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THE INFLUENCE OF HIGHLIGHTED TEXT ON ITS PERCEPTION WHEN PERFORMING INTERPRETING FROM A COMPUTER SCREEN

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Abstract. This paper examines an experimental study of the effect of highlighted text with color underlays on the efficiency of its perception when translating from a screen. The study was conducted using eye-tracking technology and oculography methods, to analyze the perception of stimulus material by interpreters when translating from a screen. Methods of mathematical statistics were used to process the experimental data obtained. During the experiment, participants were asked to interpret from the screen sentences presented in stimuli with different options for highlighting the text with color. Factor analysis of the experimental data obtained from the eye tracker revealed statistically significant differences in text perception effectiveness depending on the combination of the investigated factors. The analysis demonstrated that the use of a serif font, a contrasting black background, and white underlay for highlighting the semantic centers of sentences can significantly improve the quality of an interpreter's work with on-screen text. The results of this study can be applied in the development and optimization of the interface design for specialized simulators and training systems for professional training of interpreters.

Keywords: eye tracking, experiment, highlighted text, text perception, translation, education, training simulator

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ИССЛЕДОВАНИЕ ВЛИЯНИЯ ВЫДЕЛЕНИЯ ТЕКСТА ЦВЕТОМ НА ЭФФЕКТИВНОСТЬ ЕГО ВОСПРИЯТИЯ ПРИ ПЕРЕВОДЕ С ЭКРАНА

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Аннотация. В работе рассматривается экспериментальное исследование влияния выделения текста цветом на эффективность его восприятия при переводе с экрана. Исследование проводилось с использованием методов окулографиии, технологии айтрекинга для анализа восприятия стимульного материала переводчиками при переводе с экрана. Для обработки полученных экспериментальны данных использовались методы математической статистики. В ходе эксперимента участникам предлагалось выполнить перевод с экрана предложений, представленных в стимулах с различными вариантами выделения текста цветом. Факторный анализ полученных с айтрекера экспериментальных данных позволил выявить статистически значимые различия в эффективности восприятия текста в зависимости от сочетания исследуемых факторов. Анализ показал, что использование шрифта с засечками, контрастного черного фона и белого цветового выделения смысловых центров предложений может значительно улучшить качество работы переводчика при работе с экранным изображением. Результаты данного исследования могут быть применены при разработке и оптимизации дизайна интерфейса специализированных тренажеров и обучающих систем для профессиональной подготовки переводчиков.

Ключевые слова: айтрекинг, эксперимент, выделение текста, восприятие текста, перевод, обучение, обучающий тренажер

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Introduction

The modern world is characterized by an increase in the volume of information and a variety of forms of its presentation. In this context, the efficiency of textual information interpretation becomes a key component in intercultural exchange of knowledge and information. Modern interpreter training methods must adapt to these conditions, integrating advanced technologies and research to improve training effectiveness. One of the tools for studying the process of interpreting textual information is eye tracking, which provides an opportunity to study the process of perception of on-screen text and interpreters' attention to various aspects of textual information. The works of S. O'Brien, C. Walker, and F.M. Federici [1, 2] have significantly influenced the development of this area of research, highlighting the potential of eye tracking in the context of interpreter training and analysis of their professional activities. These studies became the starting point for further research aimed at optimizing the translation process using eye-tracking technologies.

The use of eye tracking in the context of interpreter training is of particular significance, since it provides an opportunity to identify key aspects of text perception based on reliable parametric data of the stimulus material viewing pattern. Analysis of eye movements in real time allows not only to determine

which areas of text the subject pays special attention to, but also to analyze the sequence of perception and transitions between different parts of the text.

The aim of this study is to examine the perception of color-highlighted text by interpreters using eye-tracking technology. This research will examine the relevance of color highlighting text when interpreting from a computer screen. Analysis of experimental data obtained using eye-tracking technology is aimed at identifying statistically significant features of color-highlighted text perception.

The research objectives are:

1. To determine the factors influencing the interpreter's perception of the text.
2. To develop stimulus material.
3. To determine the task for experiment participants.
4. To process the experiment results using mathematical statistics methods.

