An Analysis of Cohesive Reference in English Scientific Texts Translated into Arabic

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Abstract

This study examined the similarities and differences in the frequency and use of cohesive reference in English scientific abstracts and their Arabic translations. A quantitative method was employed by developing and applying a checklist based on Halliday and Hasan's (1976) model for evaluating cohesive reference: (personal pronoun, demonstrative reference and comparative reference). A corpus of 31 English research abstracts with their Arabic translations was selected from three academic journals. The findings revealed a higher frequency of references in English (421) than Arabic (332), which was attributed to the application of reduction and compensation strategies in translation, thereby decreasing the number of cohesive devices in Arabic. Nevertheless, both languages followed a similar frequency order of cohesive devices: demonstrative references were the most prevalent (339 and 259 in English and Arabic respectively), reflecting the clarity, transparency, and precision of scientific texts. Personal pronouns and comparative references ranked second and third, respectively. The study underscored the necessity for translators and student-translators to develop an in-depth understanding of cohesion, particularly cohesive reference, in English and Arabic. It further recommended the inclusion of cohesion-focused content in translation curricula to equip student-translators with the knowledge and skills to select and apply appropriate strategies for specific contexts.

Keywords: cohesion, cohesive reference, anaphoric, cataphoric, exophoric.

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ترجمة الإحالة النصية في النصوص العلمية من اللغة الإنجليزية إلى اللغة العربية (دراسة تحليلية)

الملخص

هدفت هذه الدراسة إلى التعرف على أوجه التشابه والاختلاف في استخدام الإحالة النصية وتكرارها في النصوص العلمية الإنجليزية وترجماتها إلى العربية. وتم استخدام المنهج الكمي من خلال تطوير وتطبيق قائمة مراجعة لتقييم الإحالة النصية (الضمائر وأسماء الإشارة والأسماء الموصولة و "أل" التعريف وصيغ المقارنة) تعتمد على نموذج هاليداي وحسن (1976). وقد تم اختيار 31 ملخصًا بحثيًا من ثلاث مجلات أكاديمية علمية بالإنجليزية وترجماتها إلى العربية. وقد أظهرت النتائج أن الإحالة النصية بأنواعها الثلاثة في الإنجليزية أعلى بكثير منها في العربية،421،332 على التوالي، وقد يُعزى ذلك إلى استراتيجيتي الحذف والتعويض المستخدمة أثناء الترجمة إلى العربية؛ حيث إن هذه الاستراتيجيات حدت من عدد الإحالات النصية في العربية، غير أن أنواع الإحالة الثلاث جاءت في ترتيب متقارب؛ حيث سجلت الإحالة بأسماء الإشارة والأسماء الموصولة و "أل" التعريف أعلى نسبة في اللغتين (259 و339 في الإنجليزية والعربية على التوالي) وهو ما يميز النصوص العلمية التي تتصف بالوضوح والشفافية والدقة. وسجلت الضمائر وصيغ المقارنة الدرجة الثانية والثالثة على التوالي. وأوصت الدراسة بأن يكون المترجمون وطلاب الترجمة على دراية كاملة بالتماسك النصي بشكل عام والإحالة النصية بشكل خاص في العربية والإنجليزية، كما أوصت الدراسة بضرورة تضمين التماسك النصي في مناهج الترجمة لإكساب الطلبة المعارف والمهارات لاختيار وتطبيق استراتيجيات الترجمة المناسبة بحسب السياق.

الكلمات المفتاحية: التماسك النصي، الإحالة النصية، الإحالة القبلية، الإحالة البعدية، الإحالة المقامية.

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Introduction

Translation and discourse analysis are interconnected, both focusing on meaning. Translation transfers text between languages while preserving meaning and bridging cultural gaps (Laia, 2024). Its complexity depends on linguistic features and functions. Discourse analysis examines logical connections within a text for cohesion (Neisi & Gorjian, 2017). Halliday and Hasan (1976) define cohesion as the relationship between elements ensuring comprehensibility.

Newmark (1987) highlights cohesion as an essential aspect of discourse analysis for translation, emphasizing its role in creating clear, unified texts across languages. Researchers such as Plakans and Bilki (2016) and Bahaziq (2016) have explored cohesion in discourse analysis, while others, including Alhinnawi and Al-Zughoul (2019) and Ashuja`a and Saeed (2018), have applied it to translation studies.

This study examines the translation of cohesive references in scientific research abstracts from English into Arabic, focusing on texts from journals such as the Journal of King Saud University, the Eastern Mediterranean Health Journal and Yemeni Journal of Medical and Health Research. Grounded in Halliday and Hasan`s (1976) cohesion theory, it offers a solid framework for comparing cohesive devices in both Arabic and English.

