ABSTRACT

Reading plays a vital role in updating the researchers on recent developments in the field, including but not limited to solutions to various problems and collaborative studies between disciplines. Prior studies identify reading patterns to vary depending on the level of expertise of the researcher on the content of the document. We present a pilot study of eye-tracking measures during a reading task with participants across different areas of expertise with the intention of characterizing the reading patterns using both eye movement and pupillary information.

KEYWORDS

Eye Tracking, Reading Patterns, Multidisciplinary Research

1 INTRODUCTION

The reading patterns of digital documents (scholarly articles) vary from person to person across various disciplines. Despite the consensus that reading patterns are stochastic, recent studies identify similarities between individuals with common expertise. The studies by [Jayawardena et al. 2020; Mahanama et al. 2021] identify that participants spend the most time in the methodology section, with a relatively low cognitive load.

However, these studies only rely on pilot studies of participants from the computer science domain. As a result, the findings of the studies can be questionable for other disciplines. Therefore, we present a dataset \(^1\) that includes eye-tracking behaviors of researchers from multiple disciplines. The contributions of our study are as follows,

(1) Conduct a preliminary analysis on the generalizability of claims of previous studies across domains.

\(^1\)https://github.com/nirdslab/Multidisciplinary-Reading-Patterns

2 METHODOLOGY

We recruited seven (6 F, 1 M) graduate students as researchers in Computer Science (CS) (2), Mathematics (2), and Physics (3). The research experiences of the participants ranged between one year to five years and aged between 25 - 35 years. We confirmed their experience in reading research papers in conference venues verbally. We verified the vision of the participants through a visual acuity test.

We selected two articles of two pages in Computer Science and Physics for the reading task. After reading each paper, each participant briefly summarized the article verbally and answered queries by the proctor to confirm their understanding. We allowed the participants to perform the task in a laboratory setting with their preferred lighting, brightness, and zooming levels (See Figure 1 for the experimental setup). On a given day, we limited the experiment to a single paper per participant to eliminate the effects of fatigue in the dataset.

We used PupilLabs Core \(^2\) eye-tracker to record eye-movements at a sampling frequency of 120 Hz with an accuracy of 0.60\(^\circ\). Each participant was calibrated using the 5-point calibration in Pupil Capture \(^3\) and confirmed the accuracy through manual tests. For each paper, we annotated five sections: (1) title, (2) abstract, (3) introduction and related work, (4) methodology, and (5) figures. We contacted the author and confirmed the section classification for the articles without explicitly defined sections.

For each user session, we replayed the gaze positions using Pupil Player and annotated the eye movements in each of the

\(^2\)https://pupil-labs.com/products/core/

\(^3\)https://docs.pupil-labs.com/core/software/pupil-capture/
We calculated the aforementioned eye gaze metrics for each participant, potentially indicating domain unfamiliarity increasing time spent. We presume the CS participants have only skimmed the physics article. On the contrary, we observed the number of fixations decrease while being lesser than Non-CS, indicating less cognitive load in other sections. In contrast, CS participants have undergone a higher cognitive load throughout the computer science article except abstract than Non-CS participants, despite our expectation of domain familiarity yielding a lower cognitive load.

4 DISCUSSION AND CONCLUSION

We did not observe domain familiarity impacting cognitive load expressed through pupillometric characteristics based on the results. However, we observed higher fixations in abstract, introduction, and methodology irrespective of the domain familiarity. Moreover, we noticed a higher cognitive load during introduction and methodology irrespective of participant and article.

Our preliminary results have multiple limitations. Firstly, we expect the observations to include potential biases resulting from the lack of diversity in our study sample due to the early stage of the study. We expect more generalizable gaze and pupillometric characteristics to emerge by diversifying the study participants. Further, we present only the most widely used measures in this study, while metrics beyond our study may uncover novel findings.

In the study, we performed manual annotations for mapping the gaze positions of the users to the sections of the paper, which is tedious and time-consuming for an experiment of large scale. As presented in prior studies [Jayawardena and Jayarathna 2021; Mahanama et al. 2021], automated annotation approaches can help overcome the issue and form a novel research avenue. However, our experimental setup requires a clear point of view imagery and distinctive features in the digital documents to use those approaches effectively. Further, such an automated approach must be resilient to potential false positives in categorization.

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