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Do GenAI and ESL Learners Connect Ideas Differently? A Corpus-Based Study of Cohesion in Chinese–English Translation

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English as a lingua franca plays a central role in international communication, yet it poses persistent challenges for non-native users, particularly in achieving textual cohesion, which is essential for clarity and communicative effectiveness. ESL (English as a second language) student translators often struggle to manage cohesion through the appropriate use of connectives when translating into English. The emergence of generative artificial intelligence (GenAI) has created new possibilities for supporting language learners and translators in producing cohesive texts. This study examines the potential and limitations of GenAI in generating cohesive Chinese-English translations by comparing its outputs with those produced by ESL learner translators, using sense-aware connective-based cohesion indices. The results show that, although the two groups display largely similar overall patterns in the use of discourse and non-discourse connectives, they differ substantially in specific connective categories. GenAI-generated translations show a greater reliance on comparison and expansion connectives and a relative underuse of contingency connectives, whereas ESL learner translations tend to preserve source text discourse relations more closely. These findings provide insights into the cohesion characteristics of GenAI-generated translations and point to important considerations for language learning and translation pedagogy.

Keywords: Generative artificial intelligence, ESL learners, translation, cohesion

Introduction

English as a lingua franca plays a crucial role in international communication but often poses challenges for non-native English users, particularly English as a second language (ESL) and English as a foreign language (EFL) learners. Among the linguistic features that influence the clarity and effectiveness of such communication, textual cohesion is especially important. Cohesion refers to the explicit linguistic resources that link different segments of a text, thereby contributing to overall textual unity. As a core component of textual readability, cohesive devices help readers construct a coherent mental representation of a text's structure and meaning (Halliday & Hasan, 1976). Given its central role in supporting comprehension, cohesion has received sustained attention in both language learning and translation studies.

In the context of language learning, prior research has consistently shown that ESL/EFL writers tend to misuse or overuse cohesive devices (Bolton et al., 2002; Cheng & Tsang, 2022; Leedham & Cai, 2013; Lei,

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2012; Ma & Wang, 2016). Similar tendencies have also been identified in translation studies. First, translated texts frequently exhibit the insertion of additional cohesive markers to clarify discourse relations, particularly in comparison with their source texts (Defrancq et al., 2015). Second, translations generally contain a higher density of certain cohesive markers than comparable non-translated texts produced by native speakers (Jiang & Niu, 2022; Kajzer-Wietrzny, 2022; Kruger & Rooy, 2012). For student translators engaged in second language (L2) translation tasks, these patterns point to a dual challenge: they must manage the linguistic demands of L2 production while simultaneously coping with the cognitive complexities inherent in the translation process. As such, fostering their awareness and strategic use of cohesive devices is essential for improving translation quality.

In response to the challenges of translation and evolving pedagogical demands, the role of technology in translation pedagogy has become increasingly prominent. Many translation curricula in Europe have incorporated training in translation technologies, such as computer-assisted translation tools and machine translation systems (Rodríguez de Céspedes, 2019). Even among translation learners who have not received formal instruction in translation technologies, these tools, particularly online machine translation systems, are frequently used independently to complete translation assignments (Liu et al., 2022). In earlier stages, conventional machine translation systems played a dominant role and were generally perceived as beneficial for enhancing learner translators' lexical knowledge and translation efficiency (Liu et al., 2022). However, traditional machine translation systems have often struggled with context sensitivity and the handling of nuanced meanings (Krüger, 2020). More recently, the emergence of GenAI chatbots, such as ChatGPT, has introduced a new category of translation-related tools. Unlike conventional machine translation systems, GenAI tools enable interactive human–AI collaboration and can perform a wide range of language-related tasks, including drafting, revising, and explicating translation choices. Owing to their greater fluency and contextual awareness, these tools are increasingly viewed as potentially valuable resources for language learners and translators alike. Nevertheless, despite growing interest in their pedagogical applications, the extent to which GenAI tools can effectively support ESL/EFL learner translators, particularly in producing cohesive English translations, remains largely unexplored.

This study seeks to address the identified research gap by examining textual cohesion in AI-generated Chinese–English translations and comparing these translations with those produced by ESL learner translators. Specifically, it adopts the sense-aware, connective-based cohesion indices developed by Lu and Hu (2024), which are designed to address ambiguity arising from the polysemous nature of certain connective forms. The findings aim to identify areas in which AI-generated translations exhibit similarities to or differences from ESL learner translations. The study may offer empirical insights relevant to translation pedagogy, second language acquisition, and the use of GenAI in language education, particularly regarding learners' understanding and use of connectives in achieving textual cohesion.

Related Work

Concepts of Text Cohesion and Connectives

Text cohesion refers to the connections among different parts of a text that are explicitly linked by linguistic signals, which contribute to a sense of unity across the discourse (Crossley et al., 2019; Hoey, 1991; Kamalski et al., 2008). Cohesion is different from coherence. Whereas coherence is the reader's mental representation of how ideas fit together, cohesion provides the textual cues that support readers in constructing coherence (Graesser et al., 2004; Halliday & Hasan, 1976; McNamara et al., 2014). Strong cohesion facilitates readers' comprehension by making relationships between text segments more explicit and reducing the inferential burden placed on readers (Kleijn et al., 2019; O'Reilly & McNamara, 2007). In contrast, texts with lower levels of cohesion provide fewer explicit links, requiring greater reliance on prior knowledge and more effortful inferencing, which increases processing difficulty and may hinder understanding (O'Reilly & McNamara, 2007). Cohesion, therefore, plays an important role in how texts

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are processed and comprehended.

Halliday and Hasan (1976) were among the earliest scholars to offer a systematic account of English textual cohesion. They categorized the linguistic devices that contribute to structural connections within a text into two broad types: grammatical cohesion and lexical cohesion. Grammatical cohesion is realized through reference, typically via pronouns, as well as substitution, ellipsis, and conjunction (Halliday & Hasan, 1976). Lexical cohesion, by contrast, is achieved through the reiteration and co-occurrence of lexical items across a text (Halliday & Hasan, 1976). Subsequent frameworks, such as Givón's (1995) distinction between grammar-driven and vocabulary-driven cohesion, largely echo this binary classification. Building on these earlier accounts, Hoey (1991) reconceptualized cohesion from a discourse-organizational perspective. He introduced the notion of "links" to capture both lexical and non-lexical cohesive relations and further defined a "bond" as the connection formed when the cumulative strength of links between two sentences exceeds a specified threshold.

Among the various categories of cohesive devices, connectives constitute a major area of interest. On the one hand, they provide a relatively direct means of explicitly signaling logical and rhetorical relations between clauses or discourse segments. On the other hand, their use can influence discourse flow, pragmatic intent, and reader comprehension (Halliday & Hasan, 1976). Connectives therefore play a central role in the realization of textual cohesion. Despite their importance, connective use has been consistently identified as a problem area for ESL/EFL learners across diverse first language backgrounds (Cheng & Tsang, 2022; Granger & Tyson, 1996) as well as for translators (Jiang & Niu, 2022; Kajzer-Wietrzny, 2022). These challenges may be further compounded for ESL/EFL student translators when they engage in L2 translation tasks, given the combined demands of second language production and translation processing. This situation calls for a systematic investigation. Accordingly, the present study focuses on examining the use of connectives.

