

Artificial intelligence acceptance and procrastination: metacognitive listening awareness mediation in foreign language students

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ABSTRACT

This study aimed to investigate the mediating role of metacognitive listening awareness in the relationship between artificial intelligence (AI) acceptance and academic procrastination among university students learning foreign languages, specifically examining whether metacognitive processes explain how AI acceptance influences procrastination behaviors. A sample of 646 undergraduate students (378 males, 268 females; M age=20.49 years, SD=1.01) from Al-Azhar University, Egypt, completed the AI acceptance scale, metacognitive awareness listening questionnaire (MALQ), and academic procrastination scale during the second semester of the 2024/2025 academic year. Mediation analysis using Hayes' PROCESS macro with 5,000 bootstrap resamples revealed that AI acceptance negatively predicted academic procrastination ($\beta=-.196$, $p<.001$), with metacognitive listening awareness serving as a significant partial mediator, accounting for 14.98% of the total effect. This study represents the first empirical examination of metacognitive listening awareness as a mediating mechanism in the relationship between AI acceptance and procrastination, addressing a critical gap in technology-enhanced language learning research. Educators should implement AI literacy modules within language courses that explicitly teach students to monitor their comprehension strategies while using AI tools, coupling technology training with reflective listening tasks that develop metacognitive awareness. Future research should employ longitudinal designs and examine additional mediators including self-efficacy, intrinsic motivation, and effort regulation.

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1. INTRODUCTION

Artificial intelligence (AI) is fundamentally transforming educational landscapes, with generative AI tools such as ChatGPT and AI-powered language assistants driving unprecedented changes across learning environments [1]–[4]. These large language models have rapidly transitioned from theoretical innovations to practical applications, offering capabilities ranging from personalized content generation and automated feedback to virtual tutoring and interactive learning support [5]–[9]. The scalability and 24/7

accessibility of these technologies have made them invaluable resources in higher education, where rapid integration is reshaping curricula, teaching methodologies, and assessment strategies [10]–[13].

In foreign language education specifically, AI-powered assistants are revolutionizing pedagogical practices by providing personalized feedback, enhancing learner motivation, and supporting core competencies including writing, grammar, vocabulary development, and listening comprehension [14]–[19]. These tools facilitate interactive, adaptive, and culturally relevant learning experiences while enabling formative assessment in both classroom and self-directed contexts. However, this rapid technological integration demands careful consideration of emerging challenges, including academic integrity concerns, potential biases, data privacy issues, and the necessity for human oversight to address deeper linguistic and pragmatic complexities [14], [16], [17].

Academic procrastination—the habitual postponement of academic tasks despite awareness of potential negative consequences [20]–[24]—represents a pervasive challenge in higher education worldwide. Research demonstrates that 80–97% of university students engage in procrastination to varying degrees, with approximately 75% considering themselves regular procrastinators and nearly half reporting severe or habitual patterns [21], [22], [24]–[27]. This widespread phenomenon transcends gender, academic disciplines, and institutional contexts [20], [21], [24]–[30], establishing procrastination as a universal concern demanding targeted interventions.

The consequences extend beyond delayed task completion, significantly undermining academic achievement, psychological well-being, and learning quality [20], [21], [26], [29], [31]–[34]. Students who procrastinate experience lower grades, increased stress, anxiety, guilt, and diminished self-esteem, with these effects particularly pronounced in language learning contexts where consistent practice and incremental skill development are essential [35]. Critically, procrastination is intrinsically linked to deficits in self-regulated learning, including poor time management, low self-efficacy, and inadequate metacognitive strategies [20], [21], [28]–[35].

The integration of AI in education has garnered significant attention, with technology acceptance models (TAM)—particularly the TAM and the unified theory of acceptance and use of technology (UTAUT)—providing robust frameworks for understanding student adoption behaviors [36]–[39]. These models emphasize perceived usefulness, ease of use, performance expectancy, and effort expectancy as primary determinants of technology acceptance and behavioral intentions. Research consistently demonstrates that higher AI acceptance correlates with increased engagement, enhanced motivation, improved learning achievement, and reduced academic stress [40]–[42], with factors such as self-efficacy, learning motivation, and perceived learning value emerging as critical moderators shaping how students integrate AI tools into their academic routines [43]–[45].

