

Readalyzer

Users guide

Program version 1.0
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Compevo AB
Markvardsgatan 13
S-113 53 Stockholm
SWEDEN

phone +46 – 8 673 16 20
fax +46 – 8 673 16 21
email info@readalyzer.com

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Contents

Introduction	2
System requirements	3
Installation	3
Program description	5
Menu File	5
File – New – to do a new recording	6
Profile	9
Menu View	11
View Graph	11
View Simulation	14
Extended Info	14
Menu Edit	15
Menu Locate	15
Menu Tools	16
Menu Questionnaire	16
Menu Windows	16
Appendix A - Own texts	18

Introduction.

Readalyzer is a system that analyzes a person's reading based on the eye movements. It consists of hardware to measure eye movements and software that automatically analyses the recorded eye movements and presents a number of characteristic measures for the movements. The most important features of the system is the ease of use and that the measurement disturbs the subject minimally.

The subject is reading normal printed text on paper with normal reading illumination. There are no direct restrictions for reading distance and reading position. Extensive head movements are not a problem.

The measurement of the eye movements is done by illuminating the eye with infrared light and measuring the amount of reflected light in different directions. Ordinary glasses can be used in normal position inside the measuring goggles. The only adjustment that is needed is to adjust the measuring goggles to the subject's interpupillary distance.

The analysis of the reading is made completely automatically. To check that the subject has read the text with understanding, the examiner asks a number of questions about the contents of the text. These questions will be presented on the computer screen after the reading is completed. The answers (yes/no) are entered. The analysis is made, and the measuring result is presented with numbers and a graphical profile, that give the most important values compared to standard performance. The questions are not necessary for the analysis, but influences the subject to read for thorough understanding. It is therefore important to inform the subject before the test that there will be questions about the contents after the reading.

Acknowledgement

The norm values that are used in the program were established by a research project where a number of high schools, colleges and universities in United States participated. Stanford E. Taylor initiated and coordinated the project.

CE certification

The Readalyzer is in conformance with regulations in EU. The system is protected against electrostatic discharges. If a discharge is made during measurement, there may be a glitch in the measurement. Such a glitch will probably not affect the analysis result, and the system will work properly immediately after the discharge. However, it is highly unlikely that a discharge

3. Johan tycker om att träna. Nej
4. Johan tycker om att spela. Ja
5. Johan har spelat i tre år. Nej
6. Johan tränar tre dagar i veckan. Nej
7. Johans lag spelar i en serie. Ja
8. Johans lag kom fyra förra året. Ja
9. Johans lag ligger på andra plats i år. Nej
10. Johan vill bli proffspelare. Ja

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It contains four sections, which all are separated with an empty line.

The first section is the first line in the file. This is the header, and it is shown when you select texts in the program. The line should end with level and text number. The Readalyzer program uses this information.

The second section is the actual text. It should be formatted as the text with linebreaks at same positions. It should be one space between words.

The third section is the questions. They should start with a number. There can be spaces before the numbers. The last word on the line is the answer. The first letter in the answer is the right answer.

The fourth (optional) section can contain anything. In this example it is a copyright notice.

The Readalyzer program will automatically find levels, text numbers and calculate word statistics from the text files. Special international characters can be used.

will occur during the measurement. If there is an electrostatic build-up, the discharge will come when the subject is putting on the goggles. Such a discharge will not have any effect on the measurement or the result.

System requirements:

The computer should have the following specifications:

CPU	Pentium or better.
Operating system	Windows 98/ME/2000/XP. (95 with USB support)
Computer connection	One free standard USB connector, 1.1 or better
Space on Harddrive	3 Mbyte for program, 10 kbyte/measurement.

Installation

The system consists of a pair of measuring goggles, a measuring unit with an USB connector and measuring/analysis software. To use the system, a Windows PC with one free USB port is needed. If the computer has USB connectors but none is free, USB hubs are available in computer stores.

Unpack the equipment. Connect the measuring goggles to the RJ45- connector on the measuring unit's front marked "Goggles". Connect the cable from the measuring unit with the USB connector to a free USB port. Avoid removing the goggles from the measuring unit when it is connected to a running computer.