With advances in technology, a range of computational tools have been developed to automate the analysis of textual cohesion. Among these, Coh-Metrix (Graesser et al., 2004) and the Tool for the Automatic Analysis of Cohesion (TAACO) (Crossley et al., 2016, 2019) are two of the most widely used. Both tools include indices designed to capture connective use. However, traditional connective indices are primarily word-based, identifying connectives on the basis of surface forms or lemmas without taking their contextual meaning or discourse function into account. Given the polysemous nature of many connective forms, such indices often fail to distinguish discourse uses from non-discourse uses, or to differentiate among distinct discourse-relation senses. Although Crossley et al. (2019) took initial steps to address this issue in TAACO 2.0, a comprehensive solution has yet to be achieved (Lu & Hu, 2024). To overcome these limitations, Lu and Hu (2024) introduced 34 sense-aware, connective-based cohesion indices that disambiguate polysemous connectives by incorporating their contextual discourse functions. These indices cover four top-level discourse relations, namely expansion, contingency, comparison, and temporal. When applied to a corpus of argumentative essays produced by English learners, 23 of these indices were found to show strong predictive power with respect to cohesion ratings, outperforming conventional connective indices (Lu & Hu, 2024). This recent development in automated, sense-aware connective analysis enables a more systematic, fine-grained, and functionally interpretable examination of connective use in language research.

Connective Use in Translation

Maintaining textual cohesion is a well-known challenge in translation. Achieving cohesion through the use of connectives involves more than mapping lexical or semantic equivalents between source and target texts or applying grammatical rules. Translators therefore need to be sensitive to how connectives are conventionally used in the target language and to recreate cohesive ties that are both semantically appropriate and natural sounding (Castagnoli, 2016; Stine, 1980).

Research has shown that translators tend to use connective markers in regular and predictable ways, such as inserting additional markers, relying on them more frequently, and favoring certain types over others.

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One strand of research compares translated texts with their corresponding source texts and reports a general tendency toward increased explicitness. For example, Defrancq et al. (2015) found that translators often insert additional connectives to clarify discourse relations relative to their source texts. Another strand of studies compares translated texts with comparable non-translated texts in the target language and suggests that patterns of connective use can distinguish translations from original writing. Jiang and Niu (2022) showed that both human and machine translations tend to overuse particular connectives and exhibit coherence patterns that differ from those found in written texts. Similarly, Kruger and Rooy (2012) observed higher frequencies of connectives in translations than in native writing, with usage sometimes diverging from target language norms. Kajzer-Wietrzny (2022) further reported that translators show a marked preference for additive and concessive connectives. Taken together, these findings indicate that translators manage cohesion, particularly through the use of connectives, in systematic and recognizable ways that differ from those observed in non-translated writing.

While patterns of explicitation and overuse of connectives characterize translation in general, these challenges can become particularly pronounced among learner translators who are still developing their translation competence. In a corpus-based study of learner translations, Castagnoli (2016) found that students tend to mirror the cohesive devices of the source text, a tendency that often results in unnatural target-language output. She argues that the appropriate rendering of conjunction patterns constitutes an important component of translators' pragmalinguistic competence and therefore warrants targeted instruction that helps learners distinguish between connective forms and their discourse functions in the target language. Similarly, Becher (2011) noted that decisions about when to add or omit connectives in translation involve complex judgment. Translators must take into account communicative conventions as well as the specific features and constraints of the target language system, avoid stylistically marked formulations, and ultimately strive to optimize cohesion in the target text.

In addition to translation competence, target-language proficiency constitutes another important factor in this discussion. The rise of English as a lingua franca has led to the increasing prevalence of L2 translation practice, which often requires translation into non-native English. This translation direction poses particular challenges for ESL/EFL learners, especially with respect to their use of connectives within the target-language system. The use of connectives has been extensively examined in ESL/EFL learner writing, and prior research has consistently shown that ESL/EFL learners tend to misuse or overuse connectives in comparison with native speakers. For instance, some learners employ multiple connectives to express a single discourse relation and show a marked overuse of the additive connective "and" (Cheng & Tsang, 2022). Studies focusing on Chinese learners have further reported the overuse of specific linking adverbials such as "besides" and "on the other hand" (Leedham & Cai, 2013), with Lei (2012) similarly observing frequent misuse of "besides" among Chinese doctoral students. Given the difficulties associated with appropriate connective use in both translation and L2 writing, these challenges are likely to be further compounded for novice translators who are also ESL/EFL learners.

Translation Technology and Text Cohesion

Recent technological advances, particularly in machine translation systems and GenAI, have transformed translation practice and become increasingly prevalent in both professional and educational contexts. As a result, the role and effectiveness of translation technologies in translation pedagogy have attracted growing attention, with the textual cohesion of machine-generated output emerging as a central concern.

Traditional machine translation systems have been criticized for their limited ability to maintain textual cohesion. Voigt and Jurafsky (2012) showed that machine translation performance in preserving cohesive ties varies by genre and is notably weaker than that of human translators in maintaining referential cohesion in literary texts. This limitation is likely attributable, at least in part, to the restricted context sensitivity of traditional machine translation systems (Krüger, 2020), which constrains their ability to capture discourse-level relations and sustain cohesion across a text. By contrast, GenAI's capacity to process extended contexts introduces new possibilities for maintaining textual cohesion.

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GenAI refers to a class of AI systems capable of generating content in response to user prompts. Built on large language models trained on large-scale textual data, these systems are able to identify linguistic patterns, semantic relationships, and contextual cues (Brown et al., 2020). This architecture enables GenAI to generate human-like language output and perform translation tasks. Recent studies suggest that GenAI can achieve translation accuracy and fluency comparable to, and in some cases exceeding, those of conventional machine translation systems (Bistafa, 2024; Gao et al., 2024), making it a potentially valuable resource for learners. Nevertheless, it remains unclear whether GenAI handles discourse relations in ways that are comparable to those of human translators or acceptable in pedagogical and translational contexts.

Although studies examining connective use in GenAI translations remain limited, comparative research on AI-generated and human-written essays has revealed systematic differences between GenAI and human writers. For example, Herbold et al. (2023) analyzed a broad range of linguistic features in student argumentative essays and ChatGPT-generated texts and found that, relative to GPT-3.5, GPT-4 demonstrates substantial improvements in maintaining textual cohesion and employs significantly fewer discourse markers than students. Similarly, Shaitarova et al. (2024) reported that ChatGPT receives higher coherence scores than human writers while showing a marked preference for certain connectives. Together, these findings suggest that GenAI differs from human writers in how discourse relations are realized through connectives and, in some respects, may outperform them.

Existing research thus underscores the importance of connectives in the realization of textual cohesion, while also showing that their appropriate use remains a persistent challenge for ESL/EFL learners and in translation. Given GenAI's demonstrated ability to generate cohesive texts, particularly through the effective use of connectives, it may offer valuable support for student translators translating into L2 English. However, despite growing interest in the applications of GenAI, its effectiveness in facilitating cohesive text production in Chinese–English translation remains underexplored. This translation direction is particularly demanding because Chinese, a parataxis-prominent language, often leaves discourse relations implicit (Lin et al., 2025), whereas English, a hypotaxis-prominent language, typically requires explicit connectives to ensure structural clarity (Lian, 2010). As a result, translators are often required to render implicit relations explicit through the use of connectives. Moreover, much of the existing research relies on frequency-based and word-level measures that do not account for sense distinctions, highlighting the need for more fine-grained, sense-aware analyses of connective use in this area.

