® Online or Network (3.0) Access
- Visagraph™ III Online Access

Entering Visagraph™ III via Reading Plus®
If your site has a Reading Plus® Online account or is working with the network version of Reading Plus® 3.0, you will access the Visagraph™ III application directly through the Reading Plus® Management system. After logging into Reading Plus® Management, select the Student Lists tab and click on the Visagraph button located in the lower right corner of this panel. This will open the Visagraph panel where you will be able to generate and view Visagraph™ III recordings.

Entering Visagraph™ III through Visagraph™ III Online
If you do not have access to Reading Plus® 3.0 or a Reading Plus® Online account, you will be supplied a username and password that will allow you to login directly to the Visagraph™ III application.
Entering Students

**Reading Plus® Online and Network 3.0 Users**

**Visagraph™ III Online Users**

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**Reading Plus® Online and Network 3.0 Users**

If you are working with Reading Plus®, you will have access from within the Visagraph™ III application to the students who have been entered into Reading Plus® Management. However, note that you are unable to edit Reading Plus® student info from within the Visagraph™ III application.

If all your Reading Plus® student seats have been filled, but you would like to enter additional students for Visagraph™ III testing, you may create Visagraph classes. Creating Visagraph classes allows you to enter an unlimited amount of students, thereby providing the ability to administer a Visagraph™ III appraisal on each student.

**Creating Visagraph Classes**

Click the Classes button under Class Options. You will be presented with a list of all the classes existing within Reading Plus®. To create a Visagraph class, click New and enter a class name. Note that a (V) is placed after the class name to designate this class as a Visagraph class. You are able to create an unlimited amount of Visagraph classes and enter an unlimited amount of students for Visagraph™ III testing.
**Entering New Students**

From the main Visagraph panel click the *New* button under Student Options.

This will open the Visagraph Student Panel where you will enter student information. Enter the student’s First Name, Last Name, Grade and use the pulldown to select the student’s Gender. **It is also very important to note whether or not the student wears eyeglasses.** Please be sure to use the *Glasses* pulldown and choose *Yes/No*. The Visagraph™ III will function differently for each setting, therefore, the resulting data will be inaccurate if you have not chosen *Yes/No* correctly for the subject. The remaining information fields are optional. After you have entered the information for the student, click *Close* to save the student, or click *Apply* and then *New Student*, to enter additional students.

After you have entered all the students click *Close*. This will return you to the main Visagraph panel where you will see the list of all the students you created within the class. If you would like to print this list, click *Print/Preview* under Class Options to display a student list for the selected class. This will generate a printable presentation. Click *Print* located in the upper/lower right corners.
Export Students to Reading Plus® Management
If you would like to export students to Reading Plus® classes from Visagraph™ III classes, you must first confirm that you have enough student spaces available within the Reading Plus® class.

• Click Export under Student Options from the main Visagraph panel.

• Select the Visagraph class that you wish to export from.

• Select the students you wish to export. (To select multiple students, use the Shift or Control keys while making your selection.)

• Select the Reading Plus® class that you wish to export to. Click Export.

You will now be able to enter these students into the Reading Plus® development programs.
Visagraph™ III Online Users
To add students into Visagraph™ III, you must first create a class.

Creating Visagraph Classes
Click the Classes button under Class Options. Click New and enter a class name. You will note that a (V) is placed after the class name to designate this class as a Visagraph class. You are able to create an unlimited amount of Visagraph classes and enter an unlimited amount of students in the Visagraph™ III application.

Entering New Students
From the main Visagraph panel click the New button under Student Options.
This will open the Visagraph Student Panel where you will enter student information. Enter the student’s First Name, Last Name, Grade and use the pulldown to select the student’s Gender. It is also very important to note whether or not the student wears eyeglasses. **Please be sure to use the Glasses pulldown and choose Yes/No.** The remaining information fields are optional. After you have entered the information for the student, click Close to save the student, or click Apply and then New Student, to enter additional students.

After you have entered all the students click Close. This will return you to the main Visagraph panel where you will see the list of all the students you created within the class. If you would like to print this list, click Print/Preview under Class Options to display a student list for the selected class. This will generate a printable presentation. Click Print located in the upper/lower right corners.

**Entering Examiners**

You may also want to enter the names of several teachers/examiners, who will be performing Visagraph™ III recordings. This will allow you to keep track of which examiner has administered recordings on a particular student.

From within the main Visagraph panel, click the Examiners button under Class Options. Then click New to enter a new examiner’s name.
Hardware Setup

1. Ensure that you have installed the Visagraph™ III driver on the workstation from which you plan to administer recordings.

2. Connect the A/C adapter, which has been supplied, to the electronics box and plug into an electrical outlet.

3. The electronics box should be connected directly to your workstation with the supplied USB cable. We do not recommend connecting through a USB hub.

4. Confirm that the electronics box lights are slowly pulsing after properly connecting the USB and power cable.

5. The Visagraph™ III goggles should then be properly connected to the electronics box.
Adjusting Goggles
You must ensure that the goggles have been adjusted properly to obtain an accurate recording of your subject.

1. Have your subject put the goggles on and check that they are comfortably secure.
2. The goggle cable should run over the subject’s left shoulder and connect to the electronics box.
3. The examiner and the subject should be seated to face one another. The examiner should ask the subject to focus on the examiner’s nose which should be approximately 16” to 18” away from the subject’s face to ensure that the subject’s eyes are converged as they would be in usual reading. Adjust the goggle apertures using the thumb screws to ensure that the white IPD lines marked on the eye openings are in line with the centers of the subject’s pupils. It is sometimes helpful to align the white lines slightly to the outside of the pupil if you are having difficulty generating good recordings for both eyes.
4. Desirably, the goggle apertures should be centered both horizontally and vertically so that the eyes are completely visible.

Recording Subjects Wearing Glasses
Ensure that you have set the Glasses pulldown to Yes on the Student Info panel and clicked Apply before attempting to take recordings with subjects wearing glasses.

Extra care should be taken with goggle adjustment for subjects wearing glasses as some glasses can interfere with the infrared sensing. It is important to note that some prescription lenses may prevent accurate recordings from being generated. Lenses may be polarized, tinted or photochromic and contain protective coatings that can
interfere with the infrared sensing. Bifocals or trifocals may also make it hard for the subject to read through the center of the goggle aperture.

When adjusting the IPD setting on a subject who is wearing eyeglasses, the white IPD lines may be set slightly outside of the pupils to compensate for the refraction of the lenses. Also, if the subject is wearing large eyeglasses, it might be helpful to first place the eyeglasses inside the body of the goggles and then position and adjust them on the subject. The horizontal centers of the eyeglass lenses should be in line with the horizontal center of the goggle openings.

After you have clicked Start, allow your subject to stare at the O for roughly 1 second before instructing him or her to begin reading. You should see the traces of the two eyes on the screen before saying, “now read.”

When you begin the recording you should see activity with both eyes presented on screen as the recording proceeds. If you do not, or you see a large discrepancy between the movements of both eyes, stop the recording and make adjustments to the goggles before re-recording. It may be helpful to begin another recording and ask the subject to simply move his or her eyes left and right while adjusting the IPD setting to confirm that both eyes are being recorded. Once you are satisfied with seeing the two traces, you can stop the recording and begin again with the actual test.

Check Quality of Recordings
Time permitting, you might check that your recording is good. If your IPD setting was not proper, you may see that one of the eyes appears to have a “clipped” recording. In this instance in the Model graph, you would see many fixations for one eye and the other eye would present straight lines only.

