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Artificial Intelligence and Language Processing in EFL Learning: A Neurolinguistic Perspective

Karin Ariska[1✉], Mushab Al Umairi[2]
[1] UIN Raden Intan Lampung, Indonesia
[2] Universitas Muhammadiyah Gresik, Indonesia
✉ karinariska563@gmail.com

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Abstract

Background: Artificial Intelligence (AI) has become increasingly integrated into language education and offers new opportunities to support language learning and cognitive development. From a neurolinguistic perspective, AI-assisted learning may influence cognitive processes involved in language comprehension and acquisition.
Aim: This study aims to investigate the effects of AI-based language learning systems on language processing among EFL learners from a neurolinguistic perspective.
Method: A quasi-experimental research design was employed involving 60 EFL university students divided into an experimental group and a control group. The experimental group utilized AI-based language learning systems for eight weeks, while the control group received conventional instruction. Data were collected through language processing tests, reading comprehension assessments, and learner perception questionnaires. Statistical analyses were conducted using descriptive statistics and independent samples t-tests.
Results: The findings revealed that learners exposed to AI-assisted language learning demonstrated significantly higher performance in language processing and reading comprehension tasks than those receiving traditional instruction. Furthermore, participants reported positive perceptions regarding the effectiveness, adaptability, and engagement provided by AI-based learning environments.
Conclusion: AI-assisted language learning contributes positively to language processing by facilitating attention, feedback, and repeated exposure to linguistic input. From a neurolinguistic perspective, AI technologies appear to support cognitive processes associated with language acquisition and comprehension, highlighting their potential role in future EFL instruction.

I. Introduction

The rapid development of Artificial Intelligence (AI) has transformed educational practices across various disciplines, including language education. AI technologies have increasingly been integrated into learning environments through intelligent tutoring systems, automated assessment tools, natural language processing applications, and adaptive learning platforms designed to support individualized instruction and improve learning outcomes (Holmes et al., 2019; Woolf, 2009; Roll & Wylie, 2016). In the context of English as a

Foreign Language (EFL) learning, AI offers opportunities for learners to engage with language input in more interactive, adaptive, and personalized ways than traditional instructional methods.

Language processing constitutes one of the fundamental components of second language acquisition because it involves the perception, interpretation, storage, retrieval, and production of linguistic information. Successful language learning depends not only on exposure to language input but also on learners' ability to process linguistic information efficiently during communication and learning activities (Gass & Mackey, 2015; VanPatten, 2015; Robinson, 2011). Consequently, understanding how technological innovations influence language processing has become an important area of inquiry in contemporary language education research.

Recent developments in AI have expanded the capabilities of Computer-Assisted Language Learning (CALL) systems. Early CALL environments primarily functioned as digital repositories of learning materials, whereas contemporary AI-enhanced systems incorporate adaptive feedback, learner modeling, automated error detection, and natural language processing capabilities that facilitate individualized learning experiences (Heift & Schulze, 2007; Heift, 2012; Dodigovic, 2005). These developments have enabled language learners to receive immediate feedback, personalized recommendations, and opportunities for repeated language practice, all of which may contribute to more efficient language processing.

From a neurolinguistic perspective, language processing is supported by complex interactions among attention, memory, executive control, and linguistic knowledge systems. Contemporary neurolinguistic research suggests that language acquisition involves distributed neural networks responsible for lexical retrieval, semantic integration, syntactic processing, and cognitive control (Ullman, 2004; Segalowitz, 2010; Robinson, 2011). These cognitive and neural mechanisms play essential roles in determining how learners comprehend and produce language in both first and second language contexts.

Artificial Intelligence technologies may support language processing by reducing cognitive burden associated with language learning tasks and by providing adaptive instructional support tailored to individual learner needs. Intelligent tutoring systems, for example, can monitor learner performance, identify errors, and generate personalized feedback that facilitates linguistic development (Nkambou et al., 2010; Woolf, 2009; VanLehn, 2011). Similarly, natural language processing applications allow learners to interact with language in authentic contexts while receiving immediate corrective feedback that promotes language awareness and learning efficiency.