Research Questions

This study examines the potential and limitations of GenAI in generating cohesive texts in Chinese–English translation and investigates the extent to which its outputs differ from those produced by ESL learner translators. Specifically, it analyzes patterns of textual cohesion in translations produced by ESL learners and by GenAI, as reflected in sense-aware, connective-based cohesion indices. The study addresses the following research questions:

1. To what extent do ESL learner translations and GenAI translations exhibit similarities and differences in their overall use of discourse and non-discourse connectives?

2. To what extent do ESL learner translations and GenAI translations exhibit similarities and differences in their use of specific categories of discourse connectives, namely comparison, contingency, expansion, and temporal relations?

The findings may offer empirical insights relevant to translation pedagogy, second language acquisition, and the use of GenAI in language education, particularly with regard to ESL learners' awareness and use of connectives.

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Methods

Design

This study adopts a corpus-based approach to compare textual cohesion in ESL learner translations and GenAI translations. To address the research questions comprehensively, it employs a mixed-methods design. The quantitative component involves the measurement of 34 sense-aware, connective-based cohesion indices, while the qualitative component examines selected excerpts to contextualize and interpret the quantitative findings. The study is conducted in three phases: corpus compilation, connective measurement, and data analysis (Figure 1).

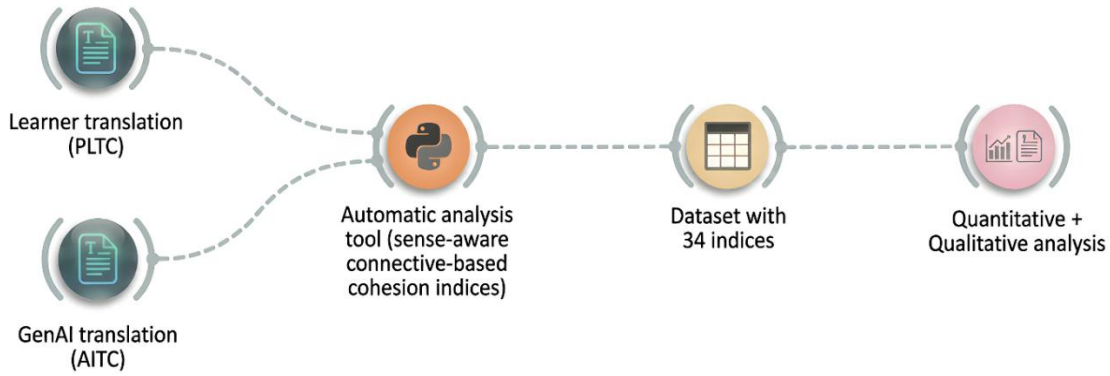

Figure 1. Study design and procedures

Corpus Compilation

This study draws on two corpora: the Parallel Learner Translation Corpus (PLTC), which consists of ESL learner translations from Chinese into English, and the GenAI Translation Corpus (AITC), which consists of GenAI translations from Chinese into English. Both corpora are multi-genre, comprising texts from academic writing, popular writing, reportage, instructional writing, persuasive writing, and creative writing. To ensure comparability, the corpora are matched in modality (written), size (85 texts of approximately 2,000 words each), genre distribution across the six text types, source language (Chinese), and target language (English). Descriptive details of the two corpora are provided in Table 1.

TABLE 1
Summary of the Corpora

Corpora	Nature	Genres	Texts	Tokens	Types	STTR
PLTC	ESL learner translations from Chinese to English without the use of GenAI	Academic writing, popular writing, reportage, instructional writing, persuasive writing, creative writing	85	202,503	15,255	41.44
AITC	GenAI translations from Chinese to English		85	192,775	14,915	42.55

Note. STTR (standardized type-token ratio) is calculated on the basis of 1,000 words.

The PLTC is a self-compiled corpus consisting of Chinese–English translations produced by student translators in Hong Kong. Specifically, it comprises L2 English translations completed by undergraduate translation majors ranging from sophomores to seniors. To ensure comparability, participant recruitment and screening targeted ESL learners with similar linguistic and educational backgrounds. Eligible

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participants primarily spoke Cantonese as their first or dominant language and received most of their education in Hong Kong. Prior to the translation task, participants were provided with a translation brief specifying the translation purpose, target audience, and genre. They were permitted to use any translation tools during the task. For the purposes of the present study, however, only translations produced without the assistance of GenAI tools were included, resulting in a total of 85 texts for analysis (see Kwok et al., 2023 for details on corpus compilation).

The AITC is another self-compiled corpus used in this study, consisting of Chinese–English translations generated by a GenAI model. Its construction involved three main stages: model selection, prompt design, and translation generation. The Generative Pre-trained Transformer series developed by OpenAI represents one of the most influential families of GenAI models. At the time this study was conducted, GPT-4o was the most recent publicly accessible model in the series and was therefore selected for the present research. Given its strong performance in both English and non-English languages, GPT-4o is well suited for translation tasks. For prompt design, zero-shot prompting was adopted in order to elicit the model's inherent translation behaviour without additional training. The user prompt specified the translation purpose, target audience, genre, and source text, mirroring the translation brief provided to student translators in the PLTC and thereby ensuring comparability between the two corpora. These instructions are consistent with prompt-engineering recommendations proposed by Peng et al. (2023) and Yamada (2023). In addition, a role definition was incorporated into the system prompt in line with these recommendations. Using this prompt configuration, the model generated translations from the same Chinese source texts as those included in the PLTC.

Measures of Connectives

This study compares ESL learner translations and GenAI translations in terms of textual cohesion, with a particular focus on connective use. It adopts 34 sense-aware, connective-based cohesion indices developed by Lu and Hu (2024) (Table 2). These indices distinguish discourse uses of connectives from non-discourse uses. Discourse connectives are explicit linguistic markers that signal relationships between discourse segments and encode different discourse-relation senses, whereas non-discourse connectives resemble connectives in form but do not function to establish discourse relations in a given context. Discourse connectives are further classified into four discourse-relation categories: comparison, contingency, expansion, and temporal. Comparison connectives mark contrastive or comparative relations; contingency connectives indicate causal or conditional relations; expansion connectives signal elaboration or addition of information; and temporal connectives express temporal sequencing or time reference. For each category, the indices capture four aspects of connective use: connective density, connective diversity, connective ratio, and type frequency counts. Density and ratio indices are calculated at both the token and type levels. In this study, the 34 sense-aware, connective-based indices were computed for each text using an automated analysis tool developed by Lu and Hu (2024).