The infrared light used for the measurement has low intensity, much lower than the infrared light from an ordinary remote control for a TV set. To avoid any possibility of problems, the electronics is made so that even with worst possible error, the light is not dangerous to the eye.

Now it is time to install the software. There are two parts of the software – the measurement and analysis program and a USB driver. Both parts are on the CD that is delivered with the system.

Switch the computer on in the normal manner. The system should now tell you that it has detected a new device. Insert the CD in the CD reader and let the system install the USB driver from the CD. Normally, the installation program for the analysis software will start automatically now. If it is not starting automatically, it is called Setup.exe

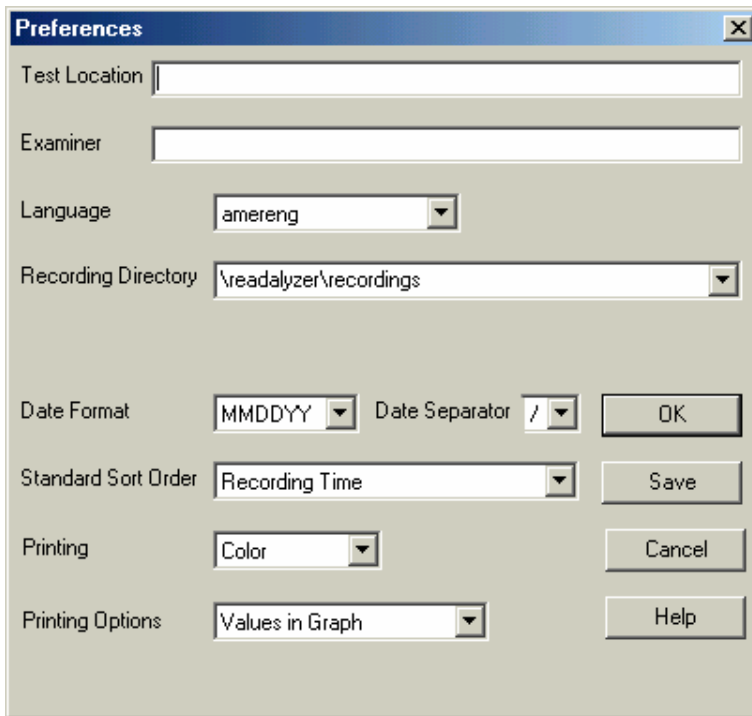
During installation, you can select which folders that should be used for the program and for the recordings and texts.

The Windows Install utility is used for installation. Use the Windows function

Add/Remove program if you want to remove the program from the computer.

The first time the program is run, you should consider some settings that can make it easier to use the system. Start the program. You should now get the Readalyzer software's main window on the screen.

Choose File – Preferences and the following window will appear.



This window contains settings that are location dependent. The fields "Test Location" and "Examiner" can be filled in for each measurement, but if they are normally the same they can be entered here. "Date format" is an option to select the order of year, month and date in the dates shown on screen and on printouts. "Date separator" is the character used to separate the numbers in dates. "Standard Sort Order" determines the order recordings are sorted when you are stepping through recordings with Next and Previous commands. "Printing" is a choice if you want the measuring results to be printed in black & white or color. Many non-color printers such as laser printers uses shades of gray to distinguish between colors, but this can sometimes give printouts that

Appendix A: Creating own texts for the Readalyzer System

There are no problems to use your own text material. However, to make the calculations correctly the program has to have access to the text in a suitable format. This is also necessary to display the text in the graph or in the simulation part.

For each text the head line, the text body, and the questions is stored in one file. The standard texts that are delivered with the system are all stored in one directory. The file names are in the form TLLLNNNN.TXT, where LLL is level number and NNNN is text number. Leading zeroes in both numbers are replaced with hyphens. The text number should be different for all texts in the same directory.

You can add new texts in the same directory or you can make a new directory. If you make a new directory, it should be placed at the same level as the existing text directory.