The research hypothesis is that the use of color-highlighted text can improve the quality of an interpreter's work with on-screen text. The results obtained during this study are to be used in the development of a training simulator for translators.

Previous studies

The results of studies conducted by V.A. Demareva, S. Toldova, and K. Rayner [3, 4, 5] have provided valuable data on readers' behavioral strategies during text perception. In particular, they identified the main patterns of viewing stimulus material, indicating a saw-tooth nature of sequential text scanning. This process is predominantly carried out from left to right and from top to bottom, which corresponds to the direction of writing in the subjects' native languages. However, in the case of languages with a reverse direction of writing, a similar movement is observed in the eye movement of the subjects. These results highlight the universality of certain reading behavioral strategies applicable to various writing systems and confirm the relevance of using eye tracking for analyzing text perception in different linguistic and cultural contexts.

Eye movements during text reading represent a sequential alternation of fixations and saccades, the proportions of which are influenced by several factors:

• Complexity of the text. If the text contains complex or unfamiliar terms, phrases or constructions, the interpreter may slow down, making longer fixations for a more thorough understanding of the text.

• Presence of specialized vocabulary. Knowledge of the topic, subject area, or text specifics can speed up the reading process and reduce the length of fixations, since the interpreter more easily recognizes and understands specific terms.

• Language skills. The interpreter's language skill level affects reading speed, as well as the proportions of fixations and saccades. Experienced interpreters may use more effective text scanning strategies, which contributes to faster and more accurate perception of information [6].

• Individual characteristics of the translator. Interpreters' personal characteristics regardless of text complexity can also influence information scanning strategies during reading, creating unique patterns of fixations and saccades [7].

According to studies by Rayner and C. Clifton [5, 8], the average saccade length during text reading is 8 characters. About 15% of saccades are regressive, with a significant part of them being short, consisting of several characters. This may be because readers make too long saccades, and short regressive movements are performed to clarify information. In addition, short regressive saccades within a word may be associated with difficulties in processing the current word on which the reader's attention is focused. However, regressions longer than 10 characters indicate more serious difficulties in understanding the text, highlighting the importance of studying and analyzing regressive eye movements during reading using eye tracking for a deeper understanding of text perception mechanisms and the processes of text reading by interpreter [5].

During saccades, as well as immediately before and after them, the perception of visual information is practically absent. This time is characterized by rapid and brief eye movements, during which the eyes

move from one fixation point to another. The perception of visual information occurs precisely during fixation, when deep and detailed processing takes place. During saccades, on the contrary, low-level visual processing occurs, which emphasizes the importance of analyzing fixation time for a more complete and meaningful perception of the text in the process of reading or translation [12]. This dynamics of the visual system's operation are important when considering the relations between eye movements and the effectiveness of text perception in the process of professional interpretation of text from a computer screen.

The use of eye tracking in the field of applied linguistics and translation studies makes it possible to obtain more accurate and objective data on visual information perception by interpreters when translating text from a computer screen. This, in turn, contributes to a deeper understanding and analysis of the professional translation process, as well as optimization of interpreter training methods. One of the forms of translation considered in this study is sight translation, which involves translating a written text from the source language into spoken text in the target language [6, 9]. Discussions regarding this type of interpretation emphasize the ambiguity of its status: whether it is a separate form of interpretation or a training exercise for other forms of interpreting [11]. Eye tracking allows for a deeper investigation of this issue, providing data for objective analysis, which is an important step towards determining the role and significance of sight translation in the general context of translation practice.

Current research widely supports the concept that sight translation has several key characteristics:

- Time constraints, due to limited time for text perception and translation decision-making, as well as high speech speed, are highlighted as one of the key characteristics of this type of translation [6, 9].
- Strict self-control, which is recognized as an important aspect, requires the accuracy of the original translation, and prohibits corrections [11, 12].
- Limited access to the context of the source text, which challenges the interpreter to convey accurately the nuances and meaning of the text.

From a cognitive load perspective, sight translation represents multiple interconnected operations that the interpreter performs in parallel. With this type of translation, the interpreter must simultaneously perceive and process visual information in the source language, form an oral message in the target language, and maintain strict control over the entire process. Thus, sight translation requires the interpreter not only to know two languages, but also to be able to effectively coordinate various cognitive tasks in real time.