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TABLE 2
Sense-Aware Connective-Based Indices (Lu & Hu, 2024)

Categories	Indices	Examples
Non-discourse connectives	Non-DC_token_density	She travelled to Hong Kong and Macau.
	Non-DC_token_ratio	
	Non-DC_ttr	
	Non-DC_type_density	
	Non-DC_type_ratio	
	Non-DC_type_num	
Discourse connectives	DC_token_density	Refer to the examples below
	DC_ttr	
	DC_type_density	
	DC_type_num	
Comparison discourse connectives	Comparison_token_density	She wanted to go to Hong Kong, but her sister wanted to stay in their hometown.
	Comparison_token_ratio	
	Comparison_ttr	
	Comparison_type_density	
	Comparison_type_ratio	
	Comparison_type_num	
Contingency discourse connectives	Contingency_token_density	She went to Hong Kong because she got a job offer there.
	Contingency_token_ratio	
	Contingency_ttr	
	Contingency_type_density	
	Contingency_type_ratio	
	Contingency_type_num	
Expansion discourse connectives	Expansion_token_density	She went to Hong Kong in 2000, and she has obtained permanent residency there.
	Expansion_token_ratio	
	Expansion_ttr	
	Expansion_type_density	
	Expansion_type_ratio	
	Expansion_type_num	
Temporal discourse connectives	Temporal_token_density	She has lived in Hong Kong since she went there in 2000.
	Temporal_token_ratio	
	Temporal_ttr	
	Temporal_type_density	
	Temporal_type_ratio	
	Temporal_type_num	

Note. For each category:

(1) token density is calculated as the number of connective tokens in that category divided by the total number of word tokens;
(2) token ratio refers to the proportion of connective tokens in that category relative to all connective tokens;
(3) TTR (type-token ratio) is defined as the ratio of connective types in that category to the connective tokens of the same category;
(4) type density is calculated as the number of connective types in that category divided by the total number of word types;
(5) type ratio represents the proportion of connective types in that category relative to all connective types; and
(6) type num (type number) denotes the total number of connective types in that category.

Data Analysis

This study employed a mixed-methods design integrating quantitative and qualitative analyses. In the quantitative phase, data normality was assessed prior to inferential analysis. As the data did not meet the

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assumption of normality, non-parametric tests were applied. Because the PLTC, representing ESL learner translations, and the AITC, representing GenAI translations, were generated from the same source texts, the two corpora were treated as paired datasets. Accordingly, Wilcoxon signed-rank tests were used for corpus comparison, with the alpha level set at .05. In the qualitative phase, representative excerpts from the PLTC and AITC were selected for close analysis to illustrate differences in the use of discourse connectives between the two corpora. Although sense-aware, connective-based indices are not directly observable at the level of individual excerpts, the qualitative analysis serves to exemplify the tendencies and patterns identified in the quantitative results, thereby contextualizing and complementing the statistical findings.

Results

Overall Use of Non-Discourse and Discourse Connectives

Table 3 summarizes descriptive statistics for the 10 sense-aware connective-based indices measuring overall connective use in ESL learner translations and GenAI translations. To address RQ1, we examined whether significant differences exist between the two corpora in terms of overall use of non-discourse and discourse connectives. The results of these comparisons are reported in Table 4.

TABLE 3
Median Values of Indices for Overall Use of Non-Discourse and Discourse Connectives

Indices	PLTC (n = 85) Mdn	AITC (n = 85) Mdn
Non-discourse connectives		
Non-DC_token_density	0.047	0.047
Non-DC_token_ratio	0.686	0.674
Non-DC_ttr	0.138	0.142
Non-DC_type_density	0.015	0.015
Non-DC_type_ratio	0.469	0.469
Non-DC_type_num	16.000	15.000
Discourse connectives		
DC_token_density	0.022	0.022
DC_ttr	0.351	0.359
DC_type_density	0.017	0.017
DC_type_num	18.000	17.000

TABLE 4
Differences in Overall Use of Non-Discourse and Discourse Connectives Between the Two Corpora

Indices	PLTC (n = 85)	AITC (n = 85)			
	Mean rank	Mean rank	*V*	*p*	*r*
Non-discourse connectives					
Non-DC_token_density	85.694	85.306	2040	> .05	.101
Non-DC_token_ratio	86.882	84.118	2126	> .05	.165
Non-DC_ttr	84.276	86.724	1744	> .05	.040
Non-DC_type_density	88.947	82.053	2289	.043	.219
Non-DC_type_ratio	88.000	83.000	1999	> .05	.179
Non-DC_type_num	90.641	80.359	1585	.002	.340
Discourse connectives					
DC_token_density	83.612	87.388	1507	> .05	.152
DC_ttr	83.171	87.829	1540	> .05	.117
DC_type_density	84.900	86.100	1733	> .05	.045
DC_type_num	86.253	84.747	1456	> .05	.081

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PLTC and AITC show similar patterns of non-discourse connective use across most indices (Table 4, Figure 2), with significant differences observed for only two measures. PLTC (mean rank = 88.947) exhibits higher type density than AITC (mean rank = 82.053; $V = 2289$, $p = .043$, $r = .219$). A stronger difference is found in type number ($V = 1585$, $p = .002$, $r = .340$), with PLTC (Mean rank = 90.641) containing a greater variety of non-discourse connective types than AITC (Mean rank = 80.359). These results suggest that overall non-discourse connective use is generally similar between the two corpora, with ESL learner translations showing a slightly higher density and a greater range of non-discourse connective types.

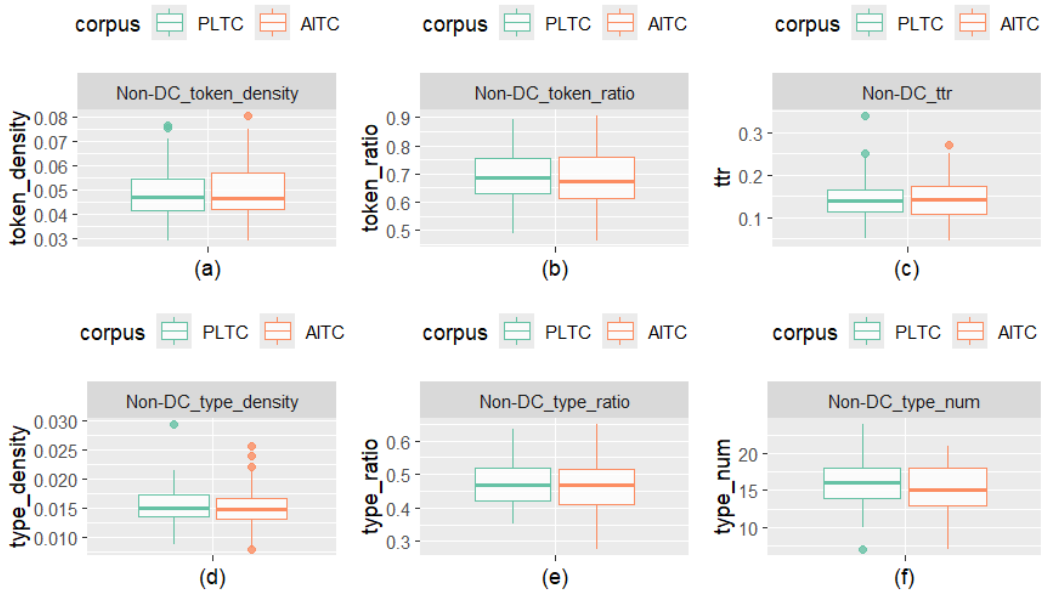

Figure 2. Non-discourse connective index scores across the two corpora: (a) token density; (b) token ratio; (c) type-token ratio; (d) type density; (e) type ratio; (f) type number.

The two corpora display similar patterns in overall discourse connective use, with no statistically significant differences across any indices (Table 4, Figure 3). All *p*-values exceed the .05 threshold, and effect sizes remain small ($r < .20$).

