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Impact of Font Type on Blink Rates and Reading Errors: A Comparative Study of Times New Roman and Verdana in Secondary School Students

Nisha Arya[1], Shilpi Saraswat[2] and Sudhanand Prasad Lal[3]*

[1]*Ph.D. Research Scholar, Department of Family and Community Resource Management, Faculty of Family and Community Science, The Maharaja Sayajirao University of Baroda, Vadodara (Gujarat), India.*
[2]*Assistant Professor, Department of Family and Community Resource Management, Faculty of Family and Community Science, The Maharaja Sayajirao University of Baroda, Vadodara (Gujarat), India.*
[3]*Assistant Professor cum-Scientist & Co-PI AICRP-WIA, Department of Agricultural Extension Education, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur (Bihar), India.*

(Corresponding author: Nisha Arya)*
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ABSTRACT: In today's digital world, font design plays a crucial role in influencing reading efficiency and cognitive ease. This study explores the impact of font type (Times New Roman and Verdana) and line spacing (1.15 and 1.5) on reading errors and blink rates among 30 secondary school students (mean age 14). Blink rates were measured using the SMI RED eye-tracking system, and reading errors were manually recorded to assess cognitive load and ocular comfort. Times New Roman with 1.15 pt line spacing resulted in a mean reading error rate of 2.90 and 11.53 blinks per minute, while 1.5 pt spacing increased errors (3.20) but reduced blink rates (9.57). Verdana with 1.15 pt spacing showed a lower error rate (1.90) and 11.87 blinks, while 1.5 pt spacing further reduced errors (1.37) but increased blinks (12.37). There were significant correlations between blink rates and reading errors for Times New Roman at both spacings (r = 0.509, p = 0.004 for 1.15 pt; r = 0.419, p = 0.021 for 1.5 pt). For Verdana, significant correlations were found at 1.15 pt line spacing (r = 0.372, p = 0.043), while at 1.5 pt line spacing, (r = 0.332, p = 0.073). Verdana consistently reduced reading errors, suggesting its role in improving visual comfort. This study emphasizes the importance of font and spacing choices for readability, with Verdana at 1.5 pt offering the best performance. Future studies should expand the scope to other fonts and tasks to enhance understanding of text presentation's impact on reading and ocular health.

Keywords: Blink rates, Cognitive load, Font design, Ocular comfort, Reading errors, Reading performance.

INTRODUCTION

Reading is a fundamental cognitive task that relies on a combination of visual perception and mental processing. However, the process of reading is not merely a cognitive task; it also involves complex ocular mechanics, including blinking, which plays a critical role in maintaining visual comfort and clarity. Various factors, including text formatting, environmental conditions, and physiological responses such as blink rates, can significantly influence reading efficiency. Blinking is crucial in maintaining eye health by lubricating the cornea and clearing debris from the eye surface, ensuring visual comfort and clarity. Blink rates, which can vary significantly based on various factors such as cognitive load and text presentation, have been shown to influence reading performance and error rates (Abusharha, 2020; Ghosh & Chakraborty 2022).

Recent studies suggest that different font types, such as Times New Roman and Verdana, may affect both the ease of reading and the frequency of blink rates, potentially leading to variations in reading errors (Kwon & Kim 2023; Lee & Kim 2020). Research indicates that decreased blink rates during reading tasks can lead to ocular discomfort and increased errors, particularly in prolonged reading sessions (Rosenfield *et al.,* 2020; Sweeney & O'Connor 2023). However, blink frequency tends to decrease during visually demanding tasks like reading, particularly on digital screens, which can negatively impact visual performance and lead to reading errors (Patel & Grayson 2021). Despite a growing body of research on factors such as font size, screen brightness, and contrast, the interaction between blink rates and font types remains an underexplored yet critical area. Blink rates naturally decline during reading tasks, especially on digital screens, resulting in increased ocular dryness and discomfort, which can subsequently lead to more frequent reading errors. In this context, font choice plays an equally important role in reading performance. Serif fonts, such as Times New Roman, are traditionally

used in print media but require greater cognitive effort due to their dense design, particularly when used on digital platforms. In contrast, sans-serif fonts like Verdana are specifically designed for digital readability and ease of legibility (Zhang & Liu 2020). The differences in the visual structure of these fonts can influence both blink frequency and reading errors, with the potential for fonts designed for specific media to reduce visual strain and improve reading accuracy.