The files used to store the necessary information are ordinary textfiles. They can be created with a number of simple text editing programs. However, since you in most cases also want to print a nice-looking text on plain paper to be used during the test, the most convenient way is to create all texts in a program like Microsoft Word, where you have all possibilities with different fonts, sizes and formatting. A typical file for the Readalyzer program looks like follows. The file is a Swedish text, but the principle is the same for all languages.

Ishockey 6-61

Johan spelar med i ett hockeylag. Det är tjugo pojkar som spelar i laget. Det är jobbigt, för man måste träna mycket. Det är inte så roligt att träna. Men det är roligt att spela och härligt när laget vinner. Johan har spelat i laget i fyra år. Han tränar två dagar i veckan. Sedan åker han skridsko och tränar med kompisar också. Johans lag spelar i en serie, och förra året så kom man på fjärde plats. I år är det två matcher kvar att spela, och man ligger på tredje plats. Johan tycker det är hemskt spännande. Han drömmer om att bli proffsspelare när han blir vuxen.

1. Johan spelar bandy. Nej
2. Det är tjugo pojkar i Johans lag. Ja

- Location, Class, Name
- Date of Birth, Name, Location, Class
- Name, Location, Class
- Recording Time

Menu Tools

The choice Statistics will extract all calculated numbers for all recordings in the recording folder to a tab-separated text file with the name STAT.TXT. This file can be loaded into an other program for statistical calculations. The first line contains headers for each column.

Menu Questionnaire

Answers to up to 40 questions can be stored with each recording. The questions are divided in 4 groups with 10 questions in each. The answer on each question can be Y/N or a number from 1 to 5. The questions are stored in text files in the program directory with the extension QST.

Menu Windows

You can open a number of recordings in different windows. This can be useful when you want to compare recordings side by side. In this menu, there are commands to organize windows.

are not very clear. If uncertain, test the two settings and select the one that gives the best result on your printer.

When all settings are as you want them, press the Save button to save the selections. If you don't want to save the changes you have made this time, press Cancel. The settings are stored in the Windows Registry.

Program description

The program follows normal Windows standards and should hopefully be straightforward to use. On top in the main window you have the menus File – View – Tools - Help. If you click on any of the menus, a number of alternatives will be listed. Under the menus are 4 buttons, speed buttons, which takes you directly to some common alternatives. If you just point to one of these buttons, a short explanation is shown next to the button, and a longer explanation is shown down to the left in the main window. If you make or open a recording, the menus Edit – Locate – Questionnaire and Window will be added.

Menu File

Here you make new recordings, get old recordings from the hard drive, set preferences, print recordings and exit program. Each recording is stored as one file in the Recordings folder. This folder is normally placed in the Readalyzer folder.

- New makes a new recording. The leftmost speed button gives same function.
- Open gets an old recording from the hard drive. There are some example recordings included with the system that can be viewed or deleted. Next speed button is equivalent.
- Preferences contain a number of different settings such as date format, standard test location and language to use.

The following print commands will be grayed if you have not made a recording or not opened an old recording.

- Print is the printout itself and the third speed button.
- Print Preview is an on-screen display of the printout.

- Print Setup is settings for the printer. If there are more than one printer connected to the computer, you can select here which printer to use.

When you have used the system, the last four recordings are shown here. Selecting one of these items is the same as open the corresponding recording.

Last alternative on the File menu is Exit, which ends the program.

In most Windows programs, there is a Save function. Since each recording is always saved as part of the measurement process, there is no need for a special save function in the Readalyzer program.

File – New – to do a new recording

You must have the measuring unit connected to the computer to do a new recording. If it is not connected, an error message is shown. Otherwise, the following window is shown.