In her research [1], O'Brien highlights the challenge of reproducing a realistic task and environment, which significantly affects the results of experiments. She emphasizes that when conducting research on translation process, it is crucial to ensure participants' natural behavior, consistent with their usual behavior during translation practices. Given that such experiments inherently have a certain degree of artificiality, creating a comfortable environment, ensuring anonymity, and providing information about the research objectives are key to ensuring the reliability of the results. These measures aim to minimize the potential influence of stress factors or unnatural conditions on study results.

Methods and materials

At the initial stage of experiment development, factors were identified that presumably influence information perception when working with on-screen text:

- Contrast. Variations in the color contrast between background and text, represented by a black background with white text and a white background with black text.
- Highlighting the semantic centers of sentences in blue, orange, black, and white underlays.
- Font. Variations in typeface design, represented by sans-serif fonts ("PT Sans") and serif fonts ("Times New Roman").

Based on the results of a previous study, it was found that abrupt changes in background caused discomfort in participants [13, 14]. Consequently, modifications were made to the stimulus material for

Fig. 1. Stimulus material with white background and text written in black with orange underlay

Fig. 2. Stimulus material with black background and text written in white with blue underlay

the present experiment. To smooth the transition between stimuli and reduce participants' eyestrain, the stimuli were interspersed with gray screens. The display time for these intermediate screens was 500 ms.

Additionally, changes were made to the method of highlighting the semantic centers of sentences. Instead of bold text, colored underlays were used. This choice was based on the results of researches by M.L. Gaddy, M. Gumbrecht, and M. Yeari, highlighting the effectiveness of this method for retaining text information [15, 16, 17].

In her experimental study [15] on the impact of color-highlighted text on the perception and retention of information, Gaddy identified the following key results:

- Highlighted or underlined information was remembered significantly better by the participants in the experiment compared to non-highlighted information.
- The color of the underlays did not significantly affect memorization process.

Gumbrecht's eye-tracking study confirms that highlighted text areas play a crucial role in the perception of visual information during reading. The data obtained show that users not only pay more attention to these areas, but also actively focus their gaze on them, with approximately half of their fixations occurring on highlighted areas of the text. This finding highlights the importance of considering highlighted areas when designing digital interfaces, as it can substantially affect users' ability to effectively find and process necessary information in digital textual contexts.

Yeari's eye-tracking study on the effect of text highlighting on the processing and retention of textual information also confirms that highlighting central information with color underlays in text reduces the rereading of information in the peripheral vision zone, while highlighting peripheral information increases the rereading of this information. Other studies also confirm the statistically significant influence of this method of highlighting information in the context of memorization process [18, 19, 20].

The task for experiment participants was to translate sentences displayed on a computer screen. As a part of the experiment, stimulus material consisting of 12 sentences was developed, including various combinations of the factors described earlier (Fig. 1–2). Parametric data on the pattern of viewing stimulus material, obtained from the eye-tracker were processed using statistical analysis methods.

The experiment involved 41 student from the 4th year of bachelor's and 1st year of master's programs in linguistics at Peter the Great St. Petersburg Polytechnic University. Thirteen participants underwent the experiment in the Human-Computer Interaction Laboratory at the Higher School of Design and Architecture using the SMI RED 250 eye-tracking hardware-software complex. Twenty-eight participants took part in the experiment at the Digital Linguistics Laboratory at the Higher School of Linguistics and Pedagogy using the Tobii TX 300 eye-tracking system.

Results

The analysis of experimental data was conducted using the automated software complex "Statistics". To identify statistical dependencies, multivariate analysis of variance was used. To confirm the statistical hypotheses, a standard ANOVA procedure was performed with the significance level (p-value) set at 0.05.