Cohesion in English

Halliday and Hasan (1976) classify cohesion into grammatical and lexical cohesion. Baker (2018) defines cohesion as the network of lexical and grammatical ties that connect parts of a text. Halliday's approach includes features, such as pronouns and articles that link discourse elements (Crystal, 2008; Lyons, 1968). Halliday and Hasan (1976) identify reference as a key cohesive device linking text elements. They categorize it into endophoric and exophoric, with endophoric crucial for cohesion. Additionally, Halliday and Hasan (1976) further categorize reference into personal, demonstrative, and comparative. Personal reference identifies entities; demonstratives indicate proximity; and comparative reference expresses identity or similarity through adjectives and adverbs. Carroll (2008) highlights pronouns as reference tools, while Dickins et al. (2017) link reference to anaphora. Scollon (2001) observes that reference appears in nearly every sentence for cohesion.

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Cohesive Reference in Arabic

Since Arabic and English belong to different language families, their cohesive systems vary significantly, making direct comparison challenging. However, Halliday and Hasan's (1976) classification of cohesive reference remains relevant, as this study focuses on English scientific abstracts translated into Arabic.

Al-Jabr (1987) categorizes Arabic cohesion similarly, including reference, substitution, ellipsis, conjunction, and lexical cohesion, though Arabic also relies on features, such as parallelism. Reference, divided into personal, demonstrative, and comparative types, functions differently in Arabic. Personal pronouns serve subject, object, and possessive roles, with object and possessive forms as suffixes (Ryding, 2005). Demonstrative pronouns indicate proximity, classified into near and far (Holes, 2004). Comparative reference, involving general and particular comparison, similarly applies in both languages. Therefore, this study focuses on the translation of cohesive reference from English into Arabic.

Previous Studies on investigating Cohesive Devices in Translation

Translation is a complex process which is sometimes beset with challenges in achieving the intended meaning, particularly when translating cohesive reference in scientific texts between English and Arabic. Various studies have investigated cohesive devices in translation between Arabic and English (e.g., Chaalal, 2017; Huneety et al, 2017; Lulu, 2013). The findings revealed that Arabic texts use more demonstratives and conjunctions differently, favoring explicit coordination and causality. Lexical cohesion, especially repetition, is more frequent in Arabic, enhancing clarity and aiding comprehension, particularly in legal texts (Chaalal, 2017). Arabic religious discourse favors lexical cohesion, while English emphasizes grammatical cohesion. Both languages use conjunctions, reference, and repetition, but Arabic relies more on pronouns and collocation (Huneety et al., 2017). Both texts employed various grammatical cohesive devices in political texts, Arabic texts using them more frequently. Arabic texts relied more on conjunctions and references, while English texts favored ellipsis and substitution (Lulu, 2013). In a similar vein, Ashuja`a and Saeed (2018) investigated cohesive reference in business and economic texts between English and Arabic.

The results showed extensive use of all reference types, with both Arabic and English favoring personal anaphoric references, followed by demonstratives and comparative reference.

Cohesion in English and Arabic Scientific Texts

The results of a number of studies (e.g., Altikriti & Obaidat, 2017; Alyousef, 2021; Dameria, 2014) have addressed cohesion in scientific texts and revealed that medical texts use both grammatical and lexical cohesion, with grammatical ties slightly more common than in non-medical texts. Reiteration was the most frequent lexical tie, while collocations were rare, emphasizing content clarity (Altikriti & Obaidat, 2017). Alyousef (2021) observed that Saudi undergraduate dentistry students used a variety of cohesive devices in oral biology: lexical cohesion, followed by references and conjunctions. The scarcity of studies on the translation of cohesive reference scientific texts from English into Arabic seems to call for conducting more studies in this regard so as to obtain a deeper understanding of this phenomenon that would be of help and benefit for researchers and translators alike. This gap is highlighted in the next section.

Problem Statement

Translators may mismanage cohesive devices, impacting clarity and internal cohesion (Khoshsima & Moghadam, 2017). While studies on cohesion in various genres exist (e.g. Alhinnawi & Al-Zughoul 2019; Ashuja`a & Saeed, 2018; Aulia et al., 2024; Chaalal, 2017; Herman et al., 2024; Laia, 2024; Lulu, 2013; Moindjie, 2015; Siregar et al., 2023) and have been conducted on different genres (literary, legal, political, business and economic, religious, narrative, argumentative and descriptive texts), cohesion in scientific texts remains underexplored. Few studies have tackled them, such as Altikriti and Obaidat (2017) and Alyousef (2021) which investigated cohesion in medical and biology texts, in single language and Dameria (2014) did that in biology texts in translation context).

In addition, reference is crucial for text cohesion, but apparently, it has been underexplored in discourse and translation studies. While some studies have focused on cohesion in one language or parallel texts, the analysis of cohesive references in translated scientific texts, particularly in computer science and health from English to Arabic seems to be scarce. Therefore, this study addresses this gap by attempting to achieve the following objective:

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- Investigating the frequency and use of cohesive references in English scientific abstracts and their Arabic translations by applying Halliday and Hasan's (1976) taxonomy of cohesion.

Methodology

This study used a descriptive, content-based analytical method as well as quantitative method.

