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INTERACTIVE TEXT READING: *A TEXT 2.0 IMPLEMENTATION*

ABSTRACT

In the article an interactive text-reading platform based on the *Text 2.0* framework is presented. An experiment was carried out to investigate the reading behaviour of Italian language learners using this platform. Average reading time and comprehension scores did not differ across the conditions (a dedicated eye tracker PCeye Go, webcam-based eye tracking and mouse-only interaction). Additionally, participants in all the groups rated high on the perceived usefulness of the developed platform and overall reading experience. The implications of using such a tool for interactive reading are presented in this paper.

KEYWORDS: eye tracking, perception, reading, interactive text, digital platform

INTRODUCTION

The digital reading era facilitated the manipulation of many physical text characteristics, such as font size, screen dimension, contrast and luminance, and line length (Dillon 2002; Dyson 2004). Machine learning tools and internet-powered interactive text presentation have dawned a new way of text generation, storage,



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and dissemination. They present numerous untapped possibilities that are not possible on paper. These possibilities include multiple indirect features such as interactive flipping pages, adaptive text style customisation, ambient changes etc. (Liu 2005). The internet has also ushered in an era where information is readily available at any time and from any location, fundamentally reshaping our interaction with text. These new augmentations to text evoke significant reading challenges and are expected to impact reading behaviour significantly (Edyburn 2007). In this article, we will look at interactive text reading and a use case for interactive text reading based on the Text 2.0 framework (Biedert *et al.* 2010).

Research in interactive text reading is multidisciplinary; numerous professionals are working on this problem to bring about the best interactive text digital transformation (Harrison 2000). Many researchers working with interactive text reading focus on understanding how these new text reading paradigms can influence readings (Li 2008). In some early reports, interactive text reading has been speculated to have some benefits over traditional paper-based reading as it engages multimodal senses for reading e.g. visual and auditory sense, where the recipient sees the text on the screen and hears it (Hill, Wölfel 2017). These reports speculate that interactive reading engages significantly to improve ease of reading, reading experience, faster reading, reading comprehension, absorption and immersion etc.

Reading is a highly individualistic task, and for a successful reading experience, readers prefer an uninterrupted reading paradigm in a comfortable environment (Foroughi *et al.* 2015). Therefore, interactive text design must consider the variable aspect of reading and make it individualistic (Chu *et al.* 2004; Pearson *et al.* 2013). Additionally, the integration of other machine learning-powered smart features like easy translations, learning to pronounce, ambient lighting, presentation size etc., can further facilitate the uninterrupted reading experience (Biedert *et al.* 2010; De Silva, Haddela 2013; Wölfel *et al.* 2013).

Initial research reports on using interactive text reading focus on either dynamically adapting text for the individuals by manipulating the fonts or using gaze-based interaction for reading. Rapid Serial Visual Presentation – RSVP (Forster 1970; Aaronson, Scarborough 1977) was one of the early interactive text designs suggested to improve reading and has been shown to provide an enhanced comprehension and reading experience. Other reports (Reichenstein 2012; Marcotte 2017) on responsive fonts have also demonstrated the facilitatory effect of the reading experience. Recently, Wölfel and Stitz (2015) developed a responsive type design which transforms letter shapes in response to external factors. This innovative concept introduces several possibilities beyond those offered by responsive typography alone. It enables improvements in readability by dynamically changing the text with physical factors like the angle of viewing, blocked viewing angle or any other constraints experienced by individual readers. For instance, if focusing becomes challenging, the letter shapes can be transformed to enhance readability under such constraints. Another interactive text font design by Wölfel *et al.* (2015) was WaveFont as shown in Figure 1.

Basis font without any characteristic

Sei ruhig bleibe ruhig mein Kind

Fonts with different characteristics

- ① **Sei ruhig bleibe ruhig mein Kind**
- ② **Sei ruhig bleibe ruhig mein Kind**
 - Higher speed
- ③ **Sei ruhig bleibe ruhig mein Kind**
- ④ **Sei ruhig bleibe ruhig mein Kind**
 - Less loudness
- ⑤ **Sei ruhig bleibe ruhig mein Kind**
- ⑥ **Sei ruhig bleibe ruhig mein Kind**
 - Higher pitch
- ⑦ **Sei ruhig bleibe ruhig mein Kind**
- ⑧ **Sei ruhig bleibe ruhig mein Kind**

Figure 1. Visual presentation of speech characteristics with WaveFont
(Reprinted from Wölfel, Schlippe 2015)

It is an interactive voice-driven font system representing additional elements such as prosody, emotions etc. This feature lets the text change a character's shape depending on the acoustic features. The vertical stroke represents its loudness, the horizontal stroke represents the pitch, and the speed is represented by width. This phoneme-grapheme-based adaptation allows us to capture spoken utterance's characteristics better and preserve individuality within the written text.