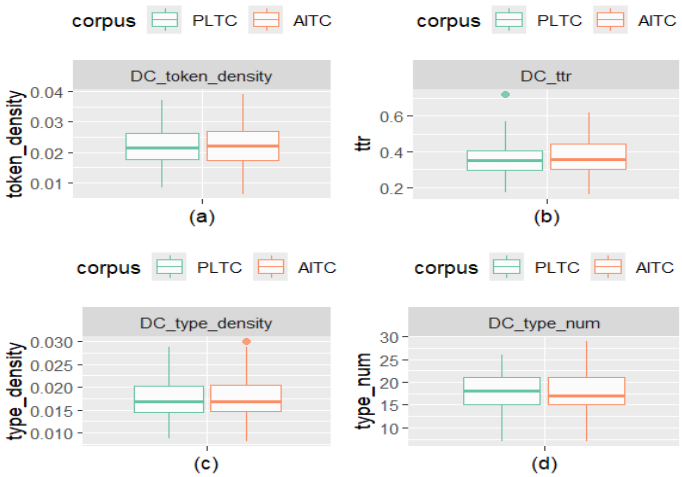

Figure 3. Overall discourse connective index scores across the two corpora: (a) token density; (b) type-token ratio; (c) type density; (d) type number

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Taken together, the two corpora exhibit largely comparable patterns of overall connective use. Where differences do emerge, they are confined to non-discourse connectives, with ESL learner translations displaying a wider range of non-discourse connective types than GenAI translations. By contrast, discourse connective use remains consistent across the two corpora.

The Use of Specific Categories of Discourse Connectives

Table 5 presents descriptive statistics for the 24 sense-aware, connective-based indices that measure category-specific discourse connective use in ESL learner translations and GenAI translations. To address RQ2, we further examined whether the two corpora differ significantly in their use of connectives expressing the four discourse-relation senses: comparison, contingency, expansion, and temporal. The results of these comparisons are reported in Table 6 and discussed in detail below.

TABLE 5
Median Values of Indices for Specific Categories of Discourse Connectives

Indices	PLTC (*n* = 85)	AITC (*n* = 85)
	Mdn	Mdn
Comparison discourse connectives		
Comparison_token_density	0.005	0.005
Comparison_token_ratio	0.073	0.079
Comparison_ttr	0.333	0.313
Comparison_type_density	0.004	0.004
Comparison_type_ratio	0.121	0.125
Comparison_type_num	4.000	4.000
Contingency discourse connectives		
Contingency_token_density	0.004	0.004
Contingency_token_ratio	0.058	0.056
Contingency_ttr	0.417	0.444
Contingency_type_density	0.004	0.003
Contingency_type_ratio	0.118	0.103
Contingency_type_num	4.000	3.000
Expansion discourse connectives		
Expansion_token_density	0.007	0.007
Expansion_token_ratio	0.098	0.098
Expansion_ttr	0.308	0.353
Expansion_type_density	0.005	0.005
Expansion_type_ratio	0.148	0.167
Expansion_type_num	5.000	5.000
Temporal discourse connectives		
Temporal_token_density	0.004	0.004
Temporal_token_ratio	0.064	0.064
Temporal_ttr	0.385	0.444
Temporal_type_density	0.004	0.004
Temporal_type_ratio	0.135	0.133
Temporal_type_num	4.000	4.000

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TABLE 6
Differences in the Use of Specific Categories of Discourse Connectives between the Two Corpora

Indices	PLTC (n = 85)	AITC (n = 85)			
	Mean rank	Mean rank	V	p	r
Comparison discourse connectives					
Comparison_token_density	81.282	89.718	1291	.028	.241
Comparison_token_ratio	82.282	88.718	1174	.015	.266
Comparison_ttr	85.453	85.547	1362	> .05	.017
Comparison_type_density	84.459	86.541	1604	> .05	.090
Comparison_type_ratio	83.329	87.671	1499	> .05	.062
Comparison_type_num	85.665	85.335	685	> .05	.041
Contingency discourse connectives					
Contingency_token_density	88.300	82.700	2371	.017	.258
Contingency_token_ratio	88.512	82.488	2372	.017	.259
Contingency_ttr	85.400	85.600	1537	> .05	.048
Contingency_type_density	94.329	76.671	2661	< .001	.396
Contingency_type_ratio	94.753	76.247	2605	< .001	.452
Contingency_type_num	95.176	75.824	1391	< .001	.501
Expansion discourse connectives					
Expansion_token_density	81.212	89.788	1388	> .05	.209
Expansion_token_ratio	82.118	88.882	1285	.026	.242
Expansion_ttr	79.659	91.341	1204	> .05	.183
Expansion_type_density	80.600	90.400	889	< .001	.446
Expansion_type_ratio	77.647	93.353	725	< .001	.454
Expansion_type_num	81.276	89.724	417	.006	.297
Temporal discourse connectives					
Temporal_token_density	84.306	86.694	1765	> .05	.030
Temporal_token_ratio	84.953	86.047	1776	> .05	.025
Temporal_ttr	81.665	89.335	1012	.043	.221
Temporal_type_density	83.282	87.718	1547	> .05	.133
Temporal_type_ratio	83.106	87.894	1364	> .05	.094
Temporal_type_num	84.653	86.347	637	> .05	.013

In terms of comparison discourse connectives, only token-level indices yield significant differences (Table 6, Figure 4). Specifically, AITC is found to have higher token density (V = 1291, p = .028, r = .241) and token ratio (V = 1174, p = .015, r = .266) than PLTC. These results indicate that GenAI translations use comparison connectives at higher rates both relative to overall text length and relative to total connective use, suggesting a greater reliance on contrastive or comparative discourse relations.

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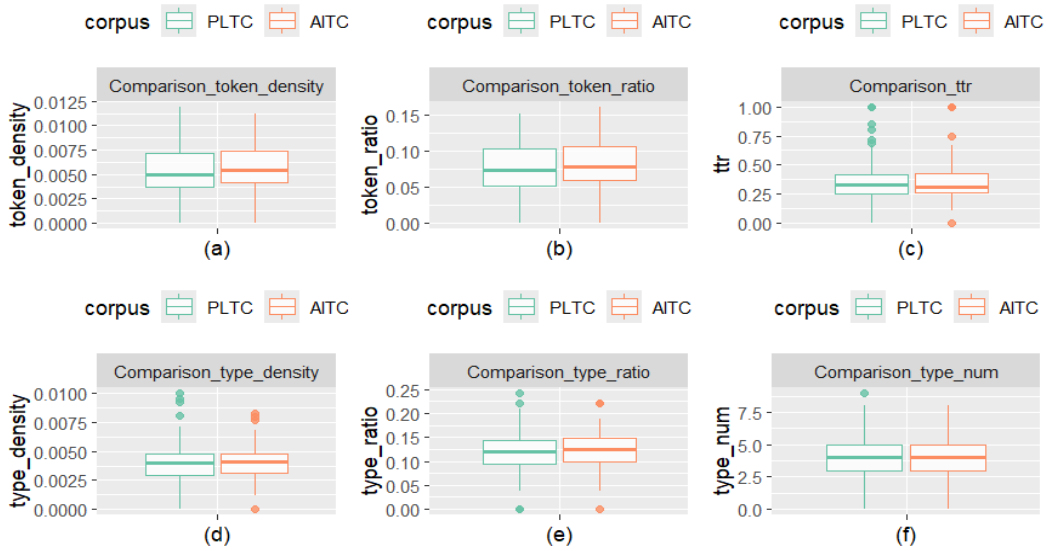

Figure 4. Comparison discourse connective index scores across the two corpora: (a) token density; (b) token ratio; (c) type-token ratio; (d) type density; (e) type ratio; (f) type number

Excerpt 1 [w2a-026] (Academic writing – natural sciences)

(1) ST: 亞洲國家沒有相應的估計數字，由於視網膜病變的潛伏期較長，健康宣傳活動不足以及資源和服務匱乏，可以想像到亞洲國家的篩查率會更低。

(1a) PLTC: Corresponding estimates are not available for Asian countries, where screening rates could conceivably be even lower due to the longer latency period of retinopathy, the lack of health promotion activities, and the scarcity of resources and services.

