

The Cognitive and Sociolinguistic Effects of Multilingual Artificial Intelligence Systems on Language Acquisition and Linguistic Evolution

Asst. Lect. Zainab Fa'iz Jassim
College of Arts, Al-Iraqia University
zainab.f.jasim@aliraqia.edu.iq



**التأثيرات اللغوية الإدراكية والاجتماعية لأنظمة الذكاء الاصطناعي متعددة اللغات
على اكتساب اللغة والتطور اللغوي**

م.م. زينب فائز جاسم
كلية الاداب, الجامعة العراقية
zainab.f.jasim@aliraqia.edu.iq



المستخلص

تتناول هذه الدراسة كيفية تأثير أدوات الذكاء الاصطناعي متعددة اللغات، مثل نماذج Chat GPT وتطبيقات الترجمة على عملية تعلم اللغات وتفاعلنا معها في المجتمعات. تبحث الدراسة في تأثير هذه الأدوات على الذاكرة والفهم ونمو المفردات بالإضافة إلى تأثيرها على السلوكيات الاجتماعية اللغوية، مثل التحول بين اللغات وبقاء اللغات الأقل شيوعًا. تظهر النتائج أن هذه الأدوات تجعل تعلم اللغات أسهل عن طريق تقليل الجهد الذهني ومساعدة المتعلمين على إنجاز مهام أكثر تعقيدًا مثل تكوين الجمل. رغم ذلك، تواجه هذه الأدوات تحديات، مثل تعزيز الاعتماد على لغات أكثر شيوعًا مثل الإنجليزية، مما يؤدي إلى تهميش اللغات الأقل انتشارًا. وعلى الجانب الإيجابي، تمتلك تقنيات الذكاء الاصطناعي القدرة على المساهمة في الحفاظ على اللغات المهددة بالاندثار من خلال مشاريع مثل مشروع اللغات المهددة بالانقراض التابع لشركة Google. تؤكد الدراسة على أهمية التعاون بين مطوري الذكاء الاصطناعي والمعلمين والمجتمعات لضمان دعم هذه الأدوات للتنوع اللغوي وتعزيز التعلم. تقدم هذه الدراسة في النهاية رؤى لصانعي السياسات ومطوري التكنولوجيا حول كيفية تحقيق التوازن بين فوائد الذكاء الاصطناعي والحاجة إلى حماية الثروة اللغوية في العالم.

الكلمات المفتاحية: الذكاء الاصطناعي متعدد اللغات، علم اللغة الاجتماعي، اكتساب اللغة، تقييم اللغويات

Abstract

This study examines how multigoal Artificial Intelligence tools, like Chat GPT models and translation apps, changing the learning and using languages in our communities. It uses cognitive experiments and surveys about language use to see how these AI systems affect memory, understanding, and vocabulary growth. It also looks at their influence on social behaviors, such as switching languages (code-switching) and the survival of minority languages. The results indicate that AI tools make it easier for people to learn languages by needing less mental effort and helping with making sentences. However, they also create problems, such as making people depend more on popular languages like English, which can push lesser-used languages aside. On a positive note, AI can help save languages at risk of disappearing, with initiatives like Google's Endangered Languages Project. The study stresses the need for teamwork among AI developers, educators, and communities to make sure these tools support language variety while improving learning. At the end, this research gives valuable information to policymakers and technology creators on balancing AI's advantages with the importance of protecting the world's language diversity.

Keywords: Multilingual Artificial Intelligence, Sociolinguistics, Language acquisition, Linguistics evaluation, Cognitive load.

1.1 Introduction

Artificial Intelligence (AI) plays a significant role in both language change and preservation, becoming a key topic of sociolinguistic interest as computational needs are increasingly incorporated. AI technologies can accelerate linguistic homogenization, as machine translation systems are primarily effective for global languages (Johnson et al., 2017, p. 339). For example, AI translation tools may encourage code-switching and language convergence, with minority languages adopting dominant language elements, such as English, to ensure clear communication (Kraemer & Gamble, 2021, p. 503). Historically, languages with greater social or economic utility tend to replace others (Pennycook, 2017, p. 24). On the other hand, AI presents opportunities for preserving endangered languages. Initiatives like Google's Endangered Languages Project and machine learning efforts to document low-resource languages showcase AI's potential in this field (Bird, 2020, p. 5). AI systems can be trained through natural language processing (NLP) to understand and produce endangered languages, creating digital archives to aid in preservation (Mager et al., 2018, p. 9). However, challenges remain, particularly with the quality of language data and biases that favor larger language groups (Mager et al., 2018, p. 10). AI is not only a tool affecting cognitive processes but also a factor in social language practices (Engeström, 1999, p. 30). In communities where multilingual AI is widespread, the preservation or shift of minority languages may depend on the performance of AI systems in those languages, alongside broader language ideologies (Lindzey, 2020, p. 19).

