Global Journal of Arts, Humanities and Social Sciences
Vol.10, No.8, pp.43-57, 2022
Print ISSN: 2052-6350(Print)
Online ISSN: 2052-6369(Online)

Analysis of Blink Data Behaviour Between Male and Female Adult Readers of English Text

Dr Louise Tooze
University of Wales, Trinity Saint David, Swansea

Citation: Louise Tooze (2022) Analysis of Blink Data Behaviour Between Male and Female Adult Readers of English Text, *Global Journal of Arts, Humanities and Social Sciences*, Vol.10, No.8, pp.43-57

ABSTRACT: *This study intended to clarify the ambiguity around gender differences during electronic English reading. Through determining a correlation amongst blink eye movement behaviour and gender. The study reviewed blink behaviour between 16 participants (n=11) male and (n=5) female participants during a silent electronic English reading task. Using a standardised white background and black font comprising three reading slides. Eye parameters measured were (i) blink count, (ii) blink duration and (iii) blink frequency. Despite previous literature published, it was found during this study that no significant results were reported amongst the two groups for the three parameters examined. This study contributes that gender does not correlate with blink behaviour during reading, therefore both groups responded the same when viewing the reading stimuli. Furthermore, it was also found that the format of material should be considered i.e., hardcopy vs electronic when conducting further research. As these, amongst other factors such as stress and fatigue are identified to influence blink behaviour in male and female readers. Further investigation into this area includes exploration into alternative cognitive eye movement parameters such as pupil diameter.*

KEYWORDS: gender differences, reading, blink behaviour, eye tracking

INTRODUCTION

At present, there are numerous investigative studies and conclusive research that attribute to the atypical eye movements observed amongst English readers. Specific differences include those observed amongst male and female counterparts. There is a long-standing debate surrounding the differences between male and females, specifically differences observed regarding behaviour. Historically, investigations amongst male and females have varied significantly. These studies have involved the measuring of processing speeds (Sternadori & Wise, 2010), emotions (Shoenfeld et al., 2012) and communication (Ford et al., 2013). Interest has been taken in the arena of cognitive abilities of males and females, with several studies attempting a distinguishment amongst the two (Bell et al., 2006), (Upadhayay & Guragain, 2014). It has been acknowledged that male and female brains differ both structurally and functionally (Koelsch et al., 2003). Subsequently, extensive research has taken place to measure brain and cognitive differences amongst male and females, though it has consistently identified mixed results. In favour of the differences, Ahmadlou et al., (2013), identified brain differences amongst male and female depressed patients. The study showed significant results in the relative convergences of EEG, between intra left and fronto left temporal lobes, revealing a difference in brain dynamic. In another study, by Koesch et al., (2003), it reviewed the auditory processing of music amongst male and female musicians. Both genders were played musical excerpts, where it was identified that early brain activity elicited by the stimuli was distributed different in females, being distributed bilaterally and localised to the right hemisphere in males. Therefore revealing that processing differences were present when auditory stimuli was played. An additional study by Kraus et al., (2000) investigated the outcome of male and female patients who has retained traumatic head injury. It was identified that females were 1.57 times more likely to experience poorer outcomes such as severe disability when compared to the male counterparts. Establishing patho-physiological differences amongst the genders. As evidenced, there are some observable differences amongst male and females, be it brain dynamic, auditory processing and patho-physiological differences. Given the varying advancements of research, coinciding with the differing results produced, there seems to be a lack of consistent agreement about male and female similarities and differences. Hence, the long-standing examination continues.

LITERATURE

Despite the continuous debate, there are many preconceived notions around male and females, specifically their academic and subject preferences. With one study identifying that females were found to be less likely to choose a STEM subject during study, and to perform less when compared to their male counterparts (Sarouphim & Chartouny, 2017). However, several studies have shown that there are minimal differences amongst genders, therefore discrediting previous accepted norms. Relating to behaviour and performance, Ardila et al., (2011) conducted a study that investigated performance amongst male and female children across several cognitive tasks, including verbal memory, visual learning and sensory perception. It was established that although differences were observed, gender accounted for a small percentage (1-3%) of variance. Furthermore, as part of a study by Núñez-Peña et al., (2016), it explored gender differences in students' grades in an open-question and a multiple-choice exam.