When this occurs you can conduct another recording with an improved IPD setting or you can use the Reading Report results for reading evaluation only (not the Visual/Functional Report) which will be based on the most active eye (the non-clipped eye.)
Types of Recordings
There are three types of recordings: Reading, Numbers and Visual Skills.

Reading
Through the recording and analysis of a subject’s eye-movements, or oculomotor activity, a teacher of reading or a reading diagnostician can make direct objective evaluations concerning a reader’s efficiency and indirect judgment about his/her effectiveness and can use this information in prescribing a program of reading fluency development to remedy or correct deficiencies in visual functioning, perception and cognition. As reading improves during fluency development training, the Visagraph™ III findings can be used in conjunction with teacher evaluations and standardized tests to measure changes in both the efficiency and effectiveness of the total reading process.

Numbers
In the event that your student is not able to read at the 1.5 level or exhibits an extremely halting non-fluent reading behavior, you should administer a Numbers test to evaluate his/her visual/functional competency. This test is especially designed for non-readers but can be used with all subjects for visual/functional competency.

Visual Skills
The information derived from the Visual Skills Report can serve as a basis for reaching judgments about the subject’s visual/functional competency and possibly a need for visual training to improve his/her reading efficiency. The Visual Skills test is more typically employed by a Vision Specialist to gain more information about a student’s control over his/her visual activity.
Generating Recordings

You must first make sure you have a quiet place in which you will be conducting the recordings. It is often helpful to take students out of a class individually to a separate room or lab if/when possible. Please read the following items to ensure success with your recording procedures:

- Ensure that you have completed all steps within Hardware Setup and have adjusted the goggles properly on the subject before recording. (Please refer to Adjusting Goggles.)

- Enter the Visagraph™ III application's main panel. Locate and double click the name of the student to whom you will be administering a recording. You will be presented with the Visagraph Student Panel on the Recordings tab. Click New Recording to open the New Eye-Movement Recording window.

- Choose the type of recording you wish to administer by clicking the Reading, Numbers or Visual Skills radio button.

- Before starting the test, the explain the recording process briefly to the subject.

Reading Test Procedure

Use the Text # or Text Title pulldown to choose the story for a Reading Test. If the student is entered within Reading Plus 3.0 or Reading Plus® Online and has completed RPA™, the RPA™ results for the student will auto assign the proper level text selection number. If this setting is not made, select the proper text number manually.

You may want to select the examiner from the Examiner pulldown menu to identify which teacher/examiner is administering the recording.

Explain the actual testing procedure to your subjects by instructing them to:

1. Read the test selection one time only (no rereading) if possible.
2. Read carefully as comprehension questions will follow.
3. Focus on the circle located above the text and begin reading when instructed.
4. Close your eyes and say that you are done when you have finished reading.

Click Start at the bottom of the recording panel. You will be presented with a setup message that will remind you of the setup steps. Clicking Start from this panel will
begin the data collection for the recording. **After you have clicked Start, allow your subject to stare at the O for roughly 1 second before instructing the student to begin reading.** Once you see two traces appear on the screen (and hear a tone if your sound is turned on), immediately instruct your student to begin reading.

*If the Examiner recognizes that either of the two eyes are not registering on screen, or there is a large discrepancy between the two eyes, click Stop to abort the recording and then click Clear. Check and adjust the IPD setting again to ensure it is accurate. Click Start to begin again.*

When the subject alerts you that s/he has finished reading, and you see straight lines in the recording window indicating that the student has closed his/her eyes, click Stop. The application will then present 10 comprehension questions.

**Comprehension of the Reading Selection**

The examiner reads the questions aloud. The subject responds Yes or No whereupon the examiner enters Y or N pressing the down arrow on the keyboard to advance to the next question. (If the subject says, “I’m not sure, should I guess?” the examiner should encourage the subject to make a good effort.) All ten questions must be completed. After all questions are answered the Comprehension Score will appear in the lower left corner. Incorrect answers are marked in red. Click Save to save the recording file or Cancel if you feel that the recording may not have been the subject’s best effort.

It is important to realize that the primary goal of the comprehension questions is to qualify the student’s reading as typical. Usually a comprehension score of 70% or better will qualify the reading performance of a given subject as typical.

If the subject’s comprehension score was less than 70%, the examiner might re-administer the same selection to be read aloud. If this test selection is read with less than the designated amount of errors, the examiner has two alternatives:

- Accept the test as valid and reflective of the subject’s reading performance.
- Administer a second test selection on the same level (or on an easier level), instructing the subject to read more carefully.

If a second test selection is administered and the comprehension level is equally low, it may be assumed that the subject reads habitually with low comprehension.
**Numbers Test Procedure**
You may want to select the examiner from the Examiner pulldown menu to identify which teacher/examiner is administering the recording. After clicking the *Numbers* radio button click *Start*. Explain the actual testing procedure to your subjects by instructing them to:

1. Look at each number one time only.
2. Focus on the circle located above the numbers and begin looking at each and every number when instructed.
3. When finished looking at all the numbers, close your eyes and say that you are done.

**Visual Skills Test Procedure**
You may want to select the examiner from the Examiner pulldown menu to identify which teacher/examiner is administering the recording. After clicking the *Visual Skills* radio button click *Start*. Explain the actual testing procedure to your subjects:

1. There are two parts to this test and you will be instructed before each part. Each of the two parts are very brief lasting only a few seconds.
2. During the first part, you will stare at an X steadily. Don’t move your eyes, and stop when told. (15 seconds)

   *Modification: With very young children, the examiner may use a pencil to point to and hold on the central X to help the child focus and maintain attention.*

3. During the second part you will see two Xs. Move your eyes as quickly as you can back and forth looking from X to X and stop when told. (20 seconds)

   *Modification: This task may be practiced with very young children ahead of testing, using a pencil as a pointer. Regardless, maturity may limit a very young child’s ability to maintain performance of this task for the time specified.*

   *Additionally, with very young children, the examiner might use a pencil and move the point of the pencil back and forth between the Xs at approximately 1 second intervals (or slightly faster). While this will reduce the number of excursions made (perhaps only 15 in 15 seconds), judgments about the equivalence of performance of both eyes may still be made.*
Interpreting Reading Recordings
After a Reading recording is generated four types of data presentations are available.

**Reading Report**
Displays data comparing a student’s reading fluency skills to normative data and grade level goals. This is the first report to review from which you may evaluate the student’s overall performance taking note of his/her Grade Level Equivalent (GLE) as compared with actual grade level.

**Simulation**
Provides a simulation of the student’s eye-movement activity across the text during the recording procedure. Simulations provide a more qualitative method for comparing recordings taken over the duration of the Reading Plus® course. As multiple recordings are generated over time, students can be shown the improvements that are being made in their visual/functional and perceptual skills.

**Visual Functional Report**
Contains additional data of the student’s reading characteristics. The most relevant data for teachers is presented in the Reading Report, but this report provides additional insight into the visual/functional efficiency of a reader.

**Graphs**
Graphic display of eye-movement during the recording. For some students it can be helpful to compare the raw data captured during the recording (Original graph) to the filtered data (Model graph) in order to observe more subtle movement characteristics.
Interpreting the Reading Report

The Reading Report provides the automatic calculations of all reading performance characteristics as well as a plot (graph) of these performances in relation to Taylor’s National Norms. The information shown on the Report can be used as a basis for reaching judgments about the subject’s need for fluency development.