Input Subject & Text Data

Last Name: Doe [Measure]

First Name: John [Pre-Entry]

Sex (M/F): M Date of Birth (MM/DD/YY): 5/11/91 [Cancel]

Class: 7A Grade: 7 Level: 2

Text #: 77 Title: The camel 3-77

Comment: [Text Area]

Test Location: [Text Field]

Examiner: [Text Field]

Extended Information

Subject information

Name: Doe John Filename: [Blank]
 Class: 6B Born: 05/22/1992 Sex: M Recorded: 07/05/2004 21:35
 School: [Blank] Directory: [Blank]
 Examiner: [Blank]

Text information

Filename: c:\Readalyzer\Texts\amereng\T--3--77.TXT
 Title: The camel 3-77
 Answers: [Blank] No of questions: 0
 Norms used: Taylor.nor Correct answers: 0

Text statistics

No of lines: 10
 No of words: 102
 Av. word length: 3.8

Recording information

Total recording time: 18.38 Duration Standard Deviation: 102 ms
 Analyzed time: 11.37 No. Saccade Start Diff. > 17 ms: 0
 Artifact time right eye: 0.00 (0%) Events with Multiple Regressions: 0
 Artifact time left eye: 0.00 (0%) Mean Regressions in Multiple Events: [Blank]
 Lines found: 9
 Lines partially reread (> 30%): 0
 Lines completely reread: 0

Ready

Menu Edit

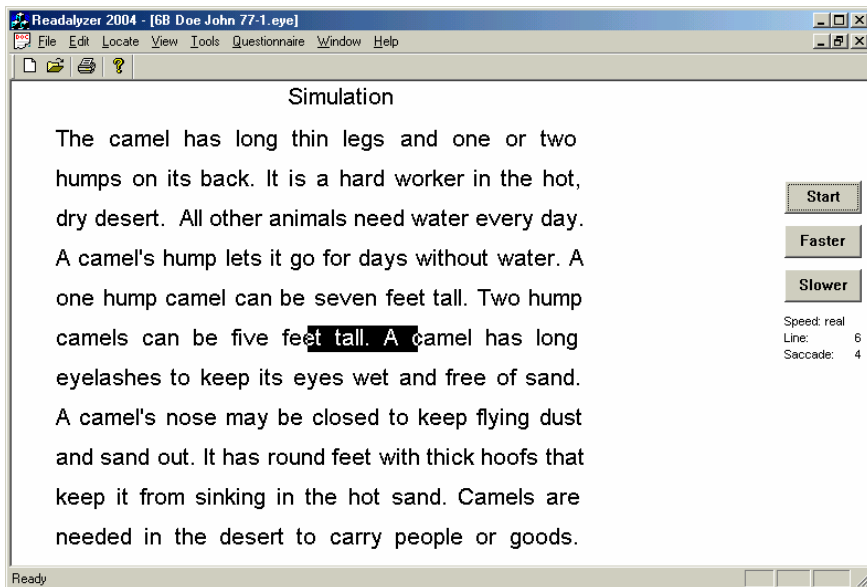
When you have a recording open, this menu is available. Subject Info opens a window, where you can change details about the subject. You can also change or add to the comment.

Menu Locate

To make it easy to step through a number of recordings, the commands Next recording and Previous recording are available. You can also use the keys N and P on the keyboard. The recording in the active window will be replaced with the next or previous recording according to the selected sorting order. There are 4 sorting orders to select from. Select sorting order in Menu File – Preferences. Don't forget to save the settings. The available sorting orders are:

View Simulation

The text read is first shown on the screen. The eye movements can now be displayed on top of the text as a black moving square. The square is big to symbolize that the eyes are reading a piece of the text. The speed can be selected as real speed, 1/2, 1/3, 1/4 or 1/5 of real speed with the buttons marked Faster or Slower. The simulation is started with the button Simulate. Only the countable part of the recording is shown. You can restart the simulation by pressing the Start button again.