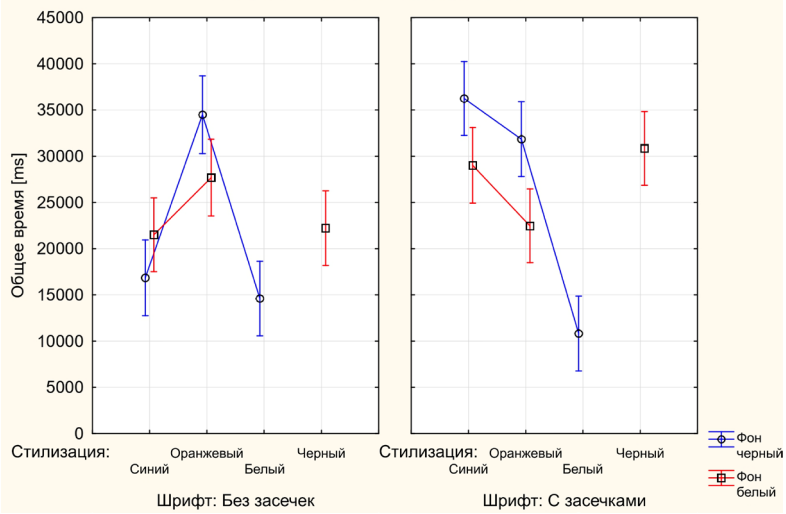

Fig. 3. Density distribution of stimulus viewing time in relation to the factors of background, highlighting, and font

Analysis of the total time spent working with the stimulus material indicates statistically significant differences in the time spent by participants on solving the experimental task when observing stimuli with various factor combinations (Fig. 3). The results show that stimuli with a black background and white underlays required the subjects the least amount of time (approximately 10000 ms) to solve the problem. This aligns with expectations based on previous research and confirms that certain combinations of factors can significantly influence text perception time [14].

The p-value obtained through statistical analysis confirms the statistical significance of differences in total working time when using various combinations of style and font factors (Table 1).

Table 1

p-value obtained as a result of ANOVA program procedure for the parameter "Total amount of time"

	p-value
Contrast	
Highlight	0,028
Font	
Contrast * Highlight	0,02
Contrast * Font	
Highlight * Font	< 0,0001
Contrast * Highlight * Font	0,113

However, an interesting result is the revealed influence of colored underlays. In particular, subjects solved the experimental problem faster when working with stimuli featuring a black background with white underlays compared to stimuli with a black background and orange underlays. The latter required significantly more time from participants (about 30000–35000 ms). Stimuli with blue underlays were second in terms of task solution speed, but only in the case of stimuli with sans-serif fonts, similarly on a black background (Table 1).

When working with stimuli on a white background, participants required an average time of 20000–30000 ms. However, despite the increase in working time with stimuli, the general trend remains. Working

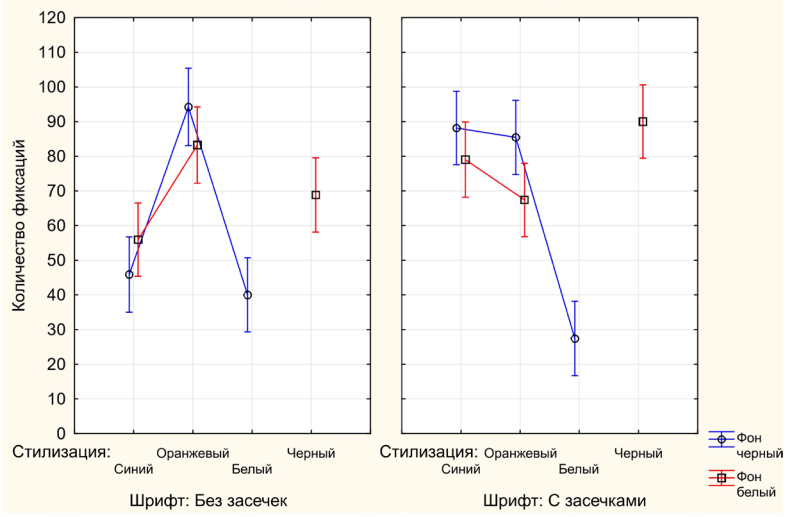

Fig. 4. Density distribution of the number of fixations during stimulus viewing in relation to the factors of background, highlighting, and font

time with stimuli reduces when using serif fonts and orange underlays, and when using sans-serif fonts and blue underlays. At the same time, the most contrasting black underlay on a white background did not result in a significant increase in the speed of solving problems, as was the case with the reverse contrast (black background and white underlays).