Automatic calculations of reading performance characteristics will appear as well as Grade Level Normative performances. In addition, there will be a plot of the characteristics of the most active eye against Taylor’s National Norms. Be aware that the shaded area in the Report is the most active eye, not necessarily the dominant eye.

With very poor readers who may employ an excessively wandering approach to reading and who are not coordinated visually, the automated calculations which result in a Reading Report or Model Graph may not be employable. Under these conditions, a manual analysis with the Original Graph may be the only recourse.
As you review a student's Reading Report consider the following:

1. The most significant indicator of reading efficiency is a student's Grade Level Efficiency (GLE), for these calculations take into account both a student's reading rate as well as the amount of visual activity during reading. Most judgments regarding the need for fluency development will be made on the basis of Grade Level Efficiency.

2. Next, take note of the number of fixations and regressions. At times a GLE may seem adequate but a student's high reading rate may still involve too many fixations (and regressions) with very short duration of fixations. This can still indicate a need for fluency development to change the nature of the visual activity reading to be more in line with a student’s reading rate.

3. Then check the reading rate with comprehension (with rereading) against the reading rate without rereading. Ideally, these two rates should be the same, indicating no rereading. If there was rereading, you might consider the reading rate without rereading as more typical. Or, time permitting, rerecord and caution the subject not to reread.

4. Look also at Directional Attack Difficulty. Even if the number of fixations is relatively low, it is important that the percentage of regressions to fixations be relatively low (less than 10-15%) to indicate proper sequencing of word impressions to short term memory.

5. Lastly, check Cross Correlation. If very low, perhaps 75% or lower, you might consider a retest (carefully checking the student’s IPD alignment to ensure a good recording). However, you might first look at the student’s Visual Functional Report to see if there were any indicators of binocular problems (data in red). And, you might administer the Student Inventory to further confirm that the low correlation was indicative of visual/functional problems.

If a student’s cross correlation is low, perhaps 90% or lower, there will likely be many indicators in the Visual Functional Report that suggest binocular problems and the student’s responses to the Student Functional Readiness Inventory will suggest problems. In this event, the student should logically be referred to a vision specialist for more complete diagnosis. Please refer to the Detection of Visual/Functional Limitations section of the Visagraph Resource Guide for recommendations on when to refer a subject to a vision specialist.
Following is a list of the various considerations reported that comprise a student’s Fundamental Reading Process:

- Fixations
- Regressions
- Average Span of Recognition
- Average Duration of Fixation
- Reading Rate with Comprehension
- Reading Rate without Rereading
- Directional Attack Difficulty
- Grade Level Efficiency
- Cross-Correlation
- Grade Norms - Normative Performance
- Grade/Goal
- Comprehension Questions Correct
- Recommendations & Summary

**Fixations**
The term fixation or eye-stop refers to that interval in reading a line of print during which the eye is held relatively stationary for a short time and during which perception takes place. The eye moves in this fashion across each line of print in a series of fixations or eye-stops and then sweeps back in another larger saccadic movement to the beginning of the next line of print. This longer eye-movement is commonly referred to as a return sweep.

The majority of people are relatively unaware of the vast number of fixations they make in proportion to the amount of words read. For instance, the average adult reading a 10-word line will tend to make from 8-10 fixations. A superior reader will make perhaps 5, while a child in elementary school will fixate from 13-22 times in 10 words. The “word by word” reader does not make one eye-stop per word but usually makes two or more. We are unaware of this amount of activity because of the rapidity with which eye-movements take place, the subtlety of the activity involved, and our lack of direct, conscious control of this process.

An individual might employ a comparatively large number of fixations for either of the following reasons:

1. **Difficulty with Visual Acuity or Binocular Coordination**
   Inability to see well enough or to coordinate the eyes properly will tend to increase the amount of fixations as well as regressions.
2. Conditioning of Early Reading Experiences
An excessive number of fixations and regressions can become part of an individual’s habitual reading performance through the conditioning that occurs during the early stages of learning to read during which time there is often:

- A considerable number of new words encountered each week which promotes considerable word scrutiny and resultant non-fluent reading.
- Emphasis on oral reading, which can influence the reader’s and the listener’s viewing habits adversely, encouraging an excess number of fixations and regressions especially when oral reading is less than fluent.
- Occasionally an overstress on phonics, which can condition an interruption of the fluent reading process if words are habitually and unnecessarily analyzed.
- Difficulties with comprehension.
- Sometimes a lack of confidence in the ability to read satisfactorily.

All of these early learning experiences can contribute to a less than fluent approach to silent reading, which often becomes incorporated into a rather habitual inefficient manner of reading during the intermediate grades.

It is a well established fact that the more efficient reader requires fewer fixations in reading a given line than the poorer reader. Certainly, it is desirable to acquire visual/functional and perceptual habits and cognitive competence that result in a minimum amount of ocular activity for, generally, the greater the number of fixations, the more time is spent in reading and the more energy is consumed in the reading process.

### Taylor National Norms

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>Col.</th>
<th>Advanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixations/100 words</td>
<td>224</td>
<td>174</td>
<td>155</td>
<td>139</td>
<td>129</td>
<td>120</td>
<td>114</td>
<td>109</td>
<td>105</td>
<td>101</td>
<td>96</td>
<td>94</td>
<td>90</td>
<td>77</td>
</tr>
</tbody>
</table>

Regressions
Regressions, or reverse fixations, are those fixations that occur following a right-to-left saccade or interfixation movement. Excessive regressions can result from less than satisfactory visual acuity or binocular coordination problems, conditioning during “beginning to read” stages, perceptual inadequacies, as well as poor or unsatisfactory comprehension.
Sometimes habitual regressions result from the inadequate formation of directional attack. When learning to read, the person tended to incorporate or employ a certain amount of corrective movement in each line of print. Many times this habit is so ingrained that regressions will occur at similar points in every line of print.

Many individuals incorporate a number of regressions into their reading performance because of a lack of confidence and an ingrained need to “double check” words and context. Their general insecurity in terms of remembering what they have read is sufficiently great to cause them to regress and even reread habitually.

Regressions require only fractions of a second (perhaps only .24 seconds), and because they are interspersed with forward fixations, the reader is seldom conscious of their occurrence. Although the time required for a single regression is small, total time spent in regressions might occupy from 1/5 to 1/3 of the total reading time. Desirably, the proportion of regressions to total fixations should not exceed 10-15%.

A more efficient reader will make fewer regressions in reading than a poorer reader and will exhibit a more efficient directional attack which results in more sequential input of information to the mind.

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Percentage of Regressions/100 words</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>52</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
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*Advanced represents typical reading performance characteristics for trained readers.

**Average Span of Recognition**

The span of recognition refers to the amount of words or word-parts perceived during a fixation or eye-pause during reading. Span of recognition does not refer to the amount of material impinging on the retina of the eye but rather to the amount the reader recognizes or can deal with interpretively. In reading, the “perceptions” are so interrelated and interdependent that it is unrealistic to think of span of recognition as a measurement during an isolated seeing situation. Rather, when considering a person’s visual in-take in reading, we must look to a reader’s performance throughout a selection as providing a more typical reflection of his/her average visual intake.

**And so the night descended on the camp.**
The calculation we refer to as average span of recognition is determined by noting the number of fixations required to read a designated number of words.

In the Visagraph™ III recording, we compute the average span of recognition, fully realizing that there is undoubtedly some variation in span of recognition from fixation to fixation.