Extended info

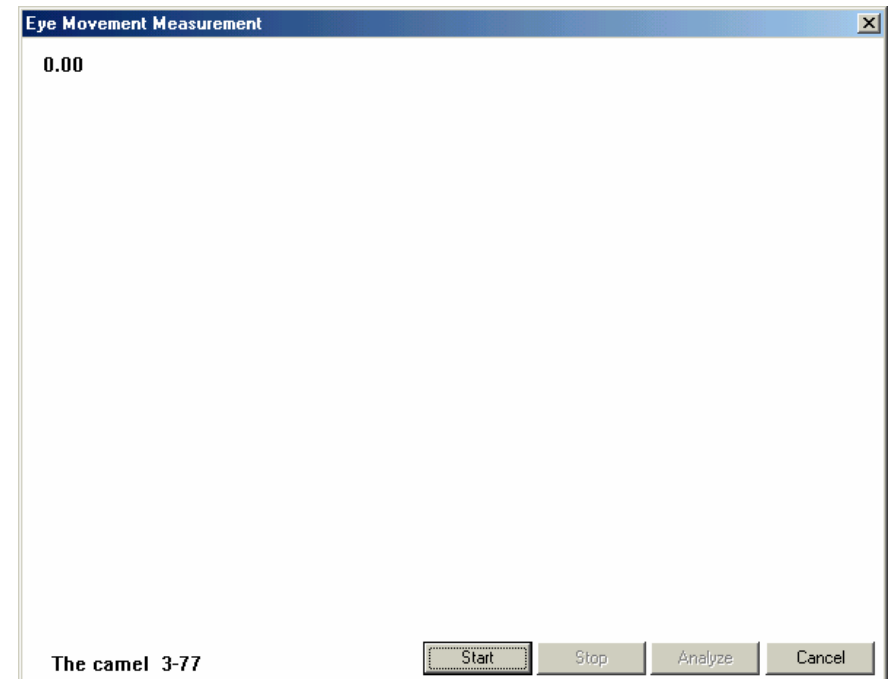
This screen contains information about the text that was read, the recording and the analysis.

This window is used to enter information about the subject and the measurement. Last name and/or first name should be entered, since the system uses these names as part of the filename for the recording. The Test Location, Text number and a sequence number are also included in the file name. Grade is used to display norm values and is number of school years. All other information is not used by the analysis but is saved together with the recording for the benefit for the user.

The text can be selected in several ways. In the title box, all available texts are listed in order. You open the title box by clicking on the down arrow. The level box contains the available text levels. If you select a level here, the title box will open at first text at that level. You can also directly enter a text number in the box labeled Text #.

You can also do a measurement without analysis. Select Measurement only in the title box by clicking the down arrow and selecting the first entry. You can also select Measurement only by entering M as Text #.

When all useful information is filled in, clicking the Measure button takes you to the measurement screen.



We are now ready for the measurement. Put the goggles on the subject. If the subject wear glasses, it can be better to open the ribbon as much as possible first. Tighten the ribbon so that the goggles are steady but not so hard so that it is unpleasant. The goggles will be steadier if you place them down towards the nose.

The measuring sensors should now be adjusted to the subjects' interpupillary distance. There are two white vertical lines on the adjustable part for each eye. Ask the subject to look at something far away. Loose the black knob a little by turning it counterclockwise, not more than ½ turn. You can now slide the adjustable part sideways. If you have loosen too much, it can be difficult to slide the adjustable part. Align the white lines to the pupil for each eye and tighten the knob. You will have good recordings even if the adjustment is a couple of millimeters off. The scale is in millimeters for each eye from the middle. You can get interpupillary distance by adding the numbers.

The cable from the goggles should be free to move. Otherwise, the goggles may be disturbed when the subject moves the head. This can compromise the measurement.

Now the subject should be instructed about the text reading. There is a fixation ring before the text. Place the text before the subject. Tell the subject that he/she should read the text quiet and thoroughly, and that there will be questions on the contents after the reading. Tell the subject to look on the fixation point and to start to read when a beep is heard from the computer. If the test is done in a noisy environment or the beep is hard to hear, you can also instruct the subject to start to read at your command.

Press space bar on the keyboard or click on the start button when the subject is ready to start. The measurement starts and a beep is heard.

The eye movements are now shown on the screen as two traces, one for right eye (blue) and one for left eye (red). Time is going vertically, and horizontal position corresponds to eye position. Elapsed time in seconds is shown in upper left corner.

By looking on screen you will directly see if the measurement is performing properly. You should get a stairway type of pattern. When the stairway pattern is replaced with a more irregular pattern of smooth movements, the reading is finished. Stop the measurement by pressing space bar or by clicking the stop button.

Down you will move more. Right eye is shown in blue and left eye in red.

