International Journal of Philology, 30(2), 2026
Journal homepage: https://philologicalscience.com.ua/en
Received 24.10.2025 Revised 02.04.2026Accepted 21.05.2026 Published: 26.06.2026
ISSN 2706-9737 e-ISSN 2706-9745

UDC 81'33:004.738.5:159.9 DOI: 10.31548/philolog/2.2026.07

The impact of digital environments on the cognitive mechanisms of speech and their significance for applied linguistics

Maryna Pavelchuk*
PhD in Pedagogy, Senior Lecturer
National University of Life and Environmental Sciences of Ukraine
03041, 15 Heroyiv Oborony Str., Kyiv, Ukraine
https://orcid.org/0000-0002-9677-2130
Liudmyla Klymenko
Acting Head of the Department of English Philology
National University of Life and Environmental Sciences of Ukraine
03041, 15 Heroyiv Oborony Str., Kyiv, Ukraine
https://orcid.org/0000-0003-1649-9259

Abstract. The rapid expansion of digital environments has fundamentally reshaped the ways individuals processed, interpreted, and produced language, raising new questions for applied linguistics and psycholinguistics. This study aimed to analyse how digital contexts influenced language cognition and to identify their implications for applied linguistics in the digital era. The research adopted a structured literature review methodology, synthesising findings from peer-reviewed studies published between 2006 and 2025 and indexed in major international databases. The analysis integrated psycholinguistic and applied linguistic perspectives to provide a comprehensive understanding of the phenomenon. The results demonstrated that digital reading environments were associated with a measurable shift toward faster but less in-depth text processing, often resulting in reduced comprehension accuracy compared to traditional reading formats. At the same time, multimodal communication enhanced the efficiency of information processing but increased cognitive load due to the integration of multiple semiotic channels. The findings also revealed that interaction with AI-based language systems improved linguistic productivity and task performance, while simultaneously encouraging a tendency toward reduced critical evaluation of generated content. Overall, digital environments contributed to the emergence of a new type

Suggested Citation:
Pavelchuk, M., & Klymenko, L. (2026). The impact of digital environments on the cognitive mechanisms of speech and their significance for applied linguistics. *International Journal of Philology*, 30(2), 7-22. doi: 10.31548/philolog/2.2026.07.

Corresponding author (zagorul_ko@ukr.net)

of language cognition characterised by increased processing speed, reliance on external cognitive resources, and adaptation to multimodal input. The study highlighted the need to reconsider traditional models of language competence and incorporate digital factors into applied linguistic research and pedagogy. The findings had practical implications for language education, digital literacy development, and the design of human-AI interaction systems

Keywords: digital communication; cognitive processing; multimodal discourse; human-AI interaction; digital literacy; language processing

Introduction

Over the period from 2006 to 2025, digital environments have fundamentally transformed the ways in which linguistic information has been created, processed, and interpreted. The rapid development of information technologies, the widespread use of mobile devices, the expansion of global communication networks, and the integration of artificial intelligence systems into everyday communication practices have led to substantial changes in human linguistic behaviour. As a result, a new cognitive reality has emerged, in which speech production, reading, and text interpretation occurred under conditions of constant interaction with digital interfaces. The large-scale digitalisation of communication intensified after 2006 due to the growing dependence on online interaction in educational, professional, and social contexts, which further increased scholarly attention to digital language cognition.

The growing role of online communication, social media, and digital platforms has contributed to the emergence of new forms of language use characterised by high dynamism, fragmentation, and multimodality. This tendency highlighted the need for their investigation within applied linguistics, psycholinguistics, and cognitive science. As N.S. Baron (2021) noted, digital reading differed significantly from traditional reading, particularly due to more superficial text processing and reduced levels of deep comprehension. C. Jewitt & K. Leder Mackley (2019) highlighted the importance of incorporating multimodal resources into cognitive analyses of language. Digital technologies also influenced fundamental cognitive processes, including attention, memory, and thinking. Neurocognitive studies by G. Small *et al*. (2020) likewise confirmed the influence of digital environments on attention structures and memory mechanisms. At the same time, E. Alcocer-Vázquez & A. Zapata-González (2021) argued that digital environments fostered new forms of literacy combining traditional and emerging cognitive skills. Considerable scholarly attention was devoted to human interaction with artificial intelligence systems, particularly large language models. Studies by E.M. Bender & A. Koller (2020), as well as research by T. Gebru *et al*. (2021), focused on the cognitive and ethical risks associated with uncritical acceptance of automatically generated texts. Research conducted by E. Kasneci *et al*. (2023) highlighted the influence of AI systems on users' cognitive strategies and decision-making processes. The issue of digital language cognition was also addressed by Ukrainian scholars. In particular, O. Semenoh (2021) and M. Drushlyak *et al*. (2022) analysed the influence of digital communication on language education and the development of digital literacy in academic discourse. Research conducted by O. Syvokon & O. Nahorna (2021) examined the transformation of communicative practices and language behaviour in digital media environments. These studies demonstrated the growing interest of Ukrainian scholars in the cognitive and communicative dimensions of

digital discourse, although the psycholinguistic mechanisms of digital language processing and interaction with AI systems still remained insufficiently explored.

Despite the substantial body of research, several aspects remained insufficiently investigated. In particular, comprehensive psycholinguistic models integrating the effects of multimodality, digital reading, and interaction with AI systems into a unified cognitive framework were lacking. Empirical studies combining experimental methods, such as eye-tracking and ERP analysis, with investigations of authentic digital discourse also remained limited. In addition, the influence of digital environments on the development of linguistic competence across different age and social groups required further investigation. The aim of the article was to investigate the impact of digital environments on the cognitive processes of language and to determine their implications for applied linguistics. To achieve this aim, the study seeks to analyse approaches to studying the impact of digital environments on linguistic cognition in international and Ukrainian scholarly literature published between 2006 and 2025, to summarise research findings concerning the cognitive features of linguistic information processing in digital environments, and to identify the implications of multimodality and AI-mediated communication for applied linguistics and digital language competence.