The results showed that female students did report higher levels of test anxiety than males, however no gender differences were observed in actual performance or final exam grade. Regarding academic achievement, the study identified that there was no difference amongst the genders, and both performed in parallel with each other. Likewise, Sarouphim et al., (2017) investigated gender differences in students' mathematics achievement and attitudes toward mathematics. The study was conducted using the Attitudes Toward Mathematics (ATM) scale, school records, and interviews with teachers. The results showed no significant gender differences in either achievement or attitudes toward mathematics. These results work towards disproving previous literature and perceptions of females in academic and educational environments. These findings are promising in the realm of gender studies and are progressively and consistently challenging previously published literature and beliefs.

A method to further investigate brain and cognitive differences in male and females is through eye tracking technology. Eye tracking (ET) is an unobtrusive and reliable method of collecting ocular metric data whilst being used to gain a deeper understanding of the processes and relationships between eye movement control and reading. The investigation into the eye movements of male and females have become a popular research area that is continuously gaining traction amongst researchers. There are numerous eye movement parameters that have been used to measure differences between male and females, namely fixation data, count, duration, frequency and regression count (Sargezeh et al., 2019). Less commonly parameter is blink behaviour and data (Sharafi et al., 2020). Blink behaviour is observed for many reasons, namely because it can provide moment to moment understanding of cognitive decisions and demands within the brain (McMonnies, 2020). In addition, blink behaviour alone can indicate levels of engagement, fatigue and stress levels (Zhan et al., 2016). Though usually, such finding has origin from transportation and medical sectors (Rodriguez., 2018) (Benedetto et al., 2011) (Zammarchi, 2021). To provide a definition, blink count is the number of blinks observed during a set period, duration is the length of the blink and frequency is the how often blinks were made (Zhan et al., 2016). Regarding communication and blink behaviour, a study by Ford et al., (2013) identified findings from a human-to-human Interaction experiment that examined human communicative non-verbal facial behaviour between male and females. It was found that female participants were found to blink twice as often as male participants and have a longer average blink duration.

This information is often used to gauge attention and difficulty of activities (Lallier & Valdois, 2012) (Hopstaken et al., (2015), for example reading. Blink behaviour is commonly used as an indicator of reading ability and difficulty (Zhan et al., 2016) identification of the presentation of text (Kang et al., 2009) and how the text is read be it out loud or silent (Jung et al., 2020). It has been identified that levels of engagement, time taken to read, and time spent on task are all indicators of reading difficulties and provide insight into how individuals interact with reading stimuli (Kunze et al., 2015). A study by Zhan et al., (2016) explained that online learners that have enhanced reading abilities usually have improved reading habits, thus blink-related indicators also have the power to identify reading ability. In addition to Zhan et al., (2016) other aspects have been known to affect eye movement behaviour amongst adults. Rayner, (1998) has contributed extensive literature in the field, that identifies that eye movements differ amongst dyslexic and non-dyslexic readers.

With dyslexic individuals exhibiting an 'erratic' eye movement profile during reading. It is imperative to distinguish if the differences observed during blink behaviour studies are correlated with gender or other various factors.

Relating specifically to blink behaviour, historically, it has been reported that air pollutants such as cigarette smoking has seen to increase blink frequency in participants (Ponder, 1927). Another study (Crevits et al., 2003) concluded that time of day and sleep deprivation had impact on the frequency of blinks in participants, with those making a higher blink frequency rate after a night of no sleep. Thus, providing insight into the behaviours and fatigue levels of individuals throughout the day. Regarding blink duration, it has been identified that substances such as alcohol and anaesthetic can affect duration, where it seems to affect cognitive state (De Waard, D., & Brookhuis, 1994).