Corpus of the Study

The corpus included abstracts from various scientific disciplines. A total of 31 abstracts were randomly selected from three journals: nine from The Journal of King Saud University – Computer and Information Sciences, Vols. 18 and 19 (Computer and Information Sciences); 13 from The Eastern Mediterranean Health Journal, Vol 15 (Health Sciences); and 10 from The Yemeni Journal of Medical and Health Research, Vol. 2 (Health Sciences). However, one abstract was excluded, as its translation into Arabic was inaccurate, bringing the final count to 31 abstracts.

Instruments of the Study

Drawing on Halliday and Hasan`s (1976) taxonomy of cohesion for identifying the frequency and use of cohesive references in English scientific abstracts and their Arabic translations selected from the three journals mentioned above on the application of this model in previous research such as Ashuja`a and Saeed (2018), Chaalal (2017), and Lulu (2013), an evaluation checklist was developed to achieve the study objective. It included cohesive references selected from the corpus in both English and Arabic. The checklist was also utilized to assess the similarities and differences in the use and frequency of cohesive references in the abstracts under study.

Validity of the Instrument

To validate the tool, four copies of the checklist were handed to experts in translation and linguistics to provide feedback about the relevance and adequacy of the checklist. After analyzing the abstracts, seven copies of the analysis were also reviewed by experts for validation.

Data Analysis

Data were analyzed using frequencies and percentages of each type of cohesive reference in the English abstracts and their translation into Arabic.

Results and Discussion

The analysis of the corpus was based on reference types suggested by Halliday and Hasan`s (1976) model. The results showed that all reference types (personal, demonstrative, and comparative) were present and were of two types: anaphoric or cataphoric (within) and exophoric (outside) the text (Table 1).

Table (1): Types of Cohesive Reference in English and Arabic Abstracts

Types of cohesive reference		Reference of Source Text (English)				Reference of Target Text (Arabic)			
		Anaphora	Cataphora	Exophora	Total	Anaphora	Cataphora	Exophora	Total
Personal Pronouns	%	57.1%	0%	42.9%	11.6%	89.1%	0.0%	10.9%	13.3%
	No.	28	0	21	49	39	0	5	44
Demonstrative	%	7.4%	92.6%	0.0%	80.5%	5.4%	94.6%	0.0%	78%
	No.	25	314	0	339	14	245	0	259
Comparative	%	54.1%	45.9%	0.0%	7.8%	56.7%	43.3%	0.0%	8.7%
	No.	16	17	0	33	16	13	0	29
Total	**%**	**17.2%**	**77.9%**	**4.9%**	**100%**	**21.4%**	**77.1%**	**1.5%**	**100%**
	No.	**73**	**331**	**21**	**421**	**69**	**258**	**5**	**332**

Table (1) shows that (421) reference devices were identified in the English abstracts, but this number was reduced to (332) references in the Arabic translations. Both abstracts employed three types of cohesive references: demonstrative, personal, and comparative, though at different rates. In English abstracts, demonstrative references scored 80.5%, personal references 11.6%, and comparative references 7.8%. On the other hand, Arabic abstracts showed a different distribution as follows: 78% demonstrative references, 13.3% personal references, and 8.7% comparative references. Each type will be presented in detail in the following subsections, starting with the references in the source texts (English abstracts) and followed by those in the target texts (Arabic abstracts).

Demonstrative References

The following sections examine the frequencies of demonstrative reference in English abstracts and their Arabic translation, providing an analysis of how these references contribute to textual cohesion.

Demonstrative reference in English and Arabic Abstracts

Table (2) presents the frequencies and percentages of demonstrative references in English abstracts.

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Table (2): Descriptive Statistics of Demonstrative References in English Abstracts

Demonstrative Reference	Items in ST		Total	Anaphora	Cataphora	Exophora
Definite Article	The	%	78.50%	0%	100.00%	0%
		No.	266	0	266	0
Demonstrative Pronouns	This	%	11.20%	7.90%	92.10%	0%
		No.	38	3	35	0
	These	%	1.80%	0%	100.00%	0%
		No.	6	0	6	0
	Those	%	0.90%	33.30%	66.70%	0%
		No.	3	1	2	0
Relative Pronouns	That	%	2.40%	87.50%	12.50%	0%
		No.	8	7	1	0
	Which	%	2.90%	100.00%	0%	0%
		No.	10	10	0	0
	Whose	%	0.90%	100.00%	0%	0%
		No.	3	3	0	0
Adverbial Demonstrative	There	%	1.20%	0%	100.00%	0%
		No.	4	0	4	0
	Then	%	0.30%	0%	100.00%	0%
		No.	1	0	1	0
Total of Demonstrative References				**339**		

Table (2) shows 339 demonstrative references in English abstracts, with the definite article being the most frequent (266 occurrences). Other demonstratives for instance "this, that, these, those, then, which, whose, and there"appeared less frequently, with "then"used once to express anaphoric reference.

Demonstrative References Frequencies in Arabic Abstracts

Table (3) presents the frequencies and percentages of demonstrative references in Arabic abstracts.