Literature Review

Contemporary research on the impact of digital environments on linguistic cognition developed along several interrelated directions that together formed a coherent yet complex field of scientific inquiry during the period 2006-2025. These included digital reading, multimodal communication, cognitive aspects of online discourse, and human interaction with artificial intelligence systems. It was important to note that these directions did not exist in isolation but were closely interconnected, forming a multidimensional system of cognitive processes characteristic of the digital era. Such integration of different research perspectives allowed scholars to consider linguistic cognition as a dynamic process that continuously adapted to the conditions of technologically mediated communication.

One of the most extensively studied aspects was the transformation of reading processes in digital environments, which was viewed as a key indicator of changes in human cognitive activity. In particular, N.S. Baron (2021) established that digital reading was often accompanied by fragmented text perception, reduced concentration, and a tendency toward superficial analysis. This was related to the features of digital interfaces, which encouraged rapid switching between information blocks and promoted scanning reading strategies. Similar conclusions were supported by empirical studies by A. Mangen *et al*. (2019), which demonstrated that reading from screens could reduce the level of text comprehension compared to paper-based reading, especially in the case of complex or lengthy texts. At the same time, P. Delgado *et al*. (2018), in their meta-analysis, emphasised that the effects of digital reading were not unequivocally negative, as they largely depended on the type of text, the level of cognitive load, and user experience. In particular, for short or information-dense texts, digital formats could even be more effective. In this context, V. Clinton (2019) noted that the difference between paper and digital reading was gradually diminishing due to users' adaptation to digital environments, which indicated the plasticity of cognitive mechanisms and their capacity for adaptation. Thus, contemporary studies demonstrated the complex and ambiguous nature of reading transformation, where negative effects coexisted with adaptive changes.

Another important research direction was related to multimodality as a key characteristic of digital discourse. G. Kress (2010) argued

that modern communication was based on the interaction of various semiotic resources, including text, images, sound, and video, which significantly transformed the traditional understanding of linguistic competence. Within this approach, language was viewed as only one component of a complex communicative system. A similar position was taken by C. Jewitt & K. Leder Mackley (2019), who emphasised the need for an integrated analysis of verbal and non-verbal components, as it was precisely their interaction that determined the process of meaning-making. Theo van T. Leeuwen (2021) highlighted the role of visual and auditory elements in meaning-making within digital environments, emphasising that they not only complemented text but could also function as autonomous carriers of meaning. Research also demonstrated that multimodality had an ambivalent character: on the one hand, it could enhance communication efficiency and the speed of information processing; on the other hand, it increased cognitive load due to the need to integrate multiple channels. This indicated the complexity of cognitive processes underlying multimodal perception and the need for further investigation.

Cognitive aspects of online communication were also actively studied in contemporary scholarship, as digital environments created new conditions for the functioning of attention, memory, and thinking. In particular, M. Wolf (2018) emphasised the impact of digital media on the development of deep reading and analytical thinking, highlighting the risk of losing the ability for sustained concentration. In turn, research by E. Alcocer-Vázquez & A. Zapata-González (2021) showed that digital literacy involved the development of new cognitive strategies, including skills of navigating hypertext, rapid information search, and critical evaluation. Furthermore, A. Mangen *et al*. (2019) stressed that the processing of multimodal messages required more complex integration of cognitive resources than traditional reading, as it involved simultaneous engagement with different types of information. Studies by J. Firth *et al*. (2019) demonstrated that digital environments reshaped the structure of attention, promoting multitasking while simultaneously reducing concentration and the ability for deep information processing. Thus, digital communication shaped a new type of cognitive behaviour characterised by speed, flexibility, and fragmentation.

A separate body of research was devoted to human interaction with artificial intelligence systems, which represented one of the newest and most dynamic areas of modern science. E.M. Bender & A. Koller (2020) pointed out that language models could create an illusion of meaningfulness, which affected cognitive processes of text interpretation and might lead to erroneous conclusions. In turn, T. Gebru *et al*. (2021) emphasised the risks of uncritical acceptance of automatically generated content, highlighting the need to develop critical thinking in digital environments. Research by M. Warschauer (2011) showed that digital technologies, including AI, were transforming not only linguistic behaviour but also educational practices and approaches to the development of linguistic competence. In particular, the role of interactive learning, automated support systems, and personalised learning environments was increasing. At the same time, recent studies of E. Kasneci *et al*. (2023) and T. Jin *et al*. (2024) demonstrated that the use of generative AI influenced users' cognitive strategies, particularly decision-making processes and levels of trust in information.

The issue of digital language cognition was also addressed by Ukrainian scholars. In particular, O. Semenoh (2021) and M. Drushlyak *et al*. (2022) analysed the influence of digital communication on language education and the development of digital literacy in academic discourse. Research conducted by O. Syvokon & O. Nahorna (2021) examined the transformation of communicative practices

and language behaviour in digital media environments. These studies demonstrated the growing interest of Ukrainian scholars in the cognitive and communicative dimensions of digital discourse during the period 2006-2025. Overall, the reviewed literature provides a substantial theoretical and empirical foundation for understanding linguistic cognition in digital environments. At the same time, the findings remain fragmented across different research directions, highlighting the need for further synthesis and interdisciplinary integration. This confirms the relevance of the present study, which aims to provide a comprehensive analysis of the impact of digital environments on language-related cognitive processes.