Analysis of the number of fixations when working with the stimulus material indicates the smallest number of fixations when using a black background, serif font, and white underlays (Fig. 4). This may indicate an increase in the speed of perception and rapid text scanning of text in this stimulus configuration. The black background and contrasting white underlays in the stimuli likely contribute to the ease of distinguishing text elements.

The results of the statistical analysis, based on p-values, indicate the statistical significance of differences in the number of fixations depending on the use of various combinations of highlighting and font factors (Table 2).

Table 2

p-value obtained as a result of ANOVA program procedure for the parameter "Quantity of fixations"

	p-value
Contrast	
Highlight	< 0,0001
Font	
Contrast * Highlight	0,053
Contrast * Font	
Highlight * Font	< 0,0001
Contrast * Highlight * Font	0,435

Conversely, the maximum number of fixations was observed when using stimuli with a black background, sans-serif font, and orange underlays. This may indicate a more complex perception of the text in this configuration, possibly due to the absence of serifs in the font and a more intense color contrast between the text and the underlays.

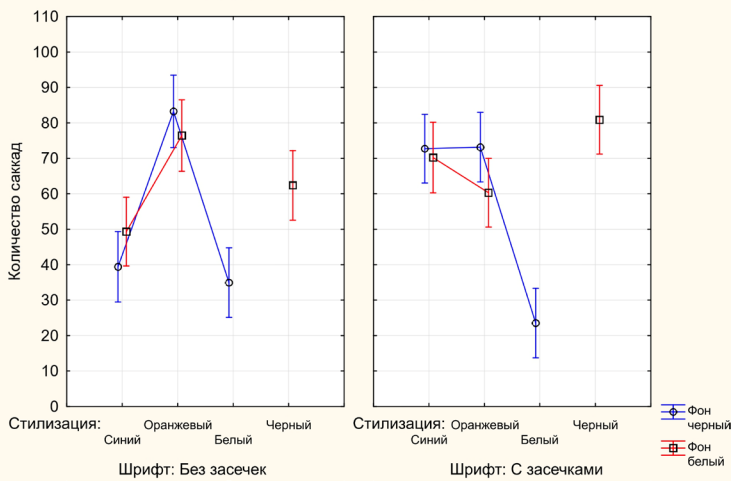

Fig. 5. Density distribution of the number of saccades during stimulus viewing in relation to the factors of background, highlighting, and font

Any combination of factors with a white background results in average fixation values. This may indicate that while a white background provides some contrast, it still reduces the level of visual impact compared to a black background.

Analysis of the number of saccades when working with stimulus material shows trends similar to the analysis of fixations shown in Fig. 5. In the case of a black background, serif font, and white underlays, the number of saccades corresponds to the minimum number of fixations. This indicates efficient text scanning and a minimum number of necessary eye movements.

Statistical analysis of the number of saccades when working with the stimulus material also confirms that the chosen method of text highlighting and font type influence the process of text perception (Table 3).

Table 3

p-value obtained as a result of ANOVA program procedure for the parameter "Quantity of saccades"

	p-value
Contrast	
Highlight	< 0,0001
Font	
Contrast * Highlight	0,057
Contrast * Font	
Highlight * Font	< 0,0001
Contrast * Highlight * Font	0,057

In a situation with a black background, sans-serif font, and orange underlays, the number of saccades increases rapidly. This aligns with the large number of fixations in this configuration and may indicate more complex text perception, requiring a more corrections and transitions between fixation points. The white background factor, in combinations with various text highlighting techniques and fonts, confirms the conclusions drawn from the analysis of fixations.

Conclusion

Based on the conducted research, a statistical dependence of text perception on background color was revealed. It was established that under certain conditions, the speed of information perception increases

on a black background. It was determined that the highest speed of information perception is achieved when text is highlighted with a white underlay on a black background, which is confirmed by statistically significant differences in the total amount of time for solving the experimental problem, the number of fixations and saccades. The statistical significance of the influence of font type on the process of text perception was also revealed. The results of this study can be used to optimize training materials in the interfaces of translator simulators, ensuring the effectiveness of their work.

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