As you can see from the chart below, a first grader at the end of the year perceives an average of only .45 of a word per eye-stop; students do not average a full word until eleventh grade; and even the average college student only 1.11, reading at the rate of 280 words per minute. Even after fluency development training, the span for a good reader seldom exceeds 2.5 words.

It is apparent, then, that phrase seeing during reading is a myth. Realizing, however, that all readers, even beginners in first grade, “think” in phrases and larger linguistic units, one can only conclude that a person constructs a thought or idea through a series of eye-stops or visual impressions as these impressions are processed in short-term memory.

**Average Duration of Fixation**

The duration of fixation refers to the length of time a reader's eyes pause during a fixation. In eye-movement recording, we use the term “average duration of fixation” which is computed from the time (in seconds) it takes a reader to read the selection and the total number of fixations employed in reading the selection.

As you can see from the chart below, an elementary school child might pause as long as .33 seconds per eye-stop, making about 3 movements per second. (This is undoubtedly influenced by the fact that his reading experience is predominantly oral and the fact that he does not recognize a great many words easily and quickly, and does not associate very rapidly.) The college student, a more mature reader, might average .24 seconds per eye-stop, or slightly more than four fixations per second. The shortest duration found in thousands of eye-movement photographs of reading was .16 seconds or 6 fixations per second, but it should be noted that this reader, though a rapid reader, was not extraordinarily rapid, for his exceptionally short duration was offset by a greater number of fixations and a correspondingly small average span of recognition.

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Advanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Span of Recognition in Words</td>
<td>1</td>
</tr>
<tr>
<td>.45</td>
<td>.57</td>
</tr>
</tbody>
</table>

In general, duration of fixation tends to shorten as the reader matures, reflecting a decrease in his reaction time and an increase in the rapidity with which he associates and comprehends. As you will note from the chart, however, duration changes only slightly after the child reaches fourth grade or ten to eleven years of age.

**Reading Rate with Comprehension**
The term “rate” refers to the time required by a reader to read through a given selection with adequate comprehension.

A measurement of rate of words per minute has the most significance when it refers to a usual manner of reading, or the way the person might typically read in a magazine, novel or other non-test situations where rereading or reflection are at a minimal level. Rather than referring to a skimming rate where only portions of the context are read, or a reflective or analytical reading which requires rereading or pauses to reflect and perhaps visualize, it is more meaningful to refer to a person’s “usual” rate, a rate at which narrative-informational material is read. This is the manner of rate referred to in Visagraph™ III recordings.

While rate cannot be considered apart from comprehension, there are certain factors that greatly influence the relative rapidity with which a reader deals with print. Among these will be a reader’s visual/functional efficiency, his/her perceptual accuracy and efficiency, and the oculo-motor activity which have become habitual through the years. These factors prevent rate from being directly proportional to the difficulty of the content, or to the experiences of the reader, or to the comprehension achieved. In other words, many people, particularly poorer or less efficient readers, will not vary greatly in their reading rate on different levels of material unless the difficulty of the material becomes overwhelming. Other readers’ comprehension will be poor no matter how slowly they read. And there are readers whose comprehension improves as they consciously attempt to increase their rate and others whose comprehension drops as they exert conscious effort to increase their rate.

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Advanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Duration of Fixation (seconds)</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>.33</td>
</tr>
</tbody>
</table>

Many persons assume that rate is a highly variable factor and that we can, at will, alter our rate to suit the situation of our purposes. In actuality, the vast majority of people vary their rate slightly on material that could be classified as easy to fairly difficult.

The chart below provides an indication of the average rate demonstrated by students at various levels when reading material at their grade level. In addition, the average adult has been found to read at rates ranging from 175 to 300 words per minute, with a more typical or average rate of 225 words per minute. The superior adult reader might average 500 words per minute and even the best readers, after completing a reading improvement course, rarely read above rates of 650 words per minute.

### Reading Rate Without Rereading

This is helpful information in comparing a subject’s performance in pre/post tests where one Visagraph™ III test involved rereading. This allows more equivalent comparison of reading performance efficiency. (Toggle the R key to view comparisons.)

The rate with comprehension will include any rereading performances. The rate adjusted for rereading is a calculation that eliminates any effect of rereading. Any intraline rereading (instances in which a regressive movement is greater than 30% of the line value, which typically exceeds usual regressive activity) and any extra lines read by a student are deleted by extrapolation in this calculation.

### Directional Attack Difficulty

The term “directional attack” refers to the characteristic tendency of the reader to perceive and organize content in a left-to-right manner. The perceptual activity and ocular patterns in reading are so interrelated that it may be said that the recorded pattern indicates, in a general manner, both the perceptual accuracy of the individual and his orderliness in dealing with the content. Thus, the pattern made by the reader’s eyes reveals the quality and nature of his/her directional attack and is as individualistic as are the components themselves.

The quality of a reader’s directional attack relates directly to the manner in which information is fed into short-term memory. When the sequence of visual impressions are sequential and regular it can be assumed that the impressions being processed...
in short-term memory are likewise sequential and reinforcing syntactically as a result. Likewise, poor directional attack would suggest a more imperfect non-syntactical and less reinforcing input into short-term memory.

Directional Attack Difficulty, as a calculation of the percentage of regressions to total fixations, is automatically provided by the Visagraph™ III. Generally, should the percentage of regressions be 10-15% or less, a reader’s directional attack can be judged relatively efficient. If the percentage is 25% or more, the reader is employing poor directional attack.

**Grade Level Efficiency**
The Visagraph™ III will automatically calculate a reader’s relative reading efficiency and equivalent grade level efficiency performance.

The grade level equivalent of a subject’s reading performance is based on the following considerations:

- It presupposes that fixations, regressions and rate are the most important components (span and duration being calculations derived from these).

- It presupposes that a person who makes more regressions is generally less effective perceptually, and that regressions, therefore, should be given additional weight in the calculations (they are already included in the total count of fixations).

**Cross-Correlation**
Although the cross-correlation report is designed to evaluate adequacy of binocular coordination, a very low cross-correlation (perhaps .75 or lower) may signify the need for another recording. A low cross-correlation can be caused by a poor recording. A confirmation of the adequacy of a recording can be made by comparing the Original Graph with the Model Graph. If they seem very similar, the recording is probably satisfactory and the Cross Correlation is probably low because of coordination difficulties. Generally, a Cross Correlation of less than 90% is cause for concern.

**Grade Norms - Normative Performance**
The profile plot displays a subject’s reading performance characteristics in relation to Taylor’s norms. The green lines indicate the extent to which performance exceeds grade norms and the red lines indicate performance less than grade level expectations. Both of these plots extend to the left and right of a subject’s Grade Level Efficiency determination.
Grade/Goal
The reading performance characteristics are displayed against Grade Norms and Goals. The Goals represent the goals that would be expected if an individual was reading with grade level normative behavior.

Comprehension Questions Correct
As mentioned previously, the comprehension score is primarily used to qualify that the subject was reading in a usual or typical manner. A score of 70% or higher comprehension is acceptable. If the comprehension score is 60% or lower, another recording should be administered using a lower level test selection (perhaps 1-2 levels lower).

Recommendations & Summary
The Report findings are used as the basis for specific recommendations as to the use of certain Taylor Associates’ fluency development programs.

Summary notes can be added by an examiner at the time of recording or at a later date.
Interpreting the Reading Simulation

Choose *Simulation* from the Reading Report dropdown menu for a graphic depiction of the subject’s eye-movements.

A colored band moves in relation to the subject’s actual eye-movements made during the recording. Click *Real Time* to view the Simulation in real time or click *Half Speed* to view the Simulation at half real time speed.