Similar Works

Similar works surrounding this research area have been outlined and expanded. Kang et al., (2009) conducted a study that evaluated the usability of electronic books in contrast to a standardised book. Male and female reading speeds and fatigue levels were identified. Females were found to have better reading efficiency during reading, with higher speed and reduced accuracy errors. Females were also found to experience less eye fatigue when reading the e-book. This provides understanding into the presentation of the reading and the differences experienced amongst the two groups. A study by Zhan et al., (2019) reviewed eye movements amongst male and females during a digital reading task. It was identified that female readers had a higher blink count than the male counter parts. This study found that blink count was a suitable eye movement to use that was sensitive to gender attribute. Sforza et al., (2008) conducted a study where spontaneous eyelid movements were monitored in younger (20-30) and older males and female (over 50 years). Blink frequency was observed to be higher in females when compared to males. Bentivoglio et al., (1997) conducted a study that measured the normal blink rate (BR) variations in relation to behavioral tasks amongst males and female. The tasks included resting, reading quietly and talking freely. It was established that during the reading task, females had a higher blink frequency recorded when compared to male equivalents. With argument, that blink frequency can be influenced by cognitive processes that differs amongst tasks presented. Further research as shown by Abushara (2017), measured blink frequency for participants reading a text presented on an electronic device and a hard copy format. It was found that blink rate decreased as visual stress symptoms were present. Similarly, Argilés et al., (2015) studied participants to evaluate eye blink rate and percentage of incomplete blinks in different hard-copy and visual display reading conditions. When compared to baseline reading conditions, a decrease in blink rate was found when compared with baseline conditions to modified conditions (all $P < 0.001$). As evidenced, extensive progress has been made in the field of cognitive interaction concerning the topic of reading, however, there is still a mixed consensus regarding the reading behaviour of male and female adults.

METHODOLOGY

A total of 16 participants took part in the study, with all participants being unpaid volunteers. The participants were divided into two groups based on gender, the male group (n=11) and the female group (n=5). The choice of reading stimulus consisted of varying passages from the Adult Reading Tool (ART).

Created by Brooks et al., (2004), ART is a test that measures reading accuracy, reading comprehension, speed of reading and speed of writing using centile scores. The reading material was presented as PowerPoint slides, with standardized white background and black font. The stimulus comprised of the level 1 Health passage and consisted of 3 slides and consisted of 3 individual paragraphs. The stimuli were designed with a paragraph per slide.

An Applied Science Laboratories (ASL) D6 High Speed Eye Tracking system was used to record subject's eye movements at 120Hz.Analysis on oculomotor events were performed using the ASL Results Plus analysis package. A chin rest device was used to help secure the subjects' heads to improve the accuracy of the data recorded. The computer screen for displaying the stimulus was position approximately 24cm from the participant. Subjects were calibrated using ASL calibration software, based upon 9 points spread across the computer screen. Each subject was individually calibrated using right eye calibration. PowerPoint slides were displayed on a 19" flat panel monitor with a resolution of 1024 x 768 pixels. The experiment procedure within this research required the subjects to perform in a silent reading task from a computer screen. As the subjects read each slide their eye movements were recorded, and three ocular metrics were calculated: blink count, blink duration and blink frequency.

RESULTS

The summarised t-test results are shown in Table 1, Table 2 and Table 3. Table 1, display the t-test results performed from the male and female groups for slides 1-3. As seen in slide 1 for blink count, the p value of 2.144 is not <0.05 meaning there is not a statistical difference amongst the two groups. Furthermore, for slide 2 as evidenced in Table 2, the p value is reported as 2.306 and is not below the advised <0.05 therefore this is not a statistically significant result. As seen in Table 3 for slide 3, a p value of 2.144, is below the recommended <0.05 and hence not statistically significant.

t-Test: Two-Sample Assuming Unequal Variances		
	Male	*Female*
Mean	2.181818182	2
Variance	2.763636364	0.5
Observations	11	5
Hypothesized Mean Difference	0	
df	14	
t Stat	0.306785996	
P(T<=t) one-tail	0.381760896	
t Critical one-tail	1.761310136	
P(T<=t) two-tail	0.763521791	
t Critical two-tail	2.144786688	

Table 1 Blink Count Slide 1

t-Test: Two-Sample Assuming Unequal Variances		
	Male	*Female*
Mean	2.636364	2.2
Variance	3.054545	2.7
Observations	11	5
Hypothesized Mean Difference	0	
df	8	
t Stat	0.482564	
P(T<=t) one-tail	0.321166	
t Critical one-tail	1.859548	
P(T<=t) two-tail	0.642332	
t Critical two-tail	2.306004	

Table 2 Blink Count Slide 2

t-Test: Two-Sample Assuming Unequal Variances		
	Male	*Female*
Mean	3.818181818	2.6
Variance	8.563636364	1.3
Observations	11	5
Hypothesized Mean Difference	0	
df	14	
t Stat	1.195380785	
P(T<=t) one-tail	0.125897351	
t Critical one-tail	1.761310136	
P(T<=t) two-tail	0.251794703	
t Critical two-tail	2.144786688	

Table 3 Blink Count Slide 3

Illustrated in Figure 1, it appears that despite no statistical differences observed amongst the male and female groups, consistently the male group had a higher blink count throughout. In addition, there is a sharp incline in the mean number of blinks from the male group for slide 3.