Despite these promising benefits, students exhibit dual perspectives characterized by enthusiasm and apprehension [41], [46]–[48]. While many recognize AI’s potential for personalized learning and enhanced academic efficiency, they simultaneously express concerns regarding ethical implications, data privacy, content reliability, and potential negative impacts on critical thinking and academic integrity. These attitudes vary significantly across academic disciplines, educational levels, and cultural contexts [49], [50]. Importantly, AI acceptance fundamentally shapes students’ approaches to learning tasks, with positive attitudes fostering innovative learning strategies and deeper content engagement, while skepticism may inhibit effective utilization and limit educational benefits [42], [46], [50].

Metacognitive awareness—learners’ understanding and regulation of their own cognitive processes—has emerged as a cornerstone of effective language acquisition [51]–[53]. This awareness encompasses both metacognitive knowledge (awareness of self, tasks, and strategies) and metacognitive skills (planning, monitoring, and evaluating learning approaches). Research consistently demonstrates that metacognitive awareness significantly enhances language learning outcomes across multiple skills, with learners exhibiting higher awareness employing learning strategies more effectively and achieving improved performance and greater language proficiency [53]–[55]. Meta-analyses confirm that metacognitive strategy training produces strong positive effects on language-learning outcomes across skill areas [54].

Metacognitive listening awareness specifically involves the conscious application of strategies to understand, monitor, and regulate listening comprehension in second language contexts [55]–[58]. This dimension includes planning approaches to listening tasks, monitoring comprehension during auditory input processing, and evaluating the effectiveness of deployed strategies. Critically, metacognitive strategies function as integral components of self-regulated learning, enabling learners to set goals, monitor progress, and adjust behaviors in response to challenges [59]–[61]. This relationship between metacognitive awareness and self-regulation is evident across diverse age groups and learning contexts, with metacognition functioning as a prerequisite for effective autonomous learning behaviors [53], [61].

Despite growing research on educational technology adoption and academic behavior, important gaps persist. Although recent studies show correlations between AI dependence and academic procrastination

[62], [63], they rely mainly on correlational designs and overlook underlying psychological mechanisms. While several mediators of procrastination—such as ego depletion, coping strategies, self-efficacy, and distraction cognitions—have been identified [64]–[66], and metacognitive self-regulation is known to be influenced by AI tools [67], [68], the role of metacognitive listening awareness as a mediator between AI acceptance and procrastination remains unexamined. This gap is especially significant in foreign language education, where AI use is increasing despite limited empirical evidence on its effects on learner behavior and metacognitive processes [63], [69]. No prior work has investigated metacognitive listening awareness as a mediator linking AI acceptance to academic procrastination in foreign language learning. Accordingly, this study asks: to what extent does metacognitive listening awareness mediate the relationship between AI acceptance and academic procrastination among university foreign language learners?

2. METHOD

2.1. Participants

Participants were recruited using a stratified convenience sampling method across two campuses of Al-Azhar University in Tafhna Al-Ashraf, Egypt. This method balanced practical feasibility with the need to represent students from all academic years, though its convenience-based nature may introduce self-selection bias and limit generalizability beyond the institution. The study targeted undergraduate foreign language learners who actively used generative AI tools—such as ChatGPT, Bard, or similar applications—at least once per week for academic purposes during the previous month, ensuring sufficient experience to evaluate AI acceptance. Focusing on foreign language programs was appropriate given the study’s emphasis on metacognitive listening awareness, a key construct in second-language acquisition. An a priori power analysis using G*Power 3.1.9.7 indicated that a minimum sample of 395 participants was needed to detect a small-to-medium effect ($f^2=.02$) in the mediation model with $\alpha=.05$ and power $=.95$. The achieved sample sizes—473 for psychometric validation and 646 for the main study—exceeded this requirement, providing strong statistical power and precise parameter estimates.

The psychometric validation sample consisted of 473 undergraduate students (229 males, 244 females) recruited from Al-Azhar University across the Faculty of Education for Boys in Tafhna Al-Ashraf and the Faculty of Humanities Studies for Girls in Tafhna Al-Ashraf. Participants’ ages ranged from 19 to 25 years ($M=20.90$, $SD=1.44$). The main study sample comprised 646 undergraduate students (378 males, 268 females) from the same institutional contexts. Participants ranged in age from 19 to 22 years ($M=20.49$, $SD=1.01$). The demographic characteristics of both samples are presented in Table 1.