In recent years, improvements in multilingual AI systems, like those used in natural language processing (NLP), have changed this area. AI tools like Google Translate and DeepL give

instant translation and generation in many languages, helping with multilingualism (Zhu et al., 2020, p.1123). For example, Google's Neural Machine Translation (GNMT) enhances translation fluency but poses challenges for less proficient speakers (Johnson et al., 2017, p.339). AI-driven platforms like Duolingo and Babbel offer personalized language learning by adapting to users' progress, simulating a tutor-learner dynamic (Loewen et al., 2019, p. 52). This reflects traditional cognitive theories, which emphasize rich input and feedback (Ellis, 2002, p. 149), while also creating new, autonomous learning contexts (Godwin-Jones, 2018, p.10).

1.2 Research Objectives

1. To investigate the cognitive effects of AI-powered multilingual systems.
2. To examine sociolinguistic patterns shaped by multilingual AI use.
3. To provide insights into AI's role in language evolution.

1.3 Research Questions

1. How do multilingual AI systems influence cognitive processes in language learners?
2. What sociolinguistic changes occur in communities as a result of AI-mediated multilingualism?
3. How do multilingual AI systems contribute to the broader evolution of languages?

1.4 The significance of the study

This study is relevant to cognitive science and sociolinguistics as it explores the impact of multilingual AI on language and thought. AI systems are increasingly used for language learning and communication, so it is crucial to

understand their cognitive effects. The research focuses on AI as a mediator in second language acquisition (SLA), with evidence showing that platforms like Duolingo and Memrise enhance language learning by reducing cognitive load and improving memory retention. Sociolinguistically, the study examines how AI tools influence language practices, potentially replicating language hierarchies and fostering "digital linguistic imperialism. It will investigate whether AI supports or hinders linguistic diversity, addressing debates around global language homogenization and efforts to preserve endangered languages through technology.

2. Literature Review

2.1 Cognitive Theories for Language Acquisition

Information Processing Theory and Working Memory Theory are foundational in language acquisition research, helping explain how learners mentally process linguistic input. According to Information Processing Theory (Gagné, 1985, p. 55), language learning follows three stages similar to computer processing: encoding, storage, and retrieval. This model suggests that learners gradually use linguistic knowledge more automatically, transitioning from explicit, effortful learning to implicit, fluid use of language structures (Schneider & Shiffrin, 1977, p. 2). Multilingual AI systems like Google Translate or AI-powered language apps act as external memory devices, reducing learners' cognitive load in acquiring vocabulary and syntax (Johnson et al., 2017, p. 340). In contrast, Working Memory Theory (Baddeley, 2000, p. 418) emphasizes the short-term storage and manipulation of information during cognitive tasks. This is especially relevant to language learning, where learners hold items in memory while comprehending or producing

sentences. AI systems that provide immediate feedback and foster practice in low-pressure settings help alleviate the burden on working memory. For instance, using AI-based translation tools allows learners to avoid translating word by word laboriously, freeing up cognitive resources for higher-order tasks like sentence parsing and meaning construction (Kang, 2015, p. 36).

From the perspective of Activity Theory (Engeström, 1987, p. 90), these cognitive theories are socially situated. Activity Theory posits that human learning is mediated by tools and shaped by social systems (Vygotsky, 1978, p. 57). For example, AI translation tools allow learners to handle complex language tasks—such as engaging in discussions or reading intricate texts—without manually translating every element (Godwin-Jones, 2017, p. 10).

2.2 Sociolinguistic Theories in Practice

The sociocultural theory of language learning (SCT) asserts that language acquisition is inherently social and requires interaction with native speakers (Vygotsky, 1978, p. 56). This theory focuses on how learners engage with experts (e.g., interlocutors, teachers, or AI) to use language not just for communication but also as a tool for cognitive development. Multilingual AI systems can act as tools that scaffold learners by offering unlimited, personalized practice. For instance, apps like Duolingo use AI agents to engage users in English conversations, simulating real-life interaction to enhance language learning (Loewen et al., 2019, p. 66). These systems provide immersion-like experiences usually only achievable through extensive cultural exposure or travel.

Language ideologies determine which languages are prioritized, often privileging dominant ones like English, which benefits from its global status in AI translation models (e.g., Google Translate), while minority languages are frequently underrepresented or poorly translated (Kraemer & Gamble, 2021, p. 501). This reflects broader sociopolitical dynamics where AI reinforces existing linguistic power hierarchies (Pennycook, 2017, p. 28). Using Activity Theory, we link sociolinguistic and cognitive aspects, demonstrating how AI tools are shaped by sociocultural norms embedded during their development. As Engeström states, AI mediates between the learner and the language task, affecting cognitive processing and societal relations around language (Engeström, 1961, p. 19). On a local scale, AI-driven translation may encourage code-switching or the adoption of global linguistic norms, potentially accelerating the erosion of minority languages (Lindzey, 2020, p. 18).

2.3 Research Gaps

While research on multilingual AI systems and their effects on language acquisition and linguistic evolution is expanding, there are notable gaps in connecting cognitive processes with sociolinguistics. Most studies on AI-mediated language learning focus on individual mental processes, with less emphasis on the social dynamics of using language through AI interfaces. This highlights a lack of research bridging these areas (Kraemer & Gamble, 2021, p. 503). Additionally, studies on AI's influence on language evolution tend to focus on major languages, neglecting minority and endangered ones (Bird, 2020, p. 7). The absence of an integrated approach to cognitive and sociolinguistic aspects makes it challenging to fully understand how AI systems mediate both language learning and the social

dynamics that drive language use and change. Further research could explore how AI tools impact both individual language learning and broader linguistic shifts by applying Activity Theory (Engeström, 1987, p. 92). This study aims to address these gaps by examining the mediating role of bilingual AI systems in both cognitive and sociocultural language learning environments, offering insights into their transformative effects on linguistic change.

3. Methodology

3.1 Research Design

This study is grounded in Activity Theory (AT) combining cognitive experiments with sociolinguistic surveys. The study links computer-based task performance with qualitative insights into multilingual AI community practices to better understand how using multiple languages affects individual cognitive abilities and broader language usage norms.

3.2 Model of Analysis – AT Triangular Model

This study applies Engeström's Activity Theory (AT) Triangle model, structured as follows:

1. Subject: Language learners using AI tools.
2. Mediating Tools: Multilingual AI systems, like Chat GPT models or translation apps, serve as mediating tools that influence both cognitive and social outcomes. The capabilities and limitations of these tools directly impact the learning experience.
3. Community and Rules: Sociolinguistic norms, language policies, and community rules shape the environment in which learners interact with AI tools.
4. Division of Labor: Multiple actors contribute to language acquisition. AI developers design the tools, teachers

incorporate them, and learners engage with them, all playing a role in the effectiveness of AI for language learning.

5. Outcome: The study assesses both cognitive outcomes (language proficiency, memory retention, and task performance) and sociolinguistic outcomes (language vitality, code-switching, and attitudes toward language policies).

3.3 Data Collection and Procedures

Data collection focused on how learners engage with AI tools, how sociolinguistic norms shape these interactions, and the cognitive and sociolinguistic outcomes:

1. Cognitive Data: Pre- and post-experiment cognitive assessments will measure changes in proficiency, memory retention, and comprehension mediated by AI tools. Participants will interact with specific AI tools (e.g., Chat GPT models) in tasks such as translation or conversation, producing quantitative data on cognitive learning outcomes.
2. Sociolinguistic Data: Surveys and interviews will gather qualitative data on community norms, language policies, and attitudes toward AI-mediated learning. Questions will assess AI tool usage frequency, perceived effectiveness, and shifts in language use (e.g., code-switching or language vitality), addressing the community and rules elements of the AT model.
3. Division of Labor: Observations and interviews with teachers and AI developers will explore their roles in language acquisition. This will illuminate the division of labor within the sociolinguistic system, as outlined in the AT model.

3.4. Data Analysis

The analysis followed the AT Triangular Model, focusing on the interplay between learners (subjects), AI systems (tools),

and sociolinguistic factors (community, rules, and division of labor):

1. Cognitive Analysis: Pre- and post-test results will be analyzed using SPSS (Statistical Package for the Social Sciences) for ANOVA and regression analysis to track changes in proficiency, memory retention, and task performance.
2. Sociolinguistic Analysis: NVivo will be used to code survey and interview responses, identifying patterns in language use, community attitudes, and sociolinguistic norms.
3. Division of Labor: The roles of AI developers, teachers, and learners will be analyzed to understand their collaboration's impact on AI effectiveness in language learning.

The researcher conducted a detailed analysis using the data from the AI-mediated multilingualism study. Utilizing the Activity Theory (AT) framework, the study explores cognitive, sociolinguistic, and division of labor (DOL) aspects by integrating results from pre-/post-tests, surveys, and interviews to investigate how AI tools impact language learning and sociolinguistic dynamics.

1. **Cognitive Data Analysis:** To evaluate how AI tools impact language learning, we looked at two groups: those using AI-based platforms (like GPT apps such as Duolingo, Babbel, or Google Translate) and those using traditional methods (like textbooks). Both groups had 60 participants from different language backgrounds, and they completed pre-and post-tests to assess their language skills, memory retention, and understanding over six weeks. The pre-test assessed language skills initially, while the post-test assessed progress. ANOVA was used to compare scores and see if those using AI

showed more improvement. A regression analysis was also performed to see if AI usage predicted improvements in cognitive tasks, such as vocabulary retention and reading comprehension. The findings showed that learners using AI tools had better language retention and understanding compared to those using traditional methods. This supports previous research that AI can lower cognitive load, allowing learners to concentrate on more difficult tasks (Sweller, 1988, p. 260). Kang (2015, p. 36) also found that AI's immediate feedback increases task efficiency, confirming these findings. This phenomenon is explained by Working Memory Theory, which highlights short-term storage and processing during language activities (Baddeley, 2000, p. 418). By letting AI handle simpler tasks (like translation), learners are free to concentrate on more complex tasks such as parsing sentences. This decrease in cognitive load improves processing, as seen in the higher post-test scores for AI users. AI tools serve as external memory, helping with the encoding and recall of language information, according to Information Processing Theory (Gagné, 1985, p. 55)

2. **Sociolinguistic Data Analysis:** sociolinguistic analysis explored how AI-mediated tools affect language practices, code-switching, and language vitality in multilingual communities. An online survey of 150 people in multilingual regions where AI translation tools are used frequently assessed attitudes toward AI, code-switching, and the impact on minority languages. Responses were coded in NVivo , and Chi-square

tests were used to examine AI use and its relationship to language behaviors. Results showed that frequent AI tool users reported increased code-switching, aligning with research by Lindzey (2020,p.17), which links AI to language shifts and erosion of minority languages due to its focus on dominant languages like English or Mandarin. some respondents noted AI's potential to preserve endangered languages. Projects like Google's Endangered Languages Project and other NLP initiatives were cited as valuable for language preservation (Bird, 2020: p.3). This highlights AI's dual role—contributing to language marginalization and preservation when implemented thoughtfully.

3. Division of Labor Analysis: The division of labor in AI-mediated language learning was studied through interviews and focus groups with learners, teachers, and AI developers to understand how collaboration impacts AI tool success. Teachers play a crucial role in adapting AI tools for specific learning environments. While AI provides real-time feedback, teachers help customize AI content to fit cultural and linguistic contexts. This aligns with Activity Theory, which holds that human learning is mediated through tools and community (Vygotsky, 1978,p. 57). Teachers reported that AI tools are most effective when integrated into structured curricula tailored to learners' needs. AI developers stressed the need for AI tools to account for sociolinguistic contexts, especially in low-resource environments.

4. Findings and Discussions

4. 1 Findings

The findings from this study offer detailed insights into how AI-mediated multilingualism influences both 'cognitive language learning' and 'sociolinguistic behaviors'. By analyzing the data collected through cognitive tests, community surveys, and interviews with key stakeholders (teachers, learners, and developers), this section explores the direct and indirect impacts of AI tools on language acquisition and community language dynamics. The discussion draws on a wide range of studies and academic sources, aligning the results with existing research to comprehensively analyze the cognitive, sociolinguistic, and structural aspects of AI-supported language learning.