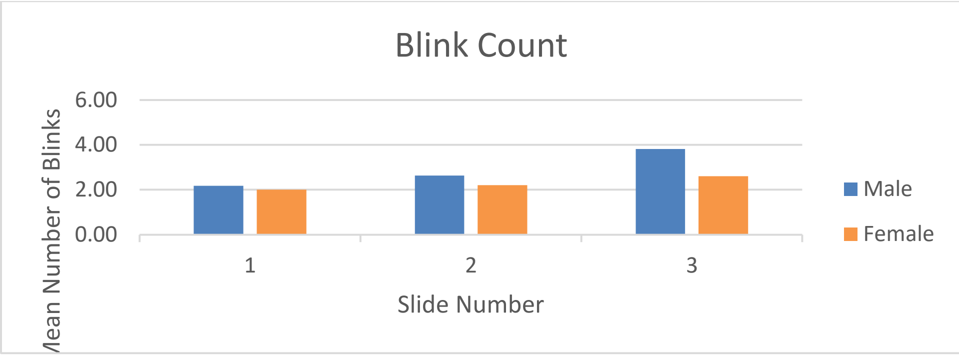

Figure 1 Blink Count Mean Differences between Male and Female

Exemplified for blink duration, Table 4, illustrates the t-test results performed from the male and female groups for reading slides 1-3. As seen in slide 1 this eye parameter, the p value of 2.228 is higher than <0.05 signifying there is not a statistical difference between the two groups. Additionally, in slide 2 as evidenced in Table 5, the p value is reported as 2.364, consequently it is not statistically significant. Evidenced in Table 3 for slide 3, a p value of 2.570, and hence not statistically significant.

t-Test: Two-Sample Assuming Unequal Variances		
	Male	*Female*
Mean	0.146363636	0.23
Variance	0.012445455	0.00815
Observations	11	5
Hypothesized Mean Difference	0	
df	10	
t Stat	-1.591585933	
P(T<=t) one-tail	0.071281021	
t Critical one-tail	1.812461123	
P(T<=t) two-tail	0.142562042	
t Critical two-tail	2.228138852	

Table 4 Blink Duration Slide 1

t-Test: Two-Sample Assuming Unequal Variances		
	Male	*Female*
Mean	0.172727	0.256
Variance	0.010002	0.01398
Observations	11	5
Hypothesized Mean Difference	0	
df	7	
t Stat	-1.36802	
P(T<=t) one-tail	0.106799	
t Critical one-tail	1.894579	
P(T<=t) two-tail	0.213598	
t Critical two-tail	2.364624	

Table 5 Blink Duration Slide 2

t-Test: Two-Sample Assuming Unequal Variances		
	Male	*Female*
Mean	0.189090909	0.182
Variance	0.001709091	0.00732
Observations	11	5
Hypothesized Mean Difference	0	
df	5	
t Stat	0.176209216	
P(T<=t) one-tail	0.433522114	
t Critical one-tail	2.015048373	
P(T<=t) two-tail	0.867044228	
t Critical two-tail	2.570581836	

Table 6 Blink Duration Slide 3

Print ISSN: 2052-6350(Print)
Online ISSN: 2052-6369(Online)

Figure 2 indicates that regardless of no statistical differences observed amongst the male and female groups, in contrast to blink count, the female group had a higher blink duration on slide 1 and slide 2. Except for slide 3 where the male group had a higher blink duration. In addition, there is a sharp incline in the mean number of blinks from the female group for slides 1 and 3 when compared to the male.