The colored band will move across the text to simulate the subject’s eye-movement performance on the test selection at his/her reading rate.

This display does not plot exact fixation locations but does reasonably depict all fixations and regressions made on all lines displayed (beginning and ending lines excluded). And if the automatic analysis program could not detect all lines, the Simulation will only display the number of lines detected starting with the second line of print and ending with the start of the last line read (countable lines only).
Interpreting the Reading Graphs

Once a recording is completed, the subject’s reading performance can be examined graphically. Choose Graphs from the drop down menu.

For your convenience, keyboard shortcuts are available to facilitate navigation through the various display options within a recording.

<table>
<thead>
<tr>
<th>Shortcut</th>
<th>Description</th>
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<tbody>
<tr>
<td>G</td>
<td>Graph</td>
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<tr>
<td>M</td>
<td>Model</td>
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<td>R</td>
<td>Report Screen</td>
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<td>X</td>
<td>Overlap Graph Lines</td>
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Examining the Reading Graphs

There are several displays of graphs that can be viewed or printed. Each graph may be examined in total by utilizing the scroll bar. Choose the desired display mode by clicking the appropriate radio button located on the right side of the graph screen.
Model Graph

Model Graph - A realigned plot that compensates for head sway and makes fixations and all other characteristics more easily discernible.

Model Graph - Data - Values Start Time - Display of any difference in the time one eye commenced its interfixation movement in relation to the other eye (R, right or L, left). The advance time will be shown in milliseconds.

The Model Graph with Data is typically the most important indicator of the nature of a subject's performance. In studying the Model Graph, note the following:

- The pattern of visual activity of both eyes should be similar both in terms of number of fixations and regressions. If there is considerable dissimilarity, take note of the data reported (in red) as an indication of visual functional difficulty.

- Variation of visual activity can suggest that you look carefully at a student's Visual Functional Report and administer the Student Inventory.
Model Overlap - Toggle the X key on the keyboard to see an overlap of the left and right eye graph lines. This may also be displayed with the values and text.

Original Graph

Original Graph - Raw data recording for both eyes.

Original Graph with Data is typically used to reach more final judgment of a student’s visual functional competence.

In the Original Graph, you’re looking in general to discern similar activity which can suggest binocular coordination problems.
Vergence - You can examine vergence or the student’s ability to coordinate and use both eyes as a team. If, for example, you see one eye holds steady and vertical during a fixation and the other seems to sway sideways, there could be a problem in a student’s holding vergence and fusing the images of both eyes. Or, at times you may see angling out of both eyes during a fixation also indicating a tendency for the student to lose vergence after fixating his/her eyes.

Head Sway - When you see both eyes swaying in the same direction, the student is moving his or her head during reading. This is not a loss of binocular control.

Anomalies - Anomalies are instances in which one eye (either eye) moves in a forward or reverse manner and the other eye does not move, or when both eyes move in different directions to a new fixation point.
Blink - A blink is detected when both eyes move radically in opposite directions and then swing back. Blinks are designated as BLN and will be indicated by dotted lines in the Model Graph plot. A blink is non-analyzed time and later this time interval is extrapolated to the usual number of fixations and regressions that would have occurred during this interval of time.

Text Display - Model and/or Original Graph may be displayed with the lines of print from the test selection.

Model & Original - Display of both Model and Original graphs.
Interpreting Results

- Duration of most active eye in milliseconds
- Interfixation movement of right eye in relation to total excursion value
- Interfixation movement of left eye
- Saccade number with each line
- Line number
- RSW = Return Sweep, BLN=Blink, RR=Regression both eyes, R=Regression one eye
- Total elapsed time

**Data - Values (Descriptors)** - Model and/or Original Graph with line numbers, fixation numbers, durations, etc. in numerical form.
Interpreting the Visual Functional Report

Many students will experience difficulty in reading because of poorly developed visual/functional competencies (binocular coordination and vergence, ocular motility and tracking). The Visagraph™ III is invaluable in that it allows an examiner to screen for possible visual impediments. Suggestions for referral of a subject are contained in the Visagraph™ III Resource Guide. It is sufficient to say that should a student exhibit many symptoms (indicated in red), s/he is a candidate for referral to a qualified vision specialist for a more complete visual diagnosis.

Following is a list of the various reporting features:

- Fixation (Difference Between the Two Eyes)
- Regression (Difference Between the Two Eyes)
- Average Duration (Difference Between the Two Eyes - mil. sec.)
- Cross-Correlation
- Excessive Saccades in Return Sweeps
- Anomalies
- Start Time Differences Between Eyes
- Student/Examiner Functional Readiness Inventory Results
- Countable Time (sec.)
- Countable Lines Found/Countable Lines
- Lines Partially Reread (> 30%)
- Lines Reread
- Artifact Time Left Eye/Right Eye (%)
- Duration Standard Deviation (ms)

**ANALYSIS**

**Fixation (Difference Between the Two Eyes)**
In most instances, the performance of a subject’s two eyes will be quite similar. However, in instances where the difference in total fixations for both eyes exceeds 10%, there may be an indication of binocular coordination difficulty.

**Regressions (Difference Between the Two Eyes)**
As with fixations, any difference that exceeds 20% may also indicate difficulty with binocular coordination.

**Average Duration (Difference Between the Two Eyes - mil. sec.)**
A difference of .01 between the two eyes may also be another indicator of binocular coordination difficulty.

**Cross Correlation**
An indicator of the degree to which the interfixational saccades of the two eyes are similar in excursion throughout the reading. A perfect correlation would be 1.000. Less than this would indicate some degree of difference in the similarity of saccades of the two eyes in either interfixation movement and/or return sweeps. Low correlations can be significant and need to be studied. It is likely that a correlation less than .90 is suspect.
Excessive Saccades in Return Sweeps
Ideally, the number of return sweep saccades will equal the number of lines found. Any excess return sweep saccades indicate compensating movements made during the process of executing a return sweep. If a student’s coordination or tracking is poor, the number of saccades and return sweeps can, at times, be 2 or perhaps 3 or more times the number of lines found. Excess return sweeps, in excess of 50% or more than the lines found, is another “red flag” that might indicate inadequate visual functioning.

Anomalies
Anomalies in excess of 4 in any of the 3 numbers reported can also signal visual/functional difficulty. These numbers reflect the following:

- The first number indicates instances in which one eye moved in a forward direction and the other eye (either eye) did not move substantially enough to be recognized as a forward fixation (the amount of movement to identify a movement as a new fixation is 1% of the total average line value. This is roughly equivalent to a letter space).

- The second number indicates instances in which one eye moved in a reverse direction and the other eye did not move sufficiently to be detected as a new regressive fixation.

- The third number indicates the instances in which the two eyes appear to move in opposite directions. Whenever this occurs, it is best to examine the subject’s original graph to be sure that the reported differences in the two eyes is truly significant.

All anomalies will be presented in red in the values that can be employed in either the Model or Original graphs.

Start Time Differences Between Eyes
The nature of start time differences between the two eyes is counted and reported. To date, however, there is no criteria as to the number of start time differences that might support the consideration that this difference in start time reflects a coordination difficulty. An excessive number of such instances in conjunction with other reported data will simply add to an indication of visual/functional difficulty. You could compare the total number of fixations in relation to the start time differences in evaluating this data.
**Student/Examiner Functional Readiness Inventory Results**

While viewing a subject’s recording file, click on the Student Info tab located in the upper left corner of the window.

