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EYE-TEACH

D2.1. Scientific Report on Key Eye Movement Predictors of Reading Comprehension

Author(s):	Diane Mézière, Johanna Kaakinen (UTU); Francesca Zermiani, Cristina Vargas, Ladislao Salmerón (UVEG); Leen Catrysse (OUNL)
Editor(s):	Francesca Zermiani (UVEG), Diane Mézière (UTU)
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1. Introduction

Reading comprehension is the process of extracting meaning from text. From a cognitive perspective, it relies on a complex network of skills ranging from word-reading skills to higher-order language comprehension skills (see McNamara & Magliano, 2009, for a review of models). The reading systems framework (RSF) (Stafura & Perfetti, 2017) provides a comprehensive theoretical foundation to explain how reading comprehension emerges. According to the RSF, reading comprehension occurs via a complex set of interconnected skills related to language processing ranging from word processing to discourse processing (Perfetti & Stafura, 2014). RSF assumes that reading comprehension is dependent on both word-reading skills (e.g., lexical knowledge, decoding) and higher-order discourse processes. The ultimate goal of such processes and strategies is that readers build a mental representation of the situation described in the text (Kintsch, 1998; Van den Broek et al., 1999).

Reading comprehension skills are necessary for academic success (Clinton-Lisell et al., 2022) and for active participation in society (OECD, 2023). Reading comprehension skills are a major predictor of grades across the disciplines, as it is a prerequisite in any scenario where texts are part of the learning process, including history, science and mathematics. Notwithstanding, its influence extends well beyond academic settings. Reading comprehension skills are also essential for key daily life actions and for civic engagement, as many of those rely on text information that must be comprehended (e.g. understanding a contract, government regulations, or the news). Thus, reading comprehension skills are at the core of many educational systems, and growing efforts aim to combat emerging divides among more and less proficient readers (OECD, 2023).

Interventions need to rely on reliable assessments to ensure progress is being accomplished. But today there is no gold standard on how to measure reading comprehension skills and the validity of reading comprehension assessments has been brought into question (Colenbrander et al., 2017; Cutting & Scarborough, 2006; Keenan et al., 2008; Kendeou et al., 2012; Mézière et al., 2023; Nation & Snowling, 1997). Traditional assessments often focus on superficial comprehension processes which are easy to measure with multiple-choice tests (e.g. identify if an idea was mentioned or not in a text), but in doing so they neglect other more complex comprehension processes such as making inferences or critically reflecting on the text (Cutting & Scarborough, 2006; Mézière et al., 2023). Another critique points to the fact that traditional tests include texts that may not reflect the variety of genres readers are confronted with (Kendeou et al., 2012). Finally, a major limitation of traditional reading comprehension texts is that they rely on the product of the task, and thus they bring little information about the comprehension processes undertaken during the reading episode (Staub & Rayner, 2007).

In sum, those limitations could be solved by an assessment method which is flexible enough to be used in authentic settings, and that captures an array of comprehension processes (from superficial to higher-order) as they are being deployed in a text. Recent research has extensively looked into the possibility of using eye movements to predict performance on reading comprehension tasks with the ultimate aim of developing a reading comprehension assessment based on eye-movement behaviour during reading. Research varies in many fundamental aspects of text comprehension (Snow, 2002) including students' (e.g. language proficiency, educational level), text (e.g. language, text length and genre) task (e.g. comprehension measures) and context characteristics (e.g. educational system). What we are still in need is for a systematic review and meta-analysis that synthesizes this heterogeneous research. This is the goal of the current study.

1.1. Predicting Reading Comprehension Performance from Eye Movements

The idea that eye-movements capture information about readers' comprehension processes can be traced back to the eye-mind hypothesis (Just & Carpenter, 1980). This hypothesis assumes that we can gain insight into a readers' ongoing processes by monitoring where and for how long they look into a text. As readers advance through a text, the eyes move in a series of jumps (saccades), and they remain stationary in between those (fixations). The eye-mind hypothesis assumes that text information is processed immediately after a word is being fixated, without any buffering or delay. In addition, it assumes that there is a direct link between the duration of fixations within a word (gaze) and the cognitive cost associated with processing it. Corroborating this, subsequent reading comprehension research across different populations and text genres has pointed to a negative association between gaze duration and comprehension (for reviews see Rayner, 1998, 2009). Conversely, short fixations may indicate shallow reading, such as in skimming (Salmerón et al., 2017).

Even though during saccades readers don't process information, they can also be interpreted to gain insights into readers' comprehension processes. When readers make regressive saccades to previously read information they don't do it randomly.

Instead, some studies suggest that regressions reflect readers' awareness of a misinterpretation or lack of understanding (e.g. difficulties retrieving a referent while reading a pronoun). Accordingly, regressions to previous parts of the text where a misinterpretation can be solved reflect comprehension difficulties (for reviews see Rayner, 1998, 2009). Nevertheless, readers with advanced comprehension skills may be able to make regressions to informative parts of the text that may help to clarify the comprehension difficulty. In those cases, regressions could be associated with improved comprehension (Inhoff et al., 2019).

Moreover, recent studies have explored the nuanced relationship between eye-movements and reading comprehension, suggesting that the relationship may vary depending on the specific type of comprehension task administered (Mézière et al., 2023). The authors suggest that when comprehension tasks rely primarily on superficial recall of ideas, eye-movements during reading mostly reflect automatic processing. But in more complex, open-ended tasks that require deep processing and integration of information, such as summarization or inference tasks, readers may strategically engage in longer fixations and more regressions, which correlate with higher performance.

In sum, although there is a consensus that eye-movements during reading reflect ongoing comprehension processes, the interpretation of well established indicators such as fixation duration or regressions is not univocal, as they depend on different factors such as students' skills or task demands. Two recent systematic reviews have aimed to provide further light on the association between eye-movements during reading and comprehension of scientific texts (Wang & Lin, 2025) and expository texts with pictures (Jiang & Chiang, 2025).

Wang & Lin (2025) reviewed 37 studies that used texts from scientific topics. The authors identified 23 common eye-movements indicators (grouped as temporal, enumerative and spatial) commonly reported in the literature of reading comprehension. From those, they were able to synthesise down to 13, highlighting the need to agree on a set of homogeneous indicators. From a narrative synthesis, they provided two relevant processing patterns for comprehension. Advanced comprehenders were characterized as engaging in reduced initial fixation times together with increased regression episodes. In addition, they would engage in longer fixations (or a high number of) on relevant parts of the text that provide useful information to answer the comprehension task. In sum, advanced comprehenders of scientific texts are quick readers that accompany speed with regressions to ensure appropriate understanding, which are able to identify task demands and map them to the specific parts of the texts .

Jiang and Chiang (2025) meta-analyzed 16 studies that used scientific texts with pictures. In addition, studies differentiated between high and low skilled learners, using a variety of assessments (i.e. reading comprehension skills, prior knowledge, learning performance, intellectual ability or grades). Results revealed that high-skilled students, as compared to low-skilled, performed more saccades between text and pictures ($g = .42$) (see also Alemdag & Cagiltay, 2018), fixated on pictures more often ($g = 0.47$) and in higher proportion than on the text ($g = 0.36$).

Reviews by Wang and Lin (2025) and Jiang and Chiang (2025) only focused on scientific texts, leaving apart other relevant genres such informative and narrative texts. In addition, they didn't systematically analyze the potential effects of moderators (reader, text, task and context) on the relationship between eye-movements and reading comprehension. Only Jiang and Chiang (2025) analyzed the effect of students' prior skills. Our study aims to fill in this gap, by meta-analyzing studies that used texts from any genre and topic, and measured reading comprehension with diverse tasks.

1.2. Moderators of the Relationship Between Eye Movements and Reading Comprehension

The reading for understanding framework (Snow, 2002) provides a comprehensive overview of factors affecting reading comprehension, which is defined as the process of extracting and constructing knowledge from text. Comprehension occurs as the interaction of four main elements: reader (individual abilities, knowledge and attitudes), text (from any genre or discipline), and activity (purpose, processes, and consequences of reading) that take place within a particular socio-cultural context (e.g. educational system). For each of those, in the following we shall discuss factors for which there is empirical evidence. To foreshadow, most previous research exploring moderators of the association between eye-movements and reading comprehension have focused on readers' characteristics, and to a lesser extent at the text, task and socio-cultural context.

1.2.1. Reader Characteristics

Prior research has extensively examined eye movements and text comprehension across different reader populations, demonstrating that eye-movement patterns are closely tied to reading comprehension skills, developmental stage and language proficiency.

A major reader characteristic studied in the literature is reading comprehension skills, as measured in standardized tests. Although such tests varied in terms of underlying theoretical framework, most measure readers' ability to identify information in the text, integrate such information into a coherent representation and reflect upon it (McNamara & Magliano, 2009). Participants in van der Schoot et al. (2012) were 12 years old, divided in two groups according to their scores in a standardized reading comprehension test (4 in the higher and 4 in the lower quartile). Participants read a series of short narratives, and answer local and global comprehension questions. Participants with low comprehension skills performed much longer first pass fixation duration, and fewer regressions to the character descriptions after an ambiguous description (although, overall, such regressions were scarce). Such differences on eye movements between high and low skilled readers, particularly related fixation times, corroborate other research (Ashby et al., 2005; Chace et al., 2005; Jian & Ko, 2017; Kraal et al., 2019; Murray & Kennedy, 1988; Spichtig et al., 2017). As for comprehension questions, not surprisingly, participants with low comprehension skills were outperformed by high skilled ones. The association between eye movement indicators and comprehension was not reported, so we can't test if those changes as a function of comprehension skills.

Differences in eye movements associated with reading comprehension skills suggest that efficient lower-level processing frees cognitive resources for meaning construction and integration. However, this relationship may not remain stable across development. A recent meta-analysis by Leachman et al. (2025) shows that reading fluency becomes less predictive of comprehension at higher grade levels, raising the possibility that eye-movement measures closely tied to fluency—such as mean fixation duration—may also decrease in explanatory power as readers mature. Developmental research highlights how eye movement behavior changes as reading comprehension skills evolve. In their review of literature on children's eye movements during reading, Blythe and Joseph (2011) concluded that compared to adult readers, children typically make more and longer fixations, and more regressions. This pattern is probably due to children's lower rate of lexical processing (Mancheva et al., 2015; Reichle et al., 2013). As readers gain proficiency, reductions in fixation duration and frequency appear to support more efficient allocation of attention to higher-level comprehension processes. Thus, associations between eye movements during reading and text comprehension may potentially differ across development, with stronger links for developing readers.

Previous work on dyslexia provides further evidence that atypical readers tend to perform more and longer fixations. The extent to which the association between those eye-movements and comprehension is different from that of typical readers is still an open question. Jones et al. (2007) analyzed a group of adults with dyslexia, this time reading silently short sentences. Readers with dyslexia, as compared to those from the control group, took longer overall to read the sentences and made more fixations per sentence. However, across the whole sentence, the average duration of fixations did not vary between groups. Instead, readers with dyslexia made more regressions. The authors used yes-no comprehension questions for some of the sentences, but they didn't correlate this with eye-movements. Similarly, Prado et al. (2007) analyzed how children (11 years old) read aloud a short paragraph. As compared to the control group, participants with dyslexia performed more and longer fixations, and more and longer regression episodes (see also Hutzler and Wimmer, 2004). The authors didn't take any measure of text comprehension, thus we can't examine the association between eye-movements and comprehension.

Similar patterns of eye movements during reading have been observed in second language (L2) readers, although the underlying causes may differ. Kuperman et al. (2023) performed a large-scale multi-lab study in 12 countries, with 543 undergraduate students, who read a set of short expository texts, both in their own language (L1) as well as in English as second language (L2). Students answered two multiple-choice comprehension questions after each text. Eye movement measures varied between from reading in L1 or L2. Specifically, while reading in L1, as compared to L2, fixations were shorter and fewer, reading rate higher, and regressions fewer (see Berzak et al., 2022, and Cop et al., 2015, for similar patterns). Critically, eye movements in L2 didn't predict comprehension outcomes, once the authors controlled for relevant individual differences such as L1 proficiency. These findings suggest that eye movements capture the additional processing effort required for reading in a non-native language.

Taken together, this literature indicates that reader's characteristics clearly influence eye movements during reading. More advanced readers, as compared to less advanced groups (e.g. younger, students with dyslexia, L2 readers) tend to show shorter and fewer fixations, as well as fewer regressions. Critically, the extent to which this association between eye movements and comprehension remains at different levels of readers' skills remains unexplored.

1.2.2. Text Characteristics

Research has explored how eye movements vary as a function of text characteristics such as text difficulty, genre, multimedia texts or language transparency. Less emphasis has been given to analyse how those features moderate the association between eye movements and comprehension.

Text difficulty can be characterized by different factors. Rayner et al. (2006) asked 32 adults to read several sentences that varied in different dimensions of difficulty (i.e., low-frequency or unpredictable words, visually harder fonts). Difficult sentences lead to longer and more fixations as well as more regressions, indicating increased processing load and tighter coupling between word-level processing and comprehension demands. In Bayat and Pomplun (2016), 21 adults read a series of short news reports varying in readability scores (Flesch-Kincaid). Mean fixation duration and reading speed didn't vary as a function of readability. Text comprehension was not assessed in this study, so we can't identify the extent to which text difficulty moderates the association between eye movements and comprehension.

