Understanding Eye Movements in Depressed and Non-Depressed College Students

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Figure 1: An example of one of the paintings used in the study with AOI boxes

ABSTRACT

Today, rates of depression and anxiety in college students are increasingly more complex than in previous years [1]. Understanding how eye movements differ between non-depressive and depressive individuals will contribute to psychologists' approach to treatment and interactions with depressed individuals. Our study sets out to discover whether students with depressive symptoms engage with artwork differently than non-depressed students on the bases of mood interpretation, dwell time, and perception of one's own fixations. There is little research in this area, and our study aims to build on prior research to contribute to the sparsely researched area. After providing participants with various paintings and collecting their responses regarding the mood of the artwork, data on the responses was collected. No significant differences were found in the means of each dependent variable between depressed and non-depressed students. Additionally, no significant differences were found in the means of the dependent variables by gender. The results of this study imply that there is no difference in how mood is interpreted or how students view and engage in paintings to reach conclusions about mood.

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1 INTRODUCTION

On a college campus today, it is not uncommon to find students who suffer from anxiety and depression, especially post-COVID-19. The ability to help these students is built on an understanding of the effects of depression on cognition. One method for building this understanding of cognition is eye-tracking [7]. While many studies in recent years have focused on understanding cognition as a whole through eye movements, virtually no studies have been published exploring the relationship between populations with depressive symptoms and those without. The need for this research lies in the effects of depressive symptoms, such as, loss of energy or increased fatigue, difficulty thinking, concentrating or making decisions, increased purposeless physical activity and slowed movements or speech [2] that result in a mental fog [8]. Cognitive processes are affected by these symptoms, which begs the question, how can we understand the effects of negative mental health, such as depressive symptoms, on eye movement?

2 BACKGROUND

In the systematic review "The effectiveness of eye tracking in the diagnosis of cognitive disorders: A systematic review and meta-analysis" [5] researchers reviewed a number of studies pertaining to eye tracking in cognitive impairment. Using the existing evidence from these studies, they summarized how effective eye tracking techniques are in diagnosing cognitive impairment. Because their main interest was in cognitive impairment there were no limitations to age, region, sex, and race. Based on what they found, eye tracking techniques could be used for detecting the decline in cognitive impairment and that the use of these techniques could be encouraged for diagnosing cognitive disorders. There are some recognized limitations to this systematic review. The studies that were reviewed all have different methods of using eye tracking techniques to screen for cognitive impairment. In addition, the studies reviewed were all written in English. This limitation possibly led to the exclusion of related material. In addition, the studies reviewed varied in overall quality. With these limitations and the overall conclusion being accounted for, eye tracking techniques being used for the diagnoses of cognitive disorders need to be further investigated.

The study "Eye tracking based dyslexia detection using a holistic approach"[6] explored the gaze patterns of individuals with dyslexia using whole time or frequency classifications as opposed to global-level features, such as x-y coordinates. By using a holistic approach, researchers hoped to develop a better method for detecting dyslexia based on eye movements alone. It is already known that dyslexic eye movements have longer fixations, are more frequent, and include shorter saccades as well as more regressions. Eye movements of both the HR group (high risk of cognitive disorder) and LR group (low risk of cognitive disorder) were recorded using the Google-based Obe-2 TM system as participants read a short text with average sentence lengths of 4.6 words. Nerušil et al. found that the reading times of participants in LR are significantly shorter than those of the participants in HR. They also found clearly visible differences between the groups in both the zero-padded signals in the time domain and in the frequency domain- both differences stem from the difference in reading times between the two groups. The holistic approach was successful in removing any additional errors introduced by the feature detection-extraction methods. Detection processes were increased from the prior 95.6% to 96.6% overall. The model also helped in differentiating between children with dyslexia who are unable to read quickly and healthy children who naturally read slowly. Limitations of this study include its focus on children, as many adults also have undiagnosed dyslexia and other cognitive disabilities that impact eye movements. Because of these limitations, our study is able to use this prior research to explore the eye movements of young adults with generalized cognitive disabilities such as depression.

