

# User Attention in the Interface: Comparative Eye-Tracking Analysis of Website Buttons

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**Abstract**—This study presents a comprehensive comparative analysis of two web application interface variants that differ in button design, specifically graphical buttons and text-based buttons. The research was conducted in the context of universal design, using eye-tracking technology, which enables objective assessment of users' visual behaviour during task performance. A range of measures was analysed, including the number and duration of fixations, the distribution of attention points, and heat maps. Furthermore, the temporal parameters of task completion and the quality of execution were considered. The findings reveal substantial disparities in the manner in which users navigate the interface, thereby substantiating the efficacy of integrating quantitative and visual analyses in the development of accessible web applications.

**Keywords**—eye tracking; user interface; universal design; accessibility; gaze fixations.

## I. INTRODUCTION

The progressive evolution of web applications has led to an escalating emphasis on the calibre of user interfaces and their accessibility to a broad audience [1]. Universal design is predicated on the creation of solutions that are useful and comprehensible for users irrespective of age, experience, or perceptual limitations [2][3]. Buttons represent a fundamental component of the interface, serving as the primary mechanism through which users interact with the system [4]. However, designing button interfaces that are both intuitive and universally accessible remains a non-trivial challenge.

In the domain of design practice, the utilisation of both text and graphic buttons is a prevalent phenomenon. Despite the potential of icons to expedite the identification of functions, their interpretation can be ambiguous. A key challenge in interface design is balancing visual efficiency with clarity of interpretation, particularly for users with diverse levels of experience and perceptual abilities. Graphic

buttons may accelerate recognition for familiar users, but can introduce ambiguity, while text buttons improve clarity at the cost of increased processing time. Conversely, text buttons necessitate a higher level of cognitive engagement, yet frequently yield enhanced precision in interaction [5][6]. The objective of this article is to provide a comparative analysis of both solutions using eye-tracking research, which allows for the assessment of actual user behaviour, rather than merely their declarations [7]-[9]. Although prior research has investigated eye tracking in the context of interface evaluation, relatively little attention has been given to the direct comparison of text and graphic buttons using both objective eye-tracking data and subjective usability measures. This study aims to fill this gap by integrating these two perspectives in a unified analysis. This study focuses on three research questions. First, it investigates whether the type of button (text versus graphic) influences visual attention patterns. Second, it examines the effect of button type on task completion efficiency. Third, it analyses how button type impacts perceived usability.

The remainder of the paper is structured as follows. Section II presents the literature review. Section III describes the methodology and experimental design. Section IV outlines the research plan. Section V presents the results of the study. Section VI discusses the findings. Finally, Section VII concludes the paper and outlines directions for future work.

## II. LITERATURE REVIEW

Issues of usability and accessibility of user interfaces represent a significant research domain within the broader field of human-computer interaction [10][11]. In the context of the proliferation of web applications, there is an increasing emphasis on the design of interfaces that are not only aesthetically pleasing, but also intuitive and accessible to users with varying perceptual abilities. In this context, interactive elements, such as buttons, which play a pivotal

role in the communication process between the user and the system, are of particular importance [12][13].

Conventional usability evaluation methodologies, encompassing task tests, surveys and heuristic analyses, furnish valuable insights concerning the quality of an interface. However, these approaches are predominantly reliant on user declarations. Consequently, there is an increasing call to supplement these methods with approaches that facilitate the recording of actual, often unconscious, user behaviour. One of the most frequently employed techniques of this nature is eye tracking, which facilitates the analysis of eye movements during interaction with the interface [14]-[16].

Eye-tracking studies are utilised for a variety of purposes, including the assessment of the visual hierarchy of interfaces, the identification of key elements for task completion, and the detection of problem areas. The analysis of the number and duration of fixations allows for the drawing of conclusions regarding the cognitive load experienced by users, while the utilisation of heat maps facilitates a visual assessment of attention distribution. In the context of universal design, these techniques are of particular importance because they allow the identification of perceptual barriers that may not be revealed in studies based solely on subjective assessments [17]-[19].