The interaction between blink rates and font type is vital in understanding how readers process information, particularly in digital environments. During reading tasks, suppressed blink rates are often observed, and this phenomenon may be exacerbated when fonts like Times New Roman, which are not optimized for screens, are used (Walker & Wang 2022). As a result, Times New Roman, although effective in print media, can cause greater visual strain and lead to increased reading errors due to decreased blink frequency and heightened cognitive load (Smith & Hocking, 2021). On the other hand, Verdana, with its design tailored for digital screens, may help reduce the negative effects of reduced blinking, resulting in fewer errors and improved reading comfort (Santos & Cooper 2020).Several studies support the notion that blink rates and visual fatigue are closely correlated with font legibility. Research by Geller and Pohl (2021) indicates that readers using Verdana reported fewer instances of visual discomfort and exhibited more consistent blink patterns compared to those using Times New Roman. This finding aligns with the hypothesis that blink rate suppression is more pronounced when reading fonts with less legibility on digital screens. Verdana's wider spacing and rounded characters reduce cognitive load, thus maintaining a more regular blink rate and minimizing errors (Roberts & Freeman 2023).

As digital reading becomes increasingly prevalent in educational, professional, and recreational settings, understanding the relationship between blink rates, font types, and reading errors is crucial. This study seeks to explore how blink rates influence reading errors in texts presented in Times New Roman versus Verdana fonts. By investigating this interaction, the research aims to provide insights that can inform the design of more accessible and efficient reading materials across various platforms (Han & Chu 2020; Taylor & Grant 2022). The findings are expected to offer practical applications for educators, content creators, and interface designers striving to enhance readability and reduce visual fatigue. With this framework, the presentation was conducted to assess the impact of blink rates on reading errors while students read text presented in Times New Roman and Verdana fonts. This study helps to understand the influence of font type on reading performance and ocular comfort.

MATERIALS AND METHODS

The research utilized a task-based experimental design to evaluate the impact of various font types on reading performance and ocular comfort. This design integrated aspects of quasi-experimental, ex post facto, and experimental research methodologies, as discussed in previous studies (Lal & Samadder 2020; Srivastava & Lal 2021; Kumar *et al.,* 2022; Shukla *et al.,* 2022; Lal *et al*., 2023; Srivastava *et al.,* 2023), with a primary emphasis on an ex post facto design for the current study. The research adhered to stringent ethical standards, including obtaining informed consent, maintaining confidentiality, and ensuring voluntary participation, as outlined by Lal and Samadder (2020). The locale of study was the Ergonomics Division Lab, ICMR-NIOH Ahmedabad Gujarat. The sample comprised 30 secondary school students of Ahmedabad city, evenly divided by gender (15 female and 15 male) and with a mean age of 14, drawn randomly from two schools to ensure a diverse demographic and educational background. Participants were required to have normal vision with no known visual impairments, and consent was obtained from both students and their guardians by ethical guidelines.

Materials and Instruments: The study utilized two font types: Times New Roman (serif) and Verdana (sans-serif). Times New Roman, characterized by its formal and traditional appearance, is frequently used in print, whereas Verdana, designed for digital readability with wider letter spacing, is intended for enhanced clarity (Pugh & Karp 2022; Kwon & Kim 2023). Four reading passages, each approximately 200 words in length, were created—two in Times New Roman and two in Verdana—ensuring equivalence in difficulty, topic, and length. Participants read these passages displayed on a computer screen, with each passage assigned a one-minute reading period. Blink rates were recorded using the SMI RED Eye-Tracking System, and reading errors, including skipped words, misread words, and incorrect pronunciations, were manually documented by the researcher. Each participant completed reading tasks in both fonts, with the order of presentation counterbalanced to mitigate sequencing effects. A brief inter-task break was provided to reduce eye fatigue.