In research reports focusing on gaze-controlled interactive reading (Biedert *et al.* 2010; Sharmin *et al.* 2013; Menges *et al.* 2017), features like controlling page turns, scrolling etc., have been demonstrated to have a supportive role in readers. These approaches demonstrate the potential for leveraging gaze-based interactions to optimise reading interfaces and promote a more immersive and uninterrupted reading experience (Ngyuen *et al.* 2015; Rendl *et al.* 2016). Rosenberg (2005) presented a gaze-responsive interface to facilitate the user's return to where the reading was interrupted. This was accomplished using a reading place marking feature, where the readers look away and even move this place marker. The reading place marker would be removed when the user's gaze is back at the specific part of the text. Biedert *et al.* (2010) proposed a new framework called Text 2.0, a web-based gaze-controlled system focused on building real-time applications. On the homepage of the Text 2.0 framework¹ seven interactive features were highlighted (Table 1 below):

¹ <https://text20.net>

Table 1. Text 2.0 framework features and their function

Feature	Function
Interactive images	Images that change based on the line you are reading
Translation	Automatic translation of the word on the activation
Word explanations	Explanation about a specific word which flies in on activation
Compound word	Breaking down a complex word into its components for easy understanding
Place marker	It guides you back to where you left off
Pronunciation assistant	It helps you pronounce a specific word
Skimming feature	Bolds the most important elements in the text

The framework also includes multiple plugins and additional tools to build standalone applications. Multiple applications have been developed based on this framework, such as *eyeBook* (Biedert *et al.* 2009), *iDict* (Hyrskykari 2006), the reading assistant (Sibert *et al.* 2000), *AdeLE* (Mödritscher *et al.* 2006) etc. Since the availability of the framework, it has been used in multiple other projects (Biedert *et al.* 2012; Jermann *et al.* 2010; Chen *et al.* 2019). The need for dedicated eye-tracking hardware makes it difficult to build universal applications using this framework, and in recent years the support for the framework has been stopped. This, coupled with improvements in technology and the availability of other webcam-based eye-tracking tools such as *WebGazer.js* (Papoutsaki *et al.* 2016), *Searchgazer* (Papoutsaki *et al.* 2017), *OWLET* (Werchan *et al.* 2022) etc. have made it easier to build real-time applications without the use of a dedicated eye tracker.

The present study aims to build a web application using the web-cam-based eye-tracking method to mimic the text 2.0 features. By building an interactive text-reading platform that can interact with the gaze behaviour of the reader, we plan to measure the users' reading experience. The build platform would be tested with different eye-tracking methods to determine the feasibility of the new interactive text reading system as a standalone solution. The current study had specific goals, which were as follows:

1. To assess the features required for the Text 2.0 framework that can be beneficial for individuals who are new to the language.
2. To create an interactive reading platform that incorporates the concepts of Text 2.0.
3. To test the developed platform in various conditions.

EXPERIMENTAL SETTINGS

The current study was conducted in two phases at the Empirical Visual Aesthetics lab at the University of Vienna. In phase one of the experiment, a new reading platform with Text 2.0 features was built. The new reading platform was developed as a web application, making it accessible for large-scale implementation on multiple platforms. In the second phase of the experiment, a field study with the developed reading platform and different eye-tracking methods was conducted. The study was based on the project developed for the digital experience in the humanities seminar led by Dr Arndt Niebisch².

PHASE I: TEXT 2.0 FEATURE GRADING AND DESIGN OF THE PLATFORM

For the implementation of Text 2.0 features into a web platform, a feedback questionnaire from 10 participants was collected. It was done to evaluate the most important features that a new language user would require. Each participant was shown the Text 2.0 framework video, as noted on the framework's homepage, and the current experiment's objectives were explained. Further, each participant rated the seven features as described in Table 1 on a 3-point rating scale ("Highly useful", "Not sure" & "Not useful").

Based on the results of the feedback rating, appropriate features suitable for the new web platform were selected and chosen for further prototype design. For ease of implementation, the translation feature was chosen as the first feature to be considered in the prototype. The web platform was designed as a standalone web application that can run on different devices without any third-party installation. Additionally, to improve the scalability of the prototype, two major decisions were taken: firstly, the platform was built with a panel design to provide easy access to read, annotate and edit interactive text features, secondly, the interactive text feature was coupled with the mouse pointer and depended on the participant's dwell time. The gaze tracking was coupled with the mouse pointer to use the web application without a dedicated eye tracker. The web platform was built using webgazer.js, an online eye-tracking library that uses JavaScript to render real-time eye-tracking. A snippet from the implemented platform can be seen in Figure 2 below.

The developed prototype was further subjected to field testing with different experimental conditions using different eye-tracking methods, and corresponding reading behaviour was documented. Further groupwise comparisons across the different eye-tracking methods were conducted.

² <https://www.germ.univie.ac.at/arndt-niebisch/>



Figure 2. The prototype with text 2.0 feature

PHASE II: A FIELD STUDY OF THE PLATFORM

Once the web application was compiled, it was used with three different conditions (dedicated eye tracker, webcam-based eye tracking, mouse-only reading) and the subsequent reading behaviour (comprehension and reading experience) was compared.

MATERIALS

The story “Fortune and the man” from the book titled “Italian Reader Short Stories” by Alex Kouzine was used in this study. The original book contains texts in English, where each passage is followed by an Italian translation. In the designed platform, the text was also in English and the translation of the passages appeared in an additional window above the original text when the reader fixed his gaze longer on the specific text element. As described earlier, the necessary element of interactive translations was loaded using the developer panel. Textual analysis based on linguistic profiling as per the experimental protocol set by Mendhakar (2022) revealed that the text excerpt used has a total of 197 words with an average word per-sentence count of 9.23. A method of learning a third language through a second language was used here, making the task more complex. But the text was graded at A2 based on the readability and reading level score.

