A Self-training System for Text Entry With Blinking Color Imaging

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Abstract. The majority of visually impaired people would have fewer problems if they were experienced users of a conventional computer keyboard or the Braille keyboard. The goal of our work was to develop multi-sensory approach to typing training for the visually impaired persons by combining tactile and visual feedback during text input while using a conventional keyboard and peripheral monitor. The self-training system for text entry was designed to use visual color patterns displayed with the help of a single two-color light emitting diode coupled to glasses. Our results show that using this system both promotes the learning of the blinking coded alphabet and decreases a period of typing training.

Keywords: text entry, visually impaired people, blinking color pattern

1. Introduction

A significant portion of our population has visual impairments, which reduce their ability to use safely standard consumer products and to gain efficiently access to services or information sources. According to statistics, about 6.5 million people in the European countries have visual impairment, and in wider geographic Europe approximately 11.5 million people have low vision, and about 1.1 million are blind [4].

Lacking visual feedback, visually impaired writers can use alternative means of text imaging which rely on the hearing and tactile senses. Visually impaired persons who cannot be accommodated with available fonts and colors often use screen magnification software, which allows enlarging the viewing area of a display. Such devices also have some disadvantages. The magnification reduces visual field and evokes a distortion if the image is viewed from an angle. Still the use of touchpad or touch screen remains as an inefficient method for partially sighted people even at the presence of speech feedback when it is necessary to quickly find or point a particular item within the keyboard or any layout.

However, blind people still have some problems if they learn to manipulate with special computer applications, because they cannot emulate habitual key combinations of the Qwerty keyboard. There is the higher risk of wrong placement of the fingers, aggravated by the variable layout between different keyboards. It should also be noted that visually impaired Braille readers are in a minority as well as the majority of blind people, which are not using such a form of access to the textual information. This is especially true for those persons who have gone blind in later life. Besides that diabetes could have unfortunate consequences for the aging Braille reader by gravely accelerating the loss of tactile acuity [5].

Thus, partially sighted people require adaptive or strengthened feedback during interaction rather than novel input devices. The feedback should require minimum
resources of the visual perception and the use of special markers or rely on natural anatomical position of the fingers during the use of a conventional keyboard.

The goal of this work was to develop multi-sensory approach to the typing training for the visually impaired persons through combining tactile, kinesthetic and visual modalities during text-input when using of a conventional keyboard and a peripheral monitor. Such means should provide reliable textual input, which is available for sighted users.

3. Methodology

3.1 Participants

12 volunteers from staff and students at the University of Tampere took part in the test. Limited amount of participants meant that only a small number of subjects really used blind typing. The ages of the subjects ranged from 21 to 47 years, and all had a normal color sight but low visual acuity. There were six male and six female. None had prior experience on the blinking coded alphabet or had used the peripheral monitor before.

3.2 Apparatus

The experiment software Blinking Sign was developed in Microsoft Visual Basic 6.0. Speech feedback cues were wave files formed via AT&T text-to-speech engine [1] for each character within test sentences and for whole sentences or commands. Visual color patterns were presented through a blinking spot, which was projected into paracentral field of the sight on the screen of 30 mm in diameter. The peripheral display for such method consists of only a single light emitting diode (LED), which was coupled with glass es. The LED is located close to an eye (paracentral unfocused position and diffused luminescence), it does not require to recognize a precise form of characters from segments, and thus does not create essential inconveniences in a direct viewing [3]. The keyboard and loudspeakers were positioned on a separate desk away from the experimenter’s host machine in a special usability laboratory. Monitoring of the testing procedure on the examiner side and the experimental setup are shown in Figure 1 and Figure 2.

![Figure 1. Monitoring of the testing procedure on the examiner side](image1)

![Figure 2. The experimental setup](image2)

3.3 Implementation of the design

In earlier papers [2, 3] we have explored a variant of the light code for transformation efficiency of textual information into visual color patterns. The comparative analysis was
carried out of the amount of recognized test symbols among noise symbols switching attention obtained under the investigation of pairs at exposition times from 320 up to 640 ms. In our previous experience the task of subjects consisted in temporal remembering the single color combination and counting the amount of these color patterns appearing within the presented sequence. That is, the subjects did not learn the whole blinking alphabet. It was found that even after getting past the basic level of the subjects’ familiarity with the blinking alphabet some symbols were hard to remember during of the learning process. They were incorrectly distinguished in the pattern of the word when peripheral monitor was used. Therefore, we modified some of the letters in the blinking coded alphabet. Both versions of letters before and after modification are shown in the Table 1.