Research investigating AI in language education has reported positive outcomes related to vocabulary acquisition, grammar learning, writing development, reading comprehension, and learner motivation. Studies suggest that AI-assisted learning environments may enhance learner engagement by increasing opportunities for interaction, practice, and individualized instruction (Chapelle, 2009; Heift, 2012; Holmes et al., 2019; Graesser et al., 2012; VanLehn, 2011). Nevertheless, despite the growing popularity of AI-based educational technologies, limited empirical research has specifically examined their influence on language processing from a neurolinguistic perspective.

Furthermore, previous studies have often focused on technological effectiveness without adequately addressing the cognitive and neurological mechanisms underlying observed learning outcomes. As a result, important questions remain regarding how AI-assisted learning environments influence cognitive processes involved in language acquisition, including attention allocation, information processing, memory activation, and language comprehension (Segalowitz, 2010; Robinson, 2011; Holmes et al., 2019).

Therefore, this study aims to investigate the effects of AI-based language learning systems on language processing among EFL learners. Specifically, the study seeks to examine differences in language processing performance between learners exposed to AI-assisted instruction and those receiving conventional language instruction. By integrating perspectives from artificial intelligence, language education, and neurolinguistics, this study contributes to a deeper understanding of the relationship between technological innovation and cognitive mechanisms underlying language learning.

II. Literature Review

Artificial Intelligence in Education

Artificial Intelligence (AI) has become one of the most influential technological innovations in contemporary education. AI refers to computational systems capable of performing tasks that typically require human intelligence, including problem-solving, pattern recognition, decision-making, and language processing. Within educational contexts, AI has been increasingly applied to support personalized learning, adaptive instruction, automated assessment, and intelligent tutoring systems designed to enhance learning effectiveness and learner engagement (Woolf, 2009; Roll & Wylie, 2016; Holmes et al., 2019).

The integration of AI into education has led to the emergence of Artificial Intelligence in Education (AIED), a field that combines educational theory, computer science, and cognitive psychology to develop intelligent learning environments. AIED systems are designed to monitor learner performance, diagnose learning difficulties, and provide individualized feedback tailored to learners' needs. Such capabilities allow educational technologies to move beyond traditional one-size-fits-all approaches and support more adaptive forms of instruction (Nkambou et al., 2010; Woolf, 2009; Holmes et al., 2019).

One of the primary advantages of AI-based educational systems is their ability to provide immediate feedback. Research has demonstrated that timely feedback plays a crucial role in facilitating learning because it enables learners to identify errors, modify strategies, and strengthen knowledge representations. Consequently, AI technologies may contribute to more efficient learning processes by creating opportunities for continuous monitoring and adaptive support throughout the learning experience (VanLehn, 2011; Roll & Wylie, 2016; Holmes et al., 2019).

Furthermore, recent studies indicate that AI applications continue to expand across educational contexts, supporting adaptive learning, learner analytics, and personalized instructional feedback (Zawacki-Richter et al., 2019; Roll & Wylie, 2016; Aleven et al., 2017).

Language Processing in Second Language Acquisition

Language processing refers to the cognitive operations involved in understanding, storing, retrieving, and producing linguistic information. In second language acquisition (SLA), language processing plays a central role because learners must continuously interpret incoming linguistic input while simultaneously constructing meaningful representations of language knowledge. Successful language learning therefore depends on the efficiency with which learners process linguistic information during communication and instructional activities (Gass & Mackey, 2015; VanPatten, 2015; Robinson, 2011).

Contemporary SLA theories emphasize that language acquisition occurs through active engagement with language input. Learners are required to attend to linguistic forms, identify meaningful patterns, and integrate new information into existing cognitive structures. During this process, attention, memory, and information processing mechanisms work together to facilitate language development. As a result, language learning can be understood as both a linguistic and cognitive phenomenon (VanPatten, 2015; Robinson, 2011; Gass & Mackey, 2015).