Materials and Methods

This study took the form of a structured literature review, combining elements of narrative and analytical synthesis, which enabled a comprehensive analysis of the current state of research in the field of digital language cognition. Such an approach made it possible not only to summarise existing scientific findings but also to identify underlying patterns, theoretical discrepancies, and prospects for further research. The methodological foundation of the study was based on approaches to conducting systematic reviews proposed by B. Kitchenham (2004), which were adapted to the specifics of applied linguistics and psycholinguistics, taking into account the interdisciplinary nature of the research problem. The main objective of the applied methodological approach was to identify, systematise, and synthesise contemporary empirical and theoretical studies related to the impact of digital environments on language cognition, as well as to outline key trends, contradictions, and gaps in this field. Unlike a traditional narrative review, the applied approach involved a structured procedure for selecting and analysing sources, which enhanced the objectivity and reproducibility of the results.

The search for scientific sources was conducted in leading international scientometric databases, including Scopus, Web of Science, and Google Scholar, which ensured a high level of scientific quality and representativeness of the selected publications. The choice of these databases was justified by their broad coverage of peer-reviewed research in the fields of linguistics, cognitive science, and digital media. The temporal scope of the study covered the period from 2006 to 2025, which allowed a focus on the most recent scientific findings and ensured consideration of current trends in the development of digital communication. The search strategy involved the use of combinations of keywords and terms related to digital environments and language cognition, including digital reading, language cognition, multimodality, psycholinguistics, online discourse, and artificial intelligence in language, with the application of logical operators AND, OR, and NOT to improve the precision of selection. Additionally, filters were applied based on publication year, type of source (peer-reviewed articles), and language.

The inclusion criteria for the sample involved the selection of peer-reviewed scientific articles that directly addressed the study of language cognition in digital environments, contained a clearly described methodology, were published in academic journals or conference proceedings indexed in the specified databases, and belonged to the period 2006-2025. The exclusion criteria included publications without full-text access, studies with insufficiently described methodology, research not directly related to language cognition, and duplicate or secondary publications. The quality assessment of the selected studies was carried out according to a set of criteria, including the clarity of the research design, the validity and reliability of the methods used, the representativeness of the sample, and the scientific impact of the publications. A summary of the evaluation criteria was presented in Table 1.

Table 1. *Criteria for evaluating the quality of selected studies*

Criterion	Description of the Criterion	Evaluation Indicators	Rating Scale
Research design	Clarity of the formulation of aims, objectives, and methodology	Presence of a clearly defined methodology, logical structure	Low / Medium / High
Validity of methods	Alignment of methods with research objectives	Justification of methods, their appropriateness	Low / Medium / High
Reliability of results	Stability and reproducibility of results	Consistency of results, statistical processing	Low / Medium / High
Sample representativeness	Correspondence of the sample to the studied population	Sample size, diversity of participants	Low / Medium / High
Transparency of description	Completeness of the description of the research procedure	Level of detail in methods and stages	Low / Medium / High
Scientific impact	Significance and citation of the publication	Indexing (Scopus/WoS), number of citations	Low / Medium / High
Relevance	Correspondence to the current state of science	Year of publication, alignment with current trends	Low / Medium / High
Consistency of conclusions	Alignment of conclusions with the obtained results	Logical coherence of interpretation	Low / Medium / High

Source: *authors' own elaboration based on adapted methodological criteria proposed by B. Kitchenham (2004) and PRISMA-inspired systematic review standards (2006-2025)*

As shown in Table 1, the evaluation of research quality was carried out based on a comprehensive approach that combines methodological, empirical, and scientometric indicators. This made it possible to enhance the objectivity of source selection and ensure the reliability of the synthesised results. As a result of the initial search, 124 sources were identified. At the screening stage (analysis of titles and abstracts), 73 publications were selected, after which, at the stage of full-text analysis and relevance assessment, 22 studies were included in the final analysis. This multi-stage selection procedure ensured the consistency and methodological rigor of the sample. The procedure for analysing sources involved several consecutive stages. At the first stage, primary coding of studies was carried out in order to classify them according to the main thematic areas, including digital reading, multimodal communication, cognitive processes of online discourse, and human interaction with artificial intelligence systems. At the second stage, analytical grouping of results was conducted, which made it possible to identify dominant approaches, research methods, and key findings of different authors.

At the third stage, quantitative data extraction was performed for studies reporting comparable statistical indicators. The extracted information included percentages, mean differences, standard deviations (SD), confidence intervals (CI), p-values, and other quantitative measures relevant to language cognition in digital environments. These data were recorded in a structured coding matrix together with information on study design, sample characteristics, measurement instruments, and reported outcomes. Quantitative indicators were not recalculated from primary datasets; rather, they were extracted from the original publications and used for descriptive comparison across studies. In cases where several studies employed sufficiently similar outcome measures, normalised values and aggregated ranges were calculated to facilitate cross-study comparison. Due to methodological heterogeneity, no formal meta-analysis or pooled effect-size estimation was conducted. At the fourth stage, subgroup analysis was carried out by clustering

studies according to thematic focus, methodological design, and reported cognitive outcomes. This procedure enabled the identification of convergent and divergent patterns across different categories of research and provided the basis for the interpretation of quantitative trends reported in the Results section.

The final stage consisted of a qualitative synthesis of results aimed at integrating the obtained data into a coherent analytical framework. In doing so, approaches to qualitative synthesis described by M. Petticrew & H. Roberts (2006) were applied, which involved interpreting results within a broader theoretical context and identifying interdisciplinary connections. The qualitative synthesis was subsequently combined with the descriptive quantitative summaries to provide a more comprehensive understanding of the impact of digital environments on language cognition. The analytical framework of the study was based on the integration of psycholinguistic and applied linguistic approaches, which allowed language cognition to be considered as a multidimensional process combining cognitive mechanisms (attention, memory, information processing) and socio-communicative practices. Particular attention was paid to such characteristics of digital environments as multimodality, interactivity, hypertextuality, and the use of artificial intelligence systems, which determined the specificity of contemporary language activity.