A significant area of research pertains to the comparison of diverse forms of interface element presentation, encompassing graphic and text buttons. It has been posited by certain authors that the employment of graphic icons can facilitate more expeditious recognition of functions and enhance the visual appeal of the interface [20]. It is emphasised that the effectiveness of these systems is contingent upon the clarity of the symbols employed and the experience of the users. In some cases, this may result in interpretative uncertainty. Conversely, text buttons are frequently regarded as offering enhanced clarity and predictability, although they may necessitate a more protracted information processing duration [21].

Research on interface usability increasingly emphasises the importance of combining eye-tracking analyses with usability survey results. This methodological approach facilitates the comparison of objective measures of visual behaviour with subjective assessments of comfort, readability and ergonomics of the interface [22]. The findings of preceding studies suggest that a thorough evaluation of interfaces must encompass both considerations to enhance the efficacy of the design decision-making process [23]. However, existing studies often focus on either subjective usability or isolated eye-tracking metrics, without integrating both perspectives, which limits the comprehensiveness of their conclusions.

### III. METHODOLOGY

Issues of accessibility and usability of user interfaces are widely discussed in the relevant literature. The authors of numerous works have indicated that classic evaluation methods, such as surveys or heuristic tests, should be supplemented with techniques that enable the recording of

unconscious user reactions. One such methodology is eye tracking, which facilitates the analysis of eye movements.

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A corpus of previous studies comparing text and graphic elements indicates that the superiority of one solution over the other depends on the context of the task and the experience of users. This article provides a detailed expansion on the aforementioned research, with a focus on a comprehensive analysis of visual perception patterns.

#### A. Participants

The study involved 10 participants (4 females, 6 males), aged between 23 and 25 years. All participants were students of Computer Science at the Lublin University of Technology who were recruited on a voluntary basis. They reported normal or corrected to normal vision. The respondents had extensive experience with web layouts (web design and development), although they had no prior experience with the tested interfaces. The participation in the study was voluntary. Informed consent was obtained, and the participants were informed about the purpose of the study.

#### B. Apparatus

The Gazepoint GP3 HD eye tracker characterised by a sampling rate of 150 Hz with an accuracy of 0.5-1° was used to conduct the study. The device was connected to the Acer Nitro 5 AN517-41-R48Y laptop with a 17.3-inch screen with a resolution of 1920 × 1080 pixels. The experiment was performed under identical conditions in a laboratory with stable light conditions to ensure the accuracy of the measurements.

#### C. Experimental Design

The research plan was developed in such a way as to enable a reliable comparison of the two interface variants while maintaining repeatable experimental conditions. This can be seen in Figure 1.

The study was divided into two primary sections, corresponding to two methods of interface presentation: method A, which employed graphic buttons, and method B, which utilised text buttons. Participants were randomly assigned to one of the two interface variants, thus allowing the experimenters to avoid both the learning effect and the transfer of experience between application versions. The applied design ensured independent observations and a more reliable comparison of the two interface variants.

A comprehensive dataset was meticulously collected for each task performed during the study. It encompassed two main categories of information: eye-tracking metrics, which captured detailed aspects of participants' visual behaviour, and temporal information, providing insight into how much

time was devoted to each activity. Every participant completed a total of 10 tasks. With ten participants involved in the study, the experiment yielded 100 task-level observations (10 participants multiplied by ten tasks). This enabled a direct comparative analysis between the two interface versions under investigation. Once the experimental phase had concluded, the collected data was carefully organised and prepared for further analysis. This analysis consisted of two complementary components: a comparison of average metric values obtained for each interface version, and an assessment of visual representations of users' visual behaviour. Together, these approaches provided both a quantitative and a qualitative perspective on the results.