Table 1. Demographic characteristics of study participants

Variable	Category	Psychometric sample (N=473)		Main sample (N=646)	
		N	%	N	%
Academic year	First year	87	18.4	114	17.6
	Second year	88	18.6	142	22.0
	Third year	122	25.8	189	29.2
	Fourth year	176	37.2	201	31.1
Residence	Urban	165	34.9	233	36.1
	Rural	308	65.1	413	63.9
Gender	Male	229	48.4	378	58.5
	Female	244	51.6	268	41.5

Note: all participants were active users of AI technologies

2.2. Measures

The generative artificial intelligence acceptance scale (GAIAS) was employed to assess students’ acceptance levels of generative AI applications, such as ChatGPT, Bard, and DALL-E in educational contexts [70]. The scale was theoretically grounded in the UTAUT framework. The instrument comprises 20 items distributed across four primary dimensions: performance expectancy (7 items), effort expectancy (5 items), facilitating conditions (3 items), and social influence (5 items). Participants responded to each item on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating greater acceptance of generative AI technologies. The Arabic adaptation demonstrated satisfactory reliability and validity indices. Confirmatory factor analysis (CFA) yielded acceptable model fit statistics: $\chi^2(165)=468.165$, $p<.001$, Chi-square to degrees of freedom ratio (χ^2/df)=2.837, goodness of fit index (GFI)=.910, adjusted goodness of fit index (AGFI)=.885, comparative fit index (CFI)=.927, Tucker-Lewis index (TLI)=.916, root mean square error of approximation (RMSEA)=.062. Composite reliability (CR) for the overall scale was .800, with average variance extracted (AVE) of .508 and maximum reliability H of .827. Internal consistency reliability coefficients were robust across all subscales: performance expectancy

($\omega=.871$, $\alpha=.870$), effort expectancy ($\omega=.837$, $\alpha=.834$), facilitating conditions ($\omega=.747$, $\alpha=.745$), and social influence ($\omega=.859$, $\alpha=.853$). The total scale demonstrated excellent reliability ($\omega=.899$, $\alpha=.901$). Item-total correlations ranged from .653 to .854, confirming satisfactory internal consistency.

The metacognitive awareness listening questionnaire (MALQ) was used to measure metacognitive awareness in second-language listening contexts [71]. The instrument consists of 21 items, rated on a 6-point Likert scale from 1 (strongly disagree) to 6 (strongly agree). The scale encompasses five theoretically derived dimensions: problem-solving (6 items), planning and evaluation (5 items), mental translation (3 items), person knowledge (3 items), and directed attention (4 items). The Arabic adaptation demonstrated strong psychometric properties. CFA demonstrated excellent model fit: $\chi^2(182)=398.156$, $p<.001$, $\chi^2/df=2.188$, GFI=.925, AGFI=.905, CFI=.951, TLI=.943, RMSEA=.050. The overall scale exhibited robust CR (CR=.841, AVE=.531, maximal reliability (Hancock's H) (MaxR(H))=.900). Reliability analyses for individual subscales were satisfactory: problem-solving ($\omega=.864$, $\alpha=.864$), planning and evaluation ($\omega=.851$, $\alpha=.851$), mental translation ($\omega=.793$, $\alpha=.787$), person knowledge ($\omega=.769$, $\alpha=.760$), and directed attention ($\omega=.777$, $\alpha=.760$, $\lambda_2=.771$). Total scale reliability was excellent ($\omega=.901$, $\alpha=.901$). Item-total correlations ranged from .509 to .828, supporting strong internal consistency.