A major distinction among text genres is between expository and narrative texts. Expository texts, compared to narratives, tend to use complex academic vocabulary and more abstract knowledge. This makes expository texts harder to comprehend (Best et al., 2008; Graesser & McNamara, 2011). Few studies have compared eye movements across different text genres. Gómez-Merino et al. (2022) asked 19 adolescents to read short narrative and expository texts from a standardized reading comprehension test. Expository texts yielded longer gaze duration and more regressions than narrative ones. Similar patterns of gaze duration in children were found by Chen and Ko (2011) and Kraal et al. (2019). Although Gómez-Merino et al. (2022) included comprehension questions, they didn't correlate them with eye movements.

Within educational expository texts, a prominent subgenre consists of multimedia documents, that is, texts that include informative images. Within this scenario, previous meta-analyses have identified a robust association between eye-movements indicators and text comprehension (Alemdag & Cagiltay, 2018; Jiang & Chiang, 2025). Specifically, higher number of visual transitions between the text and the images positively correlates with comprehension. This suggests that eye-movements are capturing a strategic comprehension process aimed at integrating different representations.

The extent to which language-specific features such as script type and orthographic transparency shape eye-movement during text reading is still an open debate. Potentially, linguistic characteristics such as orthographic transparency influence the rate of acquisition of a language. In transparent orthographies, decoding becomes accurate relatively early, so fluency plays a somewhat reduced role in predicting children's text processing, and potentially comprehension, compared to deeper orthographies. This relationship can change over time as readers of deeper orthographies develop experience and automatize decoding (Leachman et al., 2025). Prior studies have compared a few languages. In Feng et al. study (2009) 129 students (3rd, 5th grade and undergraduates), from the US and China, read short narratives. Gaze time per word was higher in English than in Chinese for younger students, and similar for adults. Conversely, average fixation duration was similar for young students, and higher for adult Chinese. Average fixation duration was similar for each sample across languages. A different pattern was found in Liversedge et al. (2016), who tested 66 undergraduate students from UK, China and Finland while they read several short expository texts. Students from China made fewer but longer fixations than English. Those from Finland made more and shorter fixations than the other two samples. A third pattern was found by Rayner et al. (2007), who tested 79 undergraduate students from the US and China while reading sentences. No differences in average fixation duration were observed. Although comprehension was measured in those studies, they were not directly related to eye movement measures.

In sum, previous research provides some evidence on the effects of text characteristics on eye movements while reading texts, with longer and more fixations in more difficult texts, and in expository as compared to narrative. There is no clear consensus on how linguistic characteristics such as orthographic transparency leads to differential processing. As was the case with readers' characteristics, the extent to which the association between eye movements and comprehension changes as a function of text features remains largely unexplored.

1.2.3. Task Characteristics

Reading comprehension processes can be influenced by the task demands (Rouet et al., 2017; Snow, 2002). Prior studies have analyzed how task purposes (e.g. reading for understanding or for error detection) and type of comprehension tasks (e.g. multiple choice questions or summary tasks) influence readers' eye-movements and comprehension outcomes. The major focus has been to identify changes in eye-movement patterns, and less in testing the extent to which the association between eye-movements and comprehension varies with different tasks demands.

Readers engage with texts with a particular purpose, as determined by different types of reading tasks. Research has mostly focused on exploring eye-movements in different reading tasks, comparing standard reading for comprehension with other tasks such as proofreading (Schotter et al., 2014), skimming (Duggan & Payne, 2009), word verification (Radach et al., 2008) or error detection (Søby et al., 2023). Not surprisingly, readers systematically adapt their eye movements to what they are asked to do with a text, and this adaptation shows up in their eye-movements.

The influence on eye-movements for specific text comprehension tasks is not so evident. Prior research has analyzed the effects of different item types (e.g. multiple choice questions, CLOZE items) of text comprehension tests on eye-movements (Bax & Chan, 2019; Mézière et al., 2023). Potentially, open items can demand for higher-order comprehension processes, while multiple-choice questions are more prone to literal or recognition processes. Overall, results are difficult to interpret, as items can potentially demand for different comprehension processes (e.g. locate or integrate ideas). Salmerón et al. (2017) varied comprehension demands while keeping item format constant (i.e. multiple choice questions). Specifically, 27 students from 9th-10th grade read a Wikipedia like text while answering two types of multiple-choice questions following the PISA framework (OECD, 2009). Retrieve questions requested to identify information stated in the text, while integrate questions required to connect pieces of information via inferences within different subsections. Question type didn't influence a number of eye-movement indicators: number of dwells to paragraphs, first or second dwell times to paragraphs. This pattern highlights students' difficulty in differentiating subtle tasks demands, such as differentiating the specific processes required for text comprehension questions (Rouet et al., 2017).

Overall, research suggests that different reading tasks clearly influence readers' eye-movements during reading. The effect of different text comprehension tasks on readers' processing is less evident.

1.2.4. Context Characteristics

Reading takes place within a particular socio-cultural context, which can influence text comprehension via different elements (Lee, 2020), such as country's literacy rates (or different emphasis on literacy across educational systems), through cultural familiarity (the extent to which a text represents culturally relevant information for readers), or cultural artifacts (the device in which reading takes place).

Overall, research on eye-movements during reading has not particularly focused on context characteristics. An exception are studies analyzing processing differences across reading devices (e.g. paper vs. tablet), which report minor to null differences in terms of eye-movements (Delgado & Salmerón, 2019). Of potential interest for text comprehension development is readers' global educational and cultural context. At population level, there are sharp differences among countries on reading comprehension level (OECD, 2019), probably reflecting countries' economic structures and cultural dynamics. But to the best of our knowledge, there are currently no known studies that explicitly correlate national-level literacy rates with aggregated eye-movement metrics during reading. Instead, the literature links eye movements to individual reading skill and, separately, discusses cross-linguistic or cross-cultural differences in reading behavior. Potentially, the associations between eye-movements and comprehension across countries could mimic the clear link between eye-movements and reading skills discussed above.

All in all, the effects of context characteristics on eye-movements during reading remains underexplored.

1.3. Aims and Research Questions

Prior research on eye-movements during reading has identified major indicators linked to word decoding (e.g. early number and duration of fixations) and strategic comprehension processing (e.g. number of regressions) (Rayner, 1998; Rayner et al., 2005). Evidence reveals that eye-movements depend to a large extent on readers, text and task characteristics. Critically, the extent to which eye-movements predict readers' final text comprehension, and specifically how such association is moderated by readers, text and task characteristics, has received less attention in the literature. The aim of this meta-analysis is to clarify and quantify those associations and moderations.

The meta-analysis seeks to combine existing research into a larger analysis, as this may help to overcome some of the limitations of individual studies, including low sample sizes and heterogeneity in reported eye-movements and text comprehension measures. Studies measuring eye-movements during reading tend to be conducted with rather small samples, which reflects the difficulty to collect reliable data with eye-tracking systems. This limitation has been addressed by a small number of recent large-scale corpora, which nevertheless remain the exception in the literature. A meta-analysis has the potential to overcome this drawback by adding up samples from individual studies into a large sample. In addition, prior research has reported different types of eye-movement indicators, often with subtle differences among studies, such as the region of interest (AOI) taken as reference (e.g. word or sentence). In their review, Wang & Lin (2025) reported 23 eye-movements indicators, indicating duration, amount or spatial information. A meta-analysis allows to match identical eye-movement indicators across studies, to ensure precision on the analyses to predict text comprehension. Finally, prior research has assessed text comprehension with a variety of methods, which makes the comparison across individual studies difficult. A meta-analysis can identify important differences of assessment (e.g. item format) and test its potential influence on the association between eye-movements and text comprehension.

Our pre-registered meta-analysis aims at responding to main research questions.

RQ1: Which eye movement indicators predict reading comprehension outcomes?

We will adjust our analyses to the eye movement indicators for which there is a substantial amount of identical indicators in the literature. We anticipate that indicators linked to word decoding (e.g. amount and duration of first fixations) will be negatively associated with text comprehension, reflecting difficulties in accessing word meaning (Rayner, 1998; Rayner et al., 2005). Potentially, fewer and shorter first fixations may indicate shallow reading (like in skimming, Duggan & Payne, 2009) and thus be linked to lower text comprehension (Salmerón et al., 2017). Still, we don't expect that most students will skim text during comprehension tasks, thus across studies we anticipate negative associations.

In addition, indicators linked to comprehension processing difficulties (e.g. number of regressions), will be negatively associated with text comprehension outcomes. Potentially, if regressions allow to fix comprehension errors, they could be associated with improved comprehension (Inhoff et al., 2019).

RQ2: Which characteristics of the reader, text, task and context influence the relationship between eye movements and reading comprehension?

Based on the literature reviewed on the effects of reader, text, task and context on eye-movements, we expect that such influences will also moderate the associations between eye-movements and text comprehension. First, regarding readers' characteristics, we expect that the association between eye-movements indicators of word decoding (e.g. amount and duration of first fixations) and text comprehension will be stronger in less advanced readers (e.g. younger, students with dyslexia, L2 readers), as they reflect lack of automatizity in word meaning access. As for eye-movement indicators of comprehension processing (e.g. regressions), for less advanced readers we expect negative associations, as they indicate comprehension difficulties. By contrast, for more advanced readers we anticipate null or even positive associations, as they had the skills to use the information during regression episodes to solve the comprehension difficulties that arose (Inhoff et al., 2019).

Second, regarding text characteristics, we expect that eye-movement indicators of word decoding will signal higher difficulties in word meaning access in more difficult texts, as well as in expository rather than narrative texts. Accordingly, the negative association between amount and duration of first fixations and text comprehension would increase in more demanding texts. Given the lack of consensus in the literature, we do not advance specific predictions regarding eye-movement indicators of comprehension processes, nor regarding the role of linguistic characteristics such as orthographic transparency. One exception concerns multimedia documents: in light of previous meta-analyses (Alemdag & Cagiltay, 2018; Jiang & Chiang, 2025), we anticipate that visual transitions between text and images will be associated with higher comprehension.

Third, as for task characteristics, the evidence on how item format and text comprehension tasks are inconclusive, and thus we don't hold any strong prediction. Potentially, tasks with closer comprehension demands towards the text representation, such as multiple-choice items or retrieve-locate questions, will be more sensitive to eye-movement indicators of word meaning access. Those with higher demands towards a higher-order representation (i.e. situation model) could be more sensitive to eye-movement indicators of comprehension processes.

Finally, as for context characteristics, due to the limited research, we will explore potential moderation effects of country-literacy levels. The link between eye-movements and text comprehension across countries could follow a similar pattern as that described above for reading skills. Accordingly, we speculate that the association between eye-movement indicators of word decoding (e.g. amount and duration of first fixations) and text comprehension will be stronger in countries with lower literacy levels.

2. Methods

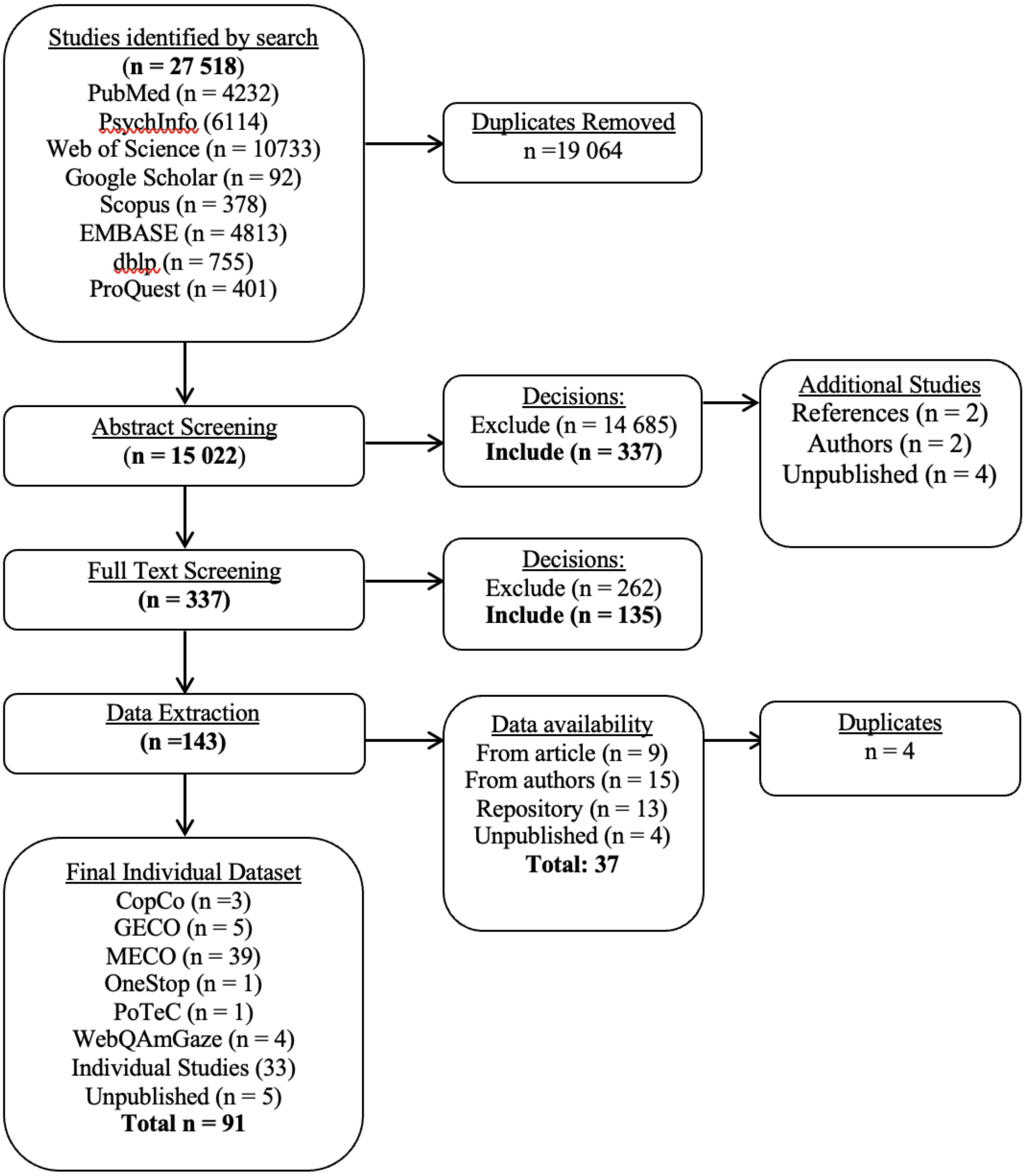
This meta-analysis was pre-registered in the international prospective register of systematic reviews PROSPERO [https://www.crd.york.ac.uk/prospero/], under the registration number CRD420251018501, in April 2025.