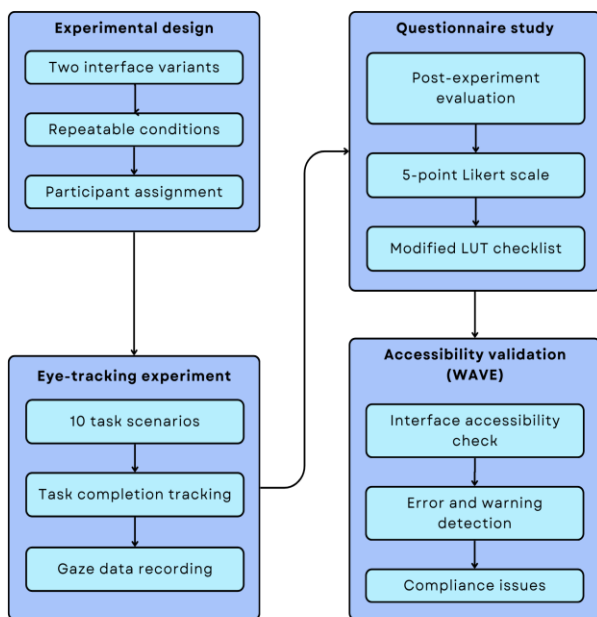


Figure 1. Research plan of the study.

#### D. Procedure

The participants in the study performed a series of tasks involving the identification and utilisation of particular application functions. The tasks included: (1) locating a specific function within the interface, (2) navigating to a selected section of the application, and (3) completing predefined actions requiring interaction with the available buttons. These tasks were designed to reflect typical user scenarios and to ensure comparability between the two interface variants. The tasks were meticulously designed to necessitate active searching for interface elements and the formulation of interactive decisions, thereby facilitating the observation of natural visual exploration strategies. The imposition of a time limit during the execution of the tasks was deemed unnecessary, as this could have resulted in the introduction of undue pressure, which might have influenced the user behaviour in an unnatural manner.

#### E. Data Collection and Measures

The experiment involved the collection of both quantitative and qualitative data. Quantitative analyses

encompassed task completion time, the number and average duration of fixations, and the number of errors made. The qualitative data comprised heat maps and visualisations of fixation distribution, which facilitated the assessment of the areas of the interface that attracted the most attention from users. The analysis of fixations was given particular emphasis, since their number and duration are widely recognised as indicators of cognitive load and the degree of clarity of the information presented.

#### F. Data Analysis

The collected data was then aggregated and subjected to a comparative analysis between the two versions of the interface. This methodology enabled a multidimensional assessment of the impact of button design on interface perception, task performance efficiency, and interaction accuracy, while maintaining the principles of universal design. For each participant, mean values were calculated for all tasks across the individual metrics analysed. Due to the small sample size, a non-parametric Mann-Whitney U test was applied instead of parametric tests to compare the two interface variants. Effect sizes ( $r$ ) were also calculated.

### IV. RESULTS

The research results include both quantitative and qualitative analysis of data obtained during the eye-tracking experiment. The integration of these two perspectives yielded a more comprehensive understanding of the variations in the perception of interfaces with graphic and text buttons.

The initial aspect analysed was the number and duration of fixations. The data presented in Table 1 illustrate the mean fixation values for both methods. In the case of the interface with graphic buttons, a greater number of fixations was observed, with a shorter duration. This configuration is indicative of a thorough scanning of the interface, necessitating the interpretation of the significance of the icons. In the case of the text interface, the number of fixations was lower, while their average duration was longer. This suggests that the subjects were focusing more intently on the information presented, and that they found it clearer. These results may suggest that the text-based interface imposed a lower cognitive load, allowing for more efficient information processing. However, this interpretation should be treated with caution, as cognitive load was not directly measured using dedicated physiological or validated workload assessment methods. The interface with graphic buttons required greater interpretative effort from users, which was reflected in the higher number of shorter fixations.

The Mann-Whitney U test did not reveal statistically significant differences between the two interface variants for each analysed metric ( $p > 0.05$ ). However, an analysis of effect sizes revealed significant differences in user behaviour. It should be noted that a large effect was observed for the fixation count ( $r = 0.56$ ) and a moderate effect for the completion time ( $r = 0.50$ ). A moderate effect was also found for fixation duration ( $r = 0.36$ ), while in the case of saccade duration and saccade count, only small effects ( $r \approx 0.10$ ) can be observed.