When there are reasons to suspect that a student’s visual function isn’t adequate (low cross-correlation, excessive return sweeps, anomalies, etc.), a Functional Readiness Inventory may be administered. These questions, which reflect a student’s awareness of visual/functional problems, will often support the numerical findings revealed by the Visagraph™ III. In instances where a parent or teacher’s responses can be obtained, the examiner’s questions are administered to further support an evaluation of a student’s visual/functional difficulties.

Obviously, the greater the number of adverse responses by a student or examiner, the greater the possibility that the student is experiencing visual/functional difficulty.

**ADDITIONAL ITEMS**

**Countable Time (sec)**

Countable Time is the time from return sweep to the second line of text to the return sweep to the last line. When displaying values in graph mode, starting and ending points are marked with <->.

**Countable Lines Found/Countable Lines**

Logically, the number of lines found by computer analysis should equal the number of countable lines. But this may not be the case. If the number of lines found exceeds the countable lines, then the subject has reread lines. Additional rereading will be compensated for in the component designated “Rate Adjusted for Rereading.”

If the number of lines is less than the countable lines, then the computer analysis could not discern a sufficient return sweep activity. For a return sweep to be detected, the cumulative minus values (indicating right to left movement) must exceed 60% of the average return sweeps for all line values. This lesser amount of lines found will not substantially affect any of the calculations. Any missing return sweeps may now be reflected as several additional regressions. But the overall nature of fixations will not be affected nor will any of the other calculations.

**Lines Partially Reread (>30%)**

Regressions larger than 30% of a normal return sweep are classified as partially reread lines.
Lines Reread
Lines completely reread are extra lines found in the countable part of text.

Artifact Time Left Eye/Right Eye (%)
The artifact time is any portion that could not be described as fixations (example blinks). This time is offset by extrapolation of data.

Duration Standard Deviation (ms)
Duration of Standard Deviation shows a range of departures from mean duration as reported in the Reading Report. The greater the deviation in duration the poorer the reading performance. A comparison of the mean deviation could be made in relation to grade level normative performances.
Numbers Test

In the event that your student is not able to read at the 1.5 level or exhibits an extremely halting non-fluent reading behavior, you may want to use the Numbers test to evaluate the student’s visual/functional competency. This test is especially helpful for non-readers but can be used with all students for visual/functional evaluation.

From within the New Eye-Movement Recording window, click the Numbers radio button. (See Generating Recordings).

You may want to select the examiner from the Examiner pulldown menu to identify which teacher/examiner is administering the recording.

When ready, click Start to begin the recording. As the subject is being recorded, two traces will appear on the screen. Wait until you see the traces appear while the student fixates on the O before saying, “Now look at each number one by one.”

*If the Examiner recognizes a failed recording in progress and wishes to abort, click Stop then Clear. Check and adjust the IPD setting again for the student to ensure it is accurate. Click Start to begin again.*

When the subject alerts you that s/he has finished reading, and you see straight lines in the recording window indicating that the student has closed his/her eyes, click Stop.

After a Numbers recording is generated three types of data presentations are available:

- *Numbers Report* - Displays data comparing a student’s reading fluency skills to normative data and grade level goals.

- *Simulation* - Provides a simulation of the student’s eye-movement activity during the recording procedure.

- *Graphs* - Graphic display of eye-movement during the recording.
Numbers Report

Keep in mind that there are no norms yet established for the Numbers test. You can, however, make reasonable judgments about the adequacy of binocular and tracking accuracy by examining the data in the Report, Simulation and graphs.

Fixations/100 Numbers (Both Eyes)

Fixations refers to the number of eye-stops made to look at each and every number. There are 50 numbers in the middle 7 countable lines on the target card (the first and the last line are eliminated). The number of fixations made is doubled to be equivalent to reading performances for 100 words. Ideally, there should be only 100 fixations/100 numbers. Less indicates that tracking was poor and numbers were skipped. More than 100 indicates the possibility of inadequate coordination and/or poor tracking. Good adult performance will be 100 fixations/100 numbers. Children not sufficiently accomplished, in terms of visual skills, may have as many as 200 fixations/100 numbers or more. It is also important to note whether there is any difference of greater than 5% between the performances of the two eyes. Any difference greater than this could suggest binocular problems.

Regressions/100 Numbers (Both Eyes)

Regressions are reverse eye-movements made in a right-to-left direction. If binocular coordination and accuracy in tracking is perfect, there will be no regressions. It is unusual, however, to see absolutely 0 regressions. Adults, performing relatively well, will make two or three regressions whereas children with visual and tracking inad-
equacies may make as many as 30 or more regressions. Since there is no context to read in the Numbers Card, any report of high regressions can only be attributed to poor visual binocular coordination and tracking inadequacies. When reading content is encountered by children who exhibit excessive regressions, this number will undoubtedly increase. Again, note the equivalence of the number of regressions between the two eyes.

**Average Duration of Fixation (Both Eyes)**
This is the average pause time for the two eyes as the eyes fixate across each line of print. It is not unusual to note durations as long as .40 seconds for some children, but more typical durations will be closer to .33 seconds for beginning or non-readers and close to .25 seconds for adults. In general, eye pauses longer than .25 or .26 seconds are extremely long considering that there is no meaning being extracted in the Numbers test in contrast with reading.

**Rate (Numbers Per Minute)**
Rate is a calculation taken from the time in seconds a child is required to look at all of the numbers in the middle 7 lines on the Numbers Card. Adults, making only 100 fixations per 100 numbers and pausing only .25 second will average 240 numbers/min. This is a reasonably good performance. Children, on the other hand, may make 200 fixations per 100 numbers and pause for as long as .33 seconds and as a result average only 90 numbers/min. Ideally a child should only make 100 fixations per 100 numbers and employ durations no longer than .33 seconds. This would result in a rate of 180 numbers per minute. A rate less than 140-150 numbers per minute is, in the author’s opinion, cause for concern as to the adequacy of binocular coordination and tracking.

**Rate w/o Rereading (number per min.)**
This represents the removal of any time a child spent looking back at any numbers on any line of print where these reverse movements exceeded 30% of the total excursion for the line or extra lines (beyond the expected 7). Extra lines would suggest that a child lost his/her place and repeated the viewing of a line of numbers. Usually you would expect the Rate and Rate Adjusted to be the same since this is not content to read and understand.

**Directional Attack (Difficulty)**
This is the percentage of regressions to total fixations (which includes regressions as well as forward fixations). Since there is no reading content to prompt any rereading, directional attack should, logically, be zero. However, this is seldom the case. Adults
may score as low as 5% for directional attack whereas many children will score as high as 30% (or in some cases, higher). As with reading, directional attack should probably not exceed 15% or be considered relatively poor.

**Cross Correlation**
This number indicates the statistical equivalence of the movement of the two eyes as they move in a horizontal fashion. A perfect correlation would be 100%. And a Cross-Correlation of less than 90% may be a cause for concern. Note: With some children who read the numbers aloud there is a tendency for the cross-correlation to be lower than if reading was done silently. Because the children have to say each number, this does prompt extra fixations and regressions and could likewise decrease Cross-Correlation, perhaps to 80% or slightly lower.

**Anomalies (Fixations/Regressions/Both)**
These three numbers indicate the number of instances in which the two eyes did not perform in a similar manner while tracking across lines of print. The first number represents instances in which one eye (either eye) moved in a forward direction and the other eye did not move sufficiently to be detected as a new fixation (it is important to realize that a new fixation will not be recognized unless the amount of movement is greater than 3% of the total line excursion movement). The second number represents instances in which one eye moved in a reverse direction (either eye) and the other eye did not apparently move. The third number reflects instances in which both eyes moved in opposite directions. There is cause for concern if any one of these numbers exceeds four.