In an effort to research double attention blindness for both positive and negative emotions, the study "Double attention bias for positive and negative emotional faces in clinical depression: Evidence from an eye-tracking study" [3] had participants complete the Beck Depression Inventory-II before viewing a series of emotional faces. Researchers used an eye tracker to look at the following: direction of initial gaze, first fixation latency, first fixation duration, and total fixation time. They found that depressed participants demonstrated longer first fixation duration and greater total fixation time on sad facial expressions in comparison to the happy and angry expressions. A limitation to this study is that the sample groups (ND and D) are very small as well as unequally distributed. Because of this, there is limited power in detecting differences in the two groups. Our study is like this one in that we will use similar methods to explore population differences in mood interpretation and reaction time, but we plan to explore self-reported mood interpretations rather than providing a mood of the image, to control for possible researcher bias in the stimuli.

3 METHOD

3.1 Participants

The participants in this study were undergraduate and graduate students from Clemson University between the ages of 20 and 30 years, both male and female. The average age of participants was 22.31 years. The participants were composed of six male students and ten female students. The students completed the PHQ-8 and had an average score of 5.38. The PHQ-8 was used to score participants on the amount of depressive and anxious symptoms they experience. The sample was composed of nine non-depressive students (ND) and seven depressive students (D). The participants received no reward or motivation for participation.

3.2 Measures

Qualtrics surveying website was used to collect survey responses. Each participant answered demographic questions, such as age, gender, whether they wore corrective lenses and had correct color vision. We also included questions regarding the amount of art the participant consumes regularly with regard to museums and paintings to control for any bias in the interpretations during the study. Next, participants completed the PHQ-8, a depressive symptoms scaling questionnaire[4]. Including this scale allows participants to be scored for depression, and the two groups of the study were found using these scores. Participants responded to questions regarding their visual gaze throughout the experiment, and the number of discrepancies between what they thought they looked at the most and what they actually looked at the most were used as additional measures.

3.3 Design

This experiment is a between-subjects design. Each participant saw all works of art, however the participants were grouped into two groups (ND and D). Participants viewed five paintings with a variety of color and facial expressions. The participants were given up to 30 seconds to view the art, but were able to hit the space key on the keyboard to continue to the questions sooner, if they wished. After viewing each individual artwork, the participants were asked to report the mood of the painting, and what they looked at to reach their conclusion. The participant responses of mood interpretation, fixation points and time spent observing the art are the dependent variables.

3.4 Apparatus

The images were presented to participants on a 22 inch Dell monitor with a resolution of 1920 x 1080. Participants' gaze will be tracked during each experimental session using a Gazepoint GP3 Eye-Tracker offering an accuracy of 1 degree of visual angle and a sampling rate of 60 Hz. The Gazepoint GP3 Eye-Tracker is a binocular pupil/corneal reflection eye tracker.

3.5 Stimulus

The selected stimuli are all portrait paintings done in similar styles. While some of these paintings vividly convey emotions through the depicted facial expressions, others offer a more subtle exploration of human emotion. Figures 1&2 are from Tai Shan Schierenberg. Schierenberg's paintings were found on a virtual gallery (Flowers, n.d.). Figures 3-4 are from Jamie Coreth. All of these paintings were found on Coreth's personal website (Coreth, n.d.).

3.6 Procedures

Participants experienced all experimental conditions. Each participant was welcomed to the study and then read a script about the study. Then, participants read an informational letter approved by Clemson University's IRB. At any point prior to the experiment,

Figure 2: "Portrait of Jim Penfold" by Jamie Coreth

Figure 3: "Capitaine" by Tai Shan Schierenberg

Figure 4: "Alice Eve" by Jamie Coreth

participants were allowed to ask questions. Once the participant finished reading the informational letter, the participant was then set up on a 22 inch Dell computer and fitted to the Gazepoint eye tracker. Next, the participant began the study and was instructed to calibrate the eye tracker using an image of five numbered circles. After calibration, the participant completed the Qualtrics survey

Figure 5: "Portrait of Fatima " by Jamie Coreth

Figure 6: "Portrait of Lydia Owen Edmunds " by Jamie Coreth

containing demographic questions, whether they wore corrective lenses, had correct color vision, the PHQ-8 and art consumption frequency. Participants then observed five paintings with a variety of color and facial expressions. The participants were given a maximum of 30 seconds to view the art, but were allowed to hit the space key on the keyboard to continue to the questions sooner, if they wanted. After viewing each individual artwork, the participants were asked to self-report both the mood of the painting and what they looked at to reach their conclusion. Once this is completed, five times, participants were thanked and allowed to leave.

