

Eye Movement Patterns on Screen Readers

An Eye-Tracking Study

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ABSTRACT

Eye movements are important when reading activities are carried out. Basically, a person's eye movements when reading do not move straight along following the line of text, but sometimes makes short, rapid, and stop movements. The visual processing of the written text is interesting to study since there are not many studies that discuss the problem in Indonesia. Based on this, this study aims to analyze patterns of eye movements when screen reading activities are based on Tobii Eye Tracker recording. The data in this study were obtained from 20 respondents who participated in reading comprehension activities in the form of scientific articles. The data is in the form of eye movement patterns recorded with the help of Tobii Eye Tracker. Through the qualitative descriptive method, the results showed that some of the eye movement patterns recorded during the reading activity indicated the commitment pattern. These results indicate that the participants are still using the word-by-word reading pattern that is usually used by early readers. Another result of the analysis is that the participants did not regress. This means that they do not experience language processing and word understanding problems in the text they read.

Keywords: *Eye movement pattern, eye-tracking, screen reader*

1. INTRODUCTION

Reading activity is one of the processes of language processing used in everyday life. Reading activity is a very complex activity because it involves eye movement functions and brain tissue. A person's cognitive processes during reading activities can be seen from the eye movement patterns when reading activities are carried out (Thiagarajan, Ciuufreda, Capo-Aponte, Ludlam, & Kapoor, 2014; Rahma, Nurhadi, & Aswan, 2019). Eye movement activity can be seen through the help of the Tobii Eye Tracker recorder. This activity can provide an overview regarding language processing when reading activities are carried out.

Language processing studies related to eye movement patterns during reading activities are mostly carried out in dyslexic sufferers. These studies focus on describing the eye movement patterns of dyslexic patients when reading a text. These studies reveal that the eye movement patterns of every human being are different, and so are people with dyslexia. Language processing, especially dyslexic sufferers, is so slow when compared to normal readers. This is evidenced by the slower fixation of recording eye movements

compared to normal readers. An illustration of how the eye movement pattern can help teachers or education policymakers in making relevant teaching materials (Prado, Dubois, & Valdois, 2007; Masulli et al., 2018; Pan, Yan, Laubrock, Shu, & Kliegl, 2014).

The more complex the reading material, the greater the chance of fixation that results from eye movements. Based on the results of the study by Ghahghaei and Linnell (2018), the human eye movement patterns in language processing can be structured or sequential from one word to another. Besides, eye movement patterns can also be drawn randomly depending on the information the reader wants to find. These eye movement patterns greatly influence human language processing.

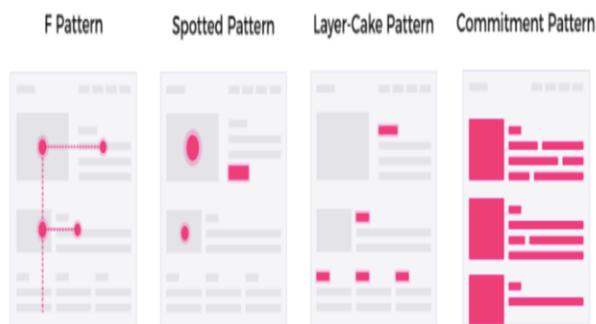
From various studies on eye tracking in the field of reading, no study has been found that examines the eye movement patterns of normal Indonesian readers. Especially in Indonesia, studies like this are still very rarely conducted. Studies using the Tobii Eye Tracker, among others, focus on revealing the condition of the human eye when viewing stimuli in the form of visual images (Shaked, Shamir, & Vakili, 2020; Wang, Hung, Chen, & Chang, 2019); Rivas-Lalaleo et al., 2017;

Krstić, Šoškić, Ković, & Holmqvist 2018; Dogusoy, Cicek, & Cagiltay, 2016). Studies that have been carried out in previous research strengthen the assumption in this study that research related to eye movement patterns when reading comprehension is important to do to see how human language processing is.