2.1. Eligibility Criteria

In line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2010), we conducted a systematic search in the following databases: PubMed, PsycINFO, Web of Science, Google Scholar, Scopus, EMBASE, dblp, and ProQuest Dissertations and Theses. This initial search was conducted in April 2025. The full search query "(eye tracking OR eye-tracking OR eye movements OR gaze behavior OR gaze tracking) AND (learning OR reading OR reading comprehension OR text comprehension)" was applied to identify articles that included any of these terms in their title, abstract, or keywords fields. The search terms therefore restricted the search to articles investigating reading comprehension through the use of eye-tracking technology. Additionally, we contacted authors in the related fields to inquire about potential unpublished datasets or articles not identified in the initial search. We received four unpublished datasets and two additional articles that we included in our meta-analysis. Finally, we performed a forward search to find articles that cited the included articles and a backward search to examine their reference lists, which led to the inclusion of two additional articles. Both forward and backward searches were conducted using *citationchaser* (Haddaway et al., 2021). Fig. 1 shows the systematic search and selection process.

The initial search yielded 27518 across databases. After removing duplicates, 15022 abstracts were screened by two authors. Duplicate identification and screening (both abstracts and full text) were done using Rayyan (Ouzzani et al., 2016). Given the large number of abstracts to screen, we first used Rayyan's keywords to identify and exclude articles that were clearly not within the scope of our meta-analysis (e.g.,, "non-human"; "infants"; "monkeys"; "mice"; "cadavers"), as many articles reported learning studies done on animals or infants. Articles were then excluded based on the type of study reported (i.e., experiment versus review) and the type of data reported (i.e., eye-tracking versus self-paced reading) such that articles were excluded if they did not report an eye-tracking study in which at least one of the tasks was reading, if the eye-tracking data was not collected during the reading comprehension task (i.e., the comprehension score is about another text than the one read while collecting the eye-tracking data), or if reading was not done at the participant's own pace (i.e., word-by-word presentation or timed reading). Articles were also excluded based on characteristics of the reading task, and we excluded studies in which the reading task was not reading for comprehension (e.g., proof-reading, looking for information in the text), reading was done aloud, the text was available when answering the comprehension questions, or the text was shorter than 2 sentences. We further excluded any article in which participants had an acquired language or reading disorder (e.g., aphasia). If these exclusion criteria were not mentioned clearly in the abstract, we included the article for full-text screening. Abstract screening yielded 337 abstracts that fit our inclusion criteria, with an agreement of 97%. Conflicts were resolved through discussion between the two authors and if no agreement could be reached the article was included for full-text screening. The full-text screening was conducted by 5 reviewers such that each article was reviewed by two people. In instances where the information was missing from the paper, we contacted authors for clarification. Articles were excluded based on the same criteria as for the abstract screening, leading to 135 articles being included, to which we added 4 unpublished dataset sent to us by authors, 2 articles not captured by the initial search indicated to us by authors, and 2 articles found through the reference search, for a total of 143 articles included for data extraction.

Figure 1. Article Selection and Data Extraction Process



2.2. Data Collection

2.2.1. Eye-Movement Measures and Effect Sizes

Data extraction was conducted according to data availability. First, all articles were screened to check for availability of the reading comprehension and eye-tracking data, and this data was extracted based on three scenarios: 1) correlations and/or mean and standard deviations are reported in the paper; 2) the data is openly available in a repository (e.g., OSF); 3) the data is not available. If the paper reported either correlations between the comprehension task and eye-movement metrics or mean and standard deviation for eye-movement metrics for groups with different reading abilities (e.g., good and poor readers) the data was extracted directly from the paper by two authors. For papers which only contained mean and standard deviation, Cohen's d was calculated and then transformed into Pearson's r. If the data was available from a repository, all data was extracted and we calculated Pearson's r correlations between eye-movement metrics and reading comprehension scores ourselves. If the data was not available, we contacted the authors asking for either correlations between comprehension scores and eye-tracking metrics, or for the raw data so that we could calculate the correlations ourselves. Duplicate datasets (e.g., multiple articles using the same data) were removed. Data was available from the paper for 9 articles and in a repository for 13 articles including data from 6 eye-movement corpuses (MECO; GECO; CopCO, PoTeC, OneStop, and WebQAmGaze). Lastly, we received correlations/data from authors for 15 articles, as well as 4 unpublished studies. As some studies and corpuses contained more than one dataset (e.g., data from different languages/lab, different participant groups, different experiments), we ultimately had 91 separate datasets which could be included in our analysis from the 37 articles for which data was available to us (See Data Pre-processing and Analysis for details on how these datasets were decided on). We considered all eye-movement metrics reported in the article or available in the datasets, and extracted metrics calculated for all analysis levels including individual words, sentences, visual (e.g., picture accompanying the text), and the whole text.

Because there is no standard as to which eye-movement metrics are used or reported across studies, we included eye-movement metrics in the analysis in two steps. First, two authors went through the list of available metrics and checked definitions or calculation methods for each metric as provided in the article itself, eye-tracker manual (e.g., Data Viewer Manual), or on additional information provided in the repository (e.g., ReadMe files with variable definitions). This was done to ensure that metrics that may be given different names across papers but are actually the same metric were treated as one (e.g., first-pass duration and gaze duration), and that metrics that may be given the same name across papers but are not calculated the same are treated as separate (e.g., total reading time at the word level versus total reading time for the whole text). Through this process, the two authors came up with uniform metric names across all datasets including the level of analysis (i.e., word, sentence, passage, visual). Secondly, we checked the number of available data points per metric to see if we had enough data to conduct the meta-analysis and excluded metrics for which less than 3 data points were available (e.g., only one article reported this measure).

2.2.2. Study Characteristics and Moderators

For each of the 37 articles for which data was available, two authors also extracted data relating to the study, including information about: 1) the article/corpus itself: date of publication, publication status, peer-review status, and country where the study was conducted; 2) information about the participants: number of participants, age (mean and sd), number of females, school grade, native language, L1 or L2 status, and reading group (e.g., dyslexia); 3) the eye-tracking equipment used: device (e.g., EyeLink 1000), sampling rate, gaze detection software/algorithm, and experimental environment (lab or school); 4) the reading task: text type (narrative, expository, mix), text language, text length, visual content (i.e., does the stimuli include a visual along with the text), comprehension task type (e.g., multiple-choice questions), number of items on the comprehension task, task developer (i.e., experimenter or standardized task), and comprehension task reliability measures (e.g., Cronbach alpha). This information is summarized in Table 1, and was extracted so we could consider several moderators in our analysis such as text language, text type, comprehension task type, L1/L2 status, and reading development (i.e., children versus adults, grade). If critical information (e.g., the type of text) was missing from the paper, we contacted authors for clarifications. If we received no response with either treated the data as missing, or when possible we made assumptions based on the most common type of experiment run in the field (e.g., L1 data is more likely if not specified).

2.3. Calculating Effect Sizes

Across studies, we extracted or calculated Pearson's r correlations as the effect size for the relationship between eye-movement metrics and reading comprehension scores. When only mean and standard deviations could be extracted, we first calculated Hedge's g as the effect size and then transformed it into Pearson's r for comparison with the other datasets. If Spearman correlations were reported, we transformed them into Pearson's r. If the correlation type was not specified, we assumed it to be Pearson's r as this is the most commonly-used method for calculating correlations between continuous variables. To normalize the effect sizes, we then applied Fisher's Z-transformation and calculated standard deviation based on sample size before conducting the meta-analysis.

2.4. Data Pre-processing and Analysis

2.4.1. Dataset Reduction Per Study/Corpus

Before finalizing the data extraction process, we made decisions about how to treat datasets that came from the same study/corpus such that we could reduce the number of datapoints that came from the same study/corpus especially if the data came from the same participants (e.g., all participants saw all conditions) and the separation was not relevant to our analysis (e.g., relevant versus irrelevant parts of text) or only reported in one study. Firstly, to minimize the influence of the MECO data which represented half of our datasets, we treated all datasets collected in the same language as one. For example, we calculated correlations between eye-movement metrics and comprehension scores for all English-language data collected from native English speakers at once (L1 Wave 1 data, L1 wave 2 data, L2 Wave 1 data, and L2 wave 2 data) such that we had only one data point for MECO data from English speakers reading in English instead of 4. This resulted in 39 datasets from MECO (21 for L1 data and 18 for L2 data). When possible we also reduced data in instances were results were reported per experimental condition (e.g., abstract versus concrete visuals: Mason et al 2013), per text type (expository versus narrative: Özer & Özdemir 2021), per relevance (e.g., relevant versus irrelevant information: Kaakinen et al., 2015, Yeari & Lev, 2021), or reading medium (tablet versus paper: Delgago et al., in preparation) by taking the average correlation across conditions so as to have only one data point per study. This was only done in instances when the participants were the same in both conditions and/or when the separation was not relevant to the analysis (e.g., reading medium). These reductions allow for multi-level analyses that take into account the fact that we have multiple data points that come from the same study/corpus, as opposed to univariance analyses which cannot do so.

2.4.2. Data Analysis

Data analysis is currently ongoing. For each eye-tracking measure included in the analysis, we will run a meta-analysis according to the number of data points available, and the number of separate studies/corpus they come from. In instances where we have data that come from at least 10 separate studies, we will run a multi-level analysis with random effects. For other cases, we have to consider the proportion of data points that come from the MECO corpus and make decisions for each of the following scenario: 1) data points come primarily from MECO (50% or more); 2) data points come exclusively from MECO (e.g., 21/18 datapoints but all from the same corpus); 3) MECO data is not included but less than 10 data points are available. We are currently working on making the appropriate decisions as to how to treat these separate cases to ensure that we can include as many eye-tracking metrics as possible while avoiding over-fitting or over-representation from MECO data.

We will also consider a number of moderators related to the country the experiment took place (e.g., literacy levels), language/script characteristics (e.g., mean word length, transparency), developmental stage (children versus adults, grade), text type (i.e., narrative, expository, mixed), and reading comprehension task (i.e., open-ended, multiple-choice, mixed). In addition, we will consider the role of reading in one's native or second language (i.e., L1 versus L2). As many of the datasets for L1 and L2 data come from the same study/corpus, we will run separate analyses for these two groups to examine the influence of native-speaker status on the relationship between eye movements and reading comprehension.

In all cases, we plan to use a random-effect meta-analysis to estimate overall effect sizes for each eye-movement metric separately, and model parameters will be estimated using restricted maximum likelihood (REML). Results will be visualized in forest plots including the average effect size and the 95% confidence interval. The presence of outliers will also be assessed and we will remove them as appropriate. To assess heterogeneity, we will apply the following statistical measures: Cochran's Q statistic, I^2 index and the 95% prediction intervals.

To explore sources of heterogeneity, we will conduct meta-regression analysis using the robust variance estimation method for both continuous and categorical moderator variables. We will evaluate publication bias using multiple approaches: a) Visual inspection of funnel plots for each eye movement metric; b) Egger's regression test; c) Meta-regression models to test whether publication status (published vs. unpublished) moderates effect size. To assess the robustness of the results, we will conduct sensitivity analysis. For instance, leave-one-out analysis will be performed to evaluate the impact of each effect size on the overall mean effect estimate. Data analysis and synthesis will be carried out using R and R-Studio.