Data Collection and Analysis: Blink rates (blinks per minute) and reading errors were measured for both font types in a controlled environment to limit external influences. Following the reading tasks, participants completed a questionnaire to gauge their subjective comfort with each font. Data were analyzed using SPSS software version 27.0.1.0, employing statistical tools such as mean, standard error, standard deviation, variance, and kurtosis (Lal *et al.,* 2023; Gupta *et al*., 2023). Descriptive statistics were used to summarize blink rates and reading errors. Correlation analysis explored the relationship between blink rates and

reading errors, while non-parametric tests compared subjective comfort ratings to evaluate perceived ease of reading between the two fonts.

RESULTS AND DISCUSSIONS

The results section of this study objectively presents the primary findings derived from the data collection and analysis. Quantitative data were systematically reported, highlighting the key results in a logical sequence. Each finding is accompanied by an interpretation and discussion to provide a comprehensive understanding of the outcomes.

Table 1: Descriptive Statistics for Reading Errors and Blink Rates of Font Type: Times New Roman and Verdana Font with line spacing 1.15 pt and 1.5pt.

Variables	N	Range	Min.	Max.	Sum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
a. READING RATE													
RE TNR 1.15	30	12	0	12	87	2.90	.562	3.078	9.472	1.606	.427	2.505	.833
RE TNR 1.5	30	16	0	16	96	3.20	.788	4.318	18.648	1.706	.427	2.051	.833
RE V 1.15	30	12	0	12	57	1.90	.451	2.468	6.093	2.555	.427	8.969	.833
RE V 1.5	30	11	0	11	41	1.37	.506	2.773	7.689	2.659	.427	6.956	.833
b. BLINK RATE													
BR TNR 1.15	30	51	0	51	346	11.53	2.327	12.746	162.464	1.399	.427	1.623	.833
BR TNR 1.5	30	32	0	32	287	9.57	1.479	8.101	65.633	1.237	.427	1.002	.833
BR V 1.15	30	38	0	38	356	11.87	2.112	11.566	133.775	1.091	.427	.098	.833
BR V 1.5	30	42	0	42	371	12.37	2.081	11.397	129.895	1.148	.427	.725	.833

BR- Blink Rate, RE- Reading Rate, TNR- Times New Roman, V- Verdana, 1.15 pt and 1.5pt is line spacing

Regarding reading errors, Table 1 presents Verdana that consistently demonstrated better performance, with fewer errors observed in both line spacings. The fewest errors occurred with Verdana at 1.5 line spacing (M = 1.37, SD = 0.506), indicating that this combination minimizes reading difficulties. Conversely, Times New Roman was associated with higher reading errors, particularly at 1.5 line spacing (M = 3.20, SD = 0.788), suggesting that its more complex design contributes to greater cognitive load and reading challenges.

In terms of blink rates, Verdana exhibited slightly higher blink rates, particularly at 1.5 line spacing (M = 12.37, SD = 2.081), compared to Times New Roman (M = 9.57, SD = 1.479). While increased blink rates can indicate higher visual discomfort, the overall reduction in reading errors with Verdana suggests that it provides better readability and reduces cognitive strain despite slightly elevated blink rates. The Times New Roman, on the other hand, showed lower blink rates at 1.5 line spacing, but this reduction did not correspond to an improvement in reading performance, as reading errors remained higher. Therefore, Verdana at 1.5 line spacing was found to be the most effective combination for reducing reading errors, suggesting enhanced readability and visual comfort. Although blink rates were somewhat higher with Verdana, the reduction in reading errors points to its superiority in promoting efficient reading performance. Times New Roman, with its higher error rates and variability, appears to be less optimal for reading tasks, regardless of line spacing. These findings emphasize the importance of selecting fonts and line spacings that balance reading efficiency with ocular comfort, with Verdana at 1.5 line spacing emerging as the preferred choice for optimizing both.