The comprehension questionnaire and the modified reading experience questionnaire based on the technology acceptance model [TAC] (Marangunić, Granić 2015) used in this experiment with all the participants have been included in Appendix 1.

PARTICIPANTS

Sixty non-native speakers of English who had enrolled at the University of Vienna for non-English courses were recruited for the field testing of the platform. Therefore, the participants recruited for the current experiment had German as their first language and English as their second language. Based on our pilot study results, it was noted that the benefit of the platform would be higher for non-native speakers of English. Once informed consent was obtained from all the participants; screening tests were carried out to evaluate each participant's reading habits and English proficiency. None of the participants had a background in Italian and were screened for their Italian language abilities (A1 level or less). Further, all the participants were motivated to learn Italian. Each participant was also screened using a battery of tests for normal eyesight, reading, writing and other cognitive deficits.

Our pilot experiments also noted that participants grouped under the avid reader category according to the reading habits questionnaires were less likely to use assistive reading technology. Therefore, in this experiment, only those participants whose reading habits were grouped as selective readers based on the reading habits questionnaire (Moniek 2020) were included in the study. This control was incorporated because we wanted to factor in the reading bias of reading habits.

PROCEDURE

The platform was loaded onto a desktop computer. The same system was fitted with a stationary dedicated eye tracker Tobii Dynavox PCEye Go, and a Web camera (Logitech HD Pro Webcam C920). Participants were randomly assigned to either of the three experimental groups (dedicated eye tracker, webcam-based eye tracking, mouse-only reading). A total of twenty participants in each experimental condition participated in the study. Each participant's gaze recording depended on the group they participated in, and an appropriate recording of gaze behaviour was carried out.

As stated in the review of literature, the overall purpose of reading for a novice reader is to understand the text easily while having a good reading experience. For the reading experience to be pleasurable, the interaction with the text has to be seamless and relatively precise to work with their fast-changing eye movements. Once the reading was completed, each participant completed an online comprehension questionnaire.

MEASURES

This study implemented two standard measures (reading time and dwell time) to measure the reading behaviour of the participants. Each participant's reading comprehension and reading experience questionnaire results were also compared across different experimental conditions. A combined analysis of all these measures helped us understand their reading experience with the developed platform.

Comprehension was measured using a custom-designed text comprehension test. The questionnaire included five multiple-choice questions (in English) related to the experiment's story to measure comprehension and 20 questions related to the translations (from Italian to English). Italian words were given, to which the meaning in English had to be added. As Italian was the language least known to the respondents, so the reverse direction (from English to Italian) would have been too difficult for participants. This was followed by a reading experience questionnaire based on the technology acceptance model. The comprehension and reading experience questionnaires are included in Appendix 1 of this study.

RESULTS

The study planned to grade the most important text 2.0 framework features necessary for novice language users and build an interactive reading platform as a web platform. The result section is also discussed in two phases; in the first phase, the survey results on text 2.0 features are highlighted, and in the second phase, reading behaviour across different gaze interaction systems, along with the questionnaire data related to comprehension and experience, are discussed.

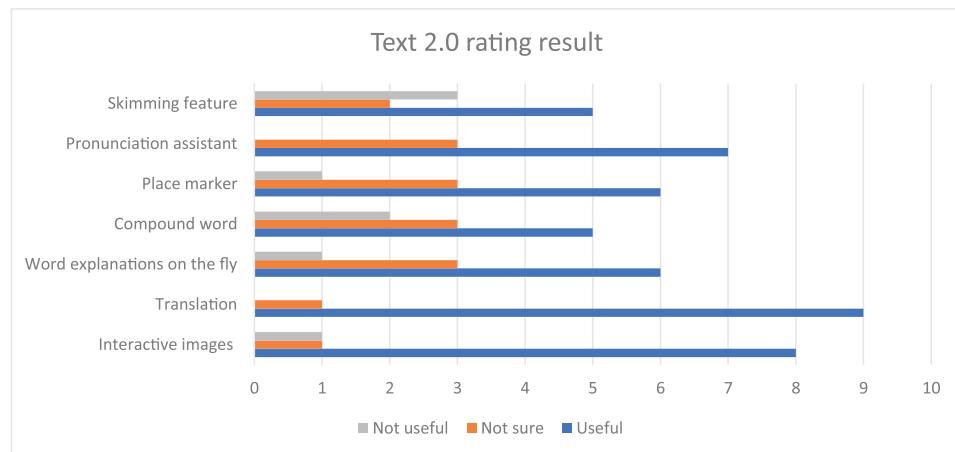


Figure 3. Rating of the Text 2.0 framework features

The seven features highlighted in the homepage video of the project were rated on the 3-point rating scale as “Useful”, “Not sure” and “Not useful”. The cumulative ratings of 10 participants are highlighted in Figure 3. It was noted that translations (90%), interactive images (80%) and pronunciation assistants (70%) were the top three features graded as “Highly useful” by the participants. Even though it can be noted that most of the features were highly intuitive and accepted by users for ease of implementation, it was decided that only translations were considered for prototype development.

In the study’s second phase, a reading experiment was conducted using the developed platform. Table 2 summarises the reading time and dwell time measured across the three gaze-based interactions (dedicated eye tracker, webcam and mouse reading condition) with the developed platform. The mean reading time across all the experimental conditions was around 50 seconds. Webcam-based reading produced the longest reading time of 53 seconds compared to the other two experimental conditions. The total reading time was 47 and 50 across PCEye Go-based and webcam-based reading, respectively. Similarly, the dwell time across the different experimental conditions was 174, 223 and 185 milliseconds for PCEye, webcam and mouse conditions. Further groupwise statistical comparisons were carried out across reading and dwell time.

Table 2. Eye tracking parameter comparison across different conditions in the study (N= number of participants in each condition)

Condition	N	Reading duration (sec)		Dwell time (msec)	
		Mean	SD	Mean	SD
PCEye Go	20	47.1	14.4	174.7	84.4
WebCam	20	53.7	15.2	223.4	75.3
Mouse	20	50.4	16.9	185.2	76.8

It was noted that differences across conditions in the mean reading time across the reading conditions were smaller than the standard deviations across the groups, i.e., a 30–45% standard deviation. A normality test was carried out across reading time and dwell time parameters, and a non-normal distribution was noted in all the experimental conditions ($p < 0.05$). The Kruskal-Wallis test examined the pairwise differences across reading and dwell time in the experimental conditions. No significant differences $\chi^2(4) = .661$, $p = .956$ were found among PCEye Go, Webcam and mouse-only reading condition participants. Therefore, there was no significant difference across the reading or dwell time across the experimental conditions.

Further groupwise comparisons across differences in comprehension and reading experiences were carried out using the comprehension and TAC-based experiencing

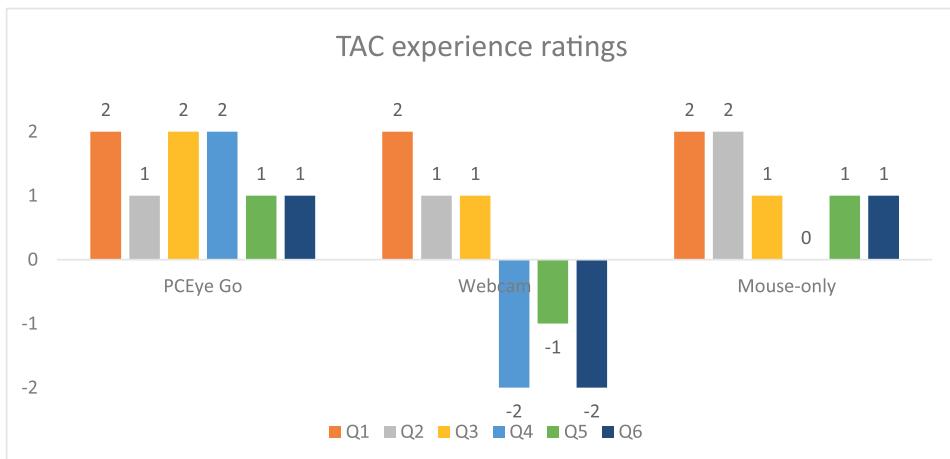


Figure 4. Mean TAC experience ratings across the conditions

questionnaire. Figure 4 shows the mean comprehension and TAC experience scores across the different experimental conditions. A total comprehension score of 23, 21 and 23 (from 5 multiple choice questions and 20 translations) was noted for the Tobii Dynavox PCEye Go, Webcam and Mouse-only reading conditions. It was noted that the reading comprehension scores did not differ across the different experimental conditions.

Figure 4 shows the average TAC experience ratings for different questions across the PCEye Go condition, webcam and mouse only condition. Questions 1–3 focused on measuring the usefulness of the reading platform, and questions 4–6 focused on measuring ease of usage. Overall, ratings for the usefulness of the reading platform did not differ across the conditions of the experiment, with the scores of either “Completely agree” (2) or “Agree” (1). Nevertheless, there was a considerable difference across the ratings noted for the ratings related to ease of usage. It was noted that the webcam group rated “Disagree” (-1) or “Completely disagree” (-2) for all the questions related to ease of usage. Further, there was no difference across the PCEye Go and mouse-only conditions.

The results revealed that participants had high comprehension scores (>84%) with no significant difference across reading conditions. Similarly, TAC-based reading experience ratings for the potential use of the reading platform did not reveal any group differences, with differences noted only for webcam conditions for ratings pertaining to ease of usage. These results are discussed with the formulated objectives of the study, with previous reports on this topic in the discussion section.

DISCUSSION

The present study aimed to build an interactive reading platform and test its utility empirically. It was focused on assisting new readers to Italian language. The generation of text 2.0 framework features according to user feedback was used to develop the reading platform. It was noted that the feature of translations, interactive images and pronunciation assistant were the top three features rated to be implemented in the reading platform. It was decided that the present study will focus on the translation feature alone and implement the remaining interactive text 2.0 features in the later stages. Translation of words to read in a new language is the primary focus of new readers to a specific language (Vermes 2010). Multiple studies show that the combination of image(s) and text, giving the whole message a multimodal dimension, increases efficiency in memorising and processing information (e.g. Pavio 1971; Pavio 1986; Mayer 2001; Mayer 2005; Ballstaedt 2009; Chan, Unsworth 2011; Unsworth, Cléirigh 2014). Similarly, other studies have pointed out that pronunciation mastery for accents, compound words, dialects etc., is a massive challenge for readers new to a language (Foote, Trofimovich 2017). Therefore, the results of the rating of text 2.0 features are in accordance with the above reports, which suggest readers would like to have an interactive platform which implements all these features in one platform.

As the present study was the first of its kind, the scope was limited to translation features only. With the developer panel, where all additional features can be integrated, the present study forms the initial report supporting the need to implement these features. Future iterations of the platform would implement other features rated as helpful for new language readers.

In the second phase of the study, to empirically understand the utility of the developed platform in readers who wanted to learn Italian language. Their reading behaviour in terms of comprehension and reading experience was documented and compared. As multiple research studies have correlated reading time as overall reading behaviour (Liversedge *et al.* 1998; Wolf *et al.* 2000; Rayner, Reichle 2010; Miller 2015), the same measure was compared across the reading conditions. The activation of interactive features was coupled with dwell time for seamless usage. It was noted that the reading time across all the conditions was, on average, around 50 seconds and did not reach any statistical difference. Considering a within-group variability in reading time of 30–40% of the total reading time, these comparisons would be obsolete. A high standard deviation in reading time highlights the individualistic approach employed by multiple individuals despite having similar reading habits. This finding is supported by multiple previous reports highlighting the variability in the reading task (Daneman 1991; Jenkins *et al.* 2003; Perfetti 1985; Pfost *et al.* 2014).

A high dwell time of 223 milliseconds in the Webcam condition was noted compared to the other two conditions (174 and 185 milliseconds). This can be

accredited to the fact that readers found it difficult to activate the translation feature using the webcam-based design. The present study used the open-source tool kit for webcam-based eye tracking (*webgazer.js*). This library has been found to have an eye-tracking accuracy of 100 px with sufficient lighting. As one of the superior open-source toolkits for webcam-based eye tracking, the present study's authors implemented an eye-tracking feature using this toolkit (Papoutsaki *et al.* 2016). *Webgazer* library is under constant development, and multiple researchers across the globe are working to improve its accuracy. Future library versions might improve the accuracy of eye tracking by up to 10–20 px, making it suitable for implementation with reading technologies.

When comparing the comprehension scores across the three reading conditions, it can be noted that all three groups demonstrated a high comprehension score of greater than 84%. Though no control group was employed in this study, the authors claim that these comprehension scores are high in new language readers. This might be because the participants were highly motivated to complete of the task and provided higher cognitive resources in completing the task (DeStefano, LeFevre 2007; Wylie *et al.* 2018).

The reading experience, which was measured using the TAC-based rating scale, focused on the perceived usefulness of the reading platform and the ease of usage. It was noted that the overall rating of "Completely agree" (2) or "Agree" (1) was noted across all conditions with positive engagement with the developed reading platform. This finding suggests that the readers believe their reading skills will significantly improve with this platform for reading in a new language. Though there were no noticeable groupwise differences, it can be said that participants belonging to PCEye Go and mouse only condition rated it higher compared to the webcam condition. It can be accredited to the fact that webcam-based readers faced significant difficulty in navigating the platform with their gaze, and their poor experience in usage hindered their ratings of the perceived usefulness of the platform. This can be verified using the ratings noted for ease of usage, where the PCEye Go and mouse-only conditions rated "Completely agree" or "Agree" ratings, and the webcam condition rated the ease of usage to be the worst with negative ratings of completely disagree. The poor reading experience using the webcam condition can be correlated with the increased dwell time of 223 milliseconds. The accuracy of webcam-based eye tracker has to significantly improve for users to interact just with their gaze using their webcam, and it would be the focus of our future research.

CONCLUSION

The rapid development of digital technology has influenced how text data is created, interacted and consumed. The digital text has the unique potential to transform and interact with multiple data formats to bring a desired media and commu-

nication output. By challenging the current status of text and developing newer interactions with the text, this study tries to harness the full potential of text on the screen (Li 2008; Hill, Wölfel 2017).

Digital reading is a highly individualistic task and might be preferred by some over traditional book reading. It is established that reading is a highly cognitively demanding task, especially for readers who are new to a specific language (DeStefano, LeFevre 2007; Wylie *et al.* 2018). In the present study, the introduction of a new digital reading platform for interactive reading was presented. Building upon the works of Text 2.0 (Bidert *et al.* 2010), a web application with gaze-based triggers to interact with digital text was presented. By rating the most valuable features from the text 2.0 framework in the first phase of the study, we get some insights into the need for new readers to acquire the vocabulary of a new language without moving across different tabs to search for the meaning of a word. Gaze-based interaction with text provides an excellent means to do so. This was verified in the experiment's second half, where different eye-tracking methods were compared to understand the gaze-powered text interaction. It was noted that the dedicated eye tracker (Tobii Dynavox PCEye Go), which is built for mouse control, revealed a better reading experience and comprehension when compared to webcam-based gaze interaction. Even though the tool kit used for webcam-based gaze tracking is built on trained modern datasets, its applicability for reading research is quite limited. The accuracy of these eye-tracking methods using webcams has to improve significantly to be used universally for interactive reading. This will be possible through collaborations with designers, software designers, engineers, artists etc., who are working on improving the accuracy of the webcam-based gaze tracking methods (Chen *et al.* 2019). The present study also demonstrated the utility of such a reading platform with mouse-only features, where the mouse mimics the gaze features. The results in this condition support the results noted in the PCEye Go condition. i.e., the facilitatory role of interactive features in reading while new to a language has been positively received by readers with dedicated eye trackers and mouse-only conditions. Until the webcam-based interaction is perfected, mouse-only-based interactions can be implemented with modern browsers to improve the usage and applicability of interactive reading features.

The initial reports presented in the study must be showcased by implementing all the Text 2.0 framework features selected by the readers based on the survey. Additionally, future experimental designs must be carefully constructed to include a control group such as book reading or digital reading without interactive reading features, to understand the utility of interactive reading. Similarly, multiple other measures of reading have to be evaluated using the interactive reading platform presented, such as narrative engagement, absorption, reading fluency etc. Reading different text materials for different purposes can also be evaluated using the interactive reading platform highlighted in this study. Another element for future research is the possibility of translating existing stories into interactive stories. This will be possible when large institutions like Kindle Direct Publishing (KDP), Pearson,

Penguin Random House etc., allocate a significant portion of their budget for implementing future technologies for text-based technology. Future research can also include a larger audience with diverse reading backgrounds and interests to compare their acceptability of interactive reading features.

The use of open-source tools and libraries in building our platform acts as a catalyst for future collaboration. The move towards interactive text reading is inevitable with interactive technology such as interactive fonts, interactive lighting, tactile text etc. Nevertheless, this transition does not necessarily indicate the digital device surpassing the superiority of paper-based reading. Mere adaptation of gaze-based interaction is insufficient to garner large-scale implementation of interactive text unless a better webcam-based eye-tracking method is introduced. Therefore, it can be said that reading is a complex task with varied experiences and expectations inherent to it. Instead of seeking a universal solution for all readers, interactive text can be coupled with machine learning technology to garner individualisation and further customisation.

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REFERENCES

- AARONSON D., SCARBOROUGH H. S. (1977): *Performance theories for sentence coding: Some quantitative models*, "Journal of Verbal Learning and Verbal Behavior", 16/3: 277–303.
- BALLSTAEDT S.P. (2009): *Text und Bild: ein didaktisches Traumpaar*, "Bildwelten des Wissens. Kunsthistorisches Jahrbuch für Bildkritik. Band", 7/1: 45–55.
- BIEDERT R., BUSCHER G., DENGEL A. (2009): "The eye book. Informatik-Spektrum", 33/3: 272–281.
- BIEDERT R., BUSCHER G., SCHWARZ S., MÖLLER M., DENGEL A., LOTTERMANN T. (2010): *The text 2.0 framework: writing web-based gaze-controlled realtime applications quickly and easily*, "Proceedings of the 2010 workshop on Eye gaze in intelligent human machine interaction": 114–117.

- BIEDERT R., HEES J., DENGEL A., BUSCHER G. (2012): *A robust realtime reading-skimming classifier*, “Proceedings of the symposium on eye tracking research and applications”: 123–130.
- CHAN E., UNSWORTH L. (2011): *Image–language interaction in online reading environments: challenges for students’ reading comprehension*, “The Australian Educational Researcher”, 38: 181–202.
- CHEN C. M., WANG J. Y., LIN Y. C. (2019): *A visual interactive reading system based on eye tracking technology to improve digital reading performance*, “The Electronic Library”, 37/4: 680–702.
- CHU Y. C., BAINBRIDGE D., JONES M., WITTEN I. H. (2004): *Realistic books: A bizarre homage to an obsolete medium?*, “Proceedings of the 4th ACM/IEEE-CS joint conference on Digital libraries”: 78–86.
- DANEMAN M. (1991): *Individual differences in reading skills*, Handbook of reading research, 2, Lawrence Erlbaum Associates, Inc: 512–538.
- DE SILVA J., HADDELA P. S. (2013): *A term weighting method for identifying emotions from text content*, “2013 IEEE 8th International Conference on Industrial and Information Systems”: 381–386.
- DESTEFANO D., LEFEVRE J. A. (2007): *Cognitive load in hypertext reading: A review*, “Computers in human behavior”, 23/3: 1616–1641.
- DILLON A. (2002): *Designing usable electronic text: Ergonomic aspects of human information usage*, CRC press. London/New York.
- DYSON M. C. (2004): *How physical text layout affects reading from screen*, “Behaviour & information technology”, 23/6: 377–393.
- EDYBURN D. L. (2007): *Technology-enhanced reading performance: Defining a research agenda*, “Reading Research Quarterly”, 42/1: 146–152.
- FOOTE J. A., TROFIMOVICH P. (2017): *Second language pronunciation learning: An overview of theoretical perspectives*, “The Routledge handbook of contemporary English pronunciation”: 75–90.
- FOROUGHI C. K., WERNER N. E., BARRAGÁN D., BOEHM-DAVIS D. A. (2015): *Interruptions disrupt reading comprehension*, “Journal of Experimental Psychology: General”, 144/3: 704.
- FORSTER K. I. (1970): *Visual perception of rapidly presented word sequences of varying complexity*, “Perception & psychophysics”, 8: 215–221.
- GUNARATNE S. A. (2001): *Paper, printing and the printing press: A horizontally integrative macrohistory analysis*, “Gazette (Leiden, Netherlands)”, 63/6: 459–479.
- HARRISON B. L. (2000): *E-books and the future of reading*, “IEEE Computer Graphics and Applications”, 20/3: 32–39.
- HILL D., WÖLFEL M. (2017): *Acoustic reading experience: aligning sound events to text using gaze tracking to improve immersion in reading*, “CERC2017: Collaborative European Research Conference; Karlsruhe, Germany, 22–23 September, 2017”: 308–310.
- HYRSKYKARI A. (2006): *Eyes in attentive interfaces: Experiences from creating iDict, a gaze-aware reading aid*, Tampere University Press.
- ISER W. (2014): *Interaction between text and reader*, “Readers and reading”, Routledge: 20–31.
- JACOBS A. M. (2015): *Neurocognitive poetics: methods and models for investigating the neuronal and cognitive-affective bases of literature reception*, “Frontiers in human neuroscience”, 9: 186.
- JENKINS J. R., FUCHS L. S., VAN DEN BROEK P., ESPIN C., DENO S. L. (2003): *Sources of individual differences in reading comprehension and reading fluency*, “Journal of Educational Psychology”, 95/4: 719–729.
- JERMANN P., NUSSLI M. A., LI W. (2010): *Using dual eye-tracking to unveil coordination and expertise in collaborative Tetris*, “Proceedings of HCI 2010 24”: 36–44.
- KLEINPETER J. R. (2010): *Typographic Innovation and Negative Criticism: A Retrospective from Gutenberg to Carson*, “Design Principles & Practice: An International Journal”, 4/3.

- KUIJPERS M. M., DOUGLAS S., KUIKEN, D. (2020): *Capturing the ways we read: Introducing the reading habits questionnaire*, "Anglistik: International Journal of English Studies", 31/1: 53–69.
- LI Y. (2008): *Dedicated e-reading devices: the state of the art and the challenges*, "FIS2309: Design of Electronic Text", 1/1, 1–7.
- LIU Z. (2005): *Reading behavior in the digital environment: Changes in reading behavior over the past ten years*, "Journal of documentation", 61/6: 700–712.
- LIVERSEEDGE S. P., PATERSON K. B., PICKERING M. J. (1998): *Eye movements and measures of reading time*, "Eye guidance in reading and scene perception": 55–75.
- MAIMON V. (2020): *Contemporary art, photography, and the politics of citizenship*, Routledge. New York.
- MARANGUNIĆ N., GRANIĆ A. (2015): *Technology acceptance model: a literature review from 1986 to 2013*, "Universal access in the information society", 14: 81–95.
- MARCOTTE E. (2017): *Responsive web design: A book apart n 4*, Editions Eyrolles, Paris.
- MAYER R. E. (2001): *Multimedia Learning*. Cambridge. MA: Cambridge University Press, Cambridge.
- MAYER R. E. (2005): *Cognitive theory of multimedia learning*, in: R. E. MAYER (eds.), *The Cambridge Handbook of Multimedia Learning*. Cambridge: Cambridge University Press: 31–48.
- MENDHAKAR, A. (2022). *Linguistic Profiling of Text Genres: An Exploration of Fictional vs. Non-Fictional Texts*. Information, 13/8: 357. <https://doi.org/10.3390/info13080357>.
- MENGES R., KUMAR C., MÜLLER D., SENGUPTA K. (2017): *Gazetheweb: A gaze-controlled web browser*, "Proceedings of the 14th International Web for All Conference": 1–2.
- MILLER B. W. (2015): *Using reading times and eye-movements to measure cognitive engagement*, "Educational psychologist", 50/1: 31–42.
- MÖDRITSCHER F., GARCÍA-BARRIOS V. M., GÜTL C., HELIC D. (2006): *The first AdeLE prototype at a glance*, "EdMedia+ Innovate Learning: Association for the Advancement of Computing in Education (AACE)": 791–798.
- NGUYEN V., KUMAR P., YOON S. H., VERMA A., RAMANI K. (2015): *SOFTii: soft tangible interface for continuous control of virtual objects with pressure-based input*, "Proceedings of the Ninth International Conference on Tangible, Embedded, and Embodied Interaction": 539–544.
- PAPOUTSAKI A., LASKEY J., HUANG J. (2017): *Searchgazer: Webcam eye tracking for remote studies of web search*, "Proceedings of the 2017 conference on conference human information interaction and retrieval": 17–26.
- PAPOUTSAKI A., SANGKLOY P., LASKEY J., DASKALOVA N., HUANG J., HAYS J. (2016): *WebGazer. Js: Democratising webcam eye tracking on the browser*. WebGazer. Js.
- PAVIO A. (1971): *Imagery and verbal processes*, New York: Holt, Rinehart and Winston.
- PAVIO A. (1986): *Mental representations: A dual-coding approach*, New York: Oxford University Press.
- PEARSON J., BUCHANAN G., THIMBLEBY H. (2022): *Designing for digital reading*, Springer Nature, UK.
- PERFETTI C. A. (1985): *Reading ability*, Oxford University Press, Oxford.
- PFOST M., HATTIE J., DÖRFLER T., ARTEL T. (2014): *Individual differences in reading development: A review of 25 years of empirical research on Matthew effects in reading*, "Review of educational research", 84/2: 203–244.
- PIROZZOLO F. J., WITTRICK M. C. (2013): *Neuropsychological and cognitive processes in reading*. Academic Press, University of Michigan.
- RAYNER K., REICHLE E. D. (2010): *Models of the reading process*, "Wiley Interdisciplinary Reviews: Cognitive Science", 1/6: 787–799.
- REICHENSTEIN O. (2012): *Responsive Typography, The Basics*.