3. Results

3.1. Study Characteristics

The characteristics of the studies/corpuses included in the analysis are summarized in Table 1. Most of the studies for which data was available were conducted in the last 10-15 years. This is partially due to the fact that while many studies fit our inclusion criteria, very few directly investigated the relationship between eye movements and reading comprehension outcomes such that we had to contact the authors of over 100 studies to ask for correlations or the data, most of which was no longer available as it was collected over 15 years ago. As such, over half of the available data came from 6 eye-tracking corpuses collected in the last 10 years, particularly the MECO data which represents about half of the available datasets. Nevertheless, the data available was collected in a wide range of countries and languages, with 22 languages represented collected in over 30 countries. In the majority of the datasets readers were reading in their native language (n = 64), and English was the most commonly reported language (n = 39) especially for studies with non-native speakers (n = 26). The majority of studies tested adult readers (n = 75), and nearly all studies reported data from typical readers (n = 90) as only one dataset included participants with dyslexia (CopCo). Across studies, the eye-tracking equipment used was also similar with EyeLink trackers being the most commonly used (n = 63) with a sampling rate of 1000 Hz or higher (n = 62). The reading task typically consisted of reading expository texts (e.g., science texts; n = 73) of short to medium-length (< 1000 words; n = 70) followed by multiple-choice questions (n = 71). Lastly, some studies included texts with a visual (e.g., diagram, picture; n = 11) and this type of task was used in both adult (n = 5) and children (n = 6) studies.

Table 1. Study Characteristics

Authors/ Corpus	Year	Country	Children/ Adult	L1/ L2	Eye-Tracker	Sampling Rate (Hz)	Text Type	Text Language	Text Length	Visual	Comprehension Task Type
Ballenghein & Lachaud	2025	France	Children	L1	Tobii Pro Glasses 2	100 Hz	Expository	French	1284; 1452 words	No	True/False
Bao et al., (MECO)	2025	China	Adults	L1	EyeLink 1000	1000 Hz	Expository	Mongolian	157 - 263	No	Yes/No questions
Berlin-Khenis et al.	2024	Russia	Children	L1	EyeLink 1000+	1000 Hz	Expository	Russian	75-111 words	No	True/False
Chen & Chen	2020	Taiwan	Children	L1	EyeLink 1000	1000 Hz	Narrative	Chinese	122 characters	No	MCQ
Chen et al.	2022	China	Adults	L2	Tobii Pro Fusion	120 Hz	NR	English	1 paragraph	No	Open ended/ MCQ
CopCO	2022	Danmark	Adults	L1 L2	EyeLink 1000	1000 Hz	Expository	Danish	1832 sentences	No	Yes/No questions
De Martino	2023	Italy	Adults	L1	Tobii Pro X2-30	NR	NR	Italian	NR	No	True/False
Delgado & Salmeron	2022	Spain	Adults	L1	SMI Eye-Tracking Glasses v1	30 Hz	Expository	Spanish	363-443 words	No	MCQ
Delgado et al	NA	Spain	Adults	L1	SMI Eye-Tracking Glasses v1	30 Hz	Expository	Spanish	4231-1161 ~ 3000 words	No	Open questions

Authors/ Corpus	Year	Country	Children/ Adult	L1/ L2	Eye-Tracker	Sampling Rate (Hz)	Text Type	Text Language	Text Length	Visual	Comprehension Task Type
GECO	2017	Belgium England	Adults	L1 L2	EyeLink 1000	1000 Hz	Narrative	Dutch Chinese English	Half/whole book	No	MCQ
Gomez- Merino et al.,	2022	Spain	Children	L1	portable SMI	60 Hz	Expository Narrative	Spanish	75 & 94 words	No	Open-ended questions
Jaafat et al.	2018	England	Adults	L2	Tobii Pro TX300	300 Hz	Expository	English	NR	Yes	Open-ended questions
Jian 2018	2018	Taiwan	Children	L1	EyeLink 1000	1000 Hz	Expository	Chinese	400 words	Yes	MCQ and Yes/No questions
Jian et al.,	2019	Taiwan	Children	L1	EyeLink 1000	1000 Hz	Expository	Chinese	439 characters	Yes	True/False questions
Kaakinen et al.	2015	Finland	Adults/ Children	L1	EyeLink 1000	1000 Hz	Expository	Finnish	63, 88, 89 words	No	Yes/No, Open
Kyriakidou et al.	NA	Canada	Adults	L1	EyeLink 1000/1000+	1000 Hz	Expository Narrative	English	NR	No	Open-ended questions
Lee et al.	2024	England	Adults	L1	EyeLink 1000	1000 Hz	Expository Narrative	English	100-200 words	No	MCQ
Liu et al.	2009	USA	Adults	L1	Applied Science Laboratories Model H6	60 Hz	Expository	English	150 words max	Yes / No	Yes/No questions
Mason Tornatora & Pluchino	2013	Italy	Children	L1	Tobii T120	120 Hz	Expository	Italian	219 words	Yes	Recall
Mason, Pluchino et al.	2013	Italy	Children	L1	Tobii T120	120 Hz	Expository	Italian	243 words	Yes	Open questions

Authors/ Corpus	***Year***	***Country***	***Children/ Adult***	***L1/ L2***	***Eye-Tracker***	***Sampling Rate (Hz)***	***Text Type***	***Text Language***	***Text Length***	***Visual***	*Comprehension **Task Type***
MECO	2022 2023 2025	Brazil Spain China Taiwan Denmark Belgium Estonia England Canada Finland Germany Switzerland Cyprus Israel India Iceland Italy South Korea Norway Russia Serbia Argentina Chile Turkey	Adults	L1 L2	EyeLink 1000 EyeLink 1000+ EyeLink Portable Duo	1000 Hz	Expository	Basque Portuguese Chinese Danish Dutch Estonian English Finnish German Greek Hebrew Hindi Icelandic Italian Korean Norwegian Russian Spanish Turkish	100-200 words	No	MCQ
Mézière et al.	2025	Australia	Adults	L1	Eyelink 1000	1000 Hz	Narrative	English	1000 words	No	Recall

Authors/ Corpus	Year	Country	Children/ Adult	L1/ L2	Eye-Tracker	Sampling Rate (Hz)	Text Type	Text Language	Text Length	Visual	Comprehension Task Type
OneStop	2024	Israel	Adults	L1	EyeLink 1000+	1000 Hz	Expository	English	109 words average	No	MCQ
Özer & Özdemir	2021	Turkey	Children	L1	SMI RED I View-X	500 Hz	Expository Narrative	Turkish	186 words; 264 words	No	Open-ended questions
PoTeC	2024	Germany	Adults	L1	EyeLink 1000	1000 Hz	Expository	German	158 words average	No	MCQ
Pothuri	NA	Finland	Adults	L2	Eyelink 1000+	2000 Hz	Expository Narrative	English	650-750 words	No	Open-ended questions
Romero-Palau et al.	NA	Spain	Children	L1	LogicOne	250 Hz	Expository	Spanish	NR	No	MCQ
Schmidtke et al.	2023	Canada	Adults	L2	EyeLink 1000/1000+	1000 Hz	Expository Narrative	English	51-130 words	No	Open-ended questions
Serrano & Pellicer-Sánchez	2022	Spain	Children	L2	Tobii T120	120 Hz	Narrative	English	26 pages	Yes	Open questions
Tsai et al.	2022	Taiwan	Adults	L1	FaceLab 4.6	60 Hz	Expository	Chinese	749 characters	No	Recall
Vibert et al.	2025	France	Adults	L1	Tobii TX 300	NR	Narrative	French	59-70 words	No	Open-ended questions
Wang et al.	2022	Taiwan	Children	L1	EyeLink 1000	1000 Hz	Expository	Chinese	772 characters	Yes	MCQ and Open-ended
WebQAmGaze	2023	Online (Multiple)	Adults	L1	Webcam	25.39 Hz average	Expository	German English Spanish Turkish	Max 1300 characters	No	Open questions and MCQ
Wong & Moss	2022	USA	Adults	L1	Tobii T60	60 Hz	Expository	English	300-400 words	No	MCQ

Authors/ Corpus	Year	Country	Children/ Adult	L1/ L2	Eye-Tracker	Sampling Rate (Hz)	Text Type	Text Language	Text Length	Visual	Comprehension Task Type
Yeari & Lev	2021	Israel	Adults	L1	SMi250	250 Hz	Expository	Hebrew	269-302	No	Recall
Yildiz & Özdemir	2024	Turkey	Adults	L1	Red 250 SMI	120 Hz	Expository	Turkish	NR	No	Open-ended questions
Zawoyski & Ardoin	2019	USA	Children	L1	EyeLink 1000	NR	Expository	English	182 words	No	MCQ and Open-ended

Note. Table 1 gives a summary of the study/corpus characteristics of the datasets included in the meta-analysis. MCQ = multiple-choice questions; Hz = Hertz.

3.2. Uniformed eye-movement indicators

Across individual studies, authors tend to use several labels to identify eye-moment indicators. Thus, to maximize the precision of the analyses, we needed to match each indicator used in the studies to a uniformed set of measures. Thus, prior to analyses, we identified the definitions of the eye-movement indicators used in the original studies, and matched them to standard eye-movement indicators.

Table 2. Uniformed eye-movement indicators used in the studies

Study/Project	Measure Name	Analysis Level	Measure Type	Definition	Uniform Measure Name
Berlin-Kenis et al 2024	Average duration of fixation (ms)	Word		Average duration of fixation in a word (p 8)	Average fixation duration
Berlin-Kenis et al 2025	Total reading time per word (ms)	Word	Late	Total time spent at a word (p 8)	Total reading time (word)
Berlin-Kenis et al 2026	Average number of fixations per word	Word		Average number of fixations in a word (p 8)	Fixation count (word)
Berlin-Kenis et al 2027	Total number of regressions	Word	Late	Total number of regressions (p 8)	Regression Count (word)
Berlin-Kenis et al 2028	Average skip rate	Word	Early	Average number of words that were skipped during the reading process (p 11, table 2)	Total skipping rate
Berlin-Kenis et al 2029	Saccade Amplitude (px)	Word	Early	Amplitude of saccades (p 8)	Saccade Size

Berlin-Kenis et al 2030	Total reading time for paragraph (s)	Word	Global	Total reading time for the paragraph (p 8)	Total reading time (text)
Berlin-Kenis et al 2031	Rereading time during first-pass reading (ms)	Word	Early	Rereading time after first-pass reading (p 8)	First-Pass rereading Duration (word)
Berlin-Kenis et al 2032	Number of regression during first-pass reading	Word	Early	Number of regressions after first-pass reading (p 8)	First-pass Regression Count (word)
Berlin-Kenis et al 2033	Gaze duration per word during first-pass reading (ms)	Word	Early	Gaze duration per word during first-pass reading (p 8)	Gaze duration
Chen et al 2022	Total fixation duration (Table 2, p 525)	Word	Late	Total fixation duration (p 524)	Fixations are very short (can we use them? What is their level of analysis?)

Chen et al 2022	Saccade Amplitude (Table 2, p 525)	Text	Global	Saccade amplitude (p 524)	Saccade Size
Chen et al 2022	Number of Fixations (Table 2, p 525)	Text	Global	Several fixations (p 524)	Fixation count (text)
CopCo	word_first_fix_dur	Word	Early	First fixation duration the duration (in milliseconds) of the first fixation prevailing word (p 1716)	First fixation duration
CopCo	word_first_pass_dur	Word	Early	First pass duration the summed duration (in milliseconds) of all fixations on the current word prior to progressing out of the current word (to the left or right) (p 1717)	Gaze duration
CopCo	word_go_past_time	Word	Late	Go-past time the sum duration (in milliseconds) of all fixations prior to progressing to the right of the current word, including regressions to previous words that originated from the current word (p 1717)	Go-Past Time

CopCo	word_mean_fix_dur	Word		Mean fixation duration the sum of all fixation durations (in milliseconds) on the current word divided by the number of fixations (p 1717)	Average fixation duration
CopCo	word_total_fix_dur	Word		Total fixation duration the sum of all fixation durations (in milliseconds) on the current word (p 1717)	Total readin time (word)
CopCo	number_of_fixations	Word		Number of fixations the total amount of fixations on the current word, including all passes (p 1716)	Fixation count (word)
CopCo	word_mean_sacc_dur	Word		Mean saccade duration the meand duration (in milliseconds) of all saccades originating from the current word (p 1717)	Saccade duration
CopCo	word_peak_sacc_velocity	Word		Peak saccade velocity maximum gaze velocity (in visual degrees per	Saccade peak velocity

				second) of all saccades originating from the current word (p 1717)	
De Martino 2018	Total duration of fixations	Sentence and paragraph		Number and Duration of Fixations: fewer and shorter fixations are supposed to be associated with lower reading (p 3)	Total reading time (text)
De Martino 2018	Number of fixations	Sentence and paragraph		Number and Duration of Fixations: fewer and shorter fixations are supposed to be associated with lower reading (p 3)	Fixation count (text)
De Martino 2018	Regression path duration	Sentence and paragraph	Late		Go-Past Time (sentence)
De Martino 2018	Re-reading duration	Sentence and paragraph	Late	Re-reading duration: it corresponds to the regression-path duration minus first-pass duration and it is assumed to reflect strategic, controlled processes	Re-reading duration (sentence)

				involved in reading comprehension (p 3)	
De Martino 2018	Re-reading duration	Sentence and paragraph	Late	Re-reading duration: it corresponds to the regression-path duration minus first-pass duration and it is assumed to reflect strategic, controlled processes involved in reading comprehension (p 3)	Re-reading duration (text)
Delgado & Salmeron (unpub)	Fixation Count	sentence			Fixation count (sentence)
Delgado & Salmeron (unpub)	Fixation Count	text			Fixation count (text)
Delgado & Salmeron (unpub)	Mean fixation duration	Text			Average fixation duration

