Improving Reading Capability of Children with Developmental Dyslexia with a Gaze-Contingent Display

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Reading disabilities

The cause for developmental dyslexia is still under debate [1,2,5,6]. According to Geiger and Lettvin, one main symptom is “the inability to mask text surrounding the word currently read” [5]. To describe differences in the masking process (also called lateral masking) Geiger and Lettvin [5] defined a field “form-resolving field” (FRF) [4]. Results show dyslexics have an asymmetric falloff in letter recognition with eccentricity that is different from that of controls. In the periphery, letter recognition rate is up to 8 times higher for dyslexics [5].

Geiger and Lettvin proposed a regimen of practice to help children to learn a new visual strategy for reading. This method includes a paper mask with a window of the size of a large word. The mask covers surrounding text and can be shifted forward to read word after word. Their results show major improvements in the reading proficiency. A computer version has been presented by Werth [2,9].

New visual strategy

To activate the next line of text the current line must be blurred or completely masked out depending on the surrounding text can be displayed in lower contrast, eye-tracker, fixated text will be emphasized.

The Reading Tutor program

Reading programs often display or highlight text at a fixed rate. Since reading speed varies within a passage of text [8] a preset rate forces the user to read at an unnatural speed. Gaze-contingent displays offer a novel way of reading support by emphasizing text parts currently read based on gaze positions. This technique is used to translate Geiger’s and Lettvin’s regimen of practice onto a computer screen and substitute the paper mask with a “digital mask”, so that the user can control the speed at which new text will be highlighted with their eye movements.

The Reading Tutor program takes arbitrary texts as input and offers different modes for displaying the chosen text. Based on gaze positions, calculated by an eye-tracker, fixated text will be emphasized. Surrounding text can be displayed in lower contrast, blurred, or completely masked out depending on the chosen mode.

To avoid flicker between lines the reader is limited to the currently read text line. Saccades to or fixations on text parts other than in the current line will be ignored. To activate the next line of text the current line must be completed by reading to the last word of the line. Then, reading text is displayed on a computer screen while an eye-tracker records the gaze positions on the screen. Based on the gaze coordinates the text currently fixated can be highlighted.

The simplified architecture model of the Reading Tutor shows how the first word of the next line will be emphasized and with its fixation the line will be activated.

Test runs with dyslexic children

To find out whether children with developmental dyslexia are able to control the Reading Tutor program with their eyes and whether they understand the test they are reading we carried out a small preliminary user study with nine children. Each child completed between one and four reading sessions and for comparison they also had to read a control text where their eye movements were recorded. The control text was displayed without highlighting or masking. All but two children could control the program, read the given texts with its help and recite the content afterwards. Usually they needed a longer text run at

Two different modes of the Reading Tutor program. The mode shown on the left image blurs text around the gaze position by blending the text image with decomposed images (Perry and Geisler [7]). In the mode shown on the right image text is simply displayed in different contrasts. Here a page break can be seen with a cleared first line where the first word of the next page is displayed. To activate the whole next page this must be fixated.

A subject reads text displayed on a computer screen while an eye-tracker records the gaze positions on the screen. Based on the gaze coordinates the text currently fixated can be highlighted.

Average learning curve of the children during test runs. After an initial session the children learned to control the Reading Tutor first to get used to the new program control, after that they could control and use the program more easily. After approx. 30 minutes most children became tired and the test runs were stopped. The feedback of the children was very positive, they enjoyed the novel kind of reading aid, were excited that they could control the program and some children performed better with the support of the Reading Tutor.

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