Input Processing Theory suggests that learners possess limited attentional resources and therefore cannot simultaneously process all aspects of linguistic input. Instead, learners selectively attend to information that appears most relevant or meaningful. This selective processing influences what linguistic information is ultimately acquired and retained. Consequently, instructional environments that effectively direct learners' attention toward relevant linguistic features may enhance language acquisition and language processing outcomes (Gass & Mackey, 2015; VanPatten, 2015; Robinson, 2011).

Neurolinguistic Foundations of Language Processing

Neurolinguistics investigates the relationship between language and the human brain. This field seeks to explain how neural systems support language comprehension, production, acquisition, and processing. Advances in cognitive neuroscience have revealed that language processing is supported by distributed neural networks involving language-specific regions, memory systems, attentional mechanisms, and executive control processes (Ullman, 2004; Segalowitz, 2010; Robinson, 2011).

One of the most influential frameworks in neurolinguistics is the Declarative/Procedural Model proposed by Ullman (2004). According to this model, language learning relies on two complementary memory systems. Declarative memory supports the acquisition and storage of lexical knowledge, vocabulary, and semantic information, whereas procedural memory facilitates the acquisition and automatization of grammatical structures and rule-based language processing. The interaction between these systems enables learners to develop linguistic competence and communicative proficiency over time (Ullman, 2004).

Neurolinguistic research further indicates that language processing involves executive functions such as attentional control, monitoring, and cognitive flexibility. These functions are essential because language users must continuously manage incoming information, suppress irrelevant stimuli, and coordinate linguistic representations during communication. Therefore, language processing should be viewed as a complex cognitive activity involving interactions among multiple neural and cognitive systems rather than as an isolated linguistic function (Segalowitz, 2010; Robinson, 2011; Ullman, 2004).

Intelligent Tutoring Systems and Language Learning

Intelligent Tutoring Systems (ITS) represent one of the most widely studied applications of AI in education. ITS are computer-based instructional systems designed to provide personalized guidance, adaptive feedback, and individualized learning experiences. Unlike traditional instructional software, ITS can analyze learner behavior, identify misconceptions, and adjust instructional content based on individual performance patterns (Woolf, 2009; Nkambou et al., 2010; VanLehn, 2011).

Research has demonstrated that ITS can significantly improve learning outcomes across various domains, including language education. Through adaptive feedback mechanisms, ITS help learners identify errors and refine linguistic knowledge while simultaneously promoting learner autonomy and engagement. Such systems create opportunities for repeated practice and individualized instruction that may contribute to more effective language acquisition and language processing (VanLehn, 2011; Heift & Schulze, 2007; Woolf, 2009).

In language learning contexts, ITS often incorporate language analysis tools capable of evaluating learner responses and generating pedagogically appropriate feedback. These features allow learners to receive immediate corrective information, thereby supporting language development and facilitating deeper processing of linguistic input (Heift & Schulze, 2007; Dodigovic, 2005; Heift, 2012).

Natural Language Processing in Language Learning

Natural Language Processing (NLP) is a branch of artificial intelligence that focuses on enabling computers to analyze, interpret, and generate human language. NLP technologies form the foundation of many contemporary language learning applications, including automated writing evaluation systems, intelligent conversational agents, grammar checking tools, and adaptive language learning platforms (Jurafsky & Martin, 2009; Meurers, 2012; Litman, 2016).

The application of NLP in language education has expanded significantly because these technologies provide learners with opportunities to interact with language in meaningful and authentic ways. NLP-based systems can analyze learner language production, identify linguistic errors, and generate feedback that supports language development. Such capabilities make NLP an important component of AI-assisted language learning environments (Meurers, 2012; Litman, 2016; Heift, 2012).

Furthermore, NLP technologies facilitate language processing by increasing learners' exposure to language input and promoting active engagement with linguistic information. Through repeated interaction with language-based AI systems, learners may strengthen cognitive representations associated with vocabulary, grammar, and discourse structures, thereby enhancing overall language competence (Jurafsky & Martin, 2009; Meurers, 2012; Chapelle, 2009). These developments have contributed to more sophisticated language-learning systems capable of providing context-sensitive feedback and learner support (Meurers, 2012; Litman, 2016; Huang et al., 2021; Chen et al., 2022).