Delgado & Salmeron (unpub)	First-pass duration	sentence			Gaze duration (sentence)
Delgado & Salmeron (unpub)	Second-pass duration (re-reading)	sentence			Re-Reading Duration (sentence)
Delgado & Salmeron, 2002	Fixation Count	sentence			Fixation count (sentence)
Delgado & Salmeron, 2002	Fixation Count	text			Fixation count (text)
Delgado & Salmeron, 2002	Mean fixation duration	Text			Average fixation duration
Delgado & Salmeron, 2002	First-pass duration	sentence			Gaze duration (sentence)
Delgado & Salmeron, 2002	Second-pass duration (re-reading)	sentence			Re-reading duration (sentence)

GECO ALL	First_fixation_duration	Word		The duration of the first fixation landing on the current word (Cop et al 2017, p 609, definition matches with Sui et al 2023 p 2751)	First fixation duration
GECO	Gaze_duration	Word		The sum of all fixations on the current word in the first-pass reading before the eye moves out of the word (Cop et al 2017, p 609)	Gaze duration
GECO	Total_time	Word		Summation of all fixation durations on the current word	Total reading time (word)
GECO-CN	Total reading time	Word		The summed duration of all fixations on the current word (Sui et al 2023, p 2751)	Total reading time (word)
GECO	Go_past_time	Word		The sum of all fixations prior to progressing to the right of the current word, including regressions to previous words that originated	Go-Past Time

				from the current word (Cop et al 2017, p 609)	
GECO-CN	Go_past_time	Word		The summed durations of all fixations and regression to the previous (left-side) words from the time the current word is first fixated until the next (right-side) word is fixated (Sui et al 2023, p 2752)	Go-Past Time
GECO ALL	Trial_fixation_count	Word		The total number of fixations in the current trial.	Fixation count (text)
GECO	Trial_total_reading_time	Word		Summation of all fixation durations in the current trial.	Total reading time (text)
GECO ALL	Mean_Pupil_Size	Word		Average pupil size across all fixations in the current word.	Average Pupil Size
GECO	Fixation_number	Word		Total fixation falling on the current word.	Fixation count (word)

GECO	Second_pass_fixation_count	Word		The number of all fixations in a trial falling in the second run of the word.	Second-pass fixation count
GECO	Third_pass_fixation_count	Word		?	Third-pass fixation count
GECO	Second_fixation_duration	Word		The duration of the second fixation on the current word, regardless of the run.	Second-fixation Duration
GECO	Third_fixation_duration	Word		The duration of the third fixation on the current word, regardless of the run.	Third-pass fixation duration
GECO	Last_fixation_duration	Word		The duration of the last fixation on the current word, regardless of the run.	Last-fixation duration
GECO	First_pass_skipping	Word		?	First-pass skipping rate

GECO-CN	Trial Dwell Time	Word		The sum of the duration of all fixations in the current trial	Total reading time (text)
GECO-CN	Fixation Count	Word		The total number of fixations on the current word	Fixation count (word)
GECO-CN	First run fixation count	Word		The number of all fications in a trial falling in the first run of the word	First-pass Fixation Count (word)
GECO-CN	Skip_rate	Word		Skip: if there is no fixation on the word in the first reading, the word is considered to be skipped ("1"). Otherwise ("0")	Total skipping rate
Gomez-Merino et al 2022	dwell (total duration)	Text		Total fixation time for the text: sum of the duration from all fixations in the text, known as dwell time if saccades are included in the computation (p 6)	Total reading time (text)

Gomez-Merino et al 2022	fcount	Text		Number of fixations	Fixation count (text)
Gomez-Merino et al 2022	regres	Text		Regressive fixations, fixations preceded by regressive saccades that go backwards within the same word or area of interest before leaving it, or go back to a previous word or line of text that has been already visited (also called revisits in the latter case), p 6	Regression Count (text)
Gomez-Merino et al 2022	sac_dur_av	Text			Saccade duration
Gomez-Merino et al 2022	sac_am_av	Text		Saccade amplitude, defined as the sum of all saccade amplitude divided by the number of saccades in the text where the amplitude is the distance from start to end point of the saccade (p 6)	Saccade Size

Jaafar et al. 2018	Integrative transition	Text/visual		Frequency measure indicating the number of atempts at integrating verbal and pictorial information (p 971)	Transition Count (Text/Visual)
Jaafar et al. 2018	Look-from text to picture fixation time	Text/visual		Time spent re-inspecting a picture AOI while re-reading a text AOI (p 971)	Transition Fixation Duration (Text/Visual)
Jaafar et al. 2018	Look-from picture to text fixation time	Text/visual		Total time spent re-reading a text AOI while re-inspecting a picture AOI (p 971)	
Jaafar et al. 2018	Look-from text to text fixation time	Text		Total time spent on a text AOI while re-reading another text AOI (p 971)	Re-reading duration (text)
Jaafar et al. 2018	Look-from picture to picture fixation time	Visual		Total time spent on a picture AOI while re-inspecting another picture AOI (p 971)	re-reading duration (visual)

Jian 2018	Total Reading Time Article	Text	Global	The sum of all fixation durations in an area of interest [AOI]. Total reading time of the whole article, text and illustrations were computed separately (p 5)	Total reading time (text)
Jian 2018	Total Reading Time Illustration	Visual	Global	The sum of all fixation durations in an area of interest [AOI]. Total reading time of the whole article, text and illustrations were computed separately (p 5)	Total reading time (visual)
Jian et al 2019	Total Fixation duration Article + Diagram	Text/visual		Total fixation duration refers to the total duration of fixations on the areas of interest (AOIs, text, representational and explanatory diagrams used as AOIs in this study) (p 5)	Total Reading Time (Text+Visual)
Jian et al 2019	Total fixation duration Text	Text		Total fixation duration refers to the total duration of fixations on the areas of interest (AOIs, text, representational and explanatory	Total reading time (text)

				diagrams used as AOIs in this study) (p 5)	
Jian et al 2019	Total Fixation Duration Diagram	Visual		Total fixation duration refers to the total duration of fixations on the areas of interest (AOIs, text, representational and explanatory diagrams used as AOIs in this study) (p 5)	Total Reading Time (Visual)
Jian et al 2019	First-Pass Total Fixation Text	Text	Early	First-pass total fixation duration refers to the total duration of all fixations on the AOI during initial reading and before exiting it (p 5)	First-pass reading time (text)
Jian et al 2019	First-Pass Total Fixation Diagram	Visual	Early	First-pass total fixation duration refers to the total duration of all fixations on the AOI during initial reading and before exiting it (p 5)	Gaze duration (visual)

Jian et al 2019	Second-Pass Total Duration Text	Text	Late	Second-pass total fixation duration (or look-back fixation time) refers to the total duration of all fixations on an AOI excluding the first-pass total fixation duration; that it, the duration of fixations leaving the AOI and then returning to reread it (for the second time, third time, and so on) (p 5)	Re-reading duration (text)
Jian et al 2019	Second-Pass Total Duration Diagram	Visual	Late	Second-pass total fixation duration (or look-back fixation time) refers to the total duration of all fixations on an AOI excluding the first-pass total fixation duration; that it, the duration of fixations leaving the AOI and then returning to reread it (for the second time, third time, and so on) (p 5)	re-reading duration (visual)
Jian et al 2019	Number Saccades between Text and Diagram	Text/visual	Global	Number of saccades between text and diagram refers to the total number of times when eye fixation	Transition Count (Text/Visual)

				shifts from the text to the picture and from the picture to the text (p 5)	
Kuperman et al 2018 (no RC data yet)					
Lee et al 2024	Trial_total_reading_time	Text	Global	Total time in ms spent reading the passage in a trial (p 9)	Total reading time (text)
Lee et al 2024	Trial_fixation_count	Text	Global	Total number of fixations made on a trial (p 9)	Fixation count (text)
Lee et al 2024	Mean_fixation_duration	Text	Global	Mean duration in ms of all fixations in a trial (p 9)	Average fixation duration
Lee et al 2024	Mean_saccade_length	Text	Global	Forward saccade length (the distance in degrees of visual angle between one fixation and the next (p 9))	Saccade Size
Lee et al 2024	Trial_Saccade_Number	Text	Global		Saccade count

Lee et al 2024	Mean_Saccade_Amplitude	Text	Global		Saccade Size
Liu et al 2009	Total reading time	Text/visual		Total reading time was measured as the time spent reading the text including all fixations to key phrases and illustrations (p 286)	Total Reading Time (Text+Visual)
Liu et al 2009	Total fixation time	Text		Fixations were defined as a minimum of two sampled eye positions occurring with a fixation diameter of 30 pixels with a minimum duration of 150 ms. Because phrases differed in length, the two fixation measures were standardized by dividing the total number of letters of each phrase (p 284)	Total reading time (text)

Liu et al 2009	Total fixation time	Visual		Fixations to illustrations were assigned to three time periods. The first period included initial fixations, which were fixations to illustration(s) occurring before one or more fixations to the text were made. The second time period included interposed fixations, which occurred after one or more fixations to the text had been made. The third time period corresponded to final fixations, which occurred after all fixations to the text had been made (p 286)	Total reading time (visual)
Liu et al 2009	Total fixation count	Text		Fixations were defined as a minimum of two sampled eye positions occurring with a fixation diameter of 30 pixels with a minimum duration of 150 ms. Because phrases differed in length, the two fixation measures were standardized by dividing the total	Fixation count (text)

				number of letters of each phrase (p 284)	
Liu et al 2009	Total fixation count	Visual		Fixations to illustrations were assigned to three time periods. The first period included initial fixations, which were fixations to illustration(s) occurring before one or more fixations to the text were made. The second time period included interposed fixations, which occurred after one or more fixations to the text had been made. The third time period corresponded to final fixations, which occurred after all fixations to the text had been made (p 286)	Fixation Count (visual)

Liu et al 2009	Regression count	Visual	Late	Re-read a word or phrase after fixating another word or phrase or after fixating an illustration (p 285)	Regression Count (Visual)
Mason et al 2013 – Do fourth graders	Integrative transition	Visual/text		suming all the time in which the eye fixation shifted form the text to the picture and form the picture to the text	Transition Count (Text/Visual)
Mason et al 2013 – Do fourth graders	First_pass_Fixation_Duration	Text	Early	First-pass fixation time on text: total duration of all fixations on text segments during the initial reading and before exiting from them (Table 1, p 97). Computed by summing the durations of all fixations (forward and backward) on the eight text segments (areas of interest) when it was read for the first time (p 101).	First-pass reading time (text)
Mason et al 2013 – Do fourth graders	Look_From_Text_Text_Duration	Text	Global	Look-from text to text fixation time: total duration of all regressive fixations on a text segment while	Re-reading Duration (text)

				re-reading another text segment (Table 2, p 97)	
Mason et al 2013 – Do fourth graders	Look_From_Text_Pic_Duration	Text/Visual	Global	Look-from text to picture fixation time: total duration of all regressive fixations on the illustration while re-reading a text segment (Table 1, p 97)	Transition Fixation Duration (Text/Visual)
Mason et al 2013 – Do fourth graders	Gaze duration	Visual	Global		Gaze duration (visual)
Mason et al 2013 – Do fourth graders	Second Pass Duration	Visual	Late	summing up the durations of all re-fixations that took off from a text segment and landed on another text segment	Re-reading Duration (visual)
Mason et al 2013b	Total Fixation Duration	Text	Global	Total fixation time on the overall text and area of interest (p 366)	Total reading time (text)

Mason et al 2013b	Total First-Pass Fixation Duration	Text	Early	First-pass fixation time on the text (p 366)	First-pass reading time (text)
Mason et al 2013b	Total Look Back Fixations Duration	Text	Late	Second-pass or look-back fixation time on the overall text and area of interest (p 366)	Re-reading duration (text)
Mason et al 2013b	Total Look Back Fixations Duration	Visual	Late	Second-pass or look-back fixation time on the illustration (p 366)	re-reading duration (visual)
Mason et al 2013b	Total Number Gaze shift	Text/visual		Number of transitions from the text, and from each of its areas of interest, to the illustration (p 366)	Transition Count (Text/Visual)
Mason et al 2013b	Total Number Gaze shift	Visual/text		Number of transitions "from the illustration to the text areas of interest" (p 366)	Transition Count (Text/Visual)
Mason et al 2013b	Total Number Fixations	Visual	Global	Number of fixations on the illustration (p 366)	Fixation Count (visual)