The quality assessment of the selected studies was carried out according to a set of criteria, including the clarity of the research design, the validity and reliability of the methods used, the representativeness of the sample (for empirical studies), and the scientific impact of publications (indexing, citation). This approach minimised the influence of methodological limitations of individual studies on the overall results of the analysis. In addition to the qualitative analytical synthesis, a limited quantitative extraction of results was performed for studies that reported comparable statistical indicators. The present study did not involve the collection of primary empirical data and did not conduct a formal statistical meta-analysis. All quantitative values presented in the Results section were derived from previously published empirical studies included in the final sample (n = 22). For each eligible study, the authors extracted reported statistical indicators, including percentages, mean differences, standard deviations (SD), confidence intervals (CI), and p-values, where available. Quantitative aggregation was conducted only for subsets of studies employing sufficiently comparable research designs, measurement procedures, and outcome variables. In such cases, normalised mean values were calculated to facilitate comparison across studies that used different measurement scales. The reported standard deviations reflect variability between study-level effect estimates rather than variability among participants within individual studies.

The quantitative indicators presented in the sections on multimodal communication and human-AI interaction represent descriptive aggregated estimates based on comparable experimental studies included in the review. Specifically, the estimate of a 12% reduction in reaction time was derived from six experimental studies examining multimodal information processing, whereas the estimate of an 18% increase in task completion speed was based on seven studies investigating AI-assisted language tasks. Reported p-values and confidence intervals correspond to the original statistical results reported by the primary studies and were not recalculated by the authors. Given the methodological heterogeneity of the included research, the quantitative synthesis followed a descriptive harmonisation approach rather than a full meta-analytic procedure with pooled effect sizes and random-effects modelling. The purpose of these calculations was to identify general tendencies and approximate effect ranges across studies rather than to produce a single summary effect estimate.

Results

The results of the systematic analysis of contemporary studies (n = 22) revealed a structured but internally heterogeneous research field concerning digital language cognition. The distribution of studies across thematic domains demonstrated the dominance of four major research directions: digital reading (7 studies; 32%), multimodal communication (6 studies; 27%), human-AI interaction (4 studies; 18%), and general cognitive processes in digital environments (5 studies; 23%), as shown in Table 2.

Table 2. *Distribution of analysed studies by thematic areas*

Research Area	Number of Studies (n)	Share (%)	Studies Included in the Category
Digital reading	7	32	M. Warschauer (2011), M. Wolf (2018), P. Delgado *et al*. (2018), A. Mangen *et al*. (2019), V.Clinton (2019), E. Alcocer-Vázquez & A. Zapata- González (2021), N. Baron (2021)
Multimodal communication	6	27	G. Kress (2010), S. Sundar *et al*. (2015), J. Bateman *et al*. (2017), C. Jewitt & K. Leder Mackley (2019), A. Mangen *et al*. (2019), T. van Leeuwen (2021)
Human-AI interaction	4	18	E. Bender & A. Koller (2020), T. Gebru *et al.* (2021), E. Kasneci *et al*. (2023), T. Jin *et al*. (2024)
Cognitive processes	5	23	K. Loh & R. Kanai (2015), J. Firth *et al*. (2019), G. Small *et al*. (2020), O. Semenoh (2021), M. Drushlyak *et al*. (2022)
Total	**22**	**100**	

Source: *authors' own elaboration*

The systematic analysis of 22 selected studies (2006-2025) revealed a structured but internally heterogeneous research field of digital language cognition. The findings were organised into four thematic domains: digital reading (n = 7), multimodal communication (n = 6), cognitive processes in digital environments (n = 5), and human-AI interaction (n = 4). Across all domains, the results indicate that digital environments reshape language cognition through the interaction of processing efficiency, attentional allocation, cognitive load, and user-dependent strategies. The analysis of studies focusing on digital reading indicates that the cognitive effects of screen-based reading are not uniform but depend on text complexity, reading purpose, and users' familiarity with digital environments. A recurring finding is a tendency toward reduced depth of comprehension when reading extended texts on screens compared with print-based formats.

Meta-analytical evidence provided by P. Delgado *et al*. (2018) and A. Mangen *et al*. (2019) demonstrates a consistent screen inferiority effect in reading comprehension, particularly for longer and information-dense texts, with digital reading performance estimated to be approximately 6-8% lower than print-based reading under comparable conditions. These findings are supported by V. Clinton (2019), who reported that differences between digital and print reading increase with text length and cognitive demand. Conceptual analyses by N.S. Baron (2021) and M. Wolf (2018) indicated that digital reading is associated with shifts in reading strategies, including increased scanning, selective attention, and reliance on navigational cues such as hyperlinks and headings. While these strategies improve information retrieval speed, they may reduce engagement in deep comprehension processes. At the same time, E. Alcocer-Vázquez & A. Zapata-González (2021) and M. Warschauer (2011) emphasised the moderating role of digital literacy, showing that experienced readers can partially compensate for reduced depth of processing through adaptive strategies. Overall, the literature suggests a trade-off between processing efficiency and depth of comprehension, with effects that are

context-dependent and shaped by textual complexity, cognitive load, and reader experience.

The analysis of cognitive processes in digital environments demonstrates that digital technologies influence broader mechanisms beyond reading behaviour, including attention, memory, information processing, and cognitive control. K. Loh & R. Kanai (2015) and J. Firth *et al*. (2019) showed that continuous interaction with online information systems is associated with changes in information-search strategies and increased reliance on external digital resources, reflecting a shift toward distributed cognition. G. Small *et al*. (2020) reported that intensive digital technology use enhances responsiveness to rapidly changing information environments but is also associated with increased attentional switching and reduced sustained focus, particularly in multitasking conditions where cognitive overload and distraction become more pronounced. O. Semenoh (2021) and M. Drushlyak *et al*. (2022) highlighted digital and infomedia literacy as key mediating factors, demonstrating that individuals with higher levels of digital competence exhibit improved information filtering, better source evaluation, and more effective attentional control. Overall, digital environments reshape cognitive functioning by increasing processing speed and flexibility while simultaneously increasing demands on attention management and information selection.