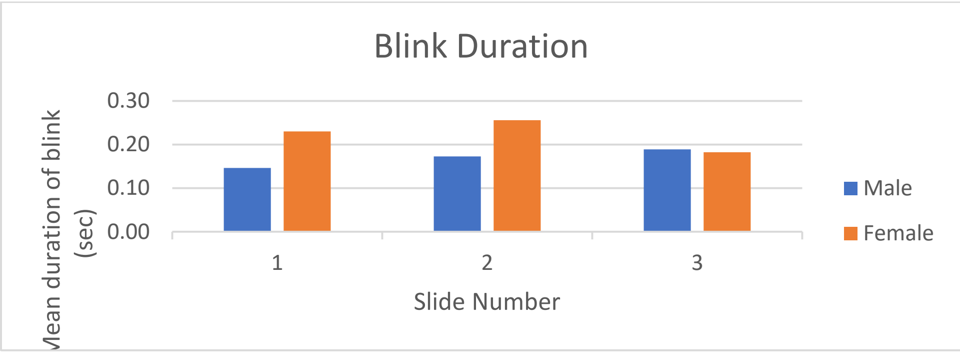

Figure 2 Blink Duration Mean Differences between Male and Female

For blink frequency Table 7 demonstrates the t-test results performed from the male and female groups for reading slides 1-3. Evidenced in slide 1 the p value of 2.262 is provided, which is higher than <0.05. Therefore, signifying there is not a statistical difference between the two groups for this slide. Moreover, in slide 2 as evidenced in Table 8, the p value is reported as 2.364 which is not below the recommended <0.05, therefore it is not statistically significant. Shown in Table 9 for slide 3, a p value of 2.262, and hence not statistically significant.

t-Test: Two-Sample Assuming Unequal Variances		
	Male	*Female*
Mean	0.138818182	0.1482
Variance	0.011886564	0.008167
Observations	11	5
Hypothesized Mean Difference	0	
df	9	
t Stat	-0.180088987	
P(T<=t) one-tail	0.43053618	
t Critical one-tail	1.833112933	
P(T<=t) two-tail	0.861072359	
t Critical two-tail	2.262157163	

Table 7 Blink Frequency Slide 1

t-Test: Two-Sample Assuming Unequal Variances		
	Male	*Female*
Mean	0.214364	0.186
Variance	0.02057	0.029154
Observations	11	5
Hypothesized Mean Difference	0	
df	7	
t Stat	0.323218	
P(T<=t) one-tail	0.377986	
t Critical one-tail	1.894579	
P(T<=t) two-tail	0.755971	
t Critical two-tail	2.364624	

Table 8 Blink Frequency Slide

t-Test: Two-Sample Assuming Unequal Variances		
	Male	*Female*
Mean	0.188090909	0.1534
Variance	0.015947691	0.0132238
Observations	11	5
Hypothesized Mean Difference	0	
df	9	
t Stat	0.542141418	
P(T<=t) one-tail	0.300442225	
t Critical one-tail	1.833112933	
P(T<=t) two-tail	0.600884449	
t Critical two-tail	2.262157163	

Table 9 Blink Frequency Slide 3

Figure 3 shows that despite no statistical differences observed amongst the male and female groups, like blink count and blink duration there is mixed trends observed within the results. The male group had a higher blink frequency on slide 2 and slide 3. Except for slide 1 where the female group had a higher blink frequency.