By knowing a person's eye movement patterns when reading activities are carried out, it can also be seen how the image of language processing that occurs in readers. Based on this, this study aims to describe the eye movement patterns of Indonesians during reading comprehension activities. This needs to be done because seeing comprehension reading activity is a very complex activity.

One of the tools that can be used to detect a person's eye movements during reading activities is to use the Tobii Eye Tracker. Tobii Eye Tracker can record the duration of eye pattern focus points during reading activities. Tobii Eye Tracker can currently use a computer or laptop to record eye point of view (fixation) and saccades during reading comprehension (Bregstrom & Schall, 2014; Eraslan, Yaneva, Yesilada, & Harper, 2019). Through this Tobii Eye Tracker recorder, eye movement patterns, and fixations during reading can be described so that researchers can make new assumptions to develop further research related to reading comprehension activities.

In general, eye movements in reading activities, based on supporting theory, can jump from one word to another. Apart from that, it can also stop at certain words. These eye movements form certain patterns. In general, the reader's eye movements can form four types of patterns, namely F pattern, Spotted-pattern, Layer-cake pattern, and Commitment pattern. These patterns can be seen as in the following picture.



(Source: <https://www.nngroup.com/articles/text-scanning-patterns-eyetracking/>)

Figure 1 Eye tracking patterns.

2. METHODS

The method used in this research is descriptive qualitative method. This method was chosen because it is following the research objectives to be achieved, namely the description of eye movement patterns in reading comprehension activities. The use of this research method is in line with the opinion of Creswell (2009) which states that qualitative methods are a means to explore and understand the subject and object of research with descriptive analysis.

This study aims to describe the eye movement patterns during reading comprehension activities. Data collection in this study involved 20 participants. Participants in this study were students of the Department of Indonesian Language and Literature Education, Indonesian Education University. The selection of participants was random.

The data collected in this study were recorded eye movement patterns when reading comprehension activities were carried out. Data collection was carried out using the Tobii Eye Tracker which is already installed on the researcher's laptop.

Procedurally, this research was conducted from several stages. First, participants are asked to complete their data on the respondent's provided sheet. Second, participants were directed to the data collection room that had been provided. Third, participants are instructed to start reading a scientific article in Indonesian language that has been provided on a computer screen (laptop). The computer device is equipped with an eye movement scanner (Tobii Eye Tracker). Fifth, the Abbreviations and Acronyms.

3. FINDINGS AND DISCUSSION

In this section, the researcher describes the results of the analysis of the participants' eye movement patterns during reading comprehension activities. The focus of the researcher is to analyze the part of the first page of the article read by the respondent. The first page was chosen because the participants' concentration center tends to be prime and focused.

Based on predetermined analytical procedures, participant data were analyzed using eye pattern movement theory. The following shows several examples of recorded images and analyzes of participants' eye movement patterns during the reading process.

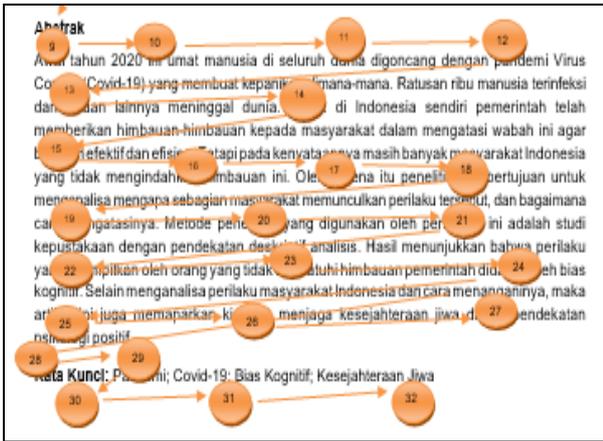


Figure 2 Eye movement patterns (subject 1).