(1b) AITC: There are no corresponding estimates for Asian countries, **but** given the long latency period of retinopathy, the lack of health promotion activities, and the scarcity of resources and services, it is conceivable that screening rates in Asian countries are even lower.

Excerpt 1b illustrates a case in which GenAI inserts an additional comparison discourse connective, *but*, to explicitly mark the contrast between the absence of available estimates in the first clause and the inferential statement in the second clause. By contrast, the ESL learner translation adheres more closely to the discourse relation encoded in the Chinese source text and does not employ an explicit contrastive marker (Excerpt 1a). This example suggests that GenAI is more inclined to interpret the broader discourse context contrastively and to render implicit contrastive relations explicit through the insertion of comparison connectives. ESL learner translators, in comparison, appear to prioritize faithfulness to the source text in their treatment of discourse relations.

More noticeable differences appear in the contingency discourse connectives (Table 6, Figure 5). AITC consistently scores lower than PLTC across all indices, with 5 of 6 indices achieving statistical significance. Significant results are found for token density ($V = 2371$, $p = .017$, $r = .258$) and token ratio ($V = 2372$, $p = .017$, $r = .259$), with stronger effects observed in type-level indices, including type density ($V = 2661$, $p < .001$, $r = .396$), type ratio ($V = 2605$, $p < .001$, $r = .452$), and type number ($V = 1391$, $p < .001$, $r = .501$). These findings show that, compared with ESL learner translations, GenAI translations employ contingency connectives less frequently, allocate a smaller proportion of their connective use to this category, and draw on a narrower variety of contingency connective types. These patterns point to a reduced tendency to explicitly mark causal and conditional relationships in GenAI translations.

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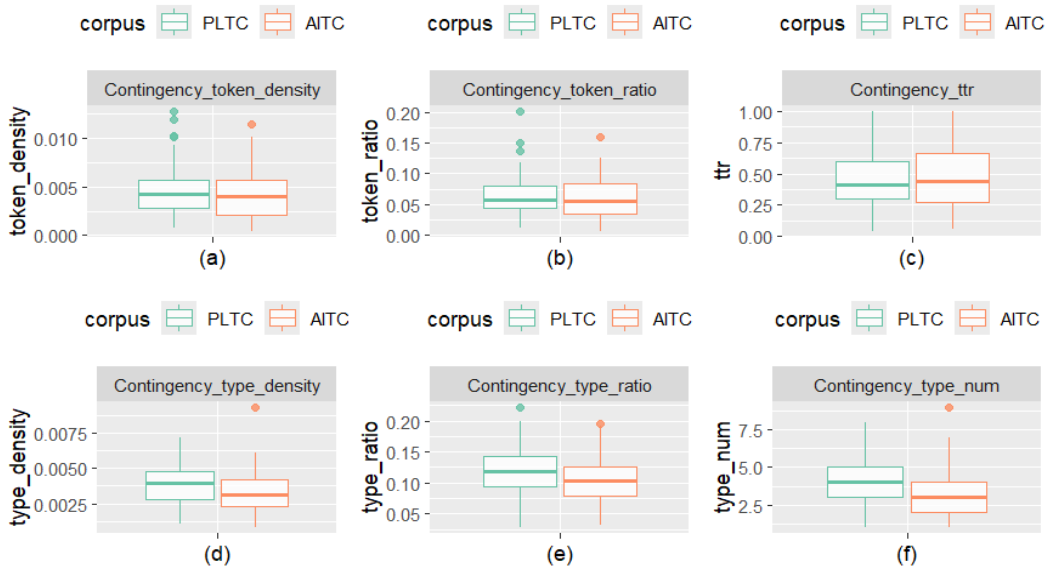

Figure 5. Contingency discourse connective index scores across the two corpora: (a) token density; (b) token ratio; (c) type-token ratio; (d) type density; (e) type ratio; (f) type number

> Excerpt 2 [w2b-035] (Popular writing – technology)
> (2) ST: 例如，二級互聯網服務供應商通過增加新用戶而不增加頻寬來降低成本，**因此**瀏覽海外網站的回應時間會變慢。
> (2a) PLTC: For example, Tier 2 ISPs are cutting costs by adding new subscribers without increasing bandwidth, and **as a result**, response times for browsing overseas sites are slower.
> (2b) AITC: For example, second-tier internet service providers reduce costs by adding new users without increasing bandwidth, slowing response times for browsing overseas websites.

Excerpt 2b illustrates a case in which GenAI omits the contingency connective "因此" in the source text and instead conveys the causal relation implicitly through a non-finite participial construction. By contrast, the ESL learner translation explicitly marks the causal relation between the reasoning in the first clause and the resulting outcome in the second clause by using the contingency connective *as a result* (Excerpt 2a), thereby closely reproducing the discourse relation encoded in the Chinese source text. Notably, the addition of *and* serves to link the two clauses grammatically and, in combination with *as a result*, reinforces the explicit marking of causality. This example further suggests that ESL learner translators tend to place greater emphasis on the faithful rendering of discourse relations, whereas GenAI appears more inclined to encode contingency relations implicitly, often through participial constructions rather than overt connective markers.

Expansion discourse connectives also reveal notable discrepancies between the two corpora, with a pattern opposite to that of contingency connectives (Table 6, Figure 6). AITC reports higher mean ranks than PLTC across all indices, with 4 of 6 indices reaching statistical significance. Significant results are observed for token ratio ($V = 1285$, $p = .026$, $r = .242$) and all type-level indices, including type density ($V = 889$, $p < .001$, $r = .446$), type ratio ($V = 725$, $p < .001$, $r = .454$), and type number ($V = 417$, $p = .006$, $r = .297$). These results suggest that, compared with ESL learner translations, GenAI translations allocate a larger proportion of their overall connective use to expansion connectives and employ a broader range of expansion connective types. These patterns indicate a stronger emphasis on expressing additive, elaborative, and clarificatory relations in GenAI translations.