AI and Cognitive Processing

The effectiveness of AI-assisted learning environments can be explained through cognitive theories of learning and information processing. AI technologies provide opportunities for repeated exposure, adaptive instruction, and individualized feedback, all of which support cognitive processes involved in language acquisition. By reducing unnecessary cognitive demands and directing learner attention toward relevant information, AI systems may facilitate more efficient language processing (Woolf, 2009; Holmes et al., 2019; Roll & Wylie, 2016).

From a cognitive perspective, learning occurs when information is effectively encoded, stored, and retrieved from memory systems. AI-assisted learning environments support these processes by presenting instructional content in adaptive and interactive formats that encourage active engagement. Consequently, AI technologies may contribute to improved language learning outcomes by enhancing cognitive mechanisms responsible for information processing and knowledge acquisition (VanLehn, 2011; Segalowitz, 2010; Holmes et al., 2019).

Conceptual Framework

Based on the reviewed literature, language processing in EFL learning can be conceptualized as the result of interactions among artificial intelligence technologies, cognitive mechanisms, and neurolinguistic systems. AI-based learning environments provide adaptive instructional support through intelligent tutoring systems, automated feedback, and natural language processing technologies. These tools influence cognitive processes such as attention, memory, and information processing, which in turn affect learners' ability to comprehend, retain, and produce linguistic information.

From a neurolinguistic perspective, language processing is supported by memory systems and executive control mechanisms responsible for language acquisition and language use. Therefore, AI technologies may indirectly facilitate language development by strengthening cognitive processes associated with language learning. The conceptual framework underlying this study assumes that AI-assisted instruction positively influences language processing performance through its effects on cognitive and neurolinguistic mechanisms (Ullman, 2004; Segalowitz, 2010; Holmes et al., 2019).

III. Method

Research Design

This study employed a quasi-experimental research design to investigate the effects of Artificial Intelligence (AI)-based language learning systems on language processing among English as a Foreign Language (EFL) learners. A quasi-experimental approach was selected because it allows researchers to examine the impact of educational interventions in naturally occurring learning environments where random assignment may not be feasible (Creswell, 2018; Mackey & Gass, 2016).

The study utilized a pre-test–post-test control group design. Participants were divided into two groups: an experimental group that received AI-assisted language learning instruction and a control group that received conventional language instruction. Both groups completed language processing assessments before and after the treatment period to determine whether significant differences existed between instructional approaches.

Research Site and Participants

The study was conducted at a public university in Indonesia where English is taught as a foreign language. The participants consisted of 60 undergraduate EFL students enrolled in English language courses during the academic year 2024/2025.

The participants were selected through purposive sampling based on the following criteria:

1. Enrolled in an EFL program.
2. Intermediate English proficiency level.
3. No prior intensive experience with AI-based language learning systems.
4. Willingness to participate throughout the study period.

The participants were divided into two groups:

Table 1. Group of Participants

Group	Number of Participants	Instruction Type
Experimental Group	30	AI-Assisted Language Learning
Control Group	30	Conventional Language Learning

Both groups were comparable in terms of age, educational background, and English proficiency level before the intervention.

Instrument

Several instruments were employed to collect quantitative and qualitative data.

1. Language Processing Test

A language processing test was developed to assess learners' ability to comprehend and process linguistic information. The test consisted of reading passages, sentence interpretation tasks, vocabulary processing items, and semantic comprehension exercises. The instrument was adapted from established language processing measures commonly used in SLA research (Gass & Mackey, 2015; VanPatten, 2015).

2. Reading Comprehension Test

A standardized reading comprehension test was administered to evaluate participants' ability to understand written English texts. The test included multiple-choice and short-response questions measuring literal, inferential, and critical comprehension skills.