TABLE I. MEAN NUMBER OF FIXATIONS AND MEAN NUMBER OF SACCADDES ACROSS INDIVIDUAL TASKS FOR BOTH METHODS

Task	Method	Fixation count	Saccade count
1	Method A	28.20	108.00
	Method B	18.80	55.75
2	Method A	11.20	38.20
	Method B	10.60	43.80
3	Method A	55.20	184.40
	Method B	27.20	106.60
4	Method A	24.80	113.80
	Method B	15.20	59.00
5	Method A	35.20	111.40
	Method B	12.20	56.60
6	Method A	7.60	32.40
	Method B	6.80	34.60
7	Method A	21.20	87.80
	Method B	13.80	80.40
8	Method A	25.80	98.00
	Method B	11.60	78.60
9	Method A	12.75	35.25
	Method B	7.80	35.60
10	Method A	16.75	55.75
	Method B	14.20	76.60

elements that are irrelevant to the task at hand. In contrast, method B has been shown to result in clear clusters of fixation within the text buttons, which are directly related to the task. This finding indicates that the correct element is recognised more quickly.



Figure 2. Heat map for task 2 for method A.

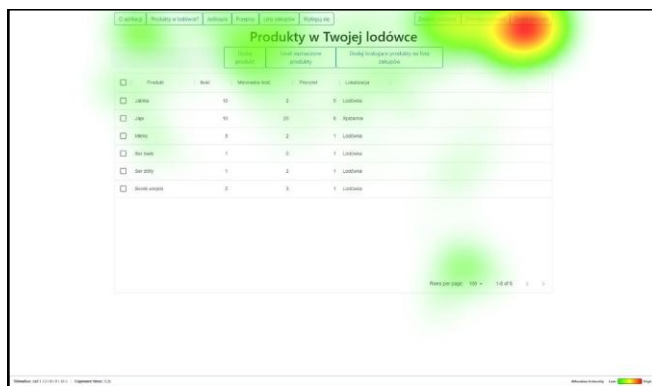


Figure 3. Heat map for task 2 for method B.

A key component of the analysis involved the heat maps generated for Task 2, as shown in Figures 2 and 3. In the case of method A, the heat maps reveal the dispersion of users' attention between several areas of the interface, including

Another parameter analysed was the task completion time. The data is presented in Figure 4.

