

Experiment Design of a Balanced Eye-Tracking Study for Measuring the Cognitive Impact of the Stimulus Word “Disinformation”

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Abstract

This paper presents the design of a controlled eye-tracking experiment for investigating the cognitive impact of the stimulus word “disinformation” in Bulgarian news texts. Rather than reporting experimental findings, the paper describes the methodological framework developed for a balanced eye-tracking study that will examine whether the presence of this word influences readers’ visual attention and gaze behaviour. The proposed design is intended for a Tobii Pro Spectrum eye tracker (600 Hz) and to compare matched pairs of authentic Bulgarian news headlines and leads in which the stimulus word is either preserved or removed while keeping the remaining textual context as similar as possible. The methodology controls for participant-related factors, including age, gender, education, prior knowledge and topic interest, as well as text-related factors such as length, readability and complexity. The experiment is designed to measure fixation duration, gaze duration and regression frequency in order to identify potential differences in cognitive processing associated with the presence of the stimulus word. By documenting the rationale behind the experimental design, the balancing strategy and the methodological challenges, this paper provides a reproducible framework for future eye-tracking studies on misinformation in Bulgarian, a low-resource language for which such experimental research is currently lacking. The resulting eye-tracking dataset and the accompanying corpus are intended to be released as open resources after completion of the study.

Keywords: eye-tracking, experimental design, disinformation, news, design.

1 Context and Motivation

Eye-tracking has become an established methodology for investigating how readers process truthful and misleading information. Previous studies have shown that gaze behaviour, including fixation duration and regressive eye movements, differs when

readers encounter factually incorrect content, making eye-tracking a promising approach for studying misinformation processing. However, most eye-tracking studies on misinformation have been conducted for English, while evidence for other languages remains scarce. Extending such research to Bulgarian is scientifically important for several reasons. Bulgarian is a low-resource language in Natural Language Processing, and, to the best of our knowledge, there is currently no publicly available eye-tracking corpus dedicated to misinformation or news credibility in Bulgarian. Furthermore, Bulgarian differs from English in its use of the Cyrillic script, rich inflectional morphology, and language-specific lexical and syntactic characteristics. These linguistic differences may influence reading behaviour and visual attention, making it inappropriate to assume that findings obtained for English can be directly generalised to Bulgarian readers. In this study, we adopt the definition of “disinformation” proposed by the European Commission as “false or misleading content that is spread with the intention to deceive or secure economic or political gain, and which may cause public harm”¹. We investigate whether the explicit presence of the stimulus word “disinformation” affects readers’ visual attention during the processing of Bulgarian news headlines. Building on this rationale, the primary contribution of this paper is a reproducible methodological framework that controls for participant-related factors (e.g., age, gender, education, prior knowledge, and topic interest) and text-related factors (e.g., length, readability, and complexity), while isolating the effect of the stimulus word “disinformation”. By documenting the methodological decisions and design challenges, we aim to establish a foundation for future eye-tracking studies on misinformation in Bulgarian.

¹<https://digital-strategy.ec.europa.eu/en/policies/online-disinformation>

2 Related Work: Eye-Tracking for Misinformation

Eye-tracking has been widely used to investigate how readers process truthful and factually incorrect information. Previous studies have shown that eye-movement behaviour can distinguish between truthful and misleading news and can support predictive models based solely on gaze measurements. For instance, studies in English have demonstrated that false headlines receive significantly less visual attention than truthful ones (Hansen et al., 2020). Beyond visual attention, previous research has investigated the psychological aspects of news presentation (Ladeira et al., 2022) and the integration of peripheral physiology with machine learning for automated disinformation detection (Filippi et al., 2025). A further behavioural indicator is that readers tend to exhibit more regressive eye movements when processing factually incorrect content (Bozkir et al., 2022). The influence of different interface elements, such as breaking-news formats and additional links, has also been analysed to understand how news presentation affects visual attention (Chu et al., 2009; Kruikemeier et al., 2020).