Research supports these findings, as Verdana's simpler letterforms reduce cognitive load and reading errors (Kwon & Kim 2023), while Times New Roman's complex design increases visual strain and blink rates (Pugh & Karp 2022). Increased blink rates in Times New Roman suggest higher visual discomfort, aligning with Rosenfield *et al.* (2020), who found that reduced blink rates correlate with ocular discomfort and reading errors.

Table 2: Correlations Between Blink Rate and Reading Errors for Times New Roman Fonts at Line Spacing of 1.15 pt and 1.5 pt.

Variables	Statistics	RE TNR 1.15	BR TNR 1.15
RE TNR 1.15	Pearson Correlation	1	.509**
	Sig. (2-tailed)	-	.004
	Sum of Squares and Cross-products	274.700	578.600
	Covariance	9.472	19.952
	N	30	30
Variables	**Statistics**	**RE TNR 1.5**	**BR TNR 1.5**
RE TNR 1.5	Pearson Correlation	1	.419**
	Sig. (2-tailed)	-	.021
	Sum of Squares and Cross-products	540.800	424.600
	Covariance	18.648	14.641
	N	30	30

***. Correlation is significant at the 0.01 level (2-tailed)
**. Correlation is significant at the 0.05 level (2-tailed)
*. Correlation is significant at the 0.10 level (2-tailed)
BR- Blink Rate, RE- Reading Rate, TNR- Times New Roman, V- Verdana, 1.15 pt and 1.5 is line spacing

A lucid examination of Table 2 presents a moderate positive correlation observed between Reading Error (RE) and Blink Rate (BR) when the text was formatted with Times New Roman at 1.15 pt line spacing, with a Pearson correlation coefficient of 0.509. This correlation was statistically significant at the 0.01 level ($p = 0.004$), indicating that as the blink rate increased, reading efficiency also tended to increase under these conditions. The significance level suggests a less than 1% probability that this correlation occurred by chance, demonstrating a meaningful relationship between the two variables. Similarly, a moderate positive correlation ($r = 0.419$) was found between RE and BR for text with 1.5 pt line spacing. However, this correlation was weaker compared to the 1.15 pt spacing and was significant at the 0.05 level ($p = 0.021$), indicating a less robust but still significant relationship. The weaker correlation and higher p-value imply that the influence of blink rate on reading efficiency was less pronounced with wider line spacing. Overall, the findings suggest that the correlation between blink rate and reading efficiency is stronger and more significant with tighter line spacing (1.15 pt), potentially indicating that blink rate plays a more critical role in reading performance under such conditions.

Previous studies have similarly highlighted the relationship between reading difficulty and ocular adjustments. Rosenfield *et al.* (2020) found that reduced blink rates during reading tasks are often associated with visual discomfort and increased reading errors. The current study extends this understanding by demonstrating that with Times New Roman, a more complex and formal font, higher reading errors correlate with increased blink rates, which may be a compensatory mechanism to manage visual strain. Conversely, simpler fonts like Verdana, which are designed for better readability and reduced cognitive load, typically result in fewer reading errors and lower blink rates (Kwon & Kim, 2023). The findings from this study support this notion, as Verdana was associated with lower mean reading errors and blink rates compared to Times New Roman. This suggests that font design significantly influences reading efficiency and visual comfort, reinforcing the importance of selecting appropriate fonts for optimal reading performance.

Table 3: Correlations Between Blink Rate and Reading Errors for Verdana at Line Spacings of 1.15 pt and 1.5 pt.