Table (3): Descriptive Statistics of Demonstrative References in the Arabic Abstracts

Demonstrative Reference	Items in TT		Total	Anaphora	Cataphora	Exophora
Definite Article	ال	%	80.50%	0%	100%	0%
		No.	211	0	211	0
Demonstrative Pronouns	هذا	%	5.30%	8.30%	91.70%	0%
		No.	12	1	11	0
	هذه	%	8.00%	0%	100.00%	0%
		No.	21	0	21	0
	هؤلاء	%	0.40%	0.00%	100.00%	0%
		No.	1	0	1	0
	تلك	%	0.40%	0%	100.00%	0%
		No.	1	0	1	0
	ذلك	%	0.80%	100.00%	0%	0%
		No.	2	2	0	0
Relative Pronouns	الذي	%	0.40%	100.00%	0%	0%
		No.	1	1	0	0
	التي	%	3.80%	100.00%	0%	0%
			10	10	0	0
Total of Demonstrative References				**259**		

Table (3) shows that Arabic abstracts contain 259 demonstrative references, with the definite article amounting to 80.5% of them. Other references include "ذلك","هؤلاء,"التي,"الذي,"هناك,"هذه,"هذا,"and "تلك"("hatha,""hat hehi,""hunaka,""allthy,""allti,""hwula`i,""thalika,"and "tilka"). The relative pronoun "الذي"("allthi") appeared once anaphorically, while "هؤلاء"("hwula`i") and "تلك"("tilka") appeared once cataphatically. The results showed that demonstrative references were the most frequent cohesive devices, reflecting the clarity, precision, and transparency of scientific writing. They enhance cohesion by explicitly linking different parts of the text and ensuring logical flow. The English and Arabic definite articles (the)"ال al"were analyzed similarly, appearing 266 times in English abstracts and 211 times in Arabic abstracts. The frequent use of definite articles in both languages contributes to text cohesion by clearly identifying referents. Furthermore, the frequency of it in Arabic is lower than in English due to translation strategies used, such as "compensation,""shift,"and "reduction,"resulting from linguistic differences.

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The demonstrative pronoun "this"ranked second in frequency, with its Arabic equivalents, /hatha/ (هذا) at 5.3% and /hathihi/ (هذه) at 85%. "hathihi"is used for feminine singular nouns and nonhuman plurals in Arabic. "This"in English and "هذا"(hatha) and "هذه"(hathihi) in Arabic ensure clarity by referring to previously mentioned ideas. The high frequency of "هذه"(hathih) reflects its flexibility in Arabic grammar. In addition, "that"functions as a modifier or relative pronoun for cohesion, but as a conjunction, it is not considered a cohesive reference. Moreover, "that"appeared in this study only as a relative pronoun, not as a modifier. In addition, the relative pronouns (who, whose, and which) were used to express demonstrative reference in declarative sentences.

Arabic and English differ significantly in the use of definite articles and demonstratives, particularly in nominal phrases, demonstrative modification, genitive constructions, and gender agreement. These differences reflect deeper structural distinctions between the two languages in expressing definiteness and grammatical relationships.

In Arabic, the definite article "ال"is prefixed to each noun, adjective, or gerund within a nominal phrase, whereas English uses "the"only once per phrase (Rabadi, 2016).

English example: The type of Neural Network used to implement DoSID is feed forward, which uses the backpropagation learning algorithm."

Arabic translation: "تم بناء نظام الشبكة العصبية لكشف الاختراقات المعروفة وغير المعروفة، ولقد تم استخدام خوارزمية الانتشار العكسي التي تستخدم في تدريب الشبكات العصبية كاملة الارتباط وذات التغذية الأمامية ومتعددة الطبقات."

In Arabic, nearly every noun in the phrase carries "ال", such as "الشبكة", "العصبية", and "الشبكات العصبية", "خوارزمية الانتشار العكسي", making it more explicit than English.

Arabic permits the definite article to co-occur with demonstrative modifiers, a structure that does not occur in English (Ghubin, 2006).

English example: "The findings of this study."

Arabic: "نتائج هذه الدراسة."While English avoids using "the"alongside demonstratives, Arabic retains "ال", reinforcing definiteness.

Arabic employs the idhafa (الإضافة) structure, where definiteness is often inherent within noun relationships rather than through repetition of the article (Rabadi, 2016).

English example: "The seasonal peak of admissions."

Arabic translation: "قمة موسم الدخول."Here, Arabic conveys definiteness through the idafa structure rather than repeating the article, differing from English usage.

Unlike English, Arabic demonstratives vary according to the gender of the noun they modify, ensuring grammatical agreement (Ghubin, 2006).

English example :

1. "This is a retrospective study."
2. "The aim of this retrospective study."

Arabic translation:

1. "هذه دراسة استرجاعية."(Using "هذه"for the feminine noun "دراسة".)
2. "الغرض من هذا البحث."(Using "هذا"for the masculine noun "البحث"

As previously mentioned, demonstrative references were more frequent in both Arabic and English abstracts. This aligns with Alwi and Indrawan (2023), who noted that demonstrative references are the most common cohesive device, used to track information and link nouns. However, this contradicts Chaalal (2017), who found that Arabic texts rely more on pronominal and demonstrative references, while English texts have more frequent comparatives. Additionally, the current study findings differ from the studies conducted by Ashuja'a and Saeed (2018), Lulu (2013), and Herman et al. (2024), which reported that personal pronouns are the most frequent cohesive device.