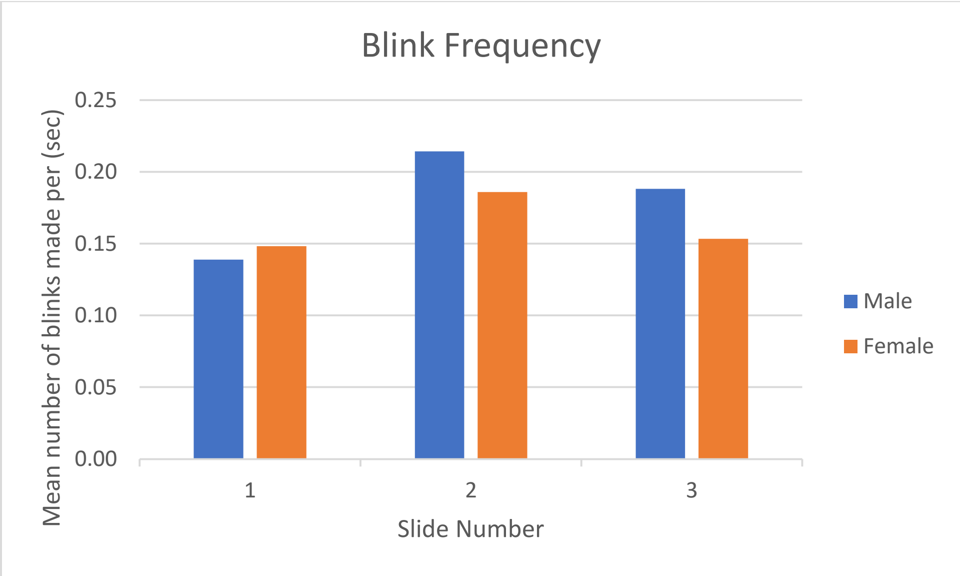

Figure 3 Blink Frequency Mean differences between Male and Female

DISCUSSION

From the results of this study, it was identified that for the eye parameters; blink count, duration and frequency there were no statistically significant results observed between male and female groups during the electronic reading task. Despite fluctuations throughout the three reading slides, there was not a consensus of a trend, with both male and females producing mixed results. For blink count, it was observed that males had a higher mean when compared to females, which was consistent across all three slides. This observation albeit not significant, contrasts with the work of Zhan et al., (2019) and Sforza et al., (2008), where it was identified that females tend to have a higher blink count than males during reading. As seen in blink duration, this also contrasted, with the female group having a higher mean duration for slides 1 and 2. This observation is in line with work of Ford et al., (2004) where a longer blink duration was identified in female readers.

Reflected in blink frequency, it was evident that mixed observations were present where both male and female had higher mean frequency count throughout. However, the findings contrast with the work of Bentivoglio et al., (1997), where a higher blink frequency was observed in females during reading. Despite no statistical differences reported amongst the two groups, care should be taken when observing male and female readers as it is evident from the study that blink behaviour can fluctuate amongst the groups. Although in this instance a standardized white background and black font was used, in agreement with Kang et al., (2009) there are variation amongst male and female reading behaviour data, however this may not necessarily attribute to statistically significant difference. As outlined be Zhan et al., (2016) differences in observations and fluctuations throughout could be attributed to other factors such as fatigue, stress and engagement levels. Consideration also must be given to the presentation of the text within this study, where electronic format was provided. As a comparison amongst formats was beyond the scope of this study, in line with the work of Argilés et al., (2015) it is important to consider the format of which the reading stimuli was presented.

IMPLICATION TO RESEARCH AND PRACTICE

In line with the findings of this study, it aimed to confront current perspectives about male and female cognitive behaviour during reading. Several studies previously reported significant difference amongst the two groups, however this study evidenced no difference. Considering the result from this research it demonstrates that further investigation in the field is required to gain a unanimous result on male and female blink behaviour during reading. Furthermore, the findings update the outdated perspectives of male and female performance and academic preferences to provide a unified understanding. It narrows the difference amongst male and females providing an equal bearing for reading tasks, through raising emphasis on other aspects not considered in this research such as learning differences, fatigue and stress levels which provide crucial information on factors that can affect cognitive ability and responses.

CONCLUSION

Previous research has identified that blink behaviour was based on physiological and functional responses within the brain. However, current literature has steadily identified that cognitive aspects can be attributed to blink behaviour, such as time of day, fatigue and stress levels. In line with recent developments, this study contributes that gender differences amongst males and females do not impact blink behaviour during electronic reading. A significant difference was not observed throughout the eye parameters: blink count, duration and fixation. Therefore, determining no correlation amongst blink behaviour differences between male and females.

The findings partially consolidate and contrast with the previous works of blink behaviour observed between male and female readers. Although it is understood that further investigation is needed to substantiate such claims. Outside of the eye parameters reviewed, it has also been discovered that external variables such as fatigue, stress can impact blink behaviour for readers which should be taken into consideration. It is recognized that a limitation to this study is sample size, due to its limited size is not a representative of the true male and female reader population. Therefore, is it advised that a large sample size is used when conducting similar research. Furthermore, researchers should seek out a balanced representative of the groups, as in this instance there were more males than females. To extend this work, it has been established that blink behaviour data in individuals can be affected by other factors, which require their own set of investigations and associations.