**Countable Lines/ Lines Found**
Logically, the number of lines found by computer analysis should equal the number of countable lines. But this may not be the case. If the number of lines found exceeds the countable lines, then the subject has reread lines. Additional rereading will be compensated for in the component designated “Rate Adjusted for Rereading.”

If the number of lines is less than the countable lines, then the computer analysis could not discern a sufficient return sweep activity. For a return sweep to be detected, the cumulative minus values (indicating right to left movement) must exceed 49% of the average return sweeps for all line values. This lesser amount of lines found will not substantially affect any of the calculations. Any missing return sweeps may now be reflected as several additional regressions. But the overall nature of fixations will not be affected nor will any of the other calculations.
Saccades in Return Sweeps
Return sweep saccades indicate the number of fixations required for a child to return to each new line of numbers over 7 lines. Ideally, the student should only require 7 return sweep saccades to view the 7 countable lines of numbers.

Some children will, however, because of poor vision, binocular coordination difficulties and/or tracking inaccuracies exhibit more than 7 return sweeps. More than 11 to 12 RSWs is a cause for concern.

Some children, with a near-point vision problem will exhibit in the Model graph, additional return sweeps (RSWs) close to the beginning of each line of print. These students, upon executing a return sweep, over-converge, fall short of the beginning of each new line and need a compensating leftward movement to return properly to the beginning of each new line of numbers. Other children will exhibit additional fixations along each return sweep movement in the Model graph. In these instances, the child lacks proper spatial control and retracks along the line of numbers previously viewed to guide him/her to the next line of numbers.

Simulation
Choose Simulation from the Numbers Report dropdown menu for a graphic depiction of the subject’s eye movements.
A colored band moves in relation to the subject’s actual eye movements made during the recording. Click Real Time to view the simulation in real time or click Half Speed to view the simulation at half real time speed.

This display does not plot exact fixation locations but does reasonably depict all fixations and regressions made on all lines displayed (beginning and ending lines excluded). And if the automatic analysis program could not detect all lines, the simulation will only display the number of lines detected starting with the second line of print and ending with the start of the last line read (countable lines only).

Examining the Numbers Graphs
Once a recording is completed, the subject’s performance can be examined graphically. Choose Graphs from the drop down menu.

Original Graph
The Original graph will display the actual pixel plot of a child’s performance and is the best source of information about binocular coordination and vergence, tremors (suggesting a lack of visual comfort), head sway (when the two eyes sway in the same direction suggesting head rotation when viewing the lines of numbers) and variations in the distance between the two eyes, suggesting a loss of binocular coordination. Note that by clicking the Start Time radio button the start time difference for either eye (L-Left or R-Right) will be displayed in milliseconds. Short start time differences of 68 milliseconds or less may not be significant. But should the difference in start time be very frequent throughout the viewing of the numbers, this may be another “red flag” in terms of poor binocular coordination.
Model Graph
Since the Numbers test is still quite new, data is being gathered from users as to their experiences. We would certainly appreciate any information you would care to share with us as you compare performances of the Numbers test and a student’s competency as s/he engages in beginning reading.

Shortcuts

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<tr>
<td>M</td>
<td>Model</td>
</tr>
<tr>
<td>O</td>
<td>Original</td>
</tr>
<tr>
<td>B</td>
<td>Both</td>
</tr>
<tr>
<td>T</td>
<td>Numbers</td>
</tr>
<tr>
<td>S</td>
<td>Simulation</td>
</tr>
<tr>
<td>R</td>
<td>Report Screen</td>
</tr>
<tr>
<td>X</td>
<td>Overlap Graph Lines</td>
</tr>
</tbody>
</table>

Access graphs from any Report screen.
Displays Model Graph.
Displays Original Graph.
Display of both Model and Original Graphs overlapping one another.
Superimposes lines of numbers onto the Graph.
Displays the Simulation screen.
Return to the Report screen from another screen display.
When viewing Model graph, toggle the X key to overlap the left and right eye lines. You may also use the forward/back arrows to bring the graph lines closer together.
Visual Skills Test

The Visual Skills Report provides the automatic calculations of the Fixation and Motility portions of the test.

While no normative behavior has yet been established with regard to this new Visual Skills test, the availability of this testing routine and the automatic calculation available in the Visagraph™ III routine will now permit normative behaviors to be collected and criteria established in terms of visual efficiency and competence. This test is more typically used by a Vision Specialist to evaluate visual/functional competence.

The information shown on the Report can be printed out at any time and can serve as the basis for reaching judgments about the subject’s need for a reading fluency development program or visual training to improve his/her reading efficiency.

Automatic calculations of performance characteristics will appear for both the left and right eye along with goals.

From within the New Eye-Movement Recording window, click the Visual Skills radio button. (See Generating Recordings.)

You may want to select the examiner from the Examiner pulldown menu to identify which teacher/examiner is administering the recording.

When ready, click Start to begin the recording. As the subject is being recorded, two traces will appear on the screen.

The Fixation portion of the test is for a fixed duration of time equaling 15 seconds. The Motility portion of the test will follow and is also a fixed duration of time equaling 20 seconds.

*If the Examiner recognizes a failed recording in progress and wishes to abort, click Stop then Clear. Check and adjust the IPD setting again for the student to ensure it is accurate. Click Start to begin again.*
VISUAL SKILLS SIMULATION
Choose Simulation from the Visual Skills Report dropdown menu for a graphic depiction of the subject’s eye movements.

A colored band moves in relation to the subject’s actual eye movements made during the recording. Click Real Time to view the simulation in real time or click Half Speed to view the simulation at half real time speed. A Simulation is available for both portions of the Visual Skills test.

VISUAL SKILLS REPORT
Fixation Maintenance (15 seconds)
Fixation Maintenance tests the ability of a subject to maintain steady fixation on a central X for 3 frames (15 seconds) of recording without a change in eye position. Ten seconds of time is analyzed.

This task is designed to evaluate a subject’s ability to focus and control attention and maintain binocular fusion for a period of time that exceeds usual reading requirements.

The calculations represent the total number of fixations (or times the eyes moved a distance greater than 3% of the mean overall eye-movement range) during 15 seconds.

Mean Saccade Size %
This value gives the mean size of the saccades during the Fixation Maintenance test expressed as percent of mean excursions during the Motility test. Ideally, children should be able to direct their gaze and maintain fixation on the central X for a period of 15 seconds (analyzed portion). A report of a single fixation for both eyes and 0% mean deviation (from prior fixations) would be ideal. However, most children will not achieve this level of performance. Variations can range from single fixation to a high of 20 fixations or more.

If there are multiple fixations but the number is the same for both eyes, this would suggest difficulty with one or more of the following:

• Attention could not be maintained on the task.
• Vergence (binocular fusion on a common point of fixation) could not be maintained, and had to be re-established at intervals.
• Habitual tendency to keep the eyes in motion prompted involuntary re-fixations.
Reports to date would suggest that up to perhaps five fixations may be usual, with a greater number signaling more difficulty with the above-cited conditions.

A more important consideration would be any difference in the number of fixations between the two eyes. While a difference of one to two fixations between the two eyes may not be significant, a greater difference might signal a lack of binocular control. An examination of the original graph would likely confirm such a loss of binocular control.