You can also view original data (raw data from recording). If the model graph looks remarkable, a check with original data can determine if the model is correct. Select in Menu View Model, Original or Both. You can also use the keys M, O or B.

Values in Menu View switch on and off saccade details. You can also use the V key. This is a three-state toggle that steps through No values – Values with right & left saccade amplitude – Values with right & left saccade start difference. The third activation goes back to No values. For each saccade the following values are shown:

Time - time in seconds with two decimals from start of recording.

CL - Saccade classification.

RSW (Return Sweep) - line shift.

BLN - Blink.

R - Regression on right or left eye. The letter is placed to the left or right depending on which eye that made the regression

RR - regression on both eyes.

<-> - marks start and stop for countable part.

Ln - (Line) - line number in text.

Sacc - saccade number in line.

If first activation of Values :

Left - Model eye movement for left eye.

Right - Model eye movement for right eye.

If second activation of Values :

Rel.Start – Difference between right & left eye movement. R or L in first column indicates which eye that moves first. The value in second column is time difference in milliseconds. Observe that time resolution is 17 milliseconds.

Fix - Following fixation length in milliseconds.

Text in Menu View or the T key will show the read text line by line placed at the return sweep to the beginning of the line.

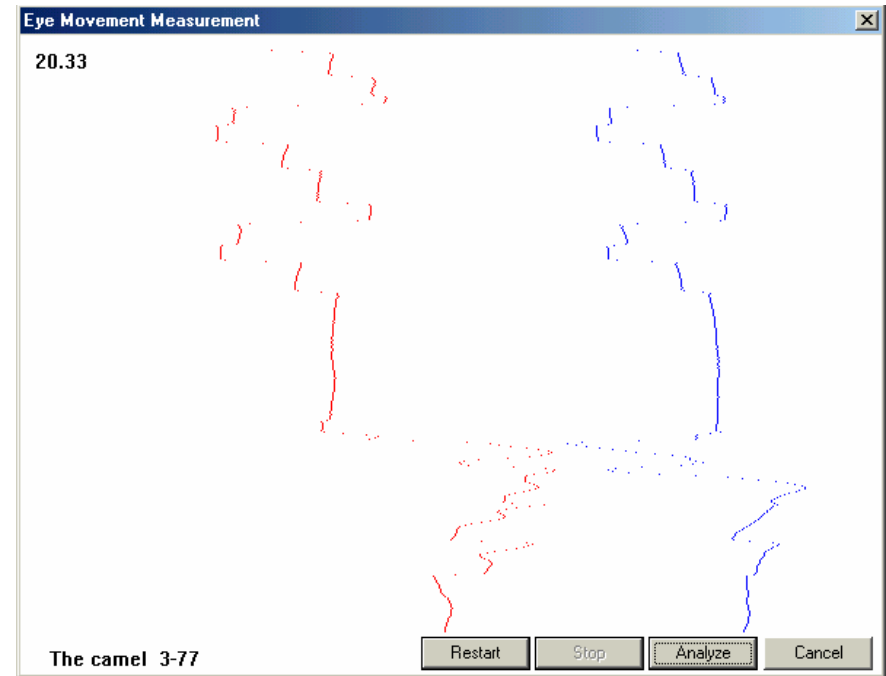
Model	Eye movements compensated for head movements.
Original	Raw measurement data.
Both Model & Original	Both simultaneously.
Text Display	The text that was read is displayed synchronized with eye movements. Each text line is placed in the graph at the position where the return sweep is made.
Value Display	Shows saccade details.

View Graph

In this view, the eye movements during the measurement are displayed as traces, similar to the traces shown during recording. Normally the model is shown. In the model, head movements are removed. Fixations are shown as vertical lines, saccades as almost horizontal lines and blinks as dashed lines.