Although eye-tracking research has expanded to several Slavic languages, it has primarily focused on linguistic phenomena rather than misinformation. Previous studies include language acquisition in Russian (Ermolina, 2022) and Czech (Juřík et al., 2025), readability assessment for Russian (Laurinavichyute et al., 2019), detection of dyslexic reading patterns in Serbian (Vajs et al., 2022), pronominal anaphora resolution in Polish (Wolna et al., 2022), and the processing of verbal aspect in Polish (Klimek-Jankowska et al., 2018). These studies demonstrate the applicability of eye-tracking methodologies to Slavic languages, while also highlighting the absence of research on misinformation processing.

To the best of our knowledge, at the time of writing this article, no previous eye-tracking study has investigated misinformation (and related concepts) processing in Bulgarian. This paper addresses this gap by proposing a balanced experimental design that isolates the cognitive effect of the stimulus word “disinformation” while controlling for participant-related and text-related variables. The proposed methodology is intended to provide a reproducible framework for future eye-tracking studies on misinformation (and similar concepts) in Bulgarian.

3 Research Question

The objective of this study is to investigate whether the presence of the stimulus word “disinformation” influences readers’ visual attention while processing Bulgarian news headlines.

Specifically, we address the following research question:

RQ1. Does the presence of the stimulus word “disinformation” influence readers’ eye-movement behaviour during the reading of Bulgarian news headlines?

To answer this question, we propose a balanced eye-tracking experiment in which participants read matched pairs of authentic Bulgarian news headlines that differ only in the presence or absence of the stimulus word. The experiment is designed to examine whether the presence of the stimulus word is associated with differences in fixation duration and regression frequency.

4 Challenges in Design

We encountered several challenges when designing the eye-tracking experiment, summarised in Table 1.

Challenge	Proposed solution
Defining factuality	Exclusion of political news and manual selection of authentic news items.
Building comparable text pairs	Creation of matched headline pairs from authentic news by minimally editing the original texts.
Prior knowledge	Assessment through pre- and post-reading questionnaires.
Prior exposure	Control question identifying previously encountered news items.
Text complexity	Readability metrics and complexity measures for Bulgarian texts.
Participant bias	Balanced participant recruitment with respect to age, gender, education, and background knowledge.

Table 1: Main methodological challenges and the corresponding mitigation strategies adopted in the experimental design.

- Political news was excluded to minimise con-

founding effects arising from participants' political attitudes and prior beliefs. In addition, factual verification of political claims is often inherently disputed because such claims may involve subjective interpretation, incomplete evidence, or evolving contexts. Fact-checking organisations cannot comprehensively cover the news cycle and may prioritise claims according to editorial criteria or public attention ((Fernández-Roldán et al., 2023), (Hameleers and Van der Meer, 2020)). Restricting the corpus to non-political news therefore improves experimental control and reduces variability unrelated to the stimulus word. We exclude political news for several reasons, including the political bias of readers and the challenge of balancing it. Political statements are often subjective or contain 'nuanced truths,' making them difficult to categorize as strictly 'true' or 'false' for a controlled experiment. Another problem is the fact-checkers' assessment of politicians' claims (Fernández-Roldán et al., 2023). Further, fact-checkers cannot check the whole news flow, and they are most likely to select news when they confirm prior attitudes (Hameleers and Van der Meer, 2020). Some scholars share that they use factually correct and factually incorrect news, but without mentioning how they decide which news is trustworthy or not (Menicocci et al., 2024).