3. AI Learning Experience Questionnaire

A questionnaire was designed to examine participants' perceptions of AI-assisted language learning. The questionnaire consisted of 20 Likert-scale items addressing:
• Perceived usefulness
• Ease of use
• Learning engagement
• Feedback effectiveness
• Learning satisfaction

The questionnaire was adapted from previous technology acceptance and educational technology studies (Davis, 1989; Holmes et al., 2019).

4. Observation Checklist

An observation checklist was utilized during the treatment period to monitor learner participation, interaction patterns, and engagement levels within the learning environment.

5. Validity and Reliability

To ensure content validity, all instruments were reviewed by three experts in applied linguistics and educational technology. Revisions were made based on their recommendations before implementation.

A pilot study involving 20 EFL students was conducted to examine instrument reliability. Cronbach's Alpha coefficients indicated acceptable reliability levels:

Table 2. Reliability Test

Instrument	Cronbach's Alpha
Language Processing Test	0.87
Reading Comprehension Test	0.84
Questionnaire	0.91

These values exceeded the recommended threshold of 0.70, indicating satisfactory reliability (Taber, 2018).

Data Collection

The data collection process was conducted over eight weeks. Data were collected through language processing tests, reading comprehension tests, classroom observations, and learner perception questionnaires. The procedure consisted of four stages: pre-test administration, treatment implementation, post-test administration, and questionnaire distribution.

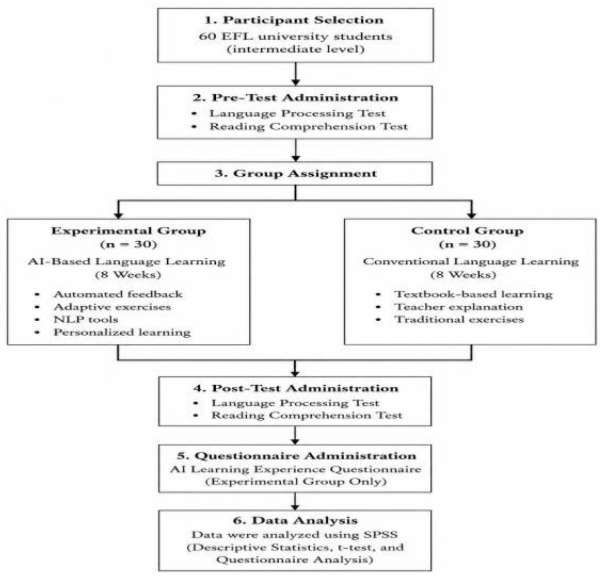

Figure 1. Research Procedure

Data Analysis

The collected data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 26. Prior to hypothesis testing, descriptive statistics were computed to obtain the mean scores, standard deviations, frequencies, and percentages of all variables. Descriptive analysis was conducted to provide an overview of participants' performance on the language processing and reading comprehension tests as well as their perceptions of AI-assisted language learning.

Subsequently, assumption tests were performed to determine the suitability of parametric statistical analyses. The normality of data distribution was examined using the Shapiro–Wilk test, while the homogeneity of variances was assessed through Levene's Test. The results indicated that the data met the assumptions required for parametric testing ($p > .05$).

To examine changes in learners' performance within each group, paired-samples t-tests were conducted to compare pre-test and post-test scores. Furthermore, independent-samples t-tests were employed to investigate differences between the experimental and control groups after the intervention. Statistical significance was determined at the .05 level ($p < .05$).

Questionnaire data were analyzed using descriptive statistics. Mean scores were calculated for each questionnaire category, including perceived usefulness, ease of use, learning engagement, feedback effectiveness, and learning satisfaction. The interpretation of mean scores followed the classification proposed by Oxford (1990), where higher mean scores indicated more positive learner perceptions toward AI-assisted language learning.

Finally, the quantitative findings were interpreted from cognitive and neurolinguistic perspectives in order to explain how AI-assisted learning environments may influence language processing, attention allocation, memory activation, and language acquisition among EFL learners.