- 1. Cognitive Findings:** The analysis of pre- and post-test results revealed that learners using AI tools showed significant improvement in vocabulary retention, comprehension, and overall proficiency compared to those using traditional methods. These findings align with Cognitive Load Theory (Sweller, 1988, p. 260), which posits that AI tools reduce cognitive burden by automating repetitive tasks like vocabulary lookup or basic grammar correction. This allows learners to focus on higher-order language tasks, such as sentence parsing and meaning construction. For instance, participants using Chat GPT-based tools like Duolingo and Google Translate demonstrated notable improvement in complex sentence construction tasks. These learners consistently outperformed those in the traditional group, supporting earlier research by Johnson et al. (2017, p. 339), which found that AI-driven translation systems, particularly sentence-level models, enhance the fluency of the learning process.

Additionally, the real-time adaptive feedback provided by AI systems (Loewen et al., 2019, p. 52) played a key role in helping learners internalize complex grammatical structures, leading to improvements in both short-term and long-term memory retention (Kang, 2015, p. 36). The use of ANOVA and regression analysis confirmed that AI-assisted learners exhibited statistically significant improvements in language proficiency. Similar findings were documented by Plonsky and Kim (2016, p. 731), who reported that learners using AI-mediated multimedia content improved vocabulary acquisition and reading comprehension more efficiently than those relying solely on traditional materials. This suggests that AI's ability to reduce extraneous cognitive load not only enhances comprehension but also supports long-term memory consolidation, as indicated by Working Memory Theory (Baddeley, 2000, p. 418). These performance improvements highlight the transformative potential of AI tools in optimizing the cognitive aspects of language acquisition.

2. Sociolinguistic Finding: The study's sociolinguistic analysis reveals both positive and negative impacts of AI-mediated multilingualism on community language practices, particularly regarding code-switching, language vitality, and language hierarchies. Data from surveys and interviews indicate that frequent use of AI translation tools in multilingual settings leads to a higher incidence of code-switching, supporting 'Sociocultural Theory' (Vygotsky, 1978, p. 57), which views language learning as a socially driven process influenced by linguistic and cultural norms. A recurring issue was the uneven quality of AI translations between dominant global languages, like English and Mandarin, and less-resourced languages, such as Catalan or Swahili. This disparity often caused participants

to default to dominant languages, aligning with the concept of "digital linguistic imperialism" (Kraemer & Gamble, 2021, p. 499). Respondents from regions like Spain and India reported a decline in the use of native languages due to the convenience of AI systems in facilitating communication in dominant languages, such as Spanish or Hindi. This reflects Pennycook's (2017, p. 24) findings that technology accelerates language shift when the benefits of global languages outweigh the value of local ones. According to 'Language Vitality Theory' (Giles et al., 1977, p. 308), the continued favoring of dominant languages by AI poses a risk of accelerated decline for minority languages, as noted by 'Lindzey' (2020, p. 17).

However, the study also highlights AI's potential in language preservation. Participants involved in language revitalization emphasized that AI systems, especially those using 'natural language processing (NLP)', offer new ways to document and promote endangered languages. Projects like 'Google's Endangered Languages Project' were cited as useful tools for preserving linguistic diversity (Bird, 2020, p. 3). Developers working on low-resource language models also stressed the role of 'machine learning algorithms' in improving translation quality for these languages, supporting 'Mager et al.' (2018, p. 9), who advocate for AI's role in preserving endangered dialects through digital archiving.

- 3. Division of Labor Findings:** The division of labor among teachers, learners, and AI developers emerged as crucial for the success of AI-mediated language learning environments. Interviews with teachers revealed that while AI tools provide personalized learning experiences and adaptive feedback, they are most effective when integrated into a structured learning framework. Teachers play a key role in contextualizing AI

outputs, particularly in teaching culturally specific language uses and idiomatic expressions, which AI often struggles to translate accurately (Loewen et al., 2019, p. 66). For instance, in bilingual settings, teachers noted that tools like 'Duolingo' are useful for vocabulary practice but insufficient for teaching cultural nuances. As 'Ellis' (2002, p. 149) explains, language acquisition involves not only grammatical rules but also understanding language in its social and cultural contexts. Thus, teachers serve as essential mediators to ensure AI-generated content is applied meaningfully, reinforcing 'Vygotsky's Activity Theory' (1978, p. 57) on the importance of socially mediated learning.

Interviews with AI developers highlighted the challenges of designing AI systems that support diverse linguistic and cultural contexts. Developers noted that biased training datasets limit AI's effectiveness in low-resource languages, a common issue in 'natural language processing' (Bender et al., 2021, p. 12). Despite these limitations, they expressed optimism about advancements in algorithmic fairness and more inclusive language models, especially through collaboration with linguistic communities. This aligns with 'Mager et al.' (2018, p. 9), who argue that AI can help preserve linguistic diversity when trained on diverse datasets. Learners also preferred AI tools with adaptive feedback but emphasized the need for human interaction. Many pointed out that while systems like 'Babbel' and 'Google Translate' were useful for basic conversation practice, they struggled with complex cultural expressions. This supports findings in 'second language acquisition', which highlight the importance of rich input and feedback for linguistic fluency (Loewen et al., 2019, p. 52).

4.2 Discussion

The findings from this study highlight the significant cognitive and sociolinguistic impacts of AI-mediated multilingualism. From a cognitive perspective, the data confirm that AI tools enhance language retention, comprehension, and proficiency by reducing cognitive load, consistent with the 'Cognitive Load Theory' (Sweller, 1988, p. 260). By automating basic tasks and providing adaptive feedback, AI allows learners to focus on more complex language skills, such as sentence construction and conversation. These improvements align with studies by 'Plonsky and Kim' (2016, p. 731) and 'Johnson et al.' (2017, p. 339), who also found significant gains for learners using AI-assisted platforms. Like peer tutoring, AI tools like GPT models reduce cognitive load by automating repetitive tasks such as vocabulary lookup and grammar correction, allowing learners to focus on higher-order language tasks like sentence parsing and meaning construction (Hameed, 2020). However, the sociolinguistic findings raise concerns about AI's role in reinforcing language hierarchies. While AI has the potential to 'preserve endangered languages' through NLP and digital archiving (Bird, 2020, p. 3), its current design often supports the dominance of global languages, marginalizing minority languages in communication and education. This 'digital linguistic imperialism' (Kraemer & Gamble, 2021, p. 499) threatens the vitality of less-resourced languages as learners increasingly rely on AI systems that prioritize widely spoken languages. Finally, the 'division of labor' findings emphasize the importance of collaboration between teachers, learners, and developers in optimizing AI-assisted learning environments. While AI offers valuable support, it cannot replace human teachers' cultural and social insights (Ellis, 2002, p. 149). Future

AI development should focus on inclusivity and fairness by addressing biases in training data and ensuring support for diverse linguistic and cultural contexts (Bender et al., 2021, p. 12).

Conclusion

In the current work, AI-mediated multilingualism is shown to have a dual effect on cognitive language acquisition and sociolinguistic dynamics. On the cognitive side, AI tools like GPT applications significantly aid language retention, comprehension, and efficiency by reducing the extraneous cognitive load (Sweller, 1988, p. 260; Baddeley, 2000, p. 418). Real-time feedback and adaptive learning, supported by Information Processing Theory (Gagné, 1985, p.55), improve language proficiency. These findings highlight AI's potential in streamlining language learning. However, the sociolinguistic impacts are noteworthy. While AI tools enhance cross-linguistic communication, they risk reinforcing linguistic hierarchies and global languages, leading to language shift and the decline of minority languages, aligning with digital linguistic imperialism (Kraemer & Gamble 2021, p. 499; Pennycook 2017, p. 24). Communities using AI tools report higher code-switching and reduced use of local languages, threatening language vitality (Giles et al., 1977, p. 308). Despite these concerns, AI shows promise in preserving endangered languages through initiatives like Google's Endangered Languages Project. Collaboration among AI developers, educators, and linguistic communities is essential to ensure AI systems support linguistic diversity (Bender et al., 2021, p. 12). While AI's cognitive benefits are clear, its sociolinguistic implications must be carefully managed to promote equitable language learning and preserve linguistic diversity.

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