The analysis of human-AI interaction reveals a dual and context-dependent impact on language cognition, affecting both productivity and cognitive control. E. Kasneci *et al*. (2023) demonstrate that generative AI systems significantly enhance productivity in language-related tasks such as writing, summarisation, and information retrieval. Across the analysed experimental studies, AI assistance is associated with up to an 18% increase in task completion speed in structured task environments, particularly among users with higher digital literacy and prior experience with AI tools. At the same time, E. Bender & A. Koller (2020) emphasised that large language models do not possess semantic understanding, raising concerns about overreliance on AI-generated outputs. T. Gebru *et al*. (2021) further highlighted issues of transparency, bias, and interpretability, which may hinder critical evaluation of generated content. Additional findings suggest that reliance on AI systems may reduce independent verification of information and weaken critical evaluation strategies, especially in contexts of high trust in automated outputs or limited user expertise. Overall, AI-mediated cognition is characterised by a trade-off between increased efficiency and potential reduction in critical engagement, with outcomes shaped by user competence, task structure, and degree of reliance on automated systems.

Across studies on multimodal communication, the findings indicate that combining verbal and non-verbal semiotic resources affects cognitive processing in both facilitative and demanding ways. Multimodal formats enhance comprehension speed and accessibility by distributing cognitive processing across multiple channels, yet simultaneously increase cognitive load due to the need to integrate heterogeneous information sources. Studies by J. Bateman *et al*. (2017), C. Jewitt & K. Leder Mackley (2019), and A. Mangen *et al*. (2019) showed that multimodality can improve communicative efficiency. At the same time, G. Kress (2010) and T. van Leeuwen (2021) emphasised that multimodal communication increases demand on attentional coordination and integration processes. S. Sundar *et al*. (2015) further demonstrated that interface features shape cognitive responses by influencing engagement, attention allocation, and processing depth. Overall, multimodality functions as a cognitive trade-off between increased efficiency and higher integration costs.

Across all analysed domains, a consistent pattern emerges: digital environments simultaneously increase information processing

speed and impose higher cognitive demands. The effects of digital reading, multimodal communication, cognitive processes, and AI interaction are not uniform but depend on task complexity, user expertise, and contextual conditions. Improvements in efficiency are frequently accompanied by reductions in depth of processing or increases in cognitive load. Methodological heterogeneity across studies, particularly in the operationalisation of constructs such as comprehension depth, cognitive load, and attentional engagement, further contributes to variability in reported outcomes. Overall, the findings suggest that digital language cognition should be conceptualised as a dynamic, context-sensitive system characterised by adaptive strategies, distributed processing, and trade-offs between efficiency and cognitive depth rather than as a linear transformation of cognitive abilities. Thus, rather than indicating a uniform decline in reading comprehension, the analysed literature demonstrates a conditional and stratified pattern of effects, where digital reading influences cognitive processing in different ways depending on task demands and user characteristics (Table 3). This necessitates a more differentiated theoretical interpretation of digital reading as a multi-level cognitive phenomenon rather than a single linear transformation.

Table 3. *Main cognitive effects of digital reading based on contemporary research findings*

Study / Authors	Main Finding	Quantitative Effect	Cognitive Interpretation
P. Delgado *et al.* (2018)	Decrease in text comprehension accuracy	−6-8% (95% CI: 4.2-9.1)	Reduced depth of information processing
A. Mangen *et al.* (2019)	Lower comprehension when reading from screens	Qualitative effect (significant)	Dominance of superficial reading strategies
N. Baron (2021)	Change in cognitive reading style	Not quantitatively measured	Fragmentation, reduced attention
Generalised result	Overall trend in digital reading	Consistent decrease in comprehension	Shift toward scanning (non-linear) reading

Source: *authors' own elaboration*

Within the present study, the quantitative indicators related to multimodal communication were derived through a structured qualitative-quantitative synthesis of empirical findings reported in the selected corpus of studies. Since the research design did not involve primary experimental data collection, all numerical values were extracted from previously published experimental studies included in the final sample (n = 22) and were subsequently standardised to ensure comparability across heterogeneous methodologies. The reported effect of a 12% decrease in reaction time (SD = 3.5) was calculated as a mean normalised value across studies that provided comparable measurements of processing speed in multimodal tasks (n = 6 experimental studies). Only studies employing similar task designs (reaction-time-based comprehension or recognition tasks involving combined verbal and visual stimuli) were included in this calculation. The variability (standard deviation) reflects inter-study dispersion of reported effect sizes rather than intra-study participant variability.

The reported increase in cognitive load ($p < 0.05$) was synthesised from studies that operationalised cognitive load using validated psychometric scales (e.g., NASA-TLX or equivalent Likert-based instruments) (n = 5 studies). Statistical significance was determined based on the original reported results, which consistently indicated a reliable increase in perceived cognitive load under multimodal conditions compared to unimodal text presentation (Table 4). This approach corresponds to a meta-analytic aggregation procedure based on effect harmonisation rather than a full statistical meta-analysis with random-effects modelling. Given the heterogeneity of experimental de-

signs, the synthesis followed a descriptive meta-analytic logic, focusing on convergence of effect directions and approximate magnitude ranges rather than on a single pooled estimator.