The picture above is the eye movement pattern of the first participant. It can be seen that the fixation or breakpoint of each line in the paragraph tends to be consistent. The fixation points from the first line to the last line are a maximum of four stop points. This first participant tends to be inconsistent in moving his eyes to the lines of words in the paragraph. Of the 13 lines in the paragraph, the participants' eye flow patterns are only on eight lines of words in the sentence, so it can be said that participants did not read all the information in the paragraph. In Figure 2, it can be seen that the participants moved their eyes downward more by occasionally looking at the left side of the page. The participant also appears to stop at the center of the page and looks like a short bar in the middle. The pattern that is formed from these eye movements is the letter "F" pattern or what is called the F pattern.

Looking at the picture in Figure 3, it can be explained that the participants started reading from the subtitles and then jumped to the 2nd word on the 4th line. From the saccades and fixations that can be seen from the recordings, it can be said that the participants only focused on the middle of the paragraph.

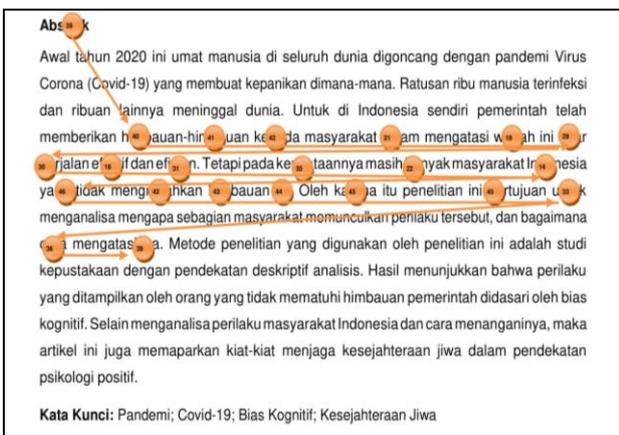


Figure 3 Eye movement patterns (subject 14).

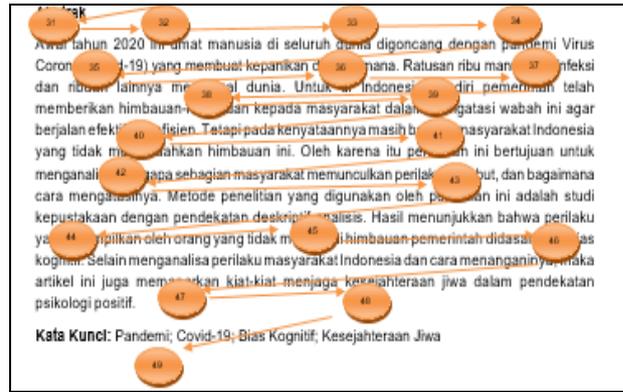


Figure 4 Eye movement patterns (subject 2).

The fixation eye movement patterns totaled 22 stop points. Even so, the eye movement pattern of the saccades looks consistent. Besides, participants tended to read word by word. Seen in Figure 3, the participants did not start reading the first sentence and only focused on certain elements, such as the subtitle and the middle of the page. The eye movement pattern as seen in fig.3 is called a *spotted pattern*.

Based on Figure 4, the participants begin reading from the first word of the abstract section. The fixation distance from the eye movements of the second participant tended to be inconsistent. Of the 13 lines of words in the writing, only 8 lines became the participants' reading centers. Fixation is done every four words per one line of the sentence. In this eye movement pattern, participants tend to pass through the walls of the text and focus only on the beginning of the title, a small part of the middle, and the end of the text. This pattern is called the *Layer-cake pattern*.

Based on the recording of the Subject 12 eye movement pattern, 50 fixation points were drawn. It can be seen from the recorded eye movement patterns that the participants read almost word for word, from the beginning of the page to the end. Participants do not scan text, but read almost every part of it. The pattern depicted in Figure. This 4 is called the Commitment pattern.