Time is running vertically. In the lower right corner, the time period is shown. With up and down arrow you can move a little, and with Page Up and Page

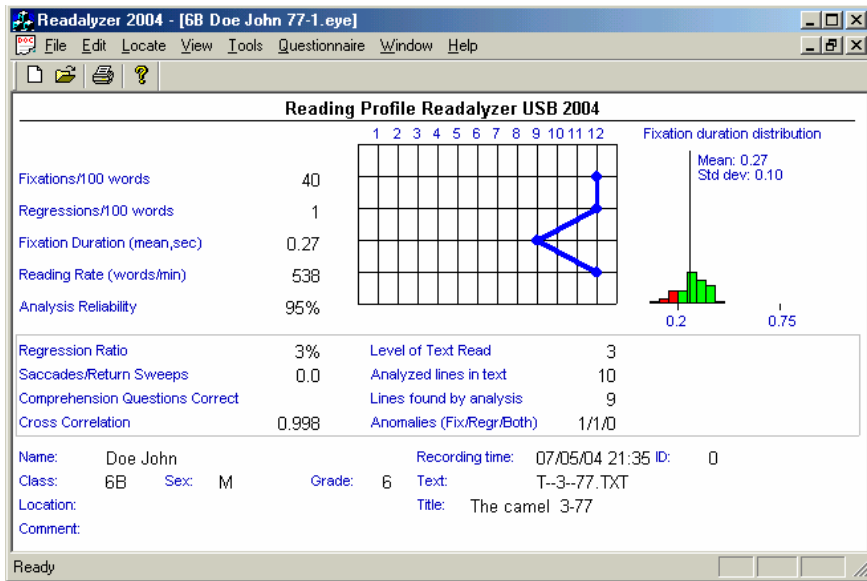


If the recording failed for some reason, you can redo it by clicking the button Restart. Select Analyze to continue with the reading comprehension questions.

To check that the subject has read the text with comprehension, there are a number of questions that should be answered with yes or no. Take the text from the subject and read the questions for the subject. Enter the answers. Use the tab key or click with the mouse to go to the next question. When all questions are answered, the correct answers are presented. 50% correct could be reached by guessing.

Profile

After a short time, the analysis will be presented on the screen. The different characteristics for a reading are shown as numbers and also as a graphical profile, where main values are compared with normal values. Each value is assigned the corresponding grade (schoolyear), and you can easily see if some



value is different. A vertical line would mean even reading abilities. You can view a measurement in many different ways. This is described in detail in Menu View further down.

Some comments:

In the analysis, first line and last line is discarded, because there are often irregularities here. The part used for calculations is called "Analyzed part". All values are calculated on this piece of the text. In Graph View, the starting and ending points of the analysis are marked with the symbol >.

During the reading, the subject performs a series of eye movements with a pause after each when the eyes are fixating a point in the text. When the subject comes to the end of the line, a number of eye movements is made to get to beginning of the next line. We call this procedure return sweep.

Fixations are the total number of eye movements.

Regressions are eye movements that move the eyes from left to right, not counting eye movements during return sweep. If you switch on Values in Graph View, the regressions are marked with R or RR.

Fixation Duration is the mean pause time between eye movements (time between saccades).

Reading Rate is reading rate in words/minute.

Analysis reliability is an indicator if there were any problems during the analysis of the recording. Maximum value is 95%. A low value suggests that there may be recording or analysis problems, and that the results may be in error. Redo the measurement or check the graph of the measurement.

The graph shows how the measured values compare to norm values. The numbers on top are school years.

Fixation duration distribution is a histogram of the fixation duration for all fixations in the analyzed part. Each group is 0.05 seconds. Fixations under 0.2 seconds and over 0.75 seconds are marked in red. The vertical black line marks the mean value. Standard deviation is also given next to the vertical line.

Regression Ratio is number of regressions divided by number of fixations.

Saccades/Return Sweep is mean number of saccades for one return sweep (line shift).

Comprehension questions correct is the percentage correct answers on comprehension questions.

Cross Correlation is the cross correlation of right and left eye saccades. A value better than 0.90 means good correlation of right and left eye. 1.0 is perfect.

Anomalies are events where the eyes are not moving in the same direction.

Menu View

This menu selects different way of viewing a recording.

- | | |
|---------------|--|
| Profile | Overview with graphical profile |
| Graph | Diagram with eye position, time and saccade details. |
| Simulation | The read text with the eye movements superimposed. |
| Extended info | More details about the recording. |

Graph selections: