# Towards Individualised Reading Support for Attention-Deficit/Hyperactivity Disorder (ADHD): User-Centred Development of an Adaptive Eye-Tracking-Based Reading Assistance System

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***Abstract*—People with Attention-Deficit/Hyperactivity Disorder (ADHD) may experience increased effort and variability in reading performance, including higher cognitive load, attentional fluctuations, and differences in eye movement patterns. While prior research has provided valuable insights into reading challenges associated with ADHD, there remains a limited understanding of how effective reading support can be designed, and a lack of empirically informed reading assistance systems developed in collaboration with and tailored to the needs of people with ADHD. Based on prior research, an early-stage reading assistance prototype with text highlighting features was implemented and refined through a participatory workshop with adults with diagnosed or suspected ADHD (*N* = 7), combining prototype exploration, group discussions, and co-design activities. The findings provide initial design principles for ADHD-specific reading assistance systems and highlight the value of integrating empirical evidence and user perspectives in assistive technology development.**

***Keywords-attention deficit; ADHD; assistive technology; user-centred design; eye-tracking.***

## I. INTRODUCTION

People diagnosed with Attention-Deficit/Hyperactivity Disorder frequently encounter challenges when reading long, complex, or non-interesting texts. Difficulties in sustaining attention and impaired oculomotor control are among the key factors contributing to these challenges. Empirical evidence indicates that individuals with ADHD exhibit increased fixation counts and duration, a higher incidence of regressive and vertical saccades, and decreased reading speed relative to neurotypical controls [1]–[5]. Beyond oculomotor differences, constraints in visual perception, including reduced contrast and colour sensitivity, have been documented in this population [6]–[8]. Compounding these difficulties, mind wandering, a prevalent symptom of ADHD [9], has been associated with reduced text comprehension [10], rendering sustained reading particularly demanding for individuals with this condition.

Assistive Systems (AS) have the potential to support people with ADHD while reading. Nevertheless, a review of assistive technologies for people with ADHD does not identify any AS specifically targeting reading [11], with existing systems primarily focusing on task organisation, reminders, or attention training. Research in this area remains limited and predominantly concentrates on samples with dyslexia or reading and spelling difficulties [12]. Only a small number of studies have explored assistive reading approaches for individuals with ADHD, including text-to-speech technologies [13][14] and text highlighting as a means of guiding attention during reading [15]. To date, no effective, scientifically validated assistive reading system exists for this population, and while adaptive assistive reading systems have recently been proposed [16][17], none have been developed or evaluated specifically for individuals with ADHD. Commercial products such as the *Bionic Reading* font [18] have not yet demonstrated improvements in reading performance in either neurotypical readers [19] or those with ADHD. Given the societal importance of reading and the lack of effective support tools, there is a clear need to investigate requirements for assistance that enhances reading comfort and experience for adults with ADHD.

To address this, we developed an early-stage prototype of an eye-tracking-based assistive reading system, grounded in existing research and design principles, and refined through a user-centred, participatory workshop with adults with ADHD.



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Exploratory findings indicate that line spacing received the highest overall ratings and font highlighting was most preferred in the eye-tracking condition, that a high degree of personalisation is essential to accommodate the heterogeneous needs of users with ADHD, and that cursor-based interaction may offer a viable and more accessible alternative to eye tracking without compromising usability.

This paper makes the following contributions:

- The design and implementation of an early-stage assistive reading prototype for adults with ADHD, grounded in empirical evidence and existing design principles.
- Exploratory insights from a user-centred, participatory workshop with adults with ADHD, covering usability, user experience, and reading support preferences.
- Initial design principles for ADHD-specific reading assistance systems, derived from workshop findings and structured around concrete design implications.
- Methodological insights for integrating target users into early stages of assistive technology research and development.

This paper is structured as follows: Section II details the development of the prototype and the design of the user-centred workshop conducted to evaluate it. Section III presents the analysis of the data gathered during the workshop, the results of which are subsequently interpreted and discussed in Section IV. Section V concludes the paper and outlines directions for future research.

## II. Methods

This section outlines the iterative development of an early-stage assistive reading prototype and the methodology employed in the subsequent user-centred workshop conducted to evaluate and refine it.

### A. Prototype Development

In order to develop a prototype that best supports the defined target group, the following approach was taken: Users read texts displayed on a screen, while their gaze direction is monitored using a remote eye-tracking system. This facilitates the tracking of the reader's gaze position on the screen, enabling the identification of the currently viewed line and word. The corresponding line is highlighted to assist the reader in maintaining focus and preventing skipping to another line. If the expected reading flow from left to right and line by line is maintained, the highlight moves accordingly. A short delay was implemented before the highlight follows an unexpected gaze jump, briefly retaining focus on the previously read position to help users recover their reading position. To ensure accuracy, a short calibration of the eye tracker is performed when the prototype is started. Four highlighting features were implemented, each grounded in prior research: (1) *background highlighting*, in which the currently viewed line receives a coloured background [15]; (2) *font highlighting*, in which the text colour of the focused line and fixated word is changed; (3) *bionic reading*, in which the first half of each word is rendered in bold, applied dynamically to the currently focused line [19][20]; and (4) *blurring*, in which non-focused lines are rendered as a grey shadow using a Gaussian blur [15]. The prototype employs a light beige background to maintain high contrast and reduce visual strain [21][22]. Users can customise font, background, and highlight colours, as well as font size and line spacing, via a cursor-controlled side menu. Figure 1 illustrates the four main assistive reading features.

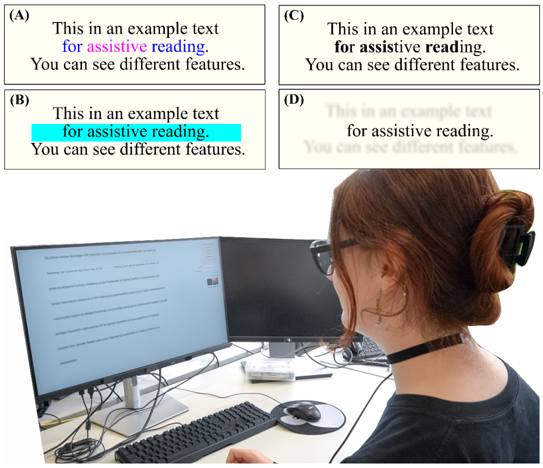


Figure 1. Assistive digital reading features. (A) Font Highlighting, (B) Background Highlighting, (C) Bionic Reading, and (D) Blurring. While reading, gaze can be tracked using eye-tracking glasses, a remote eye tracker or mouse cursor.

### B. User-centred Workshop

A participatory workshop evaluated the early-stage prototype, examining user perceptions of attention-aware reading features and collecting preliminary usability and design feedback. The features were assessed using two interaction modalities: the aforementioned eye-tracking-based interaction, and an additional mouse cursor-based interaction in which participants manually moved the cursor to simulate their gaze and trigger text highlighting.

*1) Exploratory Research Method:* To characterise individual ADHD symptom profiles, all participants completed a demographic questionnaire, including details of ADHD diagnosis (e.g., subtype and current status), and the ADHD Self-Report Scale V1.1 (ASRS-V1.1) [23], a widely used screening for ADHD symptoms. To assess participants' reading difficulties, the Adult Checklist (AC) [24] for dyslexia screening and the Adult Reading History Questionnaire (ARHQ) [25] were administered. System usability and user experience were assessed using the System Usability Scale (SUS) [26] and a custom questionnaire comparing cursor- and eye-tracking navigation, in which participants rated each digital reading feature on perceived helpfulness and ease of reading using a five-point Likert scale.

*2) Workshop Procedure:* The user-centred workshop was conceptualised as a mixed-method evaluation approach with a scheduled duration of 120 minutes. After informing participants about the research goals and workshop procedure, written informed consent was obtained. Participants received an expense allowance of 12 € per hour for their participation. First, participants completed the demographic questionnaire, ASRS-V1.1 and AC. Afterwards, a demonstration of the prototype was conducted to ensure that all participants had a shared understanding of the early-stage system. Then, participants were split into two groups. For prototype testing (Group 1), participants individually tested both interaction modalities, rated each visual reading support feature using the self-constructed questionnaire, and completed the SUS. Prior to the group activity (Group 2), participants completed the ARHQ to assess their reading habits, followed by a guided group discussion in which participants noted down their experiences and strategies. Given that many adults with ADHD have developed a range of strategies for coping with the demands of neurotypically shaped societies, the group discussion was used as a method to externalise these often implicit strategies and make them accessible for analysis. Afterwards, the two groups switched activities.

After both groups completed system testing, the subsequent activity focused on co-creation design. All participants received screenshots of the interface they had tested and were asked to (1) criticise the current interface layout and visual design, (2) suggest improvements or changes and (3) comment on alternative design proposals prepared by the researchers. The activity focused on visual design, layout, and interface clarity, rather than feature functionality. Our proposed features include adaptive elements, such as motion tracking that detects high movement, which may be linked to high cognitive demand [27][28] and, therefore, triggers reading assistance or suggestions for a break, alongside text simplification via Large Language Models (LLMs) and a wearable device providing vibration alerts for scheduled appointments to help users manage time during reading.

## III. Preliminary Findings and Insights

A total of 7 participants took part in the workshop (5 female, $M_{age}$= 27.57 years, $SD_{age}$ = 13.05), with a formal diagnosis of ADHD (*n* = 4) or a suggested, as yet unconfirmed, diagnosis of ADHD (*n* = 3). Of the four participants diagnosed with ADHD, two were diagnosed with the inattentive subtype, one with the combined subtype, while the subtype of one participant was unknown. Four subjects were identified as having ADHD based on ASRS-V1.1 screening, suggesting that their symptoms are consistent with ADHD in adults, while the mean dyslexia score, assessed by the AC amounted to 44.14 (*SD* = 9.72), suggesting only a negligible risk for dyslexia. By contrast, the high mean score of 44.29 on the ARHQ (*SD* = 10.29) indicates that there are several features of the participants' reading and learning history that are indicative of dyslexia.

### A. Descriptive Analysis

The tested prototype achieved a mean SUS score of 81.79 (*SD* = 12.48), indicating a good overall usability of the prototype. Ratings were similar for eye-tracking (*M* = 3.41, *SD* = 0.49) and cursor-based interaction (*M* = 3.37, *SD* = 0.42), suggesting no clear preference for either interaction mode. Figure 2 depicts the helpfulness ratings for each feature, differentiated by interaction mode.

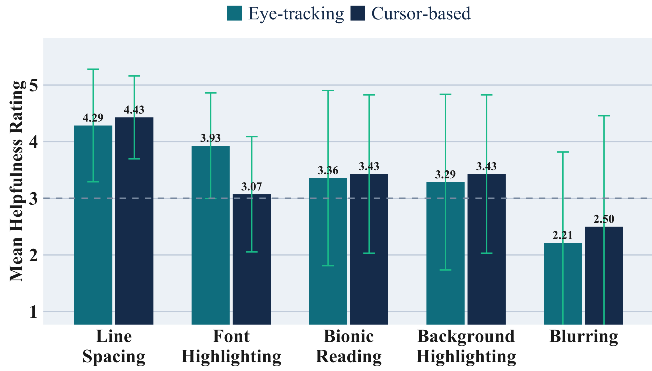


Figure 2. Feature helpfulness ratings by interaction mode. 5-point Likert scale (1 = not helpful, 5 = very helpful). Error bars represent SD.

### B. Explorative Qualitative Analysis

The analysis of exploratory qualitative data has revealed a tension between perceived support in reading and the cognitive or physical strain caused by visual aids. While font- and background-highlighting were generally reported to enhance subjective focus and comprehension, users emphasised that the intensity or persistence of visual reading support could increase cognitive load and divert attention from the text. Visual comfort emerged as a key determinant of usability: colour choice, contrast, and personalisation strongly influenced acceptance, with poorly calibrated or overly intense colours described as distracting despite the functional value of the feature.

Moreover, the performance of the prototype further mediated user experience. Delays in eye- or cursor-tracking and lag in visual feedback were consistently described as disruptive to reading flow. This was particularly salient for eye-tracking interactions, where calibration difficulties and latency reduced trust in the system and limited its effectiveness for some participants.

Blurring features produced divergent responses, reflecting individual preferences. Whereas most participants found blurring distracting or uncomfortable, a minority reported that subtle blurring supported line focus. Eye-tracking interaction was valued for enabling hands-free reading and reducing manual effort. However, feedback of eye strain, mild nausea and headaches indicate potential physical costs and highlight the need for optional deployment.