- Building indicators for factually correct and factually incorrect news is a big challenge. Some scholars made a set of features as click-bait or logical fallacies (Zhang et al., 2018), others define credible news as news which the reader wants to share (Torres et al., 2018), third group of scholars make a pair of news - true and fabricated, but the methodology of fabrication is not pretty clear (Simko et al., 2019).
- News media with different views may word the same news in different ways. The selection of texts turns out to be a major challenge in the current experiment - to define what is true and how exactly disinformation is fabricated. Our initial approach was to construct matched text pairs using articles produced by professional fact-checking organisations. However, this approach proved unsuitable for three reasons. First, fact-checking articles represent a dis-

tinct journalistic genre whose style differs substantially from conventional news reporting, making direct comparison problematic. Second, fact-checkers typically debunk broader narratives rather than individual news items, which prevented the construction of comparable one-to-one text pairs. Third, many of the original social media posts or news items referenced in fact-checking reports are no longer publicly accessible. Because the objective of this study is to compare authentic news texts under controlled conditions, we instead constructed our own corpus of Bulgarian news headlines containing the stimulus word "disinformation". The word "disinformation" was selected as a primary stimulus because it likely functions as an emotional trigger and a cognitive anchor. From a psycholinguistic perspective, such high-stakes terms can induce an 'Emotional Stroop effect', where the negative valence of the word captures attentional resources, potentially increasing the cognitive load required to process the remaining sentence. By isolating this word, we aim to measure whether its presence triggers a shift from heuristic to systematic processing, detectable through increased fixation durations and regression frequencies (Ben-Haim et al., 2016), (Singh and Goel, 2024). The experiment is designed to examine whether the presence of the stimulus word is associated with longer fixation durations and more frequent regressive eye movements.

Therefore, we took a different approach – specifically for the experiment, we created a dataset of actual news headlines from online news outlets that contain the word disinformation in a title or subtitle or lead of up to 250 characters. These headlines were collected manually over the past three years. To create pairs of almost identical comparable texts, we reworked the titles so that the word disinformation was missing from them, without replacing it with synonymous words. In some cases, only this word was removed, in others, an entire syntactic structure had to be removed to avoid its use. As a result, we have pairs of titles containing the word "disinformation" and those that do not contain it. Our goal is to check whether the word disinformation triggers attention, as opposed to its absence in the

same context.

One of the limitations of this approach is that when we have pairs of texts, given randomly, part of them will already be familiar to our participants. The text will be presented as plain without additional visual stimuli. Participants are not informed about the specific focus on 'disinformation' beforehand to prevent demand characteristics—a phenomenon where subjects subconsciously alter their reading behavior to fit the perceived goals of the study. This ensures the eye-tracking data reflects naturalistic processing. They will be notified afterwards.

- Several reader-related factors influence the reader when deciding whether a text contains factually correct information or factually incorrect information. We tried to take into account as many of them as possible.
 - Reader's previous knowledge about the text's topic. We took this factor into account by selecting readers with different education levels, and as equal as possible number of female and male participants. Additionally, we specifically looked for readers with and without previous knowledge in the text's topics. We also asked the readers to state the fields in which they had more knowledge before the experiment, and after reading each text to answer the question whether they had prior knowledge in the text's field.
 - Whether the text's topic is of interest to the reader. We took this detail into consideration by asking each reader whether they had personal interest in each text after reading it, and why.
 - The reading literacy and the media literacy of participants could be different and could influence the results. An additional post-reading questionnaire will help to measure the preparedness of the participants.
 - To account for reader fatigue, the number of texts is specifically calibrated. We measure tiredness through a self-report scale included in the post-reading questionnaire.
- Randomization of the order of texts is standard

practice (Smith et al., 2014), (Walker, 2020).

- Text length, complexity and coherence. Text complexity affects eye movement metrics (such as fixation duration), which must be isolated to ensure we are measuring the impact of the stimulus word, not the difficulty of the sentence (Torres et al., 2021). The complexity in Bulgarian is not a much-analysed topic (Petrova and Bozhikova, 2022). We tried to take news headlines and leads of a similar length. The variables frequently used for measuring complexity are the average length of the words and their frequency in the language, both accounting for semantic difficulty, as well as sentence length, which is closely related to syntactic complexity (Torres et al., 2021). To measure the complexity of our text, we calculate the average sentence length, the average word length, and apply a Bulgarian language readability formula (Kazakov et al., 2025). Given the impossibility of having only texts with the same complexity, we aim to differentiate the results given their complexity. The coherence of a text, related to its meaningfulness, a notion associated with semantics rather than grammatical structure, we analyse for each stimulus, annotating as coherent or incoherent. Topic complexity is another problem. We do also consider that some topics may be too specialised for readers with a lower age or lower level of education.
- Given all the mentioned details under consideration, we wonder how to recruit the necessary types of participants. Participants will be recruited through advertisements posted in Facebook groups representing different interests and viewpoints.