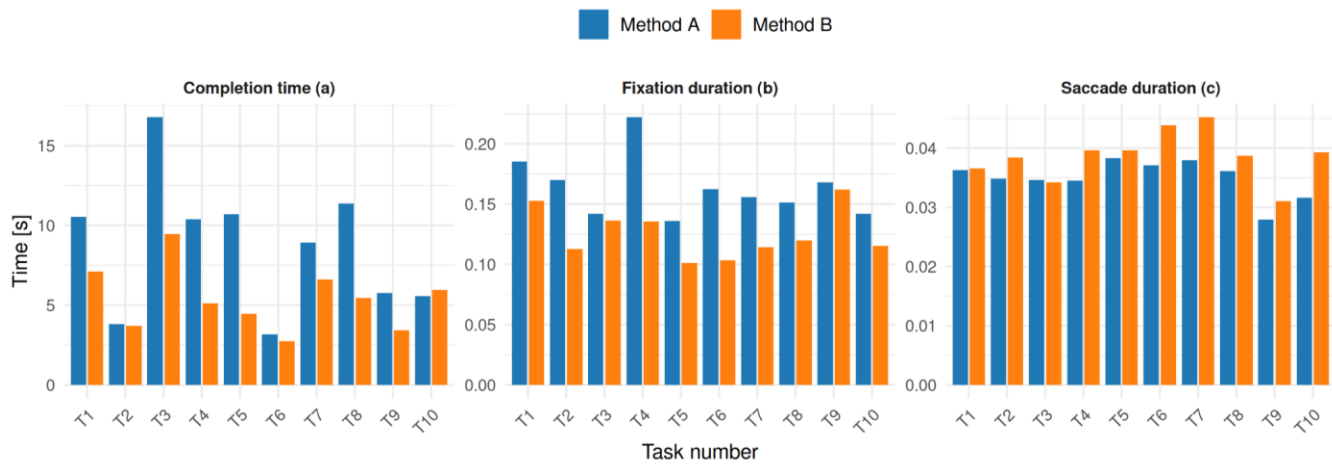


Figure 4. Mean values of eye-tracking metrics for AOI (Area of Interest) for each task: mean task completion time (a), mean fixation duration (b), mean saccade duration (c).

A thorough examination of the graph reveals that the utilisation of graphic buttons resulted in a reduction of task completion times. However, a discernible correlation between this reduction and the accuracy of completion was not observed. The text variant was characterised by a marginally extended completion time, yet concurrently exhibited enhanced stability in the results obtained by participants.

An additional element of the analysis was a chart based on the results of the LUT (Lublin University of Technology) survey, which can be seen in Figure 5. This was used to subjectively assess the usability of the interface by participants after completing the tasks. The survey incorporated a series of statements evaluated on an ordinal scale, encompassing, inter alia, aspects, such as the readability of the interface, the ease of locating functions, and the overall ergonomics of the application. The presentation of the responses in the form of a chart facilitated a direct comparison of the perception of both interface variants.

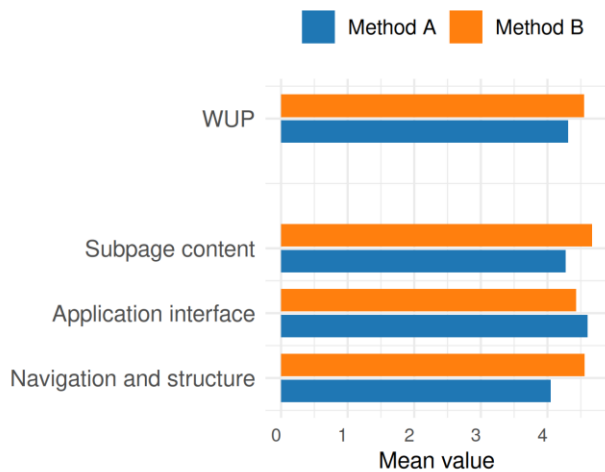


Figure 5. Mean WUP (Weighted Usability Points) scores by evaluation area and final score for Methods A and B (LUT survey).

An analysis of the LUT survey chart reveals that the interface with text buttons received higher ratings in areas related to the clarity and comprehensibility of functions. The overall WUP rating for method B was significantly higher, at around 4.6, whilst for the graphical version it remained just above 4.3. It was evident that respondents frequently asserted a high degree of certainty with regard to the function of interface elements. In contrast, there was a notable decrease in the number of instances requiring guesswork regarding the purpose of buttons. The advantages of the text-based interface were particularly evident in terms of navigation and content (in both cases, the scores ranged from 4.6 to 4.7, whilst the graphical version scored around 4.0-4.2 points). Conversely, the graphic variant was regarded as more visually appealing and dynamic with slightly higher ratings in the application interface category, approximately 4.6 points for method A vs. 4.4 for method B. However, respondents frequently highlighted the necessity for additional interpretation of the icons. The results of the LUT

survey are consistent with the observations from the eye-tracking data and complement them significantly, combining an objective perspective with the subjective assessment of users.

The WAVE tool (Web Accessibility Evaluation Tool) [24] was used to assess compliance with the Web Content Accessibility Guidelines (WCAG) 2.0 guidelines [25]. It is an automated tool that detects accessibility issues, such as errors, contrast problems, and structural elements, enabling a systematic evaluation of the interface. No significant problems or warning messages were identified during testing. A summary of the results obtained is presented in Table 2.