The original English version was translated into Arabic through a rigorous forward-backward translation procedure: two bilingual educational psychology faculty members independently translated the scale into Arabic, discrepancies were resolved through consensus discussion, a professional translator back-translated the reconciled version into English, and the research team compared the back-translation with the original to ensure semantic equivalence. This process was repeated for all instruments to maintain construct validity across linguistic contexts. The academic procrastination scale–short form (APS-SF) was employed to assess students' tendencies toward academic task postponement [72]. This brief instrument comprises 5 items rated on a 5-point Likert scale from 1 (strongly agree) to 5 (strongly disagree). The Arabic adaptation yielded favorable results. CFA supported the unidimensional structure with adequate model fit: $\chi^2(5)=24.750$, $p<.001$, $\chi^2/df=4.950$, GFI=.978, AGFI=.935, CFI=.979, TLI=.958, RMSEA=.079 [90% CI: .058, .129]. CR was satisfactory (CR=.856, AVE=.543, MaxR(H)=.857). Internal consistency reliability coefficients demonstrated strong instrument reliability ($\omega=.856$, $\alpha=.856$). Item-total correlations ranged from .784 to .818, indicating excellent internal consistency and item homogeneity.

2.3. Procedure

Data collection was conducted electronically via Google Forms during the second semester of the 2024/2025 academic year to ensure accessibility and efficient data handling. Participants received informed consent outlining the study purpose, voluntary participation, and confidentiality before completing the survey. All measurement scales, originally in English, were translated into Arabic following a systematic forward-backward translation protocol involving two independent bilingual translators, consensus-based discrepancy resolution, professional back-translation, and verification by the research team to ensure semantic and conceptual equivalence. Statistical analyses were performed using SPSS-27 and AMOS-26 for structural equation modeling and psychometric assessment.

2.4. Data analysis

Descriptive statistics, correlation analyses, and mediation analyses were performed using SPSS version 27. The mediation model was tested using Hayes [73] PROCESS macro (version 5.0, model 4) with 5,000 bootstrap samples to generate bias-corrected 95% confidence intervals for indirect effects. AI acceptance served as the independent variable, academic procrastination as the dependent variable, and metacognitive listening awareness as the mediator. Statistical significance was determined at $\alpha=.05$, with indirect effects considered significant when bootstrap confidence intervals excluded zero.

3. RESULTS

Before proceeding with the main analyses, a common-methods variance assessment was conducted to ensure that systematic measurement error did not unduly affect the study's outcomes. A single-factor test was applied, involving exploratory factor analysis without rotation to examine whether a single factor would account for the majority of covariance among the measured variables. The analysis revealed that the first unrotated factor accounted for 19.197% of the total variance, which is well below commonly accepted thresholds for concern. These results suggest that common method variance is unlikely to compromise the validity of the study findings, thereby reinforcing the reliability of the subsequent statistical interpretations.

Descriptive statistics revealed considerable variability across variables. Academic procrastination ($M=12.23$, $SD=4.50$, range=5.00–21.00) showed diverse procrastination tendencies. AI acceptance ($M=83.57$, $SD=13.77$, range=30.00–100.00) reflected generally positive attitudes with notable individual

differences. Metacognitive listening awareness ($M=105.35$, $SD=17.19$, $range=37.00-126.00$) suggested moderate to high awareness levels with substantial heterogeneity. Pearson correlations in Table 2 revealed significant bivariate associations. AI acceptance correlated negatively with academic procrastination ($r=-.196$, $p<.001$) and positively with metacognitive listening awareness ($r=.189$, $p<.001$). Metacognitive listening awareness correlated negatively with academic procrastination ($r=-.187$, $p<.001$). These patterns supported the hypothesized relationships for subsequent mediation analysis.

Table 2. Pearson correlations among study variables

Variable	1	2	3	M	SD
1. AI acceptance	1			83.57	13.77
2. Metacognitive listening awareness	.189**	1		105.35	17.19
3. Academic procrastination	-.196**	-.187**	1	12.23	4.50

Note: $N=646$, ** $p<.01$.

Mediation analysis using Hayes [73] PROCESS macro (model 4) with 5,000 bootstrap resamples examined whether metacognitive listening awareness mediated the relationship between AI acceptance and academic procrastination. Results in Table 3 demonstrated significant relationships across all paths. AI acceptance significantly predicted metacognitive listening awareness (path a: $\beta=.236$, $SE=.048$, $t=4.889$, $p<.001$, standardized $\beta=.189$). Metacognitive listening awareness significantly predicted academic procrastination controlling for AI acceptance (path b: $\beta=-.055$, $SE=.012$, $t=-4.287$, $p<.001$, standardized $\beta=-.162$). The direct effect of AI acceptance on procrastination remained significant (path c: $\beta=-.041$, $SE=.010$, $t=-3.987$, $p<.001$, standardized $\beta=-.152$).