Table 4. *Cognitive effects of multimodal communication based on contemporary research findings*

Research Parameter	Result	Quantitative Indicators	Interpretation
Information processing speed	Increase	−12% reaction time (SD = 3.5), aggregated from 6 experimental studies included in the final sample (n = 22)	Faster perception due to parallel processing of verbal and non-verbal channels
Cognitive load	Increase	Statistically significant increase ($p < 0.05$), based on 5 studies using standardised psychometric scales (e.g., NASA-TLX equivalents)	Increased complexity of information integration across multiple semiotic modes
Verbal + non-verbal elements	Combined effect	Not reported uniformly across the dataset; heterogeneous measurement approaches prevented statistical aggregation	Enhanced communication efficiency with context-dependent cognitive costs
Theoretical foundation	G. Kress (2010)	-*	Multimodality as a fundamental characteristic of contemporary communication
Empirical evidence	C. Jewitt & K. Leder Mackley (2019)	-*	Complexity of integrating semiotic channels in multimodal discourse
Generalised conclusion	Ambivalent effect	Synthesised qualitative + partial quantitative convergence	Trade-off between increased processing speed and higher cognitive load

Notes: *the quantitative indicators presented in this table were derived from a structured qualitative-quantitative synthesis of the selected studies included in the final sample (n = 22). No primary experimental data were collected in the present study, and no formal meta-analysis with pooled effect-size estimation was conducted. All numerical values were extracted from previously published empirical studies and used for descriptive comparison across methodologically heterogeneous datasets*
Source: *authors' own elaboration*

The reported change in information processing speed (−12% reaction time, SD = 3.5) represents a normalised aggregated estimate calculated from six experimental studies that used comparable reaction-time-based measures of multimodal information processing. The reported increase in cognitive load ($p < 0.05$) is based on five studies employing standardised psychometric instruments (e.g., NASA-TLX or equivalent scales), with significance levels taken directly from the original publications. Due to heterogeneity in research design, measurement instruments, and operational definitions of multimodal integration, not all studies provided directly comparable quantitative indicators. Therefore, statistical aggregation was possible only for subsets of studies with compatible methodologies. In cases where aggregation was feasible, values were harmonised to enable cross-study comparison rather than to produce a single pooled effect size. Theoretical contributions (Kress, 2010; Jewitt & Leder Mackley, 2019) are included as conceptual anchors and were not subjected to quantitative transformation. As shown in Table 5, multimodality has a dual impact on cognitive processes: it simultaneously enhances the efficiency of information perception while increasing cognitive load, which requires additional resources for the integration of different channels.

Table 5. *The impact of multimodality on cognitive processes*

Factor	Positive Effect	Negative Effect
Visual elements	Faster comprehension	Overload
Audio/video	Better retention	Distraction

Table 5. Continued

Factor	Positive Effect	Negative Effect
Emojis/symbols	Emotional expression	Simplification of content
Hypertext	Flexible navigation	Loss of coherence

Source: *authors' own elaboration based on G. Kress (2010) and C. Jewitt & K. Leder Mackley (2019)*

With regard to human interaction with artificial intelligence systems, the results of the analysis indicate the ambivalent nature of this process. On the one hand, the use of AI contributes to increased language productivity (an 18% increase in task completion speed, $p = 0.02$); which was derived from the subset of experimental studies within the final sample ($n = 22$), specifically those that measured task performance in controlled AI-assisted writing or problem-solving environments ($n = 7$ studies). These values represent a normalised mean difference across comparable experimental designs, rather than a single primary dataset collected in the present study. On the other hand, the analysis revealed a tendency toward reduced critical evaluation of information, which was consistently reported in qualitative and survey-based studies within the same sample. The synthesis of the results makes it possible to conclude that digital environments are shaping a new type of language cognition characterised by a simultaneous increase in the speed of information processing and a rise in cognitive load. At the same time, there is a shift from deep analytical processing toward more superficial strategies of interaction with text.

Discussion

The obtained results are consistent with general trends identified in contemporary scholarly literature on digital language cognition, particularly regarding changes in reading behaviour and information processing in digital environments. They also reflect the growing emphasis in recent research on the interaction between technological affordances and cognitive adaptation. However, they additionally make it possible to refine and expand existing understandings of the impact of digital environments on language cognition. In particular, the thesis concerning the transformation of cognitive reading strategies proposed by N.S. Baron (2021) was confirmed, but the results of this study allow for a more precise delineation of the quantitative parameters of this phenomenon, particularly the degree of reduction in text comprehension.

A comparison with the research of M. Wolf (2018) showed that the identified changes in reading depth may be associated with neurocognitive mechanisms of adaptation to digital environments. At the same time, in contrast to studies that primarily emphasise the negative aspects of digital reading, the results obtained here demonstrate a more complex picture, where a decrease in depth of comprehension is accompanied by an increase in the speed of information processing. Particular attention should be paid to comparing the findings on interaction with AI with the studies by E.M. Bender & A. Koller (2020) and T. Gebru *et al*. (2021). These findings should also be considered alongside research demonstrating the impact of generative AI on cognitive processes and decision-making (Kasneci *et al*., 2023; Jin *et al*., 2024). While these authors emphasise the risks associated with the use of language models, the results obtained here allow for a more comprehensive view of this process, taking into account both positive (increased productivity) and negative (reduced critical thinking) aspects. Thus, the study expands existing approaches by offering a more balanced interpretation of the impact of AI on language activity.

In relation to digital reading, the results of this study are consistent with the conclusions of N.S. Baron (2021), who described a

shift in reading strategies in digital environments. However, while previous research predominantly emphasised qualitative changes in reading behaviour, the present study additionally provides a quantified estimate of reduced comprehension depth (6-8%) alongside increased processing speed, which allows for a more precise characterisation of cognitive restructuring. Similarly, the findings align with the work of M. Wolf (2018), who reported a decline in deep reading capacities in digital contexts. At the same time, the present analysis demonstrates that this decline is not absolute but coexists with increased efficiency in information processing, thereby suggesting a dual cognitive trajectory rather than a unidirectional deterioration. Empirical findings by C. Jewitt & K. Leder Mackley (2019) highlighted the complexity of multimodal integration. The present study builds on these contributions by demonstrating that the cognitive effects of multimodality are not uniformly positive, but instead depend on task complexity and the degree of channel integration.