TABLE II. RESULTS OF THE ANALYSIS OF TWO VERSIONS OF THE INTERFACE USING THE WAVE TOOL

WAVE Category	Method	Frequency
Errors	Method A	0
	Method B	0
Contrast errors	Method A	0
	Method B	0
Alerts	Method A	0
	Method B	0
Features	Method A	1
	Method B	1
Structural elements	Method A	8
	Method B	17
Accessible Rich Internet Applications (ARIA)	Method A	8
	Method B	20

## V. DISCUSSION

The analysis of the results confirms that the form of presentation of buttons in the web application interface has a significant impact on both visual perception and the effectiveness of user interaction. The amalgamation of eye-tracking data with the results of the LUT survey facilitated a multidimensional evaluation of the solutions that were tested, thereby complementing both objective and subjective perspectives.

The interface incorporating graphic buttons encouraged faster action, which was reflected in shorter task completion times, as it was suggested in study [20]. Concurrently, the examination of fixations and heat maps suggests that users predominantly engaged their visual attention in interpreting the significance of icons. The dispersion of fixation points and the increased frequency of brief glances suggest an elevated cognitive load, particularly in circumstances necessitating unambiguous identification of the interface's functions. Moreover, the analysis of effect sizes is consistent with the visual patterns observed in the heat maps and confirms the interpretation that using an interface designed with graphic buttons demands greater cognitive effort.

The variant with text buttons demonstrated a distinct behavioural pattern. It is evident that longer and more concentrated fixations, in addition to a focus on key areas of the interface, serve to indicate greater clarity and predictability of the system's operation, which is consistent with the findings of the study [21]. Despite the slightly protracted task completion time in this instance, users demonstrated a reduced incidence of errors and exhibited a heightened sense of confidence in their decisions, a finding that is corroborated by the LUT survey results.

Analysis of data from the WAVE tool indicates that there are no errors, contrast issues, or alerts in either interface variant, which confirms their fundamental technical correctness. However, the noticeable difference in the number of structural elements and ARIA attributes (Method B has a higher number) are due to the different ways of implementing semantics and accessibility, despite compliance with WCAG 2.0.

These results are significant in the context of universal design, which aims to minimise cognitive barriers and ensure that interfaces are accessible to as wide a range of users as possible. From this standpoint, the lucidity of communications and the predictability of interactions may be of greater significance than the maximum velocity of operations. The analysis suggests that text buttons are better suited to meeting these requirements, especially in the context of utility applications.

Concomitantly, it is imperative to acknowledge that a compromise solution may be to utilise hybrid interfaces that combine graphic icons with short text labels. This observation is consistent with previous findings suggesting that graphical elements support rapid recognition, while text enhances interpretability [20][21]. This approach has the potential to address the interpretation challenges observed while maintaining the visual benefits of graphical interfaces. The findings suggest that eye tracking is an effective tool for supporting design decisions and identifying subtle usability issues that are not always revealed by traditional evaluation methods, as demonstrated in [17].

## VI. CONCLUSION AND FUTURE WORK

The article presents the findings of comparative tests conducted on two variants of a web application interface, distinguished by the form of the buttons utilised – graphic and text. The employment of eye-tracking technology, in conjunction with a LUT survey, facilitated a comprehensive evaluation of both the objective visual behaviour exhibited by users and their subjective sentiments regarding the usability of the interface. The findings suggest that there are substantial variations in visual exploration strategies, task completion time and user confidence levels contingent on the design solution adopted.

The findings of the present study demonstrate that interfaces based on text buttons promote greater clarity and accuracy of interaction, a factor that is of particular importance from the point of view of universal design. Conversely, graphic buttons can facilitate expeditious orientation within the interface; however, their judicious selection is contingent upon the selection of appropriate

symbols and the context of utilisation. The conclusions presented herein have the potential to provide practical support for user interface designers. Further research could focus on the analysis of hybrid solutions and the expansion of the research group to include users with diverse perceptual needs. Increasing the sample size would allow for a more reliable statistical verification of the observed differences. Although statistical tests were conducted in this study, no statistically significant differences were observed ( $p > 0.05$ ); however, effect size analysis revealed significant differences between the compared interface variants.

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