Table 3. Unstandardized and standardized regression coefficients for mediation model

Path	Outcome variable	Predictor variable	β	SE	T	p	Standardized β
a	MetM	AiX	.236	.048	4.889	<.001	.189
b	ProY	AiX	-.055	.012	-4.287	<.001	-.196
c	ProY	MetM	-.041	.010	-3.987	<.001	-.152

Note: AiX=AI acceptance; MetM=metacognitive listening awareness; ProY=academic procrastination; β =unstandardized regression coefficient; SE=standard error.

The total effect of AI acceptance on academic procrastination, without including the mediator in the model, was statistically significant ($\beta=-.064$, $SE=.013$, $t=-5.076$, $p<.001$, 95% CI [-.089, -.039]), with a standardized coefficient of -.196. This total effect represents the overall influence of AI acceptance on procrastination before accounting for any mediating mechanisms, providing a baseline against which to evaluate the contribution of metacognitive listening awareness to this relationship. As shown in Table 4, the decomposition of this total effect into direct and indirect components revealed that the direct effect accounted for 85.02% of the total effect ($\beta=-.055$, 95% CI [-.079, -.030]), while the indirect effect through metacognitive listening awareness accounted for 14.98% of the total effect ($\beta=-.010$, 95% CI [-.017, -.004]). The bootstrap confidence interval for the indirect effect did not include zero, confirming that the mediation effect was statistically significant at the .05 level and supporting the hypothesis that metacognitive listening awareness partially mediates the relationship between AI acceptance and academic procrastination. The standardized indirect effect was -.029 ($SE=.010$, 95% CI [-.051, -.013]), indicating that for every one standard deviation increase in AI acceptance, procrastination decreased by approximately .029 standard deviations indirectly through enhanced metacognitive listening awareness.

Table 4. Decomposition of total, direct, and indirect effects

Effect type	β	Standardized β	SE	95% CI	Percentage of total effect (%)
Total effect (AiX→ProY)	-.064	-.196	.013	[-.089, -.039]	100.00
Direct effect (AiX→ProY)	-.055	-.167	.013	[-.079, -.030]	85.02
Indirect effect (AiX→MetM→ProY)	-.010	-.029	.010	[-.017, -.004]	14.98

Note: AiX=AI acceptance; MetM=metacognitive listening awareness; ProY=academic procrastination; β =unstandardized regression coefficient; SE=standard error; CI=bias-corrected bootstrap confidence interval.

Figure 1 presents a visual representation of the mediation model with standardized path coefficients and the proportion of variance explained in each endogenous variable. The model indicates that AI acceptance explained 3.58% of the variance in metacognitive listening awareness ($R^2=.036$, $F(1, 644)=23.900$, $p<.001$),

Artificial intelligence acceptance and procrastination: metacognitive ... (Mohamed Ali Nemt-allah)

demonstrating a modest but statistically significant predictive relationship. Together, AI acceptance and metacognitive listening awareness accounted for 6.17% of the variance in academic procrastination ($R^2=.062$, $F(2, 643)=21.134$, $p<.001$), indicating that while these variables contribute meaningfully to understanding procrastination behaviors, substantial variance remains attributable to other factors not measured in this study. The pattern of results illustrated in the figure demonstrates that AI acceptance operates through two distinct pathways to reduce academic procrastination: a direct pathway representing the unique influence of AI acceptance on procrastination behaviors, and an indirect pathway whereby AI acceptance enhances metacognitive listening awareness, which in turn reduces procrastination tendencies.

The mediation analysis results provide robust empirical support for the hypothesis that metacognitive listening awareness serves as a significant mediating mechanism linking AI acceptance to reduced academic procrastination among university students learning foreign languages. The presence of partial mediation suggests that while metacognitive listening awareness plays an important explanatory role in this relationship, AI acceptance also influences procrastination through additional pathways not captured by the mediator examined in this study. These findings advance theoretical understanding of how technological acceptance influences academic behaviors and highlight the importance of considering metacognitive processes when examining the educational implications of generative AI adoption in language learning contexts.