- RENDL C., KIM D., PARZER P., FANELLO S., ZIRKL M., SCHEIDL G., HALLER M., IZADI S. (2016): *Flexcase: Enhancing mobile interaction with a flexible sensing and display cover*, “Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems”: 5138–5150.
- ROSENBERG L. B. (2008): U.S. Patent No. 7,429,108. Washington, DC: U.S. Patent and Trademark Office.
- SHARMIN S., ŠPAKOV O., RÄIHÄ K. J. (2013): *Reading on-screen text with gaze-based auto-scrolling*, “Proceedings of the 2013 Conference on Eye Tracking South Africa”: 24–31.
- SIBERT J. L., GOKTURK M., LAVINE, R. A. (2000): *The reading assistant: eye gaze triggered auditory prompting for reading remediation*, “Proceedings of the 13th annual ACM symposium on User interface software and technology”: 101–107.
- SNYDER I. (1993): *Writing with word processors: a research overview*, “Educational Research”, 35/1: 49–68.
- SUTHERLAND-SMITH W. (2002): *Weaving the literacy web: changes in reading from page to screen*, “The Reading Teacher”, 55/7: 662–669.
- UNSWORTH L., CLÉIRIGH C. (2014): *Multimodality and reading: The construction of meaning through image-text interaction*, Routledge.
- VERMES A. (2010): *Translation in foreign language teaching: a brief overview of pros and cons*, “Eger Journal of English Studies”, 10: 83–93.
- WERCHAN D. M., THOMASON M. E., BRITO N. H. (2022): *OWLET: An automated, open-source method for infant gaze tracking using smartphone and webcam recordings*, “Behavior Research Methods”: 1–15.
- WOLF M., BOWERS P. G., BIDDLE K. (2000): *Naming-speed processes, timing, and reading: A conceptual review*, “Journal of Learning Disabilities”, 33/4: 387–407.
- WÖLFEL M. (2020): *Non-distracting feedback in artificial intelligence supported learning*, “Artificial Intelligence Supported Educational Technologies”: 31–44.
- WÖLFEL M., STITZ, A. (2015): *Responsive type-introducing self-adjusting graphic characters*, “2015 International Conference on Cyberworlds (CW)”: 298–305.
- WÖLFEL M., SCHLIPPE T., STITZ A. (2015): *Voice driven type design*, “2015 international conference on speech technology and human-computer dialogue (SpeD)”: 1–9.
- WYLIE J., THOMSON J., LEPPÄNEN P. H., ACKERMAN R., KANNAINEN L., PRIELER T. (2018): *Cognitive processes and digital reading*.

APPENDIX 1

COMPREHENSION QUESTIONNAIRE

Please answer the following five questions and provide the translation of the 20 words mentioned below.

1. What was the man carrying while walking along the street?
2. What was the man wondering about people who had a lot of money?
3. What did Fortune offer to do for the man?
4. How did the man respond to Fortune's offer?
5. What happened when the bag became too heavy with diamonds?

TRANSLATION QUESTIONS WITH ANSWERS

- camminare v.intr. [cam-mi-nà-re] – to walk.
- chiedere v.tr. [chiè-de-re] – to ask, to request.
- possedere v.tr. [pos-se-dé-re] – to possess, to have, to own.
- soddisfatto agg. [sod-di-sfát-to] – satisfied, pleased.
- desiderare v.tr. [de-si-de-rà-re] – to desire, to long for.
- riguardare v.tr. [ri-guar-dà-re] – to regard; to concern.
- per quanto mi riguarda – as far as I'm concerned.
- abbastanza avv. [ab-ba-stàn-za] – enough; fairly, quite.
- passeggiare v.intr. [pas-seg-già-re] – to walk, to stroll.
- stesso agg. [stés-so] – same.
- fermare v.tr. [fer-mà-re] – to stop, to halt.
- versare v.tr. [ver-sà-re] – to pour, to spill.
- trasformare v.tr. [tra-sfor-mà-re] – to transform, to turn (into).
- aggiungere v.tr. [ag-giùn-ge-re] – to add (to).
- ancora avv. [an-có-ra] – still; yet (in negative phrases).
- po' avv. = truncated poco.
- poco agg. [pò-co] – little, not much; few.
- strappare v.tr. [strap-pà-re] – to rip, to split; to tear out.

TAC QUESTIONNAIRE

To determine the reading platform's perceived usefulness and ease of use, please rate the following questions using a Likert scale of five points.

- 2 = Completely disagree
- 1 = Disagree
- 0 = Neutral
- 1 = Agree
- 2 = Completely agree

MEASURE PERCEIVED USEFULNESS

1. Using this product for reading helped me complete my reading faster.
2. Using this product, my reading performance improved.
3. Using this product would make my reading easier.

MEASURE PERCEIVED EASE OF USE

1. Learning how to handle this product was easy for me.
2. The reading platform performed its task easily.
3. My interaction with this product was clear and smooth.