During discussions, participants emphasised the value of features that simplify or summarise text, particularly for academic literature and complex forms. Movement tracking was considered potentially useful if it leverages existing devices, such as smartwatches or smart glasses, rather than additional gadgets. For a potential reminder feature, some participants indicated a preference for visual notifications rather than vibration-based alerts. Text-to-speech functionality was widely



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endorsed. Participants also expressed a preference for profiles that store individual visual support settings, minimalistic customisation menus, and features that estimate reading time based on their typical reading speed.

Across all features, participants consistently articulated a need for customisation and feature combinability. Adjustable parameters and layered configurations were seen as essential for balancing support with comfort, underscoring the importance of flexible, user-centred design of assistance systems.

## IV. Discussion

Building on existing research on reading challenges experienced by people diagnosed with ADHD, we presented the development of an ADHD-focused reading assistance prototype and reported initial insights from a first user-centred workshop.

Overall, the prototype showed initial indicators of good usability, as evidenced by the high mean SUS score, thus suggesting that the core interaction concept may be accessible and broadly aligned with user expectations. Participants reported a subjective impression of support during reading tasks, providing preliminary evidence for the feasibility of the proposed approach. The results of the user-centred workshop revealed that line spacing received the highest overall ratings. Among the highlighting features, no consistent preference was observed in the cursor-based condition, whereas font highlighting was rated most favourably in the eye-tracking condition. In contrast, the blurring feature received the lowest overall rating, although the high standard deviation hints that it was rated positively by some participants, indicating that highly visually prominent support features may not be equally suitable for all users. This result is in line with research by Shen et al. [15], in which the blurring option had the least positive impact on reading performance. Participants commonly reported that the presence of a single, clearly visible line within the blurring feature caused irritation. While the feature might prevent slippage in the line, it potentially had an adverse effect on reading flow, as the user's visual focus shifts to the next line, but the cursor does not move to this line simultaneously.One potential feature improvement could be to display three lines together, including the line above and below the currently focused line. Font highlighting received the highest ratings, and, in contrast to other features described as 'slow' despite equivalent functionality, this perception did not apply to it. The observed discrepancy could be explained by the feature's capacity to highlight both a full line and the word currently in focus. This may provide users with continuous feedback regarding the location of their gaze, thereby facilitating a more precise comprehension of the system's accuracy and responsiveness. Bionic reading and background highlighting received mixed reviews in both the cursor- and eye-tracking-based versions, with many comments on background highlighting relating to the pre-set colour. This once again underlines the importance of a highly customisable system. The adjustable line spacing has generally received positive feedback, although criticism may be related to limitations of the prototype, as some text was not displayed correctly with wide line spacing.

Interestingly, there was no clear preference regarding prototype interaction method (mouse cursor vs. eye tracking). Nevertheless, in all conditions, cursor tracking was rated marginally higher than eye tracking, with the exception of the most preferred font highlighting feature which may be reasoned by the aforementioned highlighting of a single word and, therefore, higher perceived accuracy of the eye tracker. Given the lack of clear preference between cursor- and eye-tracking interaction, these preliminary findings suggest that a low-cost reading support system without an eye tracker may offer a viable alternative (e.g., via a PDF reader or browser plugin). Being more accessible and cost-effective, cursor tracking could support wider adoption without compromising usability.

The key finding of the workshop was that the assistive reading system must be highly personalisable, enabling users with ADHD to adapt it to their individual needs. This finding aligns with the heterogeneous symptomatology of ADHD [29] and has also been highlighted as a critical consideration in assistive technology for people with autism, another neurodevelopmental disorder [30]. An initial step in this direction was the introduction of the line spacing adaptation option, which received positive feedback during the workshop, indicating the potential value of personalisation in digital reading support. Achieving an even higher level of personalisation could be attained by implementing Artificial Intelligence (AI) technologies. This would facilitate the realisation of automated adaptation mechanisms to users' reading performance. For instance, line jumps or the rereading of words could be identified during the reading process, allowing the system to adapt in real time by introducing visual reading aids (for more details, see [31]). When combined with other sensor modalities, such as infrared cameras capable of monitoring physical movement, machine learning methodologies can be used to detect sustained, increased physical activity while reading. Given evidence that movement changes with cognitive demand in people with ADHD [27][28], this approach could, for example, trigger reading support or provide feedback recommending a break when elevated movement suggests the task is becoming overly demanding. Further user-centred workshops and co-design sessions are needed to capture the experiences and priorities of users, supporting an iterative development process that ensures the resulting tools genuinely meet their needs.