5 Experiment Description

This section describes the settings of the planned experiment, whose actual execution is left for future work.

5.1 Eye-Tracker

The experiment will use the Tobii Pro Spectrum screen-based eye-tracker, designed for scientific research with a maximum sampling frequency of 600 Hz. The data collection will take place in a controlled indoor office environment. The Tobii Pro Lab software will be employed to collect, analyse, and visualize the gaze data.

5.2 Texts Used

The stimulus material (see Table 2 for a summary) consists of matched pairs of Bulgarian news headlines and leads, each limited to 250 characters. To ensure focus on the cognitive impact of the stimulus word, political topics are excluded. The design employs Areas of Interest (AOIs) to isolate the word “disinformation”, enabling a precise comparison of fixation durations between the original and modified versions. For instance, a headline such as “CIA misled Iran with disinformation during the rescue of a US pilot” is compared against the version where the stimulus word is omitted.

Not all pairs permit such a clean single-word deletion: in some cases, removing “disinformation” without leaving an ungrammatical or semantically incoherent sentence required deleting an entire clause or syntactic structure rather than the word alone. Because such structural edits introduce changes in sentence length and syntactic complexity that could independently affect fixation duration and regression frequency, all 30 stimulus pairs will be classified prior to data collection by edit type: single-word deletion (structure otherwise unchanged) versus structural deletion (clause or phrase removed). [Report the resulting counts, e.g., “X pairs required only word deletion; Y pairs required structural deletion.”] For pairs requiring structural deletion, we will additionally compute the character-length difference and token-level edit distance between the two versions of the pair; these measures will be entered as covariates in the statistical model, alongside the word-presence factor, so that the effect of the stimulus word itself can be disentangled from the effect of the accompanying structural change.

5.3 Participants

We plan to involve in this study participants from diverse age ranges (18–79), balanced by gender and education level. The experiment will begin with an initial pilot phase (see Table 2), followed by a larger sample to ensure statistical robustness. Potential selection biases will be mitigated through diverse recruitment channels.

5.4 Participant Recruitment and Eligibility

We plan to recruit participants for a paid eye-tracking experiment designed to study visual attention. To be eligible, participants must be at least 18 years old and have normal or corrected-to-normal

Factor Category	Variables / Details
Within-subject factors	Presence of the stimulus word (with/without “disinformation”)
Between-subject factors	Education; Gender; Prior knowledge
Pilot sample	10 participants
Stimulus material	30 text pairs

Table 2: Summary of the experimental design and sample requirements.

vision. As in other eye-tracking experiments, participants should not be tired, should have had enough sleep, and should not have eye infections or medical conditions affecting the brain or cognitive processing. Potential selection biases will be mitigated through diverse recruitment channels.

The time commitment will be of one hour and a half, including setup and data collection, and participants will be paid for their time.

5.5 Experimental Procedure

We plan to conduct the actual experiment in the following way: Upon arrival, participants will complete a short agreement with basic information and a formal agreement regarding data privacy. The eye-tracker will be calibrated for each participant, followed by a brief practice trial to ensure that the participant feels comfortable with the equipment. During the session, the participants will read the stimuli while their eye movements are recorded. We will focus on fixations, saccades, and gaze duration: fixations indicate where and for how long participants look, saccades represent eye movements, and gaze duration captures the time spent on relevant parts of the text. After the experiment, the participants will be debriefed about the experiment and its aims.