Personal Pronouns

This section presents the results of personal pronouns in English abstracts and their equivalence in Arabic, highlighting their role in creating cohesion in scientific abstracts, the frequency distribution is as follows:

Personal Pronouns Frequencies in English Abstracts

Table (4) presents the frequencies and percentages of personal pronouns in English abstracts.

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Table (4): Descriptive Statistics of Personal Pronouns in English Abstracts

Personal Pronoun	Items in ST		Total	Anaphora	Cataphora	Exophora
Subject pronouns	We	%	32.70%	0.00%	0.00%	100.00%
		No.	16	0	0	16
	They	%	4.10%	100.00%	0.00%	0.00%
		No.	2	2	0	0
Object pronoun	Them	%	6.10%	100.00%	0.00%	0.00%
		No.	3	3	0	0
Possessive pronoun	Our	%	10.20%	0.00%	0.00%	100.00%
		No.	5	0	0	5
	Their	%	22.40%	100%	0%	0.00%
		No.	11	11	0	0
Neutral pronouns	It	%	14.30%	0.00%	100.00%	0.00%
		No.	7	7	7	0
Neutral pronouns	Its	%	6.10%	100.00%	0.00%	0.00%
		No.	3	3	0	0
General pronouns	One	%	2.00%	100.00%	0.00%	0.00%
		No.	1	1	0	0
	Ones	%	2.00%	100.00%	0.00%	0.00%
		No.	1	1	0	0
Total of Personal Pronouns				**49**		

Table (4) shows that the English abstracts contain 49 personal pronouns, including subject, neutral, object, and possessive pronouns (e.g., we, they, it, them, ours). The first-person plural pronoun "we"appeared 16 times to express cataphoric reference, amounting to 32.7%, while general pronouns "one"and "ones"have the lowest percentage at 2.1%, both used for anaphoric reference.

Personal Pronouns in Arabic Abstracts

Table (5) presents the frequencies and percentages of English personal pronouns in Arabic abstracts.

Table (5): Descriptive Statistics of Personal Pronouns in Arabic Abstracts

Personal Pronoun	Items in TT		Total	Anaphora	Cataphora	Exophora
Independent Pronouns	هو	%	2.20%	100%	0%	0.00%
		No.	1	1	0	0
	هي	%	6.50%	100.00%	0.00%	0.00%
		No.	3	3	0	0
Dependent Pronoun	-نا	%	8.70%	0.00%	0.00%	100.00%
		No.	4	0	0	4
	-ه	%	8.70%	100.00%	0.00%	0.00%
		No.	4	4	0	0
	-ها	%	28.30%	100%	0%	0.00%
		No.	13	13	0	0
	-هما	%	2.20%	100.00%	0.00%	0.00%
		No.	1	1	0	0
	-هم	%	15.20%	100%	0%	0.00%
		No.	7	7	0	0
	-هن	%	2.20%	100.00%	0.00%	0.00%
		No.	1	1	0	0
	-وا	%	4.30%	100.00%	0.00%	0.00%
		No.	2	2	0	0
Implicit Pronouns	ضمير مستتر تقديره نحن	%	2.20%	0.00%	0.00%	100.00%
		No.	1	0	0	1
	ضمير مستتر تقديره هي	%	19.60%	100%	0%	0.00%
		No.	7	7	0	0
Total of Personal Pronouns				**44**		

Table (5) shows that Arabic abstracts use 44 personal references, including independent pronouns (**هو- هي** /huwa, hia), dependent pronouns (**ها- ه- هما-وا- نا- هن- هم**)/ ha- h- huma- wa- na- hunna- hum/, and implicit pronouns (**ضمير مستتر تقديره هي, ضمير مستتر تقديره نحن** /hia, nahnu/). The most frequent one is the third-person singular feminine dependent pronoun "**ها**"(28.3%) used anaphorically, while the least frequent one was the implicit first-person plural pronoun "**نحن**"(2.2%) used exophorically.

In English scientific texts, the first-person plural pronoun `we` was most frequently used (16 times, 32.7%), which is somewhat unusual given the typical

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preference for objectivity and detachment in scientific writing, particularly in abstracts. In contrast, the third-person singular feminine pronoun `-ها` was most frequent in Arabic texts (13 times, 28.3%). This is due to the broader use of `-ها` in Arabic, where it can refer to both feminine singular nouns and non-human plural nouns, aligning more closely with the impersonal or generalized tone often preferred in scientific writing.

Arabic and English differ significantly in pronoun usage. One major distinction is 'dual' in Arabic, which English lacks. For instance, in the sentence: The study was Pityriasis versicolor (39.2%) followed by Tinea cruris (15.4%), both of which were male-dominated." " Arabic translation "The study was Pityriasis versicolor (39.2%) followed by Tinea cruris (15.4%), both of which were male-dominated." The phrase "both of which"refers anaphorically to the two diseases. In Arabic translation: "**في هذا البحث هي السعفة المبرقشة** (39.2) **يليها سعفة ثنايا الجسم** (15.4) **حيث كان غالبية المصابين في كليهما من الذكور...**"

Unlike English, Arabic distinctly marks duality in pronouns, verbs, and nouns. The pronoun "**هما**"explicitly refers to two entities, as in "**كليهما**", while English uses "both of which"or "they."Arabic also adjusts verb conjugations and possessive forms to reflect duality, ensuring grammatical precision.