### Table 1. Two versions of letters – before and after modification

<table>
<thead>
<tr>
<th>1st color unit</th>
<th>2nd color unit</th>
<th>3rd color unit</th>
<th>4th color unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td></td>
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<td>L</td>
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<tr>
<td>W</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Brightness level and color:
1 – B = 0.5 / green; 2 – B = 1.0 / green; 3 – B = 0.5 / red; 4 – B = 1.0 / red; 5 – B = 0, the LED switch off

### 3.4 Procedure

The main goal of this research was to acquire typing skills on a conventional Qwerty keyboard when using diffuse color (visual) and audible cues. To provide a basic level of familiarity with the color-coded blinking alphabet, the subjects had two days of practice sessions prior to data collection. Subjects were asked to learn the blinking alphabet and to repeat this system before the start of each test session. During the test session, the task of test person was to hear, remember and enter short textual sentences, which were provided by the software. The text phrases were selected randomly from a sample set of 50 phrases. Subjects were instructed to aim for both speed and accuracy when entering the characters. As well, they were told to ignore mistakes and continue with the rest of the sequence when a mistake was made. When an error occurred, a short earcon was heard. Execution of a condition consisted of a brief practice session of 10 phrases and then 3 blocs of a recorded entry (30 phrases). The formal experiment took six days, that is, 18 experimental blocks were registered for each participant. Subjects had the opportunity to playback the phrase before entering the text as many times as needed for the better remembering. To help motivate subjects, the results of each user's performance: exercise time, errors and the mean of typing speed, were displayed at the end of each block. The measuring procedure was started from the first pressing down the button of keyboard. Audible and visual cues accompanied the entering of each character. According to our previous research [6] the best exposition time for recognition of color patterns was 480 ms. Therefore, we used this exposition time for blinking color imaging.
4. Results

4.1 Text entry speed

The average performance and standard deviation of the text entry for 12 participants through 18 blocks when using the peripheral monitor and audible cues during the typing learning (training) are shown in Figure 3 and Figure 4. Text entry speed was converted to “words per minute” by using the typists’ definition of a word – five characters including spaces. Since the subjects relied on unconscious perception of visual cues during the test sessions, a significant effect of increasing users’ text entry speed has been observed only after acquiring experience with using the peripheral monitor. The full data analysis of the typing learning when using blinking color imaging over all the test blocks showed that the lower average value of text entry speed was 3.56 wpm, s < 0.57 and an upper bound for the text entry speed was 14.28 wpm, s < 0.46. The average value of text entry speed was faster (4.43 wpm and 16.54 wpm were lower and upper bound accordingly) when using the speech feedback. However, speech feedback signals had less influence on the test performance (F < 0.067).

![Figure 3](image1.png)

**Figure 3.** The average performance and standard deviation of the entry speed without training (first session)

![Figure 4](image2.png)

**Figure 4.** The average performance and standard deviation of the entry speed in the end of experiment (sixth session)
4.2 Error rate

As it was expected, there was a significant difference between the average value of the error rates in the beginning of the experimental session (11.5%) and in the end of the test (1.07%) (Figure 7). The higher error rate in the first sessions was likely due to a need for subjects to recognize color patterns immediately after typing. The blinking alphabet learning allowed the subjects to improve their typing accuracy. During the experiment we have explored what kind of errors occurred and why they took place. A typical error was adding an extra character or tangling neighboring keys due to low familiarity with keyboard layout during blind typing. The high error rate during the first and second experimental session was probably related to the deficient knowledge of the feedback signals requiring recognition efforts. Some users had less difficulty with text entry when using speech feedback cues.

![Figure 5. Decrease of errors (%) when acquiring the practice](image)

Conclusion

The self-training system for text entry was designed using visual color patterns displayed with the help of a single two-color light emitting diode (peripheral monitor) and speech feedback cues. The experimental results showed that this method both promotes learning the blinking coded alphabet and increases the typing accuracy. Speech feedback had less influence on the performance of the test. We suggest that the proposed method could be useful for development of wearable assistive devices and educational applications for visually impaired typists. An adequate color stimulation of the visual analyzer could also promote deceleration of the degeneration of visual nerve.

References

1. AT&T text-to-speech engine, Product information available at: http://www.research.att.com/~ttsweb/cgi-bin/ttsdemo