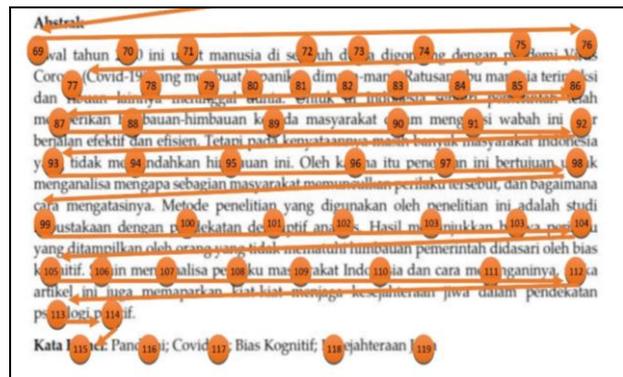


Figure 5 Eye movement patterns (subject 12).

Table 1. Analysis result of eye movement pattern

No.	Participant	Eye movement pattern
1	Subject 1	F pattern
2	Subject 2	Layer-cake pattern
3	Subject 3	F pattern
4	Subject 4	Commitment pattern
5	Subject 5	Commitment pattern
6	Subject 6	Commitment pattern
7	Subject 7	Commitment pattern
8	Subject 8	Layer-cake pattern
9	Subject 9	F pattern
10	Subject 10	F pattern
11	Subject 11	Layer-cake pattern
12	Subject 12	Commitment pattern
13	Subject 13	Commitment pattern
14	Subject 14	Spotted pattern
15	Subject 15	Layer-cake pattern
16	Subject 16	Layer-cake pattern
17	Subject 17	F pattern
18	Subject 18	Commitment pattern
19	Subject 19	Spotted pattern
20	Subject 20	Commitment pattern

The researcher performed an analysis like the example above for 20 other data. The following is the result of the analysis of the participants' eye movement patterns during reading comprehension activities. Table 1 shows that of a total of 20 participants, 40% used *commitment pattern*, 25% used *F-patterns*, 25% used *layer cake patterns*, and 10% used *spotted patterns*.

Researchers make 13 lines of words in the paragraph as the main stimulus. Based on the eye movement pattern of the saccades, as many as 7 participants focused on 10 lines of words in the paragraph, so it can be said that almost all the words in the paragraph were read by the participants. A total of 6 participants focused on 8 lines of words in the paragraph and the remaining 5 lines of words were not read. The 7 other participants only focused on less than half a line of words in the displayed paragraph.

This finding is interesting to observe because it turns out that 40% of participants use the eye movement with *commitment pattern*. In other words, they read almost every word in the text. This means that most of the participants take longer fixations to extract visual information from the text. In fact, ideally for adult readers this does not apply. These characters are usually owned by early readers who are more likely to perform shorter fixations and saccades (Blythe, 2014; Parker, Slattery, & Kirkby, 2019; Reichle et al., 2013; Schroeder, Hyönä, & Liversedge, 2015).

When viewed from the results of the analysis of the participants' eye movement patterns, the researcher found no regression. Regression is a movement of the eyes when reading which returns to the beginning of the text. These regressions generally reflect difficulties in

language processing of the text being read (Frazier & Rayner, 1982; Reichle et al., 2013) or it could be due to the reader's uncertainty about the words previously seen (Levy, Bicknell, Slattery, & Rayner, 2009; Slattery, 2009; Reichle et al., 2013). Thus, it can be said that most of the participants did not face problems in terms of language processing and understanding of the words in the text they read.

4. CONCLUSION

Based on the results of the analysis described in the previous section, it can be concluded that most of the participants (40%) used the eye movement pattern commitment pattern. This shows that the participants are still using the word-for-word reading pattern that is usually used by early readers. This of course will affect the travel time it takes to read which will be longer than other eye movement patterns. The results of the analysis also showed that the participants did not experience problems in terms of language processing and word understanding. This is indicated by the absence of regression when reading comprehension activities are carried out.

Based on these conclusions, it is necessary to carry out further research to prove the effect of the saccades eye movement pattern and fixation on reading ability during reading comprehension activities. This research is still limited to the participants' eye movement patterns during reading comprehension activities. Further research needs to be done as an effort to strengthen this research.

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