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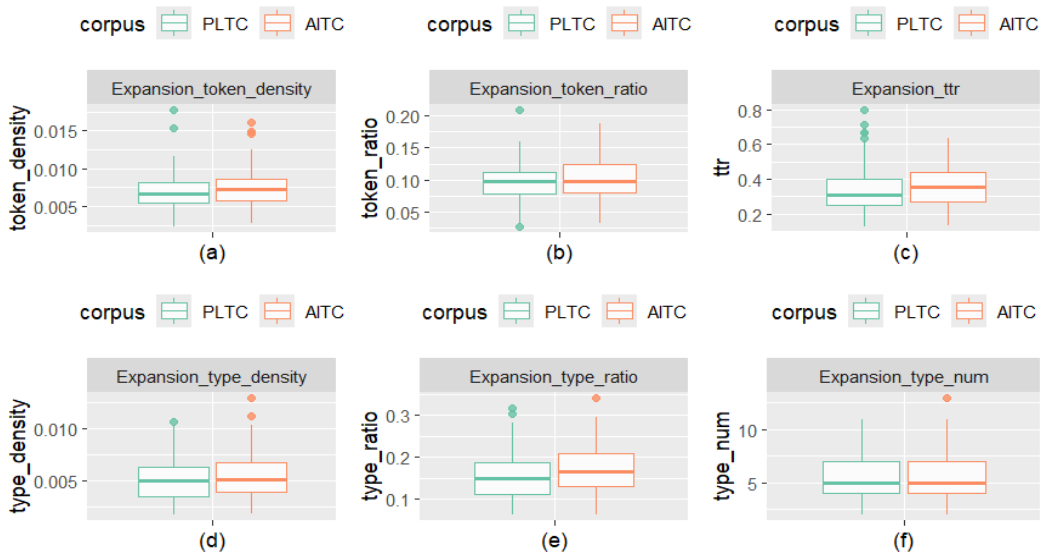

Figure 6. Expansion discourse connective index scores across the two corpora: (a) token density; (b) token ratio; (c) type-token ratio; (d) type density; (e) type ratio; (f) type number

Excerpt 3 [w2c-014] (Reportage – press news reports)
(3) ST: 我們承認入住率有點低。但這家旅舍才開業兩個月，也許有些住籠屋的人還沒聽說過。
(3a) PLTC: We admit that the occupancy rate is a bit low. But this hostel has only been open for two months, **so** maybe some of the cage dwellers haven't heard of it yet.
(3b) AITC: We acknowledge the occupancy rate is a bit low. But the hostel has only been open for two months, **and** perhaps some cage home residents haven't heard about it yet.

Excerpt 3 illustrates a case in which an implicit discourse relation in the Chinese source text is realized differently by the ESL learner translator and GenAI. The source text does not contain an explicit connective signaling the relationship between the hostel's short operating period in the first clause and the possible lack of public awareness in the second clause. Such implicit expression of discourse relations is common and acceptable in Chinese. The ESL learner translator interprets this relation as one of contingency and inserts the connective *so* to explicitly mark the causal link (Excerpt 3a), whereas GenAI opts for the expansion connective *and*, maintaining a neutral coordination without imposing causality (Excerpt 3b). This example suggests that both translations make explicit discourse relations that are implicit in the source text in response to structural differences between Chinese and English. However, GenAI appears to avoid overtly encoding contingency relations and instead favors expansion connectives that coordinate information.

The two corpora present broadly comparable patterns in temporal connective use (Table 6, Figure 7). The only exception is that AITC (mean rank = 89.335) exhibits higher TTR than PLTC (mean rank = 81.665; $V = 1012$, $p = .043$, $r = .221$), reflecting greater connective diversity within this category. All other indices yield non-significant results. This overall similarity indicates that both ESL learner translations and GenAI translations use temporal connectives in similar ways to convey chronological sequencing and time-related relationships.

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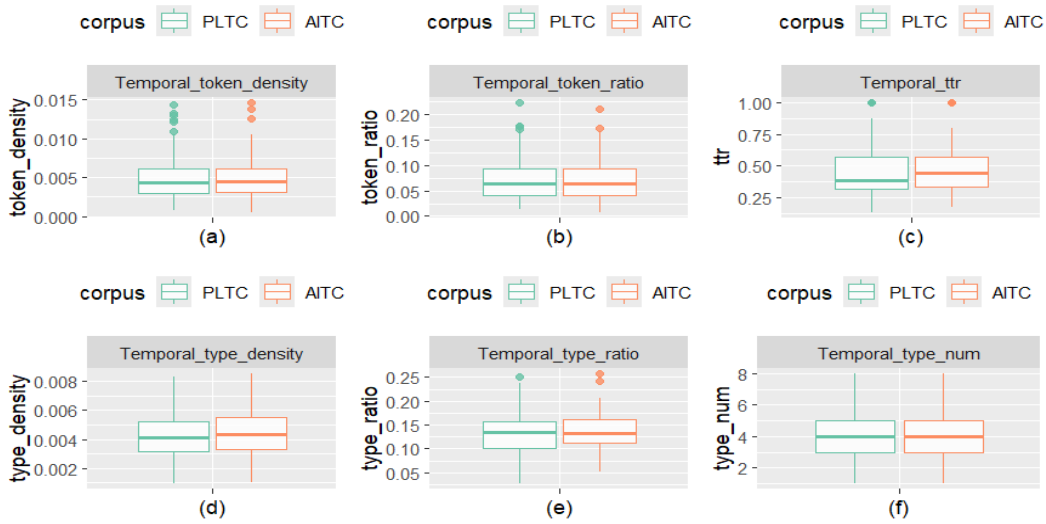

Figure 7. Temporal discourse connective index scores across the two corpora: (a) token density; (b) token ratio; (c) type-token ratio; (d) type density; (e) type ratio; (f) type number

Overall, the results show that the two corpora differ significantly in their use of comparison, contingency, and expansion discourse connectives, while exhibiting largely similar patterns of temporal connective use. GenAI translations favor comparison and expansion connectives, as reflected in their greater proportional allocation to these categories and their use of a wider range of expansion connective types. By contrast, GenAI translations rely less on contingency connectives, as indicated by lower frequency, proportion, and variety. The qualitative analysis of three representative excerpts corroborates these quantitative findings. GenAI tends to explicate implicit contrastive relations through the insertion of comparison connectives, to encode contingency relations implicitly via non-finite participial constructions, and to favor expansion over contingency connectives when translating implicit causal relations. In contrast, ESL learner translations more consistently prioritize faithfulness in rendering discourse relations, with occasional explicitations of implicit relations primarily motivated by typological differences between Chinese and English.

Discussion

This study compares textual cohesion in ESL learner translations and GenAI translations using sense-aware, connective-based indices. The results show that the two corpora exhibit similar patterns of non-discourse connective use, with the exception that ESL learner translations contain a wider range of non-discourse connective types than GenAI translations. While overall discourse connective use is comparable across the two corpora, differences emerge at the level of specific discourse-relation categories. In particular, GenAI translations display a preference for comparison and expansion connectives and a reduced reliance on contingency connectives, whereas ESL learner translations tend to preserve source-text discourse relations more closely. Because both corpora are translations of the same source texts, similarity in overall discourse connective use is expected. The observed differences in category-specific connective use are therefore likely attributable to fundamental differences in how learner translators and GenAI perform translation. This section interprets these differences by situating the findings within related literature and by considering three perspectives: GenAI architecture, learner translator behavior, and ESL/EFL pedagogy. Implications for the use of GenAI in translation and language education are also discussed.