The findings should be interpreted considering several limitations, including the small sample size, the inclusion of participants without formal ADHD diagnosis, and the exploratory nature of the workshop. In particular, it is important to bear in mind that our data is descriptive and exploratory. Thus, no statistical methods were applied. Additionally, the outcomes of the user workshop must be evaluated in conjunction with the current limitations of the prototype. One key factor is the accuracy of the eye tracker. A two-stage calibration was performed with all users to enable the most accurate tracking possible. If significant inaccuracies were detected after the second stage, the process was repeated. Nonetheless, some inaccuracy could not be prevented, as the eye tracker exhibited substantial accuracy issues, particularly with two test subjects who wore their reading glasses over their regular glasses. This scenario must be avoided in future user tests. Furthermore, a deliberately implemented delay in all visual reading features, designed to accommodate rapid line jumps, was occasionally perceived as a system flaw rather than an intentional design choice. Hence, additional refinements to the visual design of the prototype and the incorporation of customisation options are imperative. Drawing on the findings, the following initial design principles for ADHD-specific reading assistance systems are proposed, each grounded in an identified theme and accompanied by a concrete design implication:

1) **Personalisation by Design**
Reading assistance systems must provide adjustable parameters for visual features (e.g., colour, contrast, font, line spacing) and support the storage of individual user profiles to accommodate the heterogeneous needs and preferences of users with ADHD.
2) **Support Without Overload**
Visual reading aids should be designed with restraint, as overly intense or persistent highlighting can increase cognitive load and distract from reading. Features such as blurring should be optional and configurable in intensity.
3) **Sustain Reading Flow Through Accurate Feedback**
Features should provide continuous, low-latency feedback about the user's reading position (e.g., simultaneous word- and line-level highlighting) to maintain user trust and minimise disruption to reading flow.
4) **Ensure Accessible Interaction**
Where possible, reading assistance systems should be usable on devices that users already own, without requiring the purchase of additional hardware or the attachment of equipment to the body. Cursor-based tracking offers a cost-effective and widely accessible entry point, while eye tracking should be considered an optional enhancement, for instance for attention-aware adaptation, rather than a prerequisite for system use.
5) **Enable Flexible Feature Combination**
Users should be able to combine and layer features rather than selecting a single mode, enabling configurations that balance reading support with personal comfort and individual strategies.
6) **Integrate Adaptive Mechanisms Responsive to User State**
Future iterations should consider integrating AI-based adaptation mechanisms, such as detecting line jumps, rereading behaviour, or elevated physical movement, to enable the system to provide contextually appropriate support dynamically during reading.

## V. Conclusion and Future Work

The primary focus of the initial user-centred workshop was on user experience, as opposed to objective reading performance or long-term effects. Thus, the objective was to obtain an initial impression of usability, user experience, and acceptance. Additional research is needed to better understand the potential benefit of a reading support system for ADHD. Thus, as a next step, a randomised controlled trial will be conducted to compare an ADHD group with a neurotypical control group while reading digitally with the different visual support features. Multimodal (neuro-)physiological data, for instance brain, cardiac and body activity, will be collected during the study to investigate a potential benefit of visual reading support. Future work will explore adaptive extensions of the system, including context-aware mechanisms, such as motion tracking to dynamically trigger reading support or suggest breaks when cognitive demand increases. In addition, the integration of LLMs will be investigated for text simplification and summarising of challenging passages. Following the implementation of insights and feedback from the prototype testing, a subsequent user-centred workshop will be planned to further evaluate and refine the adjusted prototype. Overall, the initial assistive reading system developed for people with ADHD was perceived positively by the workshop participants. However, user workshop results have yielded clear opportunities for improvement, highlighting that while the prototype is functional in principle, additional refinement is required in order to better align with individual user needs and preferences.

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*KK and SB contributed equally to this work and share first authorship. All authors contributed to the manuscript. KK, SB, and HA designed and conducted the user-centred workshop; KK and HA analysed the data; AFK and SB developed the software. NW and CR supervised the work and coordinated the project.

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