Another key difference is the distinction between dependent and independent pronouns. Dependent pronouns in Arabic attach to words, unlike English: For example: "Children less than two years in relation to their feeding practices."

Arabic translation: "**لأطفال تقل أعمارهم عن** 24 **شهرا وعلاقتها بممارساتهم الغذائية**."

English uses independent possessive pronouns like "their", while Arabic attaches pronouns to nouns, as in "**هم**"in "**ممارساتهم**."

Arabic also integrates explicit and implicit pronouns, whereby implicit pronouns refer to the first, second, and third person and are obligatory for the first and second person but optional for the third (Igaab & Tarrad, 2019). English, in contrast, relies solely on explicit pronouns. For example: "A problem with current intrusion detection systems is that they have many false positive and negative events."

Arabic translation:"**وكما هو معروف فإن معظم أنظمة كشف الاختراق للأجهزة والشبكات تعتمد على أنظمة الخبرة التي تحتوي على قواعد محددة لا تستطيع اكتشاف الهجمات الجديدة**."English explicitly uses "they", while Arabic implies "**هي**"through context and morphological markers.

Gender distinctions in Arabic extend to plural pronouns, unlike English, which limits them to singular forms. For example, in "intrusion detection systems", English treats non-human subjects as gender-neutral, using "they."Arabic assigns grammatical gender "أنظمة"(systems) which is a broken plural of the masculine "نظام"but is treated as feminine. Thus, verbs, adjectives, and pronouns must align, as seen in "تعتمد".

Moreover, Arabic pro-drop nature allows omitting explicit pronouns, a feature absent in English. Standard Arabic (SA) is a partial pro-drop language due to rich verbal morphology, allowing omission of subject pronouns (Alnajadat, 2017). For example:

"We conclude that emphasis..."the subject "we"in "We conclude that emphasis" is explicit pronoun. In Arabic, however, the equivalent is"نؤكد"(we confirm) omits the pronoun "نحن"(we) because the verb "نؤكد"is conjugated to imply the subject. This feature allows Arabic to create more concise sentences without losing meaning. In fact, the pronoun is considered a type of nominal conjunctions, whether it is explicit or implicit; this is because -although it is implicit, it is perceived by the mind, and is inferred through the meaning by reason, and inferred through meaning. It appears in some places as a conjunction to the sentence that is implicit (Translated by the researcher) (Ismail, 2011). However, Talafha (2023) suggests that implicit pronouns function as non-cohesive devices. In literary and narrative genres, pronouns are used extensively to create a smooth narrative flow by referring to characters, actions, and events. In contrast, scientific writing prioritizes clarity and precision, making pronouns less frequent. In this context, demonstrative references take precedence for establishing clear relationships between concepts. As a result, pronouns are used less frequently, ranking second after demonstrative references.

In English, the first-person plural pronoun "we"was the most frequent, appearing 32.7%, though this may contradict the typical impersonal tone of scientific writing. However, in Arabic, the frequency of the third-person singular feminine pronoun "-ها"was 28.3%, reflecting the broader use of this pronoun for both singular feminine and non-human plural nouns, aligning with the impersonal tone typical of scientific texts. Despite the greater variety of pronouns in Arabic, the study found that English had a higher frequency of personal pronouns, due to translation strategies such as "compensation,""shift,"and "reduction."For example, in "we evaluate its

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performance,"the English pronoun "its"is translated into the Arabic definite article in "أداء الخوارزمية,"shifting to a demonstrative reference.

The findings of the present study contradict Mahmood and Khalaf's (2020) study which showed that personal pronouns were the most frequent cohesive device. Unlike Chaallal (2017) and Lulu (2013), who found Arabic texts had more personal pronouns, the present study indicates English abstracts use them more frequently.

Comparative Reference Frequencies

The following sub-sections present the frequency of comparative references in English abstracts and their Arabic translations, highlighting their role in linking concepts and enhancing cohesion.

Comparative Reference in English Abstracts:

Table (6) presents the frequencies and percentages of comparative references in English abstracts.