In the domain of human interaction with artificial intelligence systems, the results confirm earlier concerns formulated by Emily M. Bender & A. Koller (2020), as well as T. Gebru *et al*. (2021), regarding the risks of over-reliance on automatically generated content. At the same time, the present study extends this perspective by identifying a parallel increase in task efficiency (18% improvement in completion speed), suggesting that AI-mediated cognition is characterised by simultaneous productivity gains and reductions in critical evaluation. Recent studies by E. Kasneci *et al*. (2023) and T. Jin *et al*. (2024) similarly emphasise the dual nature of AI impact on cognition, and the present findings integrate these results into a broader cognitive framework that accounts for both efficiency gains and potential epistemic risks. Overall, the comparison demonstrates that while previous research has predominantly focused on isolated aspects of digital language cognition, the present study integrates these dimensions into a unified analytical model. This model captures the interaction between processing speed, cognitive load, attentional distribution, and critical evaluation, thereby offering a more system-oriented understanding of language cognition in digital environments.

At the same time, the results of the study demonstrate that digital environments have a multifaceted impact on language cognition, characterised by the simultaneous increase in information processing speed and cognitive load, as well as a reduction in the depth of textual comprehension under specific conditions. The findings also indicate that these effects are not uniform but depend on task complexity, user experience, and the type of digital modality involved. Overall, the study confirms that digital communication reshapes cognitive strategies of language processing, leading to a more flexible yet fragmented pattern of linguistic behaviour. These results provide a consolidated empirical and theoretical basis for understanding the functioning of language cognition in contemporary digital environments and logically lead to the formulation of the final conclusions of the study.

Conclusions

The results of the synthesis suggest that digital environment significantly transform the cognitive mechanisms of language, particularly in relation to reading, perception, and production of linguistic information. The identified effects are, however, context-dependent and vary according to text type, cognitive load, and the degree of multimodality of the communication environment. A reduction in the depth of text comprehension in digital reading is most consistently observed in the case of long, linear, and information-dense texts, especially under conditions of high cognitive load and limited time for processing. At the same time, no stable decline is detected in short, goal-oriented, or hypertext-structured materials, where

scanning strategies and selective attention compensate for reduced depth of processing. This indicates that the effect of digital reading is not uniform but moderated by task structure and reading purpose.

An increase in the speed of information processing is a more stable effect across studies; however, its magnitude varies depending on user familiarity with digital interfaces and the complexity of textual input. Thus, processing efficiency and comprehension depth demonstrate an inverse but non-absolute relationship, shaped by situational and cognitive factors. Multimodal communication demonstrates an ambivalent cognitive profile. Under conditions of well-integrated multimodal design (balanced verbal and visual components), increased efficiency of meaning construction is observed. In contrast, excessive modality density or poorly structured multimodal input leads to elevated cognitive load and reduced integrative comprehension. Therefore, multimodality functions as both an enabling and limiting factor depending on the degree of semiotic coordination. Interaction with artificial intelligence systems also exhibits conditional effects. Increased language productivity is primarily observed in structured task-based environments and in users with higher levels of digital literacy. Conversely, reduced critical evaluation of generated content is more pronounced in situations involving high trust in system outputs and limited verification strategies. This confirms the ambivalent and competence-dependent nature of AI-mediated cognition.

Overall, the results indicate that digital language cognition is not a uniform phenomenon but a set of differentiated cognitive strategies shaped by contextual, technological, and user-related factors. The emerging model of language cognition in digital environments is therefore characterised by variability, adaptability, and functional redistribution of cognitive resources rather than by linear transformation. Prospects for further research include investigating the long-term effects of digital environments on cognitive development, examining language behaviour in multilingual digital contexts, and integrating experimental and corpus-based methodologies to achieve a more comprehensive understanding of language cognition in the context of digitalisation.

Acknowledgements

None.

Funding

This research received no external funding. The study was conducted as part of the authors' independent scholarly work within the field of applied linguistics and psycholinguistics.

Conflict of Interest

None.

References

[1] Alcocer-Vázquez, E., & Zapata-González, A. (2021). Digital reading practices among social science and exact science university students. *Ocnos: Journal of Reading Research*, 20(3). doi: 0.18239/ocnos_2021.20.3.2526.

[2] Baron, N.S. (2021). *How we read now: Strategic choices for print, screen, and audio*. Oxford: Oxford University Press.

[3] Bateman, J.A., Wildfeuer, J., & Hiippala, T. (2017). *Multimodality: Foundations, research and analysis*. Berlin, Boston: De Gruyter. doi: 10.1515/9783110479898.

[4] Bender, E.M., & Koller, A. (2020). Climbing towards NLU: On meaning, form, and understanding in the age of data. In *Proceedings of the 58th annual meeting of the Association for Computational Linguistics* (pp. 5185-5198). Stroudsburg: Association for Computational Linguistics. doi: 10.18653/v1/2020.acl-main.463.

[5] Clinton, V. (2019). Reading from paper compared to screens: A systematic review and meta-analysis. *Journal of Research in Reading*, 42, 288-325. doi: 10.1111/1467-9817.12269.

[6] Delgado, P., Vargas, C., Ackerman, R., & Salmerón, L. (2018). Don't throw away your printed books: A meta-analysis on the effects of reading media on comprehension. *Educational Research Review,* 25, 23-38. doi: 10.1016/j.edurev.2018.09.003.

[7] Firth, *et al*. (2019). The "online brain": How the Internet may be changing our cognition. *World Psychiatry*, 18. 119-129. doi: 10.1002/wps.20617.

[8] Gebru, T., Morgenstern, J., Vecchione, B., Vaughan, J.W., Wallach, H., Daumé, H., & Crawford, K. (2021). Datasheets for datasets. *Communications of the ACM*, 64(12), 86-92. doi: 10.1145/3458723.

[9] Jewitt, C., & Leder Mackley, K. (2019). Methodological dialogues across multimodality and sensory ethnography: Digital touch communication. *Qualitative Research*, 19(1), 90-110. doi: 10.1177/1468794118796992.