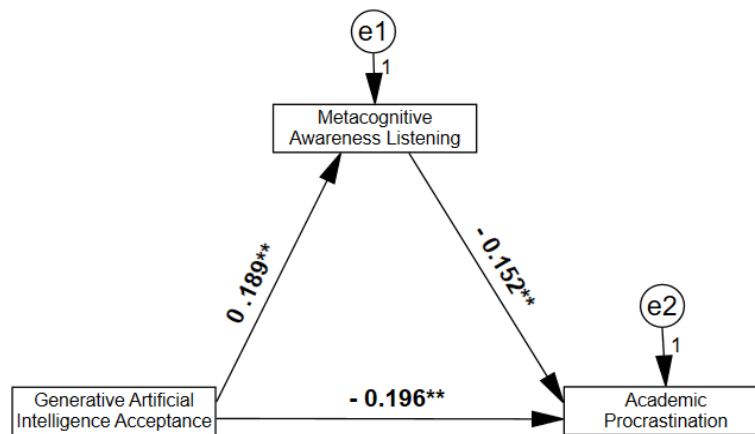


Figure 1. Mediation model of the relationship between AI acceptance and academic procrastination through metacognitive listening awareness

4. DISCUSSION

The finding that metacognitive listening awareness only partially mediates the relationship between AI acceptance and academic procrastination (14.98% of the total effect) indicates that several self-regulatory and motivational mechanisms operate simultaneously. This pattern aligns with the UTAUT, which posits that performance expectancy and effort expectancy influence behavioral outcomes through multiple pathways beyond single mediators. The substantial direct effect (85.02%) suggests AI acceptance may reduce procrastination through enhanced self-efficacy and intrinsic motivation—constructs central to self-regulated learning theory—independently of metacognitive listening processes. Although metacognitive listening awareness represents one meaningful pathway, the large remaining direct effect suggests that other psychological processes play equally important roles. Prior research shows that effort regulation—the ability to sustain effort during demanding tasks—is a stronger predictor of reduced procrastination than metacognitive self-regulation alone, indicating that students’ persistence may function independently of their metacognitive awareness [35]. Self-efficacy also forms a distinct pathway, as students’ confidence in managing academic tasks directly influences procrastination beyond metacognitive factors [35]. Moreover, the concept of “metacognitive laziness” identified by Fan *et al.* [74] highlights a potential paradox: high reliance on generative AI may reduce deep cognitive engagement, leading students to offload mental effort to AI systems rather than building their own self-regulatory skills. Thus, although AI acceptance can enhance metacognitive awareness by providing supportive scaffolding [67], [75], it may simultaneously enable alternative pathways to procrastination by lowering effortful processing and diminishing intrinsic engagement.

The observed negative correlation between AI acceptance and academic procrastination aligns with emerging evidence that technology acceptance influences learning behaviors beyond traditional mechanisms.

Previous research [41], [42] documented that higher AI acceptance correlates with enhanced engagement and reduced academic stress, consistent with our findings. However, the modest mediation percentage contrasts with studies emphasizing metacognitive self-regulation as a primary procrastination determinant [28], [31]. This discrepancy suggests that AI-mediated learning environments may activate unique behavioral pathways distinct from conventional self-regulatory frameworks, warranting reconsideration of traditional procrastination models in technologically enhanced contexts.

These findings carry important implications for educational practice and institutional policy in foreign language education. Educators should integrate AI literacy modules into language curricula that intentionally combine technology training with metacognitive listening strategy instruction. Practical classroom activities may include reflective listening journals in which students analyze how they monitor comprehension while using AI-generated audio materials, peer-collaborative tasks that require evaluating AI-generated transcripts against authentic listening passages, and scaffolded self-assessment routines that prompt learners to identify the metacognitive strategies they used before, during, and after AI-assisted listening tasks. Teacher professional development should prepare instructors to model metacognitive thinking aloud when demonstrating AI tools, design formative assessments that measure both AI literacy and listening awareness, and facilitate discussions on responsible AI use that supports rather than replaces cognitive effort. Institutions should adopt balanced policies that leverage AI's motivational benefits while preventing overreliance that may weaken cognitive engagement. Additionally, curriculum designers should incorporate structured reflection opportunities that encourage students to critically examine their AI usage patterns and sustain autonomous learning behaviors alongside technological support.