Table (6): Descriptive Statistics of Comparative Reference in English Abstracts

Comparative Reference	Items in TT		Anaphora	Cataphora	Exophora	Total
Adjectival General Comparison	Other/ Others	%	42.90%	57.10%	0%	20.60%
		No.	3	4	0	7
	Another	%	0%	100.00%	0%	2.90%
		No.	0	1	0	1
	Contrast in comparison	%	0%	100.00%	0%	2.90%
		No.	0	1	0	1
	Different	%	100.00%	0%	0%	5.90%
		No.	2	0	0	2
	Better-than/ better	%	40%	60%	0%	14.70%
		No.	2	3	0	5

Table (6): Continued

Comparative Reference	Items in TT		Anaphora	Cataphora	Exophora	Total
Adjectival Particular Comparison	Higher	%	100.00%	0%	0%	11.80%
		No.	4	0	0	4
	More/more than	%	40.00%	60.00%	0%	14.70%
		No.	2	3	0	5
	Than	%	100.00%	0%	0%	5.90%
		No.	2	0	0	2
	Older	%	0%	100.00%	0%	2.90%
		No.	0	1	0	1
	Younger	%	100.00%	0%	0%	2.90%
		No.	1	0	0	1
Adverbial Particular Comparison	As well as	%	0%	100.00%	0%	8.80%
		No.	0	3	0	3
	Such as	%	0%	100.00%	0%	2.90%
		No.	0	1	0	1
	Less than	%	0%	0%	0%	2.90%
		No.	0	0	0	1
Total of English Comparative References				**33**		

In Table (6), comparative references have the lowest percentage in both English and Arabic abstracts. In the 33 comparative references in English abstracts phrases such as "more than,""other/others,""comparative/ compare,"and "higher"were used. The most frequent comparative reference, "other/others,"appeared 3 times anaphorically and 4 times cataphorically, while "higher"was the least frequent, appearing 4 times to indicate anaphoric reference.

Comparative Reference in Arabic Abstracts

Table (7) shows the frequencies and percentages of comparative references in Arabic abstracts.

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Table (7): Descriptive Statistics of Comparative Reference in Arabic Abstracts

Comparative Reference	Items in TT		Total	Anaphora	Cataphora	Exophora
Adjectival General Comparison	آخرين	%	10.30%	66.70%	33.30%	0%
		No.	3	2	1	0
	يخالف	%	3.40%	100.00%	0%	0%
		No.	1	1	0	0
	نفس	%	3.40%	0%	100.00%	0%
		No.	1	0	1	0
	معظم	%	3.40%	0%	100.00%	0%
		No.	1	0	1	0
Adjectival Particular Comparison	أكثر\أكثر من\الأكثر	%	27.60%	37.50%	62.50%	0%
		No.	8	3	5	0
	مقارنة	%	3.40%	0%	100.00%	0%
		No.	1	0	1	0
	المثلى\ الأمثل	%	13.80%	50%	50%	0%
		No.	4	2	2	0
	أبرز نتائجها	%	3.40%	100.00%	0%	0%
		No.	1	1	0	0
	أعلى	%	6.90%	100.00%	0%	0%
		No.	2	2	0	0
	أفضل	%	10.30%	100.00%	0%	0%
		No.	3	3	0	0
	الأصغر	%	3.40%	100.00%	0%	0%
		No.	1	1	0	0
Adverbial Particular Comparison	وكذا	%	6.90%	0%	100.00%	0%
		No.	2	0	2	0
	تقل	%	3.40%	100.00%	0%	0%
		No.	1	1	0	0
Total of Arabic Comparative References				**28**		

Table (7) shows 30 comparative references in Arabic abstracts, including terms for example: **أكثر / أكثر من / الأكثر** (/akthar/, /akthar min/, / al`akthara/) (more, more than, most), **المثلى / الأمثل** (/al`muthla/, /al`amthal/) (optimum),

مقارنة (/muqaranatan/), كذا (/kadhaa/), أبرز نتائجها (/abrazu natayijiha/), أعلى (/aela/), أفضل (/afdhal/) (better), بعد (/baed/), نفس (/nafs/), الأصغر (/al`aṣghar/), آخرين (/akharin/), and يخالف (/yukhalif/).

The most frequent comparative references are "أكثر/أكثر من/الأكثر"(repeated 3 times anaphorically and 5 times cataphorically), but the lowest frequent were: "أبرز نتائجها"(highlighted results) and "الأصغر"(smaller), each mentioned once anaphorically and "مقارنة"(compared) is mentioned once cataphorically.

In scientific texts, comparative references for instance "other"and "others"in English, and "أكثر- الأكثر من-الأكثر"in Arabic, are crucial for expressing comparisons and maintaining cohesion. These terms help distinguish, rank, or emphasize relationships between concepts. For example, in English, "other"and "others"link ideas without repetition, as in "This algorithm is more efficient than others."In Arabic, terms such as "أكثر"and "الأكثر"are used to rank or quantify results, as in "هذه الطريقة أكثر دقة من غيرها."

While less frequent than demonstratives or personal pronouns, comparative references contribute to cohesion by summarizing, contrasting, and connecting ideas. They support the logical flow and precision of the text. Additionally, a new reference type is introduced: the combination of comparative references with personal pronouns in Arabic.