5.6 Guidelines

Before starting the task, participants will be instructed to read the presented headlines and leads naturally, at their own pace, as they would normally do when browsing news online. No specific emphasis will be placed on any word to ensure natural reading behavior. **To ensure data quality, participants will be asked to focus on a calibration fixation cross prior to each stimulus. After reading the text, they will manually advance the screen to**

complete the corresponding post-reading questionnaire.

5.7 Post-Reading Questionnaire

Immediately following the reading task, the participants will complete a follow-up survey designed to assess their interest and knowledge about the news items. These answers will later be compared with their gaze patterns. The post-reading questionnaire consists of the following items:

- **Factuality:** Participants must answer whether they perceive the information as factually correct, factually incorrect, or whether they cannot answer. Since it is possible that one part of a text is true while another is not, the participants will be asked to generalise and to classify the item as false if they have even the slightest doubt.
- **Prior Knowledge:** The participants must state whether they have previous knowledge of the topic.
- **Interest:** The participants must state whether the topic is interesting to them.
- **Prior Exposure:** To mitigate the potential bias of prior exposure to the news items, a control question—“Have you encountered this news story before?”—is included in the post-reading questionnaire, allowing for the exclusion of familiar texts from the final statistical analysis to ensure data purity.

6 Ethical Questions

We aim to follow all best practices and legal and ethical requirements in conducting this experiment. Specifically, we:

- are filing an ethical permission application to the Ethical Committee of our host institution;
- plan to provide each participant with a document disclosing how their personal data will be processed and ensuring that their identities and beliefs remain confidential from other participants;
- will include in the document a warning that infrared sensors are used, to prevent participation by users who might have issues with such sensors;

- will include only participants who are in the accepted working age, i.e., at least 18 years old;
- will pay participants for their time, reflecting our country’s basic salaries.

7 Limitations

A more fundamental limitation concerns the interpretability of the presence/absence manipulation itself: it does not fully isolate the emotional valence of “disinformation” from its lexical properties (length, frequency, morphological complexity), all of which are independently associated with fixation duration in reading research. Because the compared conditions differ in whether the word is present at all, rather than swapping it for a matched neutral word, observed differences in fixation duration cannot be unambiguously attributed to emotional processing as opposed to word length or frequency effects. Future iterations of this design could include a third condition substituting a length- and frequency-matched neutral word (e.g., “информация” [“information”, which shares morphological structure with “дезинформация” while lacking its negative valence) to more precisely isolate the emotional-Stroop-like effect from general lexical processing costs. Although the proposed design addresses several methodological challenges, certain further limitations remain. These include the limited availability of suitable Bulgarian news texts, the exclusion of highly political content to minimise bias, the relatively small corpus of manually collected headlines, and the possibility that some participants may already be familiar with individual news items. Despite controlling for participant- and text-related variables, unobserved individual differences may still influence reading behaviour.

8 Conclusions and Further Work

This paper has detailed a methodological framework for a balanced eye-tracking experiment investigating the cognitive impact of the stimulus word “disinformation” in Bulgarian news texts, addressing key challenges related to text selection, participant characteristics, ethical considerations, and experimental control.

A central contribution of the proposed design is the isolation of the stimulus word “disinformation”, allowing its potential influence on visual attention to be investigated under controlled conditions. The

use of matched text pairs aims to maximise internal validity while preserving the ecological validity of authentic news texts. We also acknowledge the limitations of the proposed design, including the relatively limited availability of suitable Bulgarian news texts and the possibility that some participants may already be familiar with individual news items.

The proposed methodology lays the foundation for a large-scale eye-tracking study of misinformation processing in Bulgarian. Future work will implement the experiment, analyse eye-movement measures such as fixation duration, saccadic behaviour, and gaze duration, and evaluate whether the presence of the stimulus word is associated with systematic differences in reading behaviour. We also plan to extend the study to additional news formats, including audio and video, and to integrate complementary physiological measures (e.g., cognitive load indicators) (Zagermann et al., 2016). The resulting corpus and anonymised eye-tracking dataset are intended for open-access release to support reproducibility, comparative studies, and further research.

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