IV. Result and Discussion

Result

Pre-Test Results

The pre-test was administered to determine the initial equivalence of the experimental and control groups before the intervention. Table 1 presents the descriptive statistics of the pre-test scores.

Table 3. Pre-Test Scores of Experimental and Control Groups

Group	N	Mean	SD
Experimental	30	68.73	6.45
Control	30	67.91	6.72

The results indicate that both groups demonstrated relatively similar language processing abilities before the treatment. An independent-samples t-test confirmed that there was no statistically significant difference between the two groups at the pre-test stage ($p > .05$), suggesting comparable baseline proficiency.

Post-Test Results

After eight weeks of instruction, post-tests were conducted to evaluate learners' language processing performance.

Table 2. Post-Test Scores of Experimental and Control Groups

Group	N	Mean	SD

Experimental	30	84.12	5.31
Control	30	74.28	6.07

The results demonstrate that the experimental group achieved substantially higher scores than the control group following the intervention.

Independent Samples t-Test

To examine whether the observed differences were statistically significant, an independent-samples t-test was conducted.

Table 3. Independent Samples t-Test Results

Variable	t	Sig. (2-tailed)
Post-Test Scores	6.74	.000

The significance value was below .05, indicating a statistically significant difference between the experimental and control groups. Therefore, learners who received AI-assisted instruction outperformed those who received conventional instruction.

Questionnaire Results

The questionnaire was administered to the experimental group to investigate learners' perceptions of AI-assisted language learning.

Table 4. Learners' Perceptions of AI-Assisted Learning

Statement Category	Mean	Interpretation
Perceived Usefulness	4.42	Very High
Ease of Use	4.31	Very High
Learning Engagement	4.46	Very High
Feedback Effectiveness	4.58	Very High
Learning Satisfaction	4.49	Very High
Overall Mean	4.45	Very High

The findings suggest that learners held highly positive attitudes toward AI-assisted language learning. Feedback effectiveness received the highest mean score, indicating that immediate and personalized feedback was particularly valued by participants.

Discussion

The findings indicate that AI-assisted language learning significantly improved learners' language processing performance. Participants in the experimental group achieved higher post-test scores than those in the control group, suggesting that AI-based learning environments can facilitate more efficient language acquisition and language comprehension. These findings support previous studies highlighting the effectiveness of intelligent educational technologies in enhancing language learning outcomes (Holmes et al., 2019; VanLehn, 2011; Heift, 2012).

The increasing integration of artificial intelligence into language education also reflects broader trends in educational technology, where adaptive systems, intelligent tutoring, and learning analytics are becoming central components of personalized learning environments (Zawacki-Richter et al., 2019; Ng et al., 2023; Roll & Wylie, 2016).

One possible explanation for these findings is that AI-assisted systems provide immediate feedback and adaptive learning support. According to cognitive theories of language learning, timely feedback enables learners to identify linguistic errors, modify learning strategies, and strengthen knowledge representations. Consequently, learners may process language input more effectively and develop stronger linguistic competence over time (Woolf, 2009; Roll & Wylie, 2016; VanLehn, 2011).

From a neurolinguistic perspective, AI-assisted learning may facilitate language processing by supporting attentional control and working memory functions. Language learning requires learners to allocate cognitive resources efficiently while processing vocabulary, grammar, and meaning simultaneously. Adaptive AI systems reduce unnecessary cognitive demands by tailoring learning materials to individual proficiency levels, thereby allowing learners to focus on relevant linguistic information (Segalowitz, 2010; Robinson, 2011; Ullman, 2004).

The positive learner perceptions reported in the questionnaire further reinforce the effectiveness of AI-assisted instruction. Participants indicated that AI technologies increased engagement, improved learning flexibility, and enhanced feedback quality. These findings align with previous research demonstrating that intelligent learning environments contribute positively to learner motivation and autonomous learning behaviors (Holmes et al., 2019; Chapelle, 2009; Heift & Schulze, 2007).