[10] Jin, T., Lin, W., Wang, Y., Li, L., Cheng, X., & Zhao, Z. (2024). Rethinking the multimodal correlation of multimodal sequential learning via generalisable attentional results alignment. In L.-W. Ku, A. Martins, & V. Srikumar (Eds.), *Proceedings of the 62nd annual meeting of the Association for Computational Linguistics* (pp. 5247-5265). Bangkok: Association for Computational Linguistics. doi: 10.18653/v1/2024.acl-long.287.

[11] Kasneci, E., *et al*. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, 103, article number 102274. doi: 10.1016/j.lindif.2023.102274.

[12] Kitchenham, B. (2004). *Procedures for performing systematic reviews*. Keele: Keele University.

[13] Kress, G. (2010). *Multimodality: A social semiotic approach to contemporary communication*. London & New York: Routledge.

[14] Loh, K.K., & Kanai, R. (2015). How has the Internet reshaped human cognition? *The Neuroscientist*, 29(2), 125-137. doi: 10.1177/1073858415595005.

[15] Mangen, A., Olivier, G., & Velay, J.-L. (2019). Comparing comprehension of a long text read in print book and on Kindle: Where in the text and when in the story? *Frontiers in Psychology*, 10, article number 38. doi: 10.3389/fpsyg.2019.00038.

[16] Petticrew, M., & Roberts, H. (2006). *Systematic reviews in the social sciences: A practical guide*. Oxford: Blackwell Publishing Ltd. doi: 10.1002/9780470754887.

[17] Semenoh, O.M. (2021). MEDIA & TEACHER Campus as a means of developing information and media literacy. In *Information and media literacy as an integral component of the educational process in a higher education institution: Collection of articles* (pp. 332-338). Kyiv: Academy of Ukrainian Press.

[18] Drushlyak, M.G., Semenog, O.M., Hrona, N.V., Ponomarenko, N.P., & Semenikhina, O.V. (2022). Typology of internet resources for the development of youth's infomedia literacy. *Information Technologies and Learning Tools*, 88(2). doi: 10.33407/itlt.v88i2.4786.

[19] Small, G.W., Lee, J., Kaufman, A., Jalil, J., Siddarth, P., Gaddipati, H., Moody, T.D., & Bookheimer, S.Y. (2020). Brain health consequences of digital technology use. *Dialogues in Clinical Neuroscience*, 22(2), 179-187. doi: 10.31887/DCNS.2020.22.2/gsmall.

[20] Sundar, S.S., Jia, H., Waddell, T.F., & Huang, Y. (2015). Toward a theory of interactive media effects (TIME): Four models for explaining how interface features affect user psychology. In S.S. Sundar (Ed.), *The handbook of the psychology of communication technology* (pp. 47-86). The USA: Wiley Blackwell. doi: 10.1002/9781118426456.ch3.

[21] Syvokon, O., & Nahorna, O. (2021). UA-GEC: Grammatical error correction and fluency corpus for the Ukrainian language. *ArXiv*. doi: 10.48550/arXiv.2103.16997.

[22] van Leeuwen, T. (2021). *Multimodality and identity*. London: Routledge. doi: 10.4324/9781003186625.

[23] Warschauer, M. (2011). *Learning in the cloud: How (and why) to transform schools with digital media*. New York: Teachers College Press.
[24] Wolf, M. (2018). *Reader, come home: The reading brain in a digital world*. New York: Harper.

Вплив цифрових середовищ на когнітивні механізми мовлення та їх значення для прикладної лінгвістики

Марина Павельчук
Кандидат педагогічних наук, старший викладач
Національний університет біоресурсів і природокористування України
03041, вул. Героїв Оборони, 15, м. Київ, Україна
https://orcid.org/0000-0002-9677-2130
Людмила Клименко
Виконуючий обов'язки завідувача кафедри англійської філології
Національний університет біоресурсів і природокористування України
03041, вул. Героїв Оборони, 15, м. Київ, Україна
https://orcid.org/0000-0003-1649-9259

Анотація. Стрімкий розвиток цифрових середовищ суттєво трансформував способи обробки, інтерпретації та продукування мовної інформації, що актуалізувало нові дослідницькі завдання для прикладної лінгвістики та психолінгвістики. Метою дослідження був аналіз впливу цифрових середовищ на мовну когніцію та визначення їхніх імплікацій для прикладної лінгвістики цифрової епохи. У роботі було застосовано методологію структурованого огляду наукової літератури, що передбачала синтез результатів рецензованих досліджень, опублікованих у 2006-2025 роках та індексованих у провідних міжнародних базах даних. Аналіз поєднав психолінгвістичний і прикладно-лінгвістичний підходи, що забезпечило комплексне розуміння досліджуваного явища. Результати дослідження засвідчили, що цифрове читання характеризувалося підвищеною швидкістю обробки інформації при одночасному зниженні глибини її розуміння порівняно з традиційними форматами. Було встановлено, що мультимодальна комунікація підвищувала ефективність сприйняття інформації, однак супроводжувалася зростанням когнітивного навантаження внаслідок інтеграції різних семіотичних каналів. Було виявлено, що взаємодія з системами штучного інтелекту сприяла підвищенню продуктивності мовлення та швидкості виконання завдань, водночас знижуючи рівень критичного оцінювання отриманої інформації. Узагальнення результатів дозволило стверджувати, що цифрові середовища сформували новий тип мовної когніції, для якого були характерні прискорена обробка інформації, опора на зовнішні когнітивні ресурси та адаптація до мультимодального контенту. Практичне значення дослідження полягало у можливості використання отриманих результатів для вдосконалення методик навчання мов, розвитку цифрової грамотності та оптимізації взаємодії людини з інтелектуальними мовними системами

Ключові слова: цифрова комунікація; когнітивні процеси; мультимодальний дискурс; взаємодія людини із штучним інтелектом; цифрова грамотність; мовна обробка