Mason et al 2013b	Total Fixation Duration	Visual	Global	Total fixation time on the illustration (p 366)	Total reading time (visual)
MECO	blink	Word	Global	Variable indicating whether there was blink directly before, during, or directly after the IA was fixated	Blink Rate (word)
	firstrun.skip	Word	Early	Variable indicating whether the IA was skipped during first-pass reading	First-pass skipping rate
	nrun	Word	Global	Number of times the IA was reread within the trial ("reread" means that it was read again after it has been left to the left or right)	Re-reading count (word)
	reread	Word	Late	Variable indicating whether the IA was reread at least once during the trial	Re-reading rate (word)
	nfix	Word	Global	Number of fixations on the IA during the whole trial	Fixation count (word)

	refix	Word	Late	Variable indicating whether the IA has been refixated at least once during a trial	Re-reading rate (word)
	reg.in	Word	Late	Variable indicating whether there was at least one regression into the IA	Regression Rate (word)
	reg.out	Word	Late	Variable indicating whether there was at least one regression from the IA	Regression Rate (word)
	Total_time (dur)	Word	Late	Total time the interest area was read during the trial in ms (total reading time)	Total reading time (word)
	firstrun.nfix	Word	Early	Number of fixations made on the IA during first-pass reading	First-pass Fixation Count (word)

	frstrun.refix rate	Word	Early	Variable indicating whether the IA was refixated during first-pass reading	First-pass Re-reading rate (word)
	First_pass_reg_in_rate	Word	Early	Variable indicating whether there was a regression into the IA during first-pass reading	First-Pass Regresion Rate (word)
	First_pass_reg_out_rate	Word	Early	Variable indicating whether there was a regression from the IA during first-pass reading	First-Pass Regresion Rate (word)
	firstrun.dur / Gaze Duration	Word	Early	Time the IA was read during first-pass reading (gaze duration)	Gaze duration
	firstrun.gopast / Go-Past Time	Word	Late	Sum of all fixations durations from the time the IA was entered until it was left to the right (go-past time/regression path duration)	Go-Past Time
	First_fixation_duration	Word	Early	Duration of the first fixation on the IA (first fixation duration)	First fixation duration

	skip	word	Global	Variable indicating whether the IA was fixated in the trial	Total skipping rate
	singlefix.dur	Word	Early	Duration of the first fixation on the IA when it was read only once	Single Fixation Duration (word)
	Rate (reading rate?)	Text	global		Reading Speed (wpm)
	Sac_report: dist.let (saccade)	Text	global		Saccade Size
	Sac_report: amp.deg (sac amplitude)	Text	global		Saccade Size
	fixation_report: dur	Text	global		Average fixation duration
	fixation_report: ia.fix	Text	global	Number of fixation on IA	Fixation count (word)

	passage_report: nblink	Text	global		Blink Count (text)
	passage_report: nrun	Text	global	Number of times the IA was reread within the trial ("reread" means that it was read again after it has been left to the left or right)	Re-Reading Count (text)
	passage_report: sac	Text	global	mean forward saccade length	Saccade Size
	passage_report:skip	Text	global	proportion of 1st pass skipped words	First-pass skipping rate
	passage_report:reg	Text	late	proportion of words which have been regressed into	Regression Proportion (text)
	passage_report: refix	Text	late	Variable indicating whether the IA has been refixated at least once during a trial	re-reading rate (text)

	passage_report: nfix	Text	global	Number of fixations on the IA during the whole trial	Fixation count (text)
	passage_report: firstpass	Text	early	summed gaze duraion for all words in the trial	First-pass reading time (text)
	passage_report: rereading	Text	late	total reading time – first-pass reading time	Re-reading duration (text)
	passage_report: total	Text	late	Total time the interest area was read during the trial in ms (total reading time)	Total reading time (text)
	passage_report: rate	Text	global	wpm	Reading Speed (wpm)
	sentence_data: skip	Sentence	global	Variable indicating whether the IA was fixated in the trial	Sentence skipping rate

	sentence_data:nrun	Sentence	global	Number of times the IA was reread within the trial ("reread" means that it was read again after it has been left to the left or right)	Re-reading count (sentence)
	sentence_data: reread	Sentence	global	Variable indicating whether the IA was reread at least once during the trial	re-reading rate (sentence)
	sentence_data: reg.in	Sentence	late	Variable indicating whether there was at least one regression into the IA	Regression Rate (sentence)
	sentence_data reg.out	Sentence	late	Variable indicating whether there was at least one regression from the IA	Regression Rate (sentence)
	sentence_data: total.nfix	Sentence	global		Fixation count (sentence)

	sentence_data: total.dur	Sentence	global	Total time the interest area was read during the trial in ms (total reading time)	Total reading time (sentence)
	sentence_data:rate	Sentence	global	wpm	Reading Speed (wpm)
	sentence_data:gopast	Sentence	late	Sum of all fixations durations from the time the IA was entered until it was left to the right (go-past time/regression path duration)	Go-Past Time (sentence)
	sentence_data: firstrun.skip	Sentence	early	Variable indicating whether the IA was skipped during first-pass reading	Sentence first-pass skipping rate
	sentence_data: firstrun.reg.out	Sentence	early	Variable indicating whether there was a regression from the IA during first-pass reading	First-pass regression rate (sentence

	sentence_data: firstrun.reg.in	Sentence	early	Variable indicating whether there was a regression into the IA during first-pass reading	First-pass regression rate (sentence
	sentence_data: firstpass.nfix	Sentence	early	Number of fixations made on the IA during first-pass reading	First-pass fixation count (sentence)
	sentence_data: firstpass.dur	Sentence	early	Time the IA was read during first-pass reading (gaze duration)	First-pass reading time (sentence)
	sentence_data:firstpass.reread.dur	Sentence	early	duration of rereading fixations during first-pass reading	First-pass re-reading duration (sentence)
Mézière et al 2025	Mean_fixation_duration	Text	Global	"Average duration of all fixations in a text" (p. 7)	Average fixation duration

	Mean_saccade_length	Text	Global	"Length of all rightward eye movements in the text, in character space" (p.7)	Saccade length
	First_pass_skipping	Word	Early	"proportion of words skipped during first-pass (p. 7)	First-pass skipping rate
	First_fixation_duration	Word	Early	duration of the first fixation on a word (p. 7)	First fixation duration
	Gaze_duration	Word	Early	sum of all first-pass fixations on a word (p. 7)	Gaze duration
	Regression_in_rate	Word	Late	proportion of regressions in the text (p. 7)	Regression Rate (word)
	Go_past_time	Word	Late	sum of all fixations made on a word up to when the word is exited to the right, including time spent during regression (p. 7)	Go-Past Time

	Total_time	Word	Late	the sum of all fixations on a word (p. 7)	Total reading time (word)
OneStop	IA_AVERAGE_FIX_PUPIL_SIZE	Text	Global	Average pupil size across all fixations in the interest area	Average Pupil Size
	IA_DWELL_TIME	Word	Late	The sum of the duration across all fixations that fell in the current interest area	Total reading time (word)
	IA_FIRST_FIXATION_DURATION	Word	Early	Duration of the first fixation event that was within the current interest area	First fixation duration
	IA_FIRST_RUN_DWELL_TIME	Word	Early	Dwell time of the first run (i.e., the sum of the duration of all fixations in the first run of fixations within the current interest area).	Gaze duration

	IA_FIRST_RUN_FIXATION_COUNT	Word	Early	Number of all fixations in a trial falling in the first run of the current interest area.	First-pass Fixation Count (word)
	IA_FIXATION_COUNT	Word	Global	Total number of fixations falling in the interest area.	Fixation count (word)
	IA_REGRESSION_IN	Word	Late	Whether the current interest area received at least one regression from later interest areas (e.g., later parts of the sentence). (p. 66)	Regression Rate (word)
	IA_REGRESSION_IN_COUNT	Word	Late	Number of times interest area was entered from a higher IA_ID (from the right in English).	Regression Count (word)
	IA_REGRESSION_PATH_DURATION	Word	Late	The summed fixation duration from when the current interest area is first fixated until the eyes enter an interest area with a higher IA_ID.	Go-Past Time

	IA_SKIP (first-pass)	Word	Early	An interest area is considered skipped (i.e., IA_SKIP = 1) if no fixation occurred in first-pass reading.	First-pass skipping rate
	TRIAL_DWELL_TIME	Text	Global	Dwell time (i.e., summation of all fixation durations) for the whole trial (p. 68)	Total reading time (text)
	TRIAL_FIXATION_COUNT	Text	Global	Total number of fixations in the trial (p. 68)	Fixation count (text)
	Mean_fixation_duration (CURRENT_FIX_DURATIO N, fixation report)	Text	Global	Duration of the current fixation.	Average fixation duration
PoTeC	First_fixation_duration (FFD)	Word	Early	duration of the first fixation on a word if this word is fixated in first-pass reading,	First fixation duration

	Single_fixation_duration (SFD)	Word	Early	duration of the only first-pass fixation on a word, 0 if the word was skipped or more than one fixations occurred in the first-pass (equals FFD in case of a single first-pass fixation)	Single Fixation Duration (word)
	First-Pass Reading Time (FPRT)	Word	Early	sum of the durations of all first-pass fixations on a word (0 if the word was skipped in the first-pass)	Gaze duration
	Total_time (TFT)	Word	Late	sum of all fixations on a word	Total reading time (word)
	Total Fixation Count (TFC)	Word	Late	number of all fixations on a word	Fixation count (word)

	Rereading_duration (RRT)	Word	Late	sum of the durations of all fixations on a word that do not belong to the first-pass	Re-reading duration (word)
	inclusive regression-path duration (RPD_inc)	Word	Late	sum of all fixation durations starting from the first first-pass fixation on a word until fixating a word to the right of this word (including all regressive fixations on previous words)	Go-Past Time
	Skip_rate (reversed) Fix	Word	Global	1 if the word was fixated, otherwise 0 (FPF or RR)	Total skipping rate
	First_pass_skipping (reversed) FPF	Word	Early	1 if the word was fixated in the first-pass, otherwise 0	First-pass skipping rate
	Refixation_rate (RR)	Word	Late	1 if the word was fixated after the first-pass reading, otherwise 0	Re-reading rate (word)

	First_pass_reg_in_rate (FPReg)	Word	Early	1 if a regression was initiated in the first-pass reading of the word, otherwise 0	First-pass Regression Rate (word)
	Regression_in_count (TRC_out)	Word	Late	total number of regressive saccades landing on this word	Regression Count (word)
	Regression_out_count (TRC_in)	Word	Late	total number of regressive saccades initiated from this word	Regression Count (word)
	Saccade_length_in	Word	Global	length of the saccade that leads to first fixation on a word in number of words; positive sign if the saccade is a progressive one, negative sign if it is a regression	Saccade Size
	Saccade_length_out	Word	Global	length of the first saccade that leaves the word in number of words; positive sign if the	Saccade Size

				saccade is a progressive one, negative sign if it is a regression; 0 if the word is never fixated	
Pothuri	Total Fixation Time	Word	Late	sums all fixations on a word throughout the entire reading session.	Total reading time (word)
	First-Fixation Duration	Word	Early	duration of the reader's first fixation on a word	First fixation duration
	Go_past_time	Word	Late	includes the time spent fixating on a word along with any regressions to earlier text before moving forward	Go-Past Time
	Gaze Duration	Word	Early	which is the sum of all fixations on a word before the eyes move past it	Gaze duration
	Skip_rate	Word	Early	likelihood that a word is skipped during the initial reading	First-pass skipping rate

Romero-Palau et al	Total Duration	Text	Global		Total reading time (text)
	Average Fixation Duration	Text	Global		Average fixation duration
	Total Fixation Count	Text	Global		Fixation count (text)
Schmidtke et al papers	TotalTime	Word		Total fixation duration per word (mw)	Total reading time (word)
	NunSkip	Word		total number of times a word was skipped	Total skipping rate
	NumFix (word)	Word		Total number of fixations per word	Fixation count (word)
	NumFix (Text)	Text		the total number of times a fixation was made on any word during passage reading (2025, p. no p number)	Fixation count (text)

	NumRegOut	Word		total number of times an eye movement is launched back to earlier parts of the text)	Regression Count (word)
Kyriakidou et al., 2025 – L1	Reading Rate	Text	global		Reading Speed (wpm)
	Saccade Length	Text	global		Saccade Size
	Pupil Size	Text	global		Average Pupil Size
	Average Fixation Duration	Text	global		Average fixation duration
	Skipping	Word	early		First-pass skipping rate
	First Fixation Duration	Word	early		First fixation duration
	Gaze Duration	Word	early		Gaze duration

	Regressions	Word	late		Regression Rate (word)
	Go-Past Time	Word	late		Go-Past Time
	Total Fixation Duration	Word	late		Total reading time (word)
Serrano & Pellicer-Sanchez 2022	Total dwell time	Text	late	the sum of all fixation durations made within an AOI	Total reading time (text)
	Num fix	Text	global	the total number of fixations made within an AOI	Fixation count (text)
	Avg fix dur	Text	global	the mean of the duration of each individual fixation within an AOI	Average fixation duration
Tsai et al 2022	Total_Reading_Time	Text	global	NR (different from variables reported in paper)	Total reading time (text)

	Total_Fixation_Count	Text	global	NR (different from variables reported in paper)	Fixation count (text)
	Total_Fixation_Duration	Text	global	NR (different from variables reported in paper)	Total Reading Time (text)
	Mean Fixation Duration	Text	global	NR (different from variables reported in paper)	Average fixation duration
Vibert et al 2025	Fixation Duration	Text		"average duration of fixations made during that trial	Average fixation duration
	Saccade Amplitude (cm)	Text		Avegage horizontal amplitude of saccades made during the trial	Saccade Size
	Regression_proportion	Text		proportion of regressive saccades	Regression Proportion (text)
Wang et al 2022	Fixation Count	Text	Global	"the number of fixations on the AOI" (p. 15)	Fixation count (text)