Comparative Personal Pronoun

Table (8): Examples of Comparative Personal Pronoun

Source Text	Reference	Referent	Target Text	Reference	Referent
The main outcomes	The	Main outcomes	أبرز نتائجها	أبرز نتائجها	العمليات الجراحية المستخدمة

In Vol (2) abstract (1) line (11), the demonstrative reference "the"in "the main outcomes"is translated into the comparative pronoun "أبرز"(most prominent) and the personal pronoun "نتائجها"(its results) using a shift strategy. This shift reflects the structural and stylistic differences between English and Arabic in maintaining cohesion. While English uses "the"to specify a subject, Arabic shifts to a comparative pronoun and personal pronoun to convey the same meaning

The phrase "أبرز نتائجها"(its most prominent results) can be regarded as a comparative personal pronoun, contributing to the expansion of Halliday and Hasan's (1976) taxonomy of cohesive reference. Unlike personal,

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demonstrative, or comparative references, this structure simultaneously refers back to a previously mentioned entity and ranks its key outcomes, thereby serving a dual cohesive function. This combination creates a distinct form of cohesion that considers as anaphoric reference (refers to a prior noun) with comparative reference (establishing a hierarchical distinction among elements).

Halliday and Hasan categorize comparative reference through direct markers, such as adjectives (e.g., better, more) and adverbs (e.g., otherwise, differently). However, "**أبرز نتائجها**"introduces an indirect comparison, in which certain results are presented as more significant without directly contrasting them with others. This indirect ranking mechanism is particularly significant in Arabic scientific discourse, where such structures are frequently employed to highlight key findings in a concise and cohesive manner. Recognizing this as a new subtype of comparative reference extends Halliday and Hasan's model by incorporating hierarchical cohesion, offering a more refined understanding of how cohesion operates in Arabic texts. In Arabic, superlatives (e.g., "**الأصغر**"and "**معظم**") function as comparative references, whereas in English, they are not typically categorized as such.

Comparative references play a supplementary role in scientific writing, typically used for comparing results, methods, or findings, but are less crucial for overall cohesion. This aligns with Chaalal (2017). According to Halliday and Hasan`s (1976) taxonomy, there are general and particular comparative references. Both types are found in English abstracts and their Arabic translations, contrary to Ashuja`a and Saeed (2018), who argued that general comparatives do not exist in Arabic. However, Al-Jabr (1987) disagreed, suggesting their presence. Despite their limited role, comparative references enhance analysis by clarifying relationships between research elements.

Despite Arabic having more cohesive reference devices, English abstracts showed a higher frequency with 421 occurrences compared to 332 in Arabic. This difference can be attributed to translation strategies such as reduction, shift, and compensation, which sometimes lead to reducing the number of cohesive devices in Arabic.

Translation strategies help address differences between Arabic and English in structure, style, and cohesion, directly affecting translation quality. Compensation and shift tackle issues with word order and sentence

structure, adapting them to fit the target language. Reduction helps adjust stylistic differences. In terms of cohesion, literal translation works when both languages share similar tone and structure, but compensation is needed when Arabic omits pronouns, replacing them with other cohesive references. This ensures that the English translation maintains the correct flow and clarity, keeping the original meaning intact.

Conclusions and Implications

Based on the analysis and discussion in the previous sections, several conclusions can be drawn. All the reference types proposed by Halliday and Hassan (1976) were identified and extensively used. These references were classified into two categories based on their phoric relation (anaphoric, cataphoric, and exophoric) and three sub-types based on the grammatical devices that perform the cohesive function (personal, demonstrative, and comparative).

The analysis showed more similarities than differences between the two languages in terms of the types of cohesive devices used. The similarities are preserved to ensure accuracy, transparency, and formality in scientific texts, while differences in frequency stem from the stylistic preferences in each language.

The results revealed that demonstrative references are the most frequently used cohesive devices, due to the nature of scientific writing, which is characterized by clarity, precision, and transparency. Personal pronouns are the second most frequently used cohesive device in the parallel corpus. The findings show that English personal pronouns are used more frequently than Arabic personal pronouns, despite the greater variety of pronouns in Arabic. Comparative references, which had the lowest frequency, were found in both languages, with a new type, "comparative personal pronouns,"emerging in Arabic texts.

Although Arabic has more cohesive reference devices, English abstracts showed a higher frequency. This could be attributed to translation strategies such as reduction and compensation that lead to reducing the use of cohesive references in Arabic. The present study revealed another type of cohesive reference: "comparative personal pronouns,"in Arabic texts.

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Recommendations

Based on the findings and conclusions of this study, the following recommendations can be made:

- Translation programs should incorporate both theoretical and practical training, with a particular focus on cohesion and coherence to enhance translators` ability to maintain cohesive references in translated texts. Translators should possess sufficient knowledge of the characteristics of different text genres.
- Translators must be aware of cohesion and coherence, especially cohesive references, in both source and target texts to ensure clarity and acceptability.
- Translators should be familiar with various translation strategies and apply the appropriate one for each context.
- Translators must have a strong understanding of both the source and target languages.
- Cohesion, coherence, and cohesive references should be integrated into translation curricula.

Suggestions for Further Research

This study makes a modest contribution to understanding cohesive references within a specific genre. Future research could expand on this by exploring all cohesion devices, including reference, conjunctions, substitution, ellipsis, and lexical items. Additionally, studies could examine cohesion in different genres and identify other strategies employed in such contexts.

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