Print ISSN: 2052-6350(Print)
Online ISSN: 2052-6369(Online)

FUTURE RESEARCH

This works builds on the current foundations and knowledge of the blink behaviour between male and females during electronic English reading. As stated, further investigation is needed to investigate trends of behaviour observed amongst male and female groups in this study, in addition to the consideration of variables such as stress, engagement levels and fatigue. In addition, it should be identified whether the individual has learning or reading disabilities which may impact the eye movements. To extend this study, further work needs to be conducted using a larger reading stimulus to ensure maximum eye movement data is recorded, in addition to the level of difficulty of the task.

Capturing this data can provide insights into the involuntary eye movement behaviours male and females perform when faced with challenging or difficult reading tasks. Consideration should be given with the format of reading stimuli as this has been confirmed to affect blink behaviour amongst genders. Consequently, a comparative study ought to be conducted to ensure that the results obtained are consistent amongst format types. Additionally, further inquiry into this research area includes exploration into alternative cognitive eye movement parameters. An example being pupil diameter that has been evidenced as a promising indicator of cognitive behaviour. Further insight into the cognitive processes during reading can provide a reliable indicator of differences amongst male and female readers.

ACKNOWLEDGEMENTS

The authors would like to extend gratitude to University of Wales Trinity Saint David for the use of the equipment and facilities, and to all individuals who participated in this study.

REFERENCES

Abusharha, A. A. (2017). Changes in blink rate and ocular symptoms during different reading tasks. Clinical optometry, 9, 133. https://doi.org/10.2147/OPTO.S142718

Ahmadlou, M., Adeli, H., & Adeli, A. (2013). Spatiotemporal analysis of relative convergence of EEGs reveals differences between brain dynamics of depressive women and men. Clinical EEG and neuroscience, 44(3), 175-181.

Ardila, A., Rosselli, M., Matute, E., & Inozemtseva, O. (2011). Gender differences in cognitive development. Developmental psychology, 47(4), 984.

Argilés, M., Cardona, G., Pérez-Cabré, E., & Rodríguez, M. (2015). Blink rate and incomplete blinks in six different controlled hard-copy and electronic reading conditions. *Investigative ophthalmology & visual science*, *56*(11), 6679-6685.

Argyle, E. M., Marinescu, A., Wilson, M. L., Lawson, G., & Sharples, S. (2021). Physiological indicators of task demand, fatigue, and cognition in future digital manufacturing environments. *International Journal of Human-Computer Studies*, *145*, 102522. https://doi.org/10.1016/j.ijhcs.2020.102522

Bell, E. C., Willson, M. C., Wilman, A. H., Dave, S., & Silverstone, P. H. (2006). Males and females differ in brain activation during cognitive tasks. Neuroimage, 30(2), 529-538.

Benedetto, S., Pedrotti, M., Minin, L., Baccino, T., Re, A., & Montanari, R. (2011). Driver workload and eye blink duration. Transportation research part F: traffic psychology and behaviour, 14(3), 199-208. https://doi.org/10.1016/j.trf.2010.12.001

Bentivoglio, A. R., Bressman, S. B., Cassetta, E., Carretta, D., Tonali, P., & Albanese, A. (1997). Analysis of blink rate patterns in normal subjects. Movement disorders, 12(6), 1028-1034.

Brooks, P., Everatt, J., & Fidler, R. (2004). Adult Reading Test (ART). Roehampton: Roe-hampton University of Surrey.

Crevits, L., Simons, B., & Wildenbeest, J. (2003). Effect of sleep deprivation on saccades and eyelid blinking. European neurology, 50(3), 176-180.

De Waard, D., & Brookhuis, K. A. (1996). The measurement of drivers' mental workload.

Ford, C. C., Bugmann, G., & Culverhouse, P. (2013). Modeling the human blink: A computational model for use within human–robot interaction. International Journal of Humanoid Robotics, 10(01), 1350006.