Although the present study does not include a native English reference corpus and thus cannot directly benchmark the translations against native connective use, previous research offers a useful point of comparison. Prior studies have shown that both human translators and ESL/EFL learners tend to favor

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comparison and expansion connectives (Cheng & Tsang, 2022; Kajzer-Wietrzny, 2022; Leedham & Cai, 2013). The present findings further indicate that GenAI translations exhibit even higher token density and token ratios for comparison connectives, as well as higher token ratios, and type frequencies, density, and ratios for expansion connectives, than ESL learner translations. Together, these results suggest that GenAI output amplifies the use of comparison and expansion connectives.

The overuse of comparison connectives and the reduced use of contingency connectives in GenAI translations are often accompanied by discourse restructuring. Consistent with previous GenAI-related research, several recurring structuring tendencies can be observed. For example, GenAI translations show reduced reliance on contingency connectives and, in some cases, use expansion connectives to convey causal relations, as illustrated in Excerpt 3. Similar patterns have been reported in ChatGPT-generated writing, where contingency connectives are underused and the coordinator *and* is overused to link causal clauses (Zhou et al., 2023). In addition, GenAI outputs tend to employ participial phrases as substitutes for other syntactic constructions. In the present study, GenAI replaces a contingency connective in the source text with a participial structure, as shown in Excerpt 2. Likewise, Kwok et al. (2025) found that GPT-edited translations frequently use participial phrases in place of dependent-clause structures. These patterns suggest that GenAI translations favor particular connective choices and syntactic realizations across tasks. Such tendencies may increase reliance on expansion connectives while diminishing the use of contingency connectives, leading to discourse patterns that are less balanced or context-sensitive.

The recurrence of similar patterns across tasks suggests that these tendencies are more likely attributable to the underlying architecture of GenAI systems than to task-specific factors. Built on large language models, GenAI systems are trained on massive text corpora to learn statistical regularities and contextual cues of language use (Brown et al., 2020; Haleem et al., 2022). Text generation proceeds through iterative next-token prediction, whereby the model selects the most probable continuation given the preceding context (Siu, 2024). Within this probabilistic framework, high-frequency syntactic continuations are often favored over less frequent alternatives. As a result, GenAI architecture may bias connective use and encourage the replacement of explicit contingency markers with implicit syntactic structures when such patterns constitute more probable word sequences.

In contrast, learner translators exhibit a different set of discourse-structuring behaviors. The present study shows that ESL learner translations tend to render discourse relations more faithfully, corroborating previous findings that learner translators often mirror the cohesive devices of the source text (Castagnoli, 2016). From this perspective, connective use in learner translations may reflect source-language influence. Translation is a cognitively demanding process involving bilingual activation (Grosjean, 2013), source-text comprehension, and sensitivity to target-language norms. ESL learner translators, who are still developing translation competence, may find it difficult to balance faithfulness to the source text with acceptability in the target culture. The interaction of cognitive demands, linguistic constraints, and communicative expectations thus shapes learners' decision-making processes, often leading them to adopt risk-minimization strategies (Pym, 2015) through close adherence to source-text structures.

ESL/EFL pedagogy may also shape learner translation products. In the present study, translations were produced by Hong Kong student translators working from their native Chinese into L2 English. Although this translation direction facilitates source-text comprehension (Campbell, 1998), it also poses challenges for non-native English production (Samuelsson-Brown, 2010). Learners' English proficiency, together with the ESL pedagogy they have received, may therefore influence their metalinguistic awareness of English connectives and their handling of discourse relations. As Cheng and Tsang (2022) note, instructional materials and teaching practices in English education play a crucial role in shaping learners' connective use. In particular, ESL instruction often presents connectives as decontextualized lists, with limited attention to semantic distinctions and contextual appropriateness (Cheng & Tsang, 2022). Textbook exercises likewise tend to require learners to link isolated sentences using connectives, rather than to select connectives in extended discourse contexts (Kwan, 2017). Such instructional practices may encourage ESL learner translators to prioritize word-for-word connective translation as a low-risk strategy, which may help explain the strong source-text orientation and faithful rendering of discourse connectives observed in this study.

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Viewed through the combined lenses of GenAI architecture, learner translator behavior, and ESL/EFL pedagogy, both GenAI and learner translators appear to face constraints in their handling of discourse relations through connectives. While GenAI may deviate from more balanced or context-sensitive discourse patterns, learner translators remain strongly influenced by source-text structures. These findings point to the need for a more critical pedagogical framing, from which several pedagogical implications can be drawn.

First, learner translators' tendency to adopt word-for-word connective translation indicates a need for more context-sensitive training that familiarizes students with stylistic conventions for connective use in English in both ESL and translation education. As Castagnoli (2016) argues, the appropriate translation of connective patterns is a component of translators' pragmalinguistic competence and therefore requires targeted instruction. In ESL instruction, this implies moving beyond decontextualized lists and mechanical exercises toward an emphasis on contextual appropriateness of connective use. Classroom tasks can be designed to sharpen learners' discrimination between discourse and non-discourse uses of connective-like forms and to raise awareness of contrasts in the intended meanings and functions of different connectives in different contexts. In translation education, learners need to develop the competence to make informed decisions about connective rendering, whether to retain, add, or omit a connective, with reference to the immediate context, so that the target text realizes the appropriate relation while aligning with target-language conventions. To support such context-sensitive training, data-driven learning using corpora can provide learners with authentic, contextualized examples of connective use. By examining concordance lines or bilingual aligned sentences, learners can explore how particular connective forms are used to realize different discourse relations across text types and can identify patterns in connective choice.

Second, the growing use of GenAI calls for attention to learners' abilities, which includes not only pragmalinguistic proficiency but also the ability to critically evaluate GenAI's handling of discourse connectives. Although prior research has highlighted the pedagogical potential of GenAI in language learning contexts (Guo & Wang, 2024; Guo et al., 2022), the present findings reveal limitations in GenAI's use of discourse connectives. Specifically, the GenAI tendency to favor comparison and expansion connectives while under-realizing contingency relations may pose a risk when learners rely heavily on GenAI without careful post-editing, as the texts may undergo subtle shifts in discoursal meaning. Learners therefore need to develop critical awareness of these tendencies and to handle GenAI output with caution. To mitigate limitations in GenAI outputs, recent work in ESL education has sought to integrate GenAI with corpus querying (Cheung & Crosthwaite, 2025; Zhu et al., 2025). This integration enables learners to compare GenAI-generated connective use with the patterns in authentic corpus data, strengthening their ability to evaluate discourse function and contextual fit. It also allows them to triangulate GenAI suggestions against corpus evidence. Such an approach may support more reliable language learning and more informed connective choices during drafting and post-editing.

Conclusion

This study contributes to ongoing discussions on the use of GenAI in translation by foregrounding how discourse relations are realized through connectives in learner and machine-generated translations. By adopting sense-aware connective-based indices, it demonstrates the value of moving beyond surface-level frequency measures toward more functionally informed analyses of cohesion. The findings point to several directions for future research. Incorporating native English reference corpora would allow for more robust benchmarking against target-language norms. Further work should also examine GenAI use in more authentic, interactive translation scenarios, where iterative prompting and revision play a central role. In addition, more fine-grained analyses at the level of individual connectives could yield deeper insights into preference patterns and pragmatic appropriateness across translation types. More broadly, the study underscores the need for continued critical engagement with GenAI in translation and language education. As GenAI becomes increasingly integrated into learning and professional practice, attention to discourse-

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level features such as cohesion will be essential for ensuring not only fluent but also contextually appropriate and pragmatically effective translation output.

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