	Fixation Count	Paragraph	Global	"the number of fixations on the AOI" (p. 15)	Fixation count (text)
	Fixation Count	Visual	Global	"the number of fixations on the AOI" (p. 15)	Fixation Count (visual)
	Proportion of Fixation Duration	Text	Global	percentage that the fixation duration on specific AOI accounted from the total fixation duration during the learning episode (p. 15)	Proportion of Fixation Duration (text)
	Proportion of Fixation Duration	Visual	Global	percentage that the fixation duration on specific AOI accounted from the total fixation duration during the learning episode (p. 15)	Proportion of Fixation Duration (visual)
	Saccades Between Text and Diagram	Text/Visual	Global	number of times the participant fixated from the text to diagram or vice versa (p. 15)	Transition Count (Text/Visual)
WebQAmGaze	Total Reading Time	Word	Global	summed duration of all fixations on a word (p. 17)	Total reading time (word)

	Fixation Count	Word	Global	"includes all words"	Fixation count (word)
Wong & Moss 2022	Text: RegressionT (Total_Regression_Count)	Text	Global	total number of regressions	Regression Count (text)
	Text: DurationR (Total_time)	Text	Global	total time spent fixating on text	Total reading time (text)
	Text: FixT (Total_Fixation_Count)	Text	Global	total number of fixations	Fixation count (text)
Yeari & Levi 2021	Total Duration (TD)	Text	Late	the sum of durations of all fixations landed within a text unit (p.223)	Total reading time (text)
	First-Pass Reading Time (FP)	Text	early	the sum of durations of all fixations landed within a text unit before any subsequent unit was fixated on (p. 223)	First-pass reading time (text)
	Re-Reading Time (Regression Duration)	Text	Late	the run of durations of all fixations landed within a text unit that had	Re-reading duration (text)

				already been read once before (p-223)	
	Re-Reading Frequency (Regression Number)	Text	Late	the number of occurrence a text unit was reread after it was read for the first time. (p. 223)	Regression Count (text)
Yildiz & Ozdemir 2024	Fixation Count	Text	Global	NR	Fixation count (text)
	Total Fixation Time	Text	Global	NR	Total reading time
	Saccade Count	Text	Global	NR	Saccade count
	Saccade Duration	Text	Global	NR	Saccade duration
	Saccade length	Text	Global	NR	Saccade Size
	Total Reading Time	Text	Global	NR	Total reading time (text)

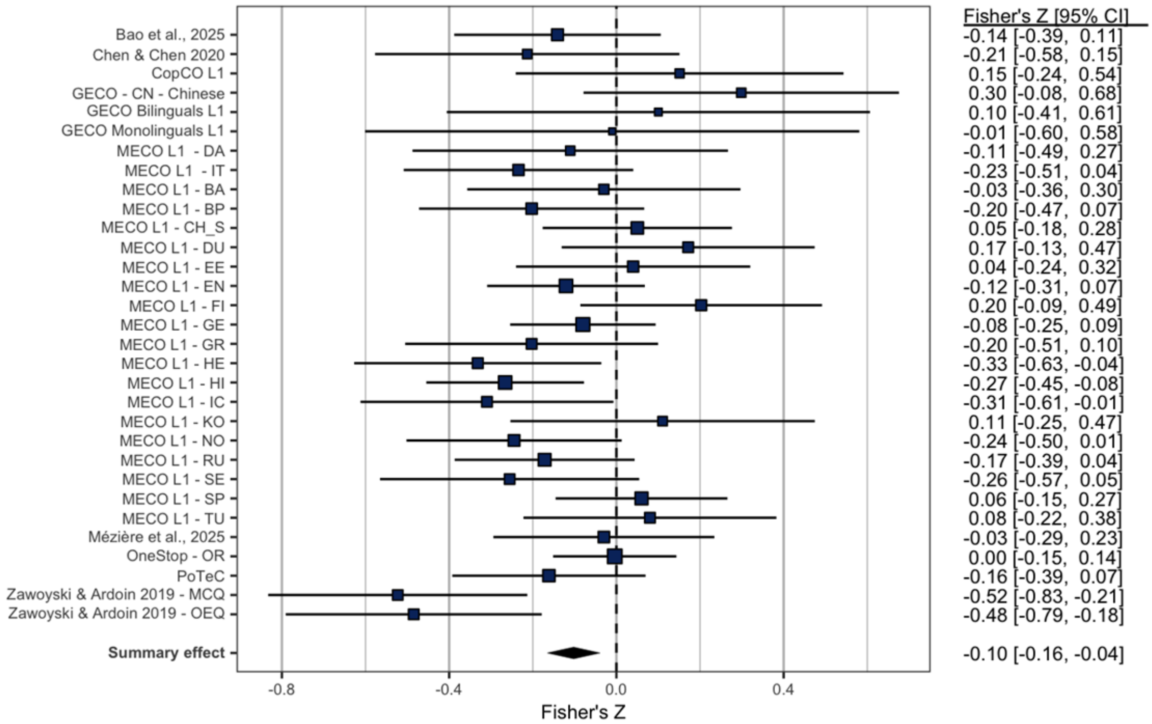
	Regression Count	Text	Global	NR	Regression Count (text)
Zawoyski & Ardouin 2019	First-Fixation Duration	Word	early	Duration (in ms) of the initial fixation on a word	First fixation duration
	Gaze Duration	Word	early	Sum (in ms) of all fixations on the initial viewing of a word	Gaze duration
	Total Fixation Time	Word	Late	Duration (in ms) of all fixations made on a word	Total reading time (word)
	Interword regressions	Word	Late	Number of regressions made between words	Regression Count (word)

	Average Fixation Count	Word	Global	Average number of fixations made on each word	Fixation count (word)

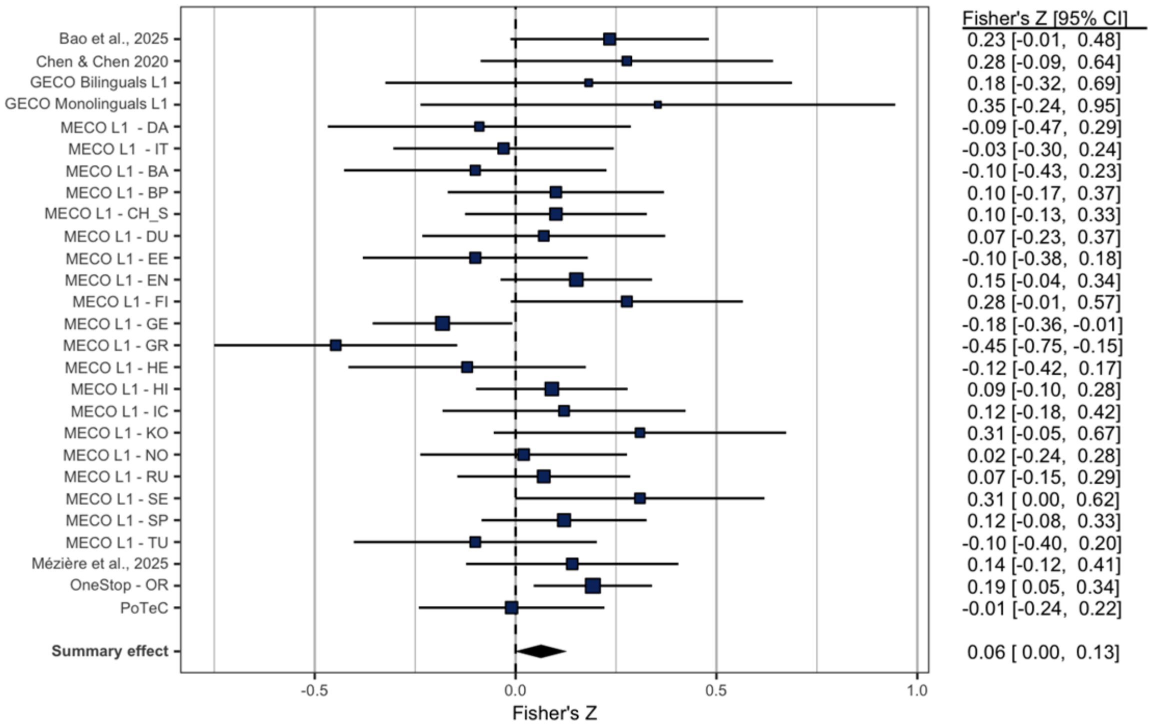
3.3. Main analyses

The following are ongoing analyses based on individual meta-analyses for each eye-movement indicator. As not all primary studies incorporate all eye-movement measures, only studies that incorporate a particular indicator are included in each analysis.

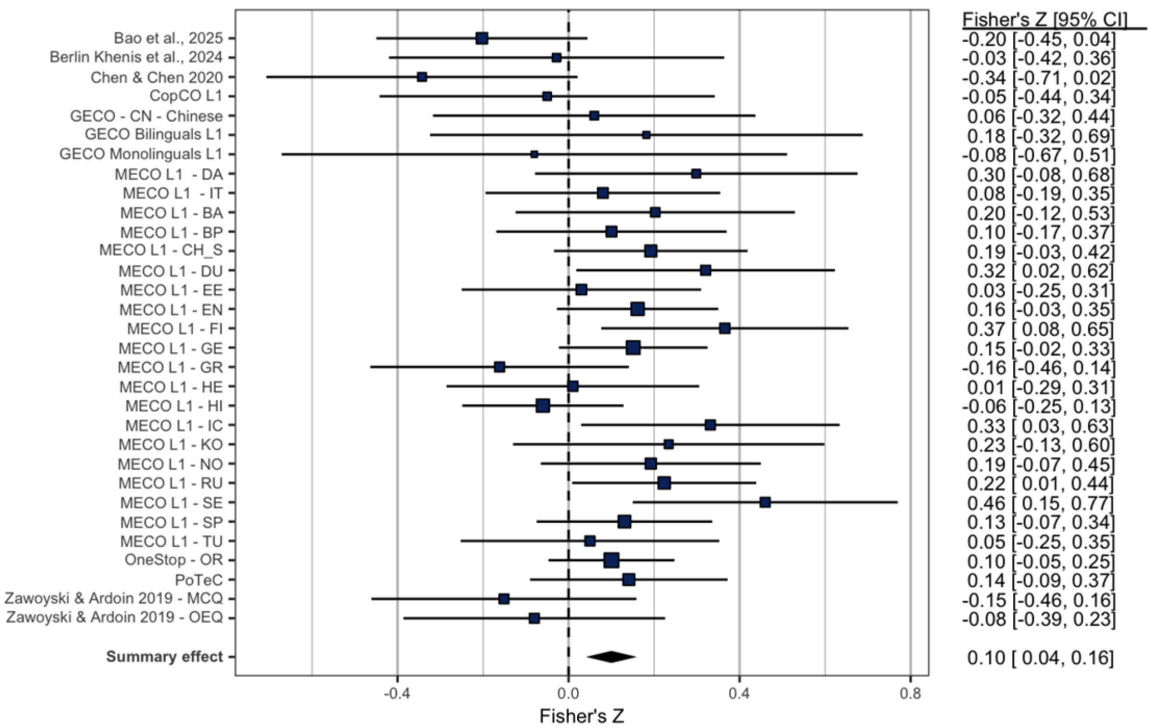
Results L1 First-Fixation Duration (word)



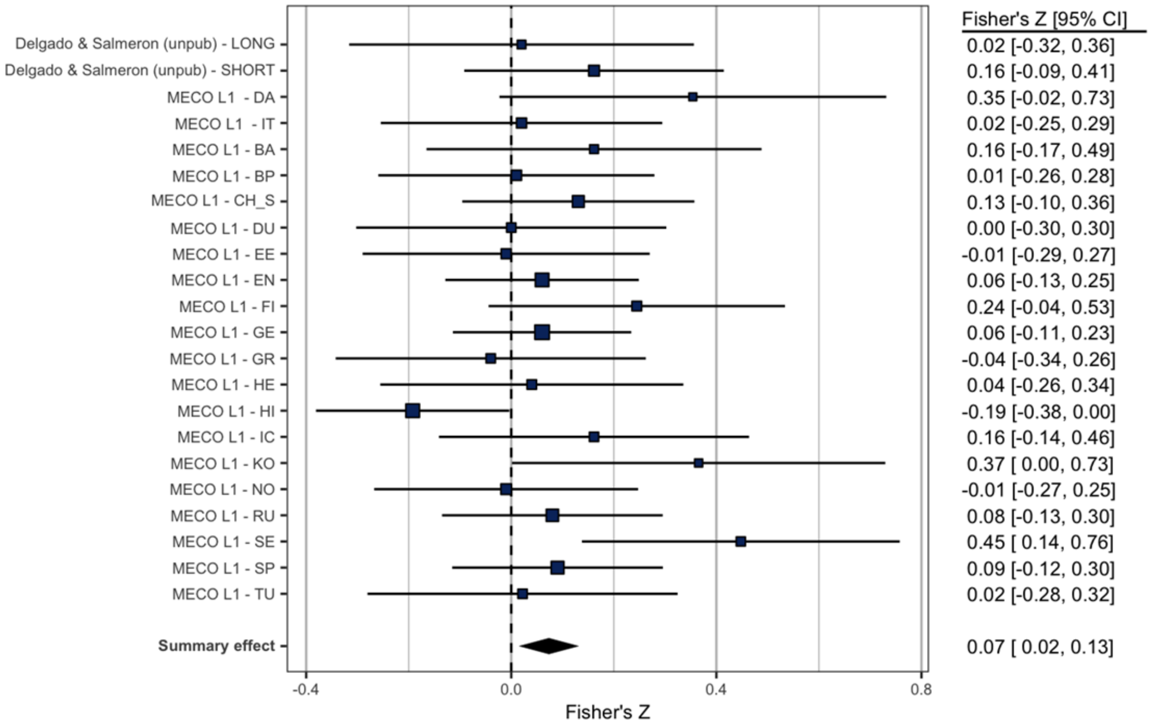
Results L1 First-Pass Skipping Rate (word)