Variable	Statistics	RE V 1.15	BR V 1.15
RE V 1.15	Pearson Correlation	1	.372**
	Sig. (2-tailed)	-	.043
	Sum of Squares and Cross-products	176.700	307.600
	Covariance	6.093	10.607
	N	30	30
Variable	**Statistics**	**RE V 1.5**	**BR V 1.5**
RE V 1.5	Pearson Correlation	1	.332*
	Sig. (2-tailed)	-	.073
	Sum of Squares and Cross-products	222.967	303.967
	Covariance	7.689	10.482
	N	30	30
***. Correlation is significant at the 0.01 level (2-tailed) **. Correlation is significant at the 0.05 level (2-tailed) *. Correlation is significant at the 0.10 level (2-tailed) BR- Blink Rate, RE- Reading Rate, TNR- Times New Roman, V- Verdana, 1.15 pt and 1.5 is line spacing			

Table 3 presents the correlation analysis between blink rate (BR) and reading errors (RE) for Verdana font at two different line spacings: 1.15 pt and 1.5 pt. For Verdana at 1.15 pt line spacing, a moderate positive correlation was observed between BR and RE, with a Pearson correlation of 0.372, which was statistically significant at the 0.05 level ($p = 0.043$). This suggests that as the blink rate increased, the number of reading errors also increased, indicating that higher visual strain may be associated with more frequent reading errors when using this font and line spacing.

In contrast, for Verdana with 1.5 pt line spacing, the correlation between reading errors (RE) and blink rate (BR) was moderately positive ($r = 0.332$) and significant at the 0.10 level ($p = 0.073$; sig. at 10%). This indicates that the relationship between blink rate and reading errors was moderately evident at wider line spacing, suggesting that increased spacing may reduce the impact of blink rate on reading performance. The findings indicated that tighter line spacing in Verdana results in a stronger association between visual strain (as indicated by blink rate) and reading errors, whereas wider line spacing diminishes this effect. Additionally, the table shows a significant positive correlation between reading rate and blink rate when using Verdana font size 1.15 with line spacing 1.15.

This finding aligns with prior research highlighting that increased reading errors often correlate with higher blink rates, regardless of font type. For instance, Rosenfield *et al.* (2020) observed that reading tasks causing greater visual strain are associated with reduced blink rates, suggesting that ocular discomfort can

prompt increased blinking. Although Verdana is generally associated with better readability (Kwon & Kim 2023), the correlation in the 1.15 line spacing reflects that some degree of cognitive load and visual discomfort persists, even with more readable fonts.

CONCLUSION

The findings of this study emphasize the significant influence of serif: Times New Roman and sans-serif: Verdana font design and line spacing 1.15pt and 1.5pt on reading performance and ocular comfort. Verdana, characterized by its simpler letterforms, demonstrated better readability, leading to fewer reading errors and suggesting a reduction in cognitive load when compared to Times New Roman. In contrast, Times New Roman, with its more complex design, was associated with a higher frequency of reading errors and blink rates, indicating greater visual strain. The observed relationship between reading errors and blink rates suggests that increased cognitive load or visual discomfort may result in more frequent blinking, likely as a compensatory mechanism to alleviate visual strain. These results align with previous research, further highlighting the importance of font selection to optimize readability and minimize visual discomfort. The implications of these findings are particularly relevant for environments that require prolonged reading, such as educational settings, workplaces, and digital interfaces. Careful consideration of font and line spacing selection is critical to enhancing reading efficiency and reducing the risk of visual strain, especially in contexts involving extensive or continuous reading tasks. Future research should investigate the long-term effects of different fonts and line spacings on ocular health and explore other typographic variables that may contribute to improved reading performance and comfort. Moreover, studies focusing on diverse populations, including individuals with visual impairments, could provide further insight into designing accessible and inclusive reading materials. These recommendations aim to advance understanding of the role of typography in promoting both reading efficiency and visual well-being.

FUTURE SCOPE

Future research should expand the sample size to include diverse secondary school students and investigate additional font types beyond Times New Roman and Verdana. Exploring age-related differences in visual strain and integrating environmental factors like screen brightness and text size will enhance the study's applicability. Utilizing eye-tracking technology for real-time data on blink patterns and eye movements could provide deeper insights and help develop personalized interventions to improve reading efficiency and ocular comfort.

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Conflict of Interest. None.

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