Several methodological limitations constrain the generalizability and interpretive scope of these findings. The cross-sectional design precludes causal inferences regarding temporal precedence and directional relationships among variables; reciprocal effects whereby procrastination influences AI acceptance or metacognitive awareness cannot be ruled out. Self-report measures introduce social desirability bias and common method variance, potentially inflating observed relationships while failing to capture objective AI usage behaviors or authentic in-situ metacognitive processes. The study's exclusive focus on Egyptian university students within a single institutional context (AI-Azhar University) limits cross-cultural applicability, as collectivist educational values, technological infrastructure disparities, and culturally specific attitudes toward AI may not generalize to individualist Western contexts or other Middle Eastern settings. Additionally, the modest variance explained by procrastination (6.17%) suggests that crucial variables—including motivational orientations, personality traits, and contextual factors—remained unexamined. The reliance on convenience sampling further restricts population-level inferences. Future investigations employing behavioral observation and longitudinal tracking would significantly strengthen causal claims.

Future research should adopt longitudinal and experimental designs to establish temporal precedence and causal mechanisms linking AI acceptance, metacognitive development, and procrastination reduction. Randomized controlled trials testing metacognitive listening interventions integrated with AI literacy training would provide robust evidence for pedagogical recommendations. Cross-cultural comparative studies across Arab, Asian, European, and North American educational contexts would illuminate how cultural dimensions (individualism-collectivism and power distance) moderate the relationships observed here. Qualitative phenomenological studies employing think-aloud protocols and semi-structured interviews could reveal students' lived experiences with AI tools, uncovering nuanced mechanisms unavailable through quantitative approaches alone. Mixed-methods convergent designs combining behavioral traces (AI tool usage logs and time-on-task metrics) with self-report data would triangulate findings and reduce common-method bias. Investigations should examine additional mediators including self-efficacy, intrinsic motivation, effort regulation, and perceived autonomy to comprehensively map pathways through which AI acceptance influences academic behaviors. Moreover, researchers should investigate potential moderators such as digital literacy, learning goal orientations, and AI dependency patterns, ultimately informing theoretically grounded interventions.

5. CONCLUSION

This study provides initial evidence that metacognitive listening awareness partially mediates the relationship between AI acceptance and academic procrastination among foreign language learners, though the effect remains modest (14.98%). The findings underscore the complexity of technological integration in education, revealing that AI acceptance operates through multiple pathways—both metacognitive and non-metacognitive—to influence learning behaviors. However, several limitations constrain the generalizability of these findings. The cross-sectional design precludes causal inferences, as reciprocal relationships among variables remain unexplored. The reliance on self-report measures introduces potential response biases and may not capture actual AI usage behaviors or authentic metacognitive processes during learning activities. The modest variance explained by procrastination (6.17%) and the small effect size of the

mediation suggest that crucial variables—including motivational orientations, personality traits, and contextual factors—remained unexamined. Additionally, the study’s focus on a single institutional context in Egypt limits applicability across diverse cultural and educational systems where AI acceptance patterns may differ substantially. Future research should employ longitudinal and experimental designs to establish causal relationships, investigate additional mediators including self-efficacy and intrinsic motivation, conduct comparative studies across diverse contexts, examine potential negative consequences of AI overreliance, and utilize mixed-methods approaches. Educational stakeholders must adopt nuanced, evidence-based approaches that maximize AI’s pedagogical benefits while preserving students’ cognitive autonomy and self-regulatory development, integrating AI literacy training with explicit metacognitive strategy instruction to optimize learning outcomes.

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AUTHOR CONTRIBUTIONS STATEMENT

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- C : **C**onceptualization
- M : **M**ethodology
- So : **S**oftware
- Va : **V**alidation
- Fo : **F**ormal analysis
- I : **I**nvestigation
- R : **R**esources
- D : **D**ata Curation
- O : **O**riginal Draft
- E : **E**diting
- Vi : **V**isualization
- Su : **S**upervision
- P : **P**roject administration
- Fu : **F**unding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

Informed consent was obtained from all participants after explaining the study’s purpose, procedures, risks, and benefits, following ethical guidelines and institutional approval.

ETHICAL APPROVAL

The study protocol was approved by the Research Ethics Committee of the Faculty of Education, Al-Azhar University, Egypt (Ref. No. EDU-REC-2025-212).

DATA AVAILABILITY

The data are available from the corresponding author, [MAN-a], upon reasonable request.

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