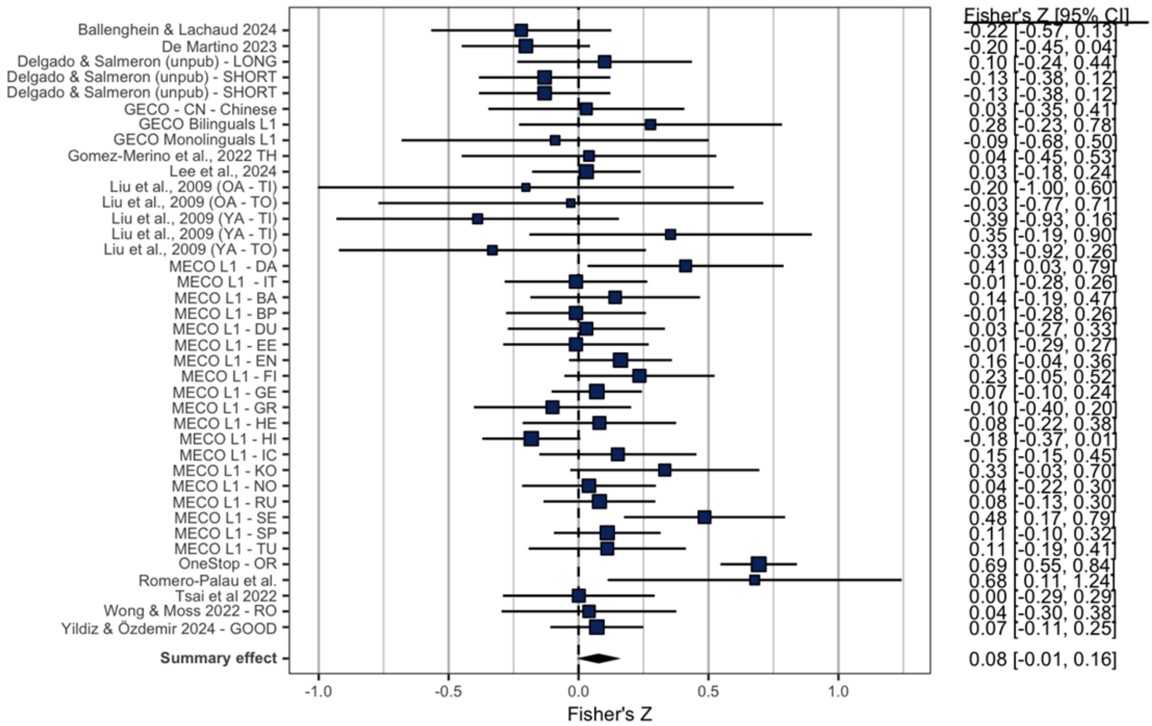
Results L1 Fixation Count (word)



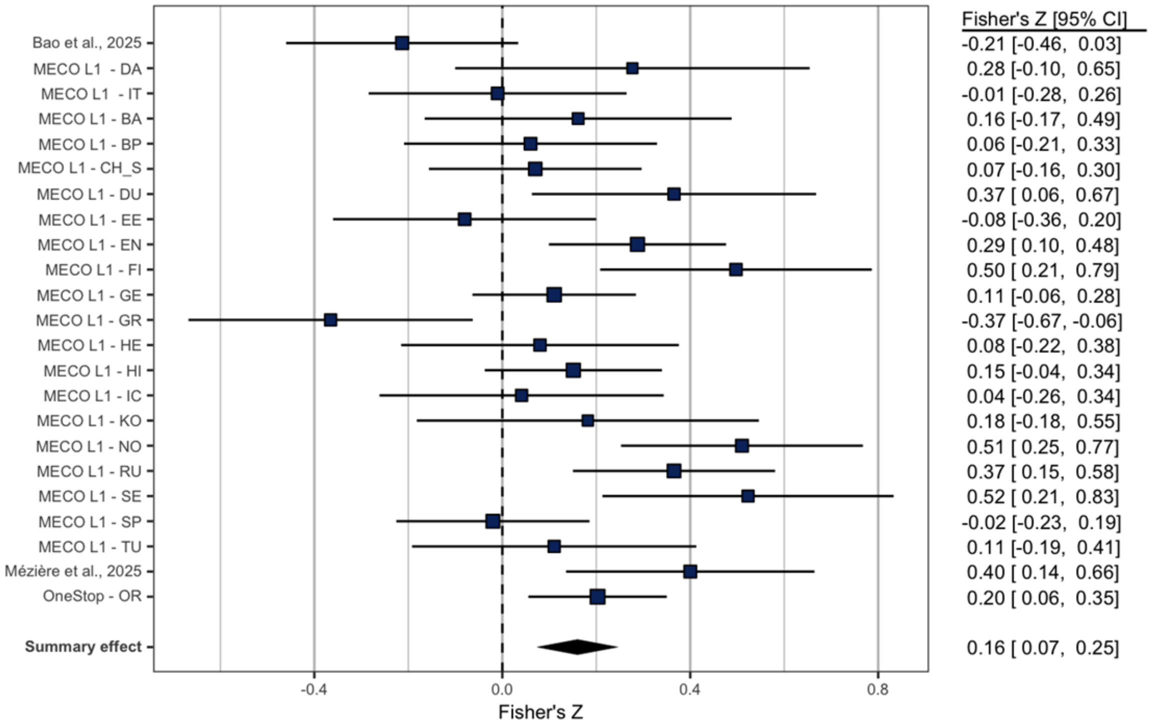
Results L1 Fixation Count (sentence)



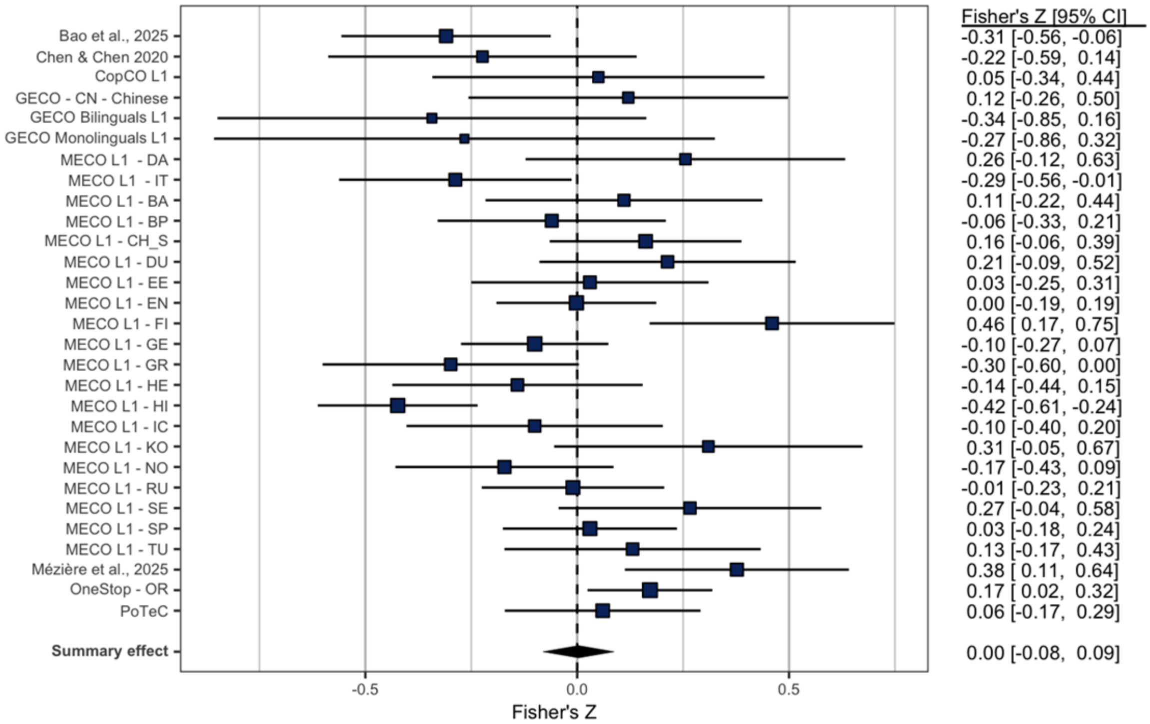
Results L1 Fixation Count (text)



Results L1 Regression rate (word)



Results L1 Go-Past Time (word)



Average effect sizes by uniformed eye-movement indicator and language status (L1 vs L2).

Measure	L1 Effect	L2 Effect
Mean Fixation Duration	**-0.09 [-0.16, -0.03]**	**-0.23 [-0.29, -0.17]**
First-Fixation Duration	**-0.10 [-0.16, -0.04]**	**-0.20 [-0.26, -0.14]**
Gaze Duration	**-0.11 [-0.17, -0.05]**	**-0.21 [-0.27, -0.15]**
First-Pass Skipping	**0.06 [0.00, 0.13]**	-0.02 [-0.08, 0.04]
Fixation Count (word)	**0.10 [0.04, 0.16]**	-0.01 [-0.09, 0.06]
Regression Rate (word)	**0.16 [0.07, 0.25]**	0.05 [-0.03, 0.13]
Go-Past Time	0.00 [-0.08, 0.09]	**-0.19 [-0.28, -0.10]**
Total Reading Time (word)	0.04 [-0.03, 0.11]	**-0.11 [-0.19, -0.03]**
Total Skipping Rate	0.00 [-0.06, 0.07]	**0.09 [0.01, 0.17]**
Fixation Count (sentence)	**0.07 [0.02, 0.13]**	**-0.12 [-0.22, -0.03]**
Fixation Count (text)	0.08 [-0.01, 0.16]	-0.08 [-0.19, 0.03]
Total Reading Time (text)	0.03 [-0.05, 0.11]	**-0.20 [-0.34, -0.06]**

4. Discussion

The following is a preliminary discussion based on the current ongoing analyses. This will be updated as the full set of analysis is finished.

4.1. Fast readers, good comprehenders

A recurring finding in the meta-analysis is that fast readers tend to be good comprehenders, a relationship that is often reflected in early eye-movement measures. Temporal and count-based metrics such as mean fixation duration, first-pass reading time, and fixation counts are typically interpreted as indexing decoding efficiency and lexical access. Readers who exhibit shorter fixations and fewer fixations overall are generally able to process words more quickly while maintaining accurate comprehension, suggesting a pattern of quick but careful reading (Wang & Lin, 2025). These early measures are therefore strongly associated with reading fluency and low-level processing efficiency, which in turn support successful comprehension by freeing cognitive resources for higher-level integration.

However, the strength and interpretation of these effects vary across reader populations. For L2 readers, early temporal and count measures often show larger negative associations with comprehension, reflecting the increased decoding demands imposed by reduced lexical familiarity and less automatized word recognition. In contrast, later eye-movement measures—particularly those involving regressions and rereading—appear to capture different aspects of comprehension. Rather than indexing decoding difficulty, late count measures are more closely related to attention allocation and strategic processing, such as revisiting earlier parts of the text to resolve ambiguities or integrate information. These findings suggest that while fast reading supported by efficient early processing is generally beneficial for comprehension, successful understanding also relies on flexible, strategic eye-movement behavior at later stages of processing, especially when readers encounter complex or demanding text.

4.2. Limited availability of corpus

Despite the growing interest in linking eye movements to text comprehension, progress in this area is constrained by the limited number and diversity of available datasets. Much of the existing empirical evidence is concentrated in a small set of large-scale resources, most notably the MECO study (Kuperman et al. 2023), which has provided invaluable cross-linguistic data but also dominates the landscape of publicly available eye-tracking corpora. As a result, many findings are derived from similar experimental designs, text types, and comprehension measures, limiting the generalizability of conclusions. This reliance on a small number of datasets restricts the exploration of variability across genres, tasks, reader populations, and languages, and makes it difficult to assess the robustness of reported relationships between eye movements and comprehension across contexts.

Moreover, a substantial portion of potentially relevant eye-tracking research does not directly address text comprehension as a primary outcome. Many studies include only minimal comprehension checks intended to ensure task engagement, rather than systematically measuring comprehension depth or variability across individuals. This limits the interpretability of eye-movement patterns with respect to comprehension processes, as it remains unclear whether observed effects relate to shallow task compliance or meaningful differences in understanding. These limitations are particularly pronounced in developmental research: studies involving children are relatively scarce and often include methodological artifacts, such as reading aloud, which substantially alters natural eye-movement behavior. Consequently, there is a critical need for more ecologically valid, large-scale datasets that combine rigorous comprehension assessment with eye-tracking across a broader range of reader populations, especially children. Addressing these gaps would significantly strengthen theoretical accounts of the eye–mind relationship and improve the predictive modeling of text comprehension.

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