Then, the mean saccadic size percentage should be inspected. If this percentage is equal for both eyes, it is likely that the two eyes have simply shifted position. If, however, there is a difference between the mean saccadic size between the two eyes, this would suggest difficulty with binocular control or fusion. For perspective, a 3% difference between the eyes is approximately equivalent to a difference of two letter spaces. In some cases where one eye deviates 7% and the other eye 1%, this would be the equivalent to a difference of three letter spaces in fixation position in reading, which probably signals a loss of vergence and adequate fusion. In connection with this hypothesis, however, it should be stated that individuals vary considerably in their ability to see and report single vision with varying amounts of retinal disparity, so one can only state that the closer this mean saccadic percentage is, one eye to the other, the better. It is likely that a difference in the mean saccadic size % of one eye in relation to the other eye that is greater than a value of 2% could be significant.

**Motility (20 seconds)**

**Excursions**

Motility tests the ability to move the eyes rapidly and accurately between two Xs for 4 frames of recording. Measurement is made of the number of excursions as well as the precision with which the excursions are accomplished. The subject is instructed to fixate rapidly back and forth between the Xs as many times as possible in 20 seconds, 20 seconds being analyzed.

This task is designed to evaluate a subject’s oculo-motor facility (ability to rotate eyes easily and rapidly), binocular capability (ability to maintain vergence and fusion) and tracking accuracy (ability to direct the eyes and fixate accurately).

Ideally, a child should be able to make a minimum of 30 excursions (left to right or right to left excursions) in 15 seconds (analyzed time). This would allow an average duration of fixation of .50 seconds if only one saccadic movement was employed to execute each excursion. The number of such excursions, however, will be determined by a child’s ocular facility, binocular control and tracking accuracy.
Fewer excursions will typically occur if a child requires a number of saccadic movements to execute such broad ocular sweeps (15 degrees at a viewing distance of 18 inches) and a longer pause time for each fixation. Therefore, it is important to look at the overall manner in which these excursions were executed as well as the number accomplished.

**Fixations**
A child with less ocular facility will also display more head movement during recording and will require more pause time per fixation. If a child’s ability to direct the eyes with accuracy is limited, compensating saccadic movements will be required, thus increasing the number of fixations reported. And beyond any numerical data, the recorded graph will likewise allow an examination of oculo-motor performance in terms of vergence and binocular coordination.

**Average Duration of Fixation**
Excellent Motility performance, for example, would be 45 to 50 excursions with a corresponding number of fixations. This would also result in an average duration of fixation of about .30 seconds. Very poor performance can be as few as 8 excursions, with perhaps 3 fixations per excursion accompanied by very long durations of fixation, perhaps .58 seconds.

More reasonable performance may result in 30 or so excursions with approximately 2 fixations per excursion, but with durations of only .25 seconds.

For additional perspective, a similar study of oculo-motor behavior was conducted at the University of Chicago in 1965 by Stanford Taylor, H. Alan Robinson in consultation with Miles Tinker. This study involved both kindergarten and first grade students. The students in this study were directed to look back and forth rapidly between two dots that were spaced at the equivalent distance of the Xs in the Visual Skills test. The test duration was for the same 15 seconds as in the Visual Skills Test. The performances observed were as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade K - October</td>
<td>8-30 excursions</td>
<td>19 excursions</td>
</tr>
<tr>
<td>Grade K - April</td>
<td>9-39 excursions</td>
<td>28 excursions</td>
</tr>
<tr>
<td>Grade 1 - October</td>
<td>8-14 excursions</td>
<td>27 excursions</td>
</tr>
<tr>
<td>Grade 1 - April</td>
<td>12-50 excursions</td>
<td>29 excursions</td>
</tr>
</tbody>
</table>
The average number of fixations per excursion was:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Time</th>
<th>Mean</th>
<th>Fixations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade K</td>
<td>October</td>
<td>Mean</td>
<td>2.69</td>
</tr>
<tr>
<td>Grade K</td>
<td>April</td>
<td>Mean</td>
<td>2.20</td>
</tr>
<tr>
<td>Grade 1</td>
<td>October</td>
<td>Mean</td>
<td>2.40</td>
</tr>
<tr>
<td>Grade 1</td>
<td>April</td>
<td>Mean</td>
<td>2.00</td>
</tr>
</tbody>
</table>

Most important is the aspect of the equivalence of the number of fixations for the left eye and the right eye. Ideally the number of fixations should be the same for both eyes. However, a difference of 1-2 fixations is not unusual and may not be significant. Considerably more than 3 fixations difference, however, might suggest coordination inadequacy. For perspective, poor performances may exhibit as much difference in fixations between the two eyes as 9 or 10 fixations. This would very likely suggest very poor binocular coordination capability.

Obviously, a child with better oculo-motor facility, binocular control and accuracy of tracking has greater potential for good visual/functional performance in reading. Excessive head movement, limited excursions and greater disparity in the performances of the two eyes would suggest that a child with these characteristics will experience more difficulty in the usual near-point requirements of reading and that this limited proficiency will affect this child’s reading ease and comfort.

**Shortcuts**

**Examining the Visual Skills Graphs**
**Printing Results**

Within all report and graph screens click the *Print Options* button to open a print dialog box. You can choose to: *Print All Students* or *Select Students to Print*.

**Print All Students**

When choosing *Print All Students* only the Print Reports option is available and is preselected. You may then click to choose specific reports within the list.

**Select Students to Print**

When choosing *Select Students to Print*, the student list will come into focus wherein you may select one or more specific students. If multiple students have been selected, only Print Reports is available. Click to select the desired reports.

When a printout of a graph is needed, first select *Graphs* from the pulldown on the Report screen. Note (in the red boxed area in the figure below) that there are a variety of display modes.
Click the appropriate boxes to select the desired mode of display. Next, click the *Print Options* button to return to the Print/Preview Options window. (Note that only one student may be selected from the list when choosing *Print Graphs.*) Click the *Print/Preview* button. The Print/Preview window will display the graph and from here you may click *Print* located in the upper/lower right corner.
Administering Inventories

When a student’s Visual Functional Report exhibits 4 or more indicators (in red) of possible visual impairments, it is recommended that a Student Inventory be administered and possibly the Examiner Inventory as well. This information will then be added to the student’s report. A student’s or an examiner’s responses to the questionnaire would likely validate the need for referral to a qualified vision specialist for a complete vision examination.

When there are reasons to suspect that a student’s visual functioning is not adequate (low cross-correlation, excessive return sweeps, anomalies, etc.), a Functional Inventory should be administered. These questions, which reflect a student’s awareness of visual/functional problems, will often support the numerical findings revealed by the Visagraph™ III. In instances where a parent or teacher’s responses can be obtained, the examiner’s questions are administered to further support an evaluation of a student’s visual/functional difficulties.

Obviously, the greater the number of adverse responses by a student or examiner, the greater the possibility that the student is experiencing visual/functional difficulty and the greater likelihood of the need for referral.
Examiners may administer the Student Inventory from within the Student Visagraph panel on the Student Info tab. The examiner may also complete an Examiner Inventory based on observations of the subject.

Click on the Student Inventory tab and then the *New Inventory* button. Twenty questions will be presented and should be read aloud to the student. Type *Y* or *N* student responses.

After all 20 questions have been answered, the problematic responses will be displayed in red. Any responses to the questions that indicate inadequate adjustment to reading and/or near-point activities can be a cause for concern. A total unproblematic/total questions will be listed with each completed inventory along with pertinent *Comments* located beneath the Inventory questions.