Hopstaken, J. F., Van Der Linden, D., Bakker, A. B., & Kompier, M. A. (2015). The window of my eyes: Task disengagement and mental fatigue covary with pupil dynamics. Biological psychology, 110, 100-106. https://doi.org/10.1016/j.biopsycho.2015.06.013

Jung, T., Kim, S., & Kim, K. (2020). Deepvision: Deepfakes detection using human eye blinking pattern. IEEE Access, 8, 83144-83154.

Kang, Y. Y., Wang, M. J. J., & Lin, R. (2009). Usability evaluation of e-books. Displays, 30(2), 49-52.

Koelsch, S., Maess, B., Grossmann, T., & Friederici, A. D. (2003). Electric brain responses reveal gender differences in music processing. Neuroreport, 14(5), 709-713.

Kraus, J. F., Peek-Asa, C., & McArthur, D. (2000). The independent effect of gender on outcomes following traumatic brain injury: a preliminary investigation. Neurosurgical focus, 8(1), 1-7.

Kunze, K., Masai, K., Inami, M., Sacakli, Ö., Liwicki, M., Dengel, A., ... & Kise, K. (2015, September). Quantifying reading habits: counting how many words you read. In *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (pp. 87-96).

Lallier, M., & Valdois, S. (2012). Sequential versus simultaneous processing deficits in developmental dyslexia. Dyslexia-a comprehensive and international approach, 73-108. https://doi.org/10.5772/39042

McMonnies, C. W. (2020). The clinical and experimental significance of blinking behavior. *Journal of Optometry*, *13*(2), 74-80.

Núñez-Peña, M. I., Suárez-Pellicioni, M., & Bono, R. (2016). Gender differences in test anxiety and their impact on higher education students' academic achievement. Procedia-Social and Behavioral Sciences, 228, 154-160.

Ponder, E., & Kennedy, W. P. (1927). On the act of blinking. *Quarterly journal of experimental physiology: Translation and integration*, *18*(2), 89-110.

Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. Psychological bulletin, 124(3), 372.

Rodriguez, J. D., Lane, K. J., Ousler III, G. W., Angjeli, E., Smith, L. M., & Abelson, M. B. (2018). Blink: characteristics, controls, and relation to dry eyes. Current Eye Research, 43(1), 52-66. https://doi.org/10.1080/02713683.2017.1381270

Sargezeh, B. A., Tavakoli, N., & Daliri, M. R. (2019). Gender-based eye movement differences in passive indoor picture viewing: An eye-tracking study. *Physiology & behavior*, *206*, 43-50.

Sarouphim, K. M., & Chartouny, M. (2017). Mathematics education in Lebanon: Gender differences in attitudes and achievement. Educational studies in mathematics, 94(1), 55-68.

Schoenfeld, E. A., Bredow, C. A., & Huston, T. L. (2012). Do men and women show love differently in marriage?. Personality and Social Psychology Bulletin, 38(11), 1396-1409.

Sforza, C., Rango, M., Galante, D., Bresolin, N., & Ferrario, V. F. (2008). Spontaneous blinking in healthy persons: an optoelectronic study of eyelid motion. Ophthalmic and Physiological Optics, 28(4), 345-353.

Sharafi, Z., Sharif, B., Guéhéneuc, Y. G., Begel, A., Bednarik, R., & Crosby, M. (2020). A practical guide on conducting eye tracking studies in software engineering. *Empirical Software Engineering*, *25*(5), 3128-3174.

Sternadori, M. M., & Wise, K. (2010). Men and women read news differently: The effects of story structure on the cognitive processing of text. Journal of Media Psychology: Theories, Methods, and Applications, 22(1), 14.

Upadhayay, N., & GUraGaiN, S. (2014). Comparison of cognitive functions between male and female medical students: a pilot study. Journal of clinical and diagnostic research: JCDR, 8(6), BC12.

Zammarchi, G., & Conversano, C. (2021). Application of eye tracking technology in medicine: a bibliometric analysis. *Vision*, *5*(4), 56.

Zhan, Z., Wu, J., Mei, H., Fong, P. S., Huang, M., & Shao, F. (2019, March). Gender differences in eye movements during online reading. In International Conference on Technology in Education (pp. 235-243). Springer, Singapore.

Zhan, Z., Zhang, L., Mei, H., & Fong, P. S. (2016). Online learners' reading ability detection based on eye-tracking sensors. Sensors, 16(9), 1457. https://doi.org/10.3390/s16091457