3.7 Analyses

When analyzing the data, the following variables were included: Age, Gender, Depression (yes or no), Number of Positive Moods Interpreted, Number of Negative Moods Interpreted, Discrepancies (between what the participants spent the most time viewing and what they thought they viewed the most), and lastly, Frequency of Art Consumption. AOIs were placed over prominent areas of each image, such as the eyes, mouth, background, and body. Age and Number of Discrepancies were left as ratio variables. Positive and Negative mood interpretations were recorded as 1 point for every positive or negative response. Frequency of Art Consumption was recoded so that "never" was 1, "rarely" was 2, "often" was 3, "very often" was 4 and "all the time" was 5. Gender was recoded

to males being 1 and females as 2. The data was then run through independent samples t-tests. This analysis provided the t-statistic for the differences in means between depressed and non-depressed individuals across all of the dependent variables and the significance levels of the differences.

4 RESULTS

To examine any potential differences in mood interpretations between depressed and non-depressed college students, two independent samples t-tests were conducted with a significance level of $\alpha = .05$ using the number of positive mood interpretations and the number of negative mood interpretations as the dependent variables, respectively. The average number of positive mood interpretations by non-depressed students (M = 2.56, SD = 1.01) was less than that of depressed students (M = 2.71, SD = 0.75); however, this difference was not statistically significant, $tt(14) = -0.24$, $p = 0.735$. The average number of negative mood interpretations by non-depressed students (M = 2.33, SD = 1.00) was greater than that of depressed students (M = 2.00, SD = 0.82); however, this difference was not statistically significant, $t(14) = 0.71$, $p = 0.487$. Overall, there is no difference in mood interpretations between depressed students and non-depressed students. Additionally, t-tests were run in an effort to discover differences between depressed and non-depressed college students' frequency of art consumption. The average frequency of art consumption by non-depressed participants (M = 3.22, SD = 1.48) was greater than that of depressed students (M = 3.14, SD = 1.21); however, this difference was not statistically significant, $t(14) = 0.11$, $p = 0.910$. Subsequently, an independent samples t-test was run to examine whether there was a difference in the number of discrepancies in what the students viewed between depressed and non-depressed college students. The average number of discrepancies by non-depressed students (M = 1.89, SD = 1.54) was greater than that of depressed students (M = 1.86, SD = 1.57); however, this difference was not statistically significant, $t(14) = 0.04$, $p = 0.968$. Lastly, independent sample t-tests were run to examine any differences due to gender; however, all analyses conducted yielded non-significant findings with $\alpha = .05$.

5 DISCUSSION

We hypothesized that participants with depressive symptoms would have a significantly lower number of positive mood interpretations and, conversely, a significantly higher level of negative mood interpretations. We also hypothesized that participants with depressive symptoms would have a significantly higher number of discrepancies in self-reported fixations. The results of the study do not support these hypotheses. While a clear difference may be expected, the study showed that there was nowhere near a significant difference between the two populations. The results only illustrate non-significant differences $t(14) = -0.24$, $p = 0.735$, $t(14) = 0.71$, $p = 0.487$ and $t(14) = 0.04$, $p = 0.968$ for positive and negative interpretations, as well as the number of discrepancies, respectively. Due to the limitations of this study, i.e., having only Clemson University students with no incentives for participation, the results could only show a fraction of the values in each population. If more participants were in the study, there could have been a larger, more significant difference between depressed and non-depressed students' responses and eye movements. The differences were well above the level of significance, meaning they were not significant. When running tests grouping participants by gender, the insignificant results further demonstrated the lack of differences in the dependent variables. The lack of significant findings in this study suggests that there are no differences in depressed and non-depressed college students' engagement and mood interpretation of artwork when measuring using an eye-tracker. Our results were greatly limited by participation. This study, although large enough to have a divided population (D and ND), only had 16 participants, which allows the data to be greatly impacted by one participant's scores. There was no incentive to participate in this study, so students may not have taken the survey seriously, which would have impacted the results. Seeing how there was no difference in any of the eight t-tests conducted, the limitations had a substantial impact on the results of the study.

6 CONCLUSION

The current study, despite its lack of significant findings, contributes to the sparsely researched area of eye movements in depressed and non-depressed students. Knowing the lack of differences in the measures provided indicates that either the limitations impacted the results or there are other factors that may impact eye movements. Further directions should explore the variables included in the current study more deeply and additional variables that influence eye movements. Some potential adjustments to the current study include using a greater number of participants, more AOIs to encapsulate all possible fixation points, more diverse works of art, and open-ended mood interpretation responses. Additionally, the findings indicate that if there is no true difference in eye movements between both populations, then the differences in experiences lie in the perception and interpretation of artwork as part of our cognitive processes.

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