Furthermore, the findings support the argument that AI technologies function not merely as instructional tools but also as cognitive support systems. Through adaptive feedback, personalized recommendations, and repeated language exposure, AI systems appear to strengthen cognitive processes involved in language acquisition. Such support may facilitate the encoding, storage, and retrieval of linguistic information, thereby improving language processing efficiency.

Overall, the results suggest that AI-assisted language learning provides significant pedagogical and cognitive benefits for EFL learners. The integration of artificial intelligence into language education therefore represents a promising direction for future instructional innovation, particularly in contexts where individualized learning support is needed.

Implications

The findings of this study have several pedagogical and theoretical implications for EFL education. First, the positive impact of AI-assisted language learning on language processing suggests that educational institutions should consider integrating artificial intelligence technologies into language instruction. AI-based systems can provide personalized learning experiences, adaptive feedback, and increased opportunities for language exposure, all of which contribute to improved language learning outcomes.

Second, language educators should recognize the importance of cognitive and neurolinguistic factors in language acquisition. The findings indicate that AI technologies can support cognitive processes such as attention, working memory, and information processing, which are essential for successful language learning. Consequently, instructional practices should be designed to facilitate these cognitive mechanisms while maximizing learner engagement and interaction.

Third, the study contributes to the growing body of research on Artificial Intelligence in Education (AIED) by providing empirical evidence regarding the relationship between AI-assisted learning and language processing. The findings support the view that AI technologies can function not only as instructional tools but also as cognitive support systems that enhance language acquisition and comprehension. Future language instruction may increasingly benefit from intelligent tutoring systems and adaptive learning technologies that personalize feedback and learning pathways according to learners' cognitive characteristics (VanLehn, 2011; Aleven et al., 2017; Graesser et al., 2012).

Limitations and Future Research

Several limitations should be acknowledged in interpreting the findings of this study. First, the study involved a relatively small sample of participants from a single university, which may limit the generalizability of the results to broader EFL populations. Future studies should include larger and more diverse participant groups from different educational contexts.

Second, the intervention period lasted only eight weeks. Although significant improvements were observed, a longer treatment period may provide deeper insights into the long-term effects of AI-assisted language learning on language processing and language acquisition.

Third, the study relied primarily on behavioral measures, including language processing tests, reading comprehension assessments, and learner perception questionnaires. These instruments provide valuable information regarding learning outcomes; however, they do not directly capture underlying neural activity associated with language processing.

Future research may employ neurolinguistic methods such as electroencephalography (EEG), event-related potentials (ERP), functional magnetic resonance imaging (fMRI), or eye-tracking techniques to investigate how AI-assisted learning environments influence brain activity during language processing. In addition, future studies may explore emerging AI technologies, including conversational agents, large language models, intelligent tutoring systems, and adaptive learning platforms, in order to better understand their potential contributions to second language acquisition and language education.

V. Conclusion

This study investigated the effects of Artificial Intelligence (AI)-assisted language learning on language processing among EFL learners from a neurolinguistic perspective. The findings demonstrated that learners who participated in AI-assisted instruction achieved significantly higher scores in language processing and reading comprehension tasks than those who received conventional instruction. These results suggest that AI-based learning environments can effectively facilitate language acquisition by enhancing learners' engagement with linguistic input and providing adaptive instructional support.

From a neurolinguistic perspective, AI-assisted learning appears to support cognitive processes associated with language acquisition, including attention allocation, working memory utilization, and information processing efficiency. Through personalized feedback, adaptive learning pathways, and repeated language exposure, AI technologies contribute to more effective processing and retention of linguistic information.

Furthermore, learners reported highly positive perceptions of AI-assisted learning environments, particularly regarding feedback effectiveness, learning engagement, and instructional flexibility. These findings indicate that AI technologies not only improve learning outcomes but also promote positive learning experiences among EFL learners.

Overall, the study highlights the potential of artificial intelligence as an innovative educational tool capable of supporting language processing and language learning. The integration of AI into EFL instruction may therefore contribute to more effective, learner-centered, and cognitively informed language education practices.

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