



Functional Analysis of Linking Adverbials in Chemistry and English Language Teaching Research Articles

Análisis funcional de los conectores adverbiales en artículos de investigación química y enseñanza del idioma Inglés

Seyed Foad Ebrahimi¹
Vafa Alboghobiesh²

Citation/ Para citar este Artículo: Ebrahimi, S. F. & Alboghobiesh, S. F. (2023). Functional Analysis of Linking Adverbials in Chemistry and English Language Teaching Research Articles. *Colomb. Appl. Linguistic. J.*, 25(1), pp. 57-70.

Received: 13-Oct.-2021 / **Accepted:** 13-May.-2023

DOI: <https://doi.org/10.14483/22487085.18596>

Abstract

Linking adverbials are important linguistic features that signal a cohesive link between parts of the discourse. This study intends to explore the frequencies and discourse functions of linking adverbials in research articles across two disciplines: English Language Teaching and Chemistry. To this end, a corpus of 40 research articles from each discipline were selected from high-prestige journals recommended by successful researchers in the respective fields. The selected research articles were taken from the 2018-2019 issues of the journals. Liu's (2008) updated and widely recognized classification of linking adverbials was employed to identify linking adverbials. Findings revealed the disciplinary differences concerning frequencies and functions of linking adverbials and categories and subcategories of linking adverbials. By comparing the results of this study with previous literature, it could be concluded that frequencies and functions of linking adverbials are imposed by the nature of discipline and genre.

Keywords: chemistry, cohesive device, disciplinary study, English language teaching, linking adverbials, research article

Resumen

Los conectores adverbiales son importantes elementos lingüísticos que establecen una relación de cohesión entre distintas partes del discurso. En este estudio se pretende explorar la frecuencia de uso y las funciones discursivas de estos conectores en artículos de investigación de dos disciplinas: la enseñanza de la lengua inglesa y la química. Para ello, se creó un corpus de 40 artículos de investigación de cada disciplina extraídos de revistas prestigiosas propuestas por investigadores relevantes en estos dos ámbitos. Los artículos de investigación seleccionados se extrajeron de los números publicados en aquellas revistas en el periodo 2018-2019. Para identificar los conectores adverbiales, se aplicó la clasificación de Liu (2008), una taxonomía actualizada y ampliamente utilizada. Los resultados revelan diferencias disciplinares con respecto a las frecuencias de uso y a las funciones discursivas, así como categorías y subcategorías de estos elementos. Al comparar los hallazgos de este estudio con previas investigaciones sobre el

1 English Department, Shadegan Branch, Islamic Azad University, Shadegan, Iran. ORCID : <https://orcid.org/0000-0001-7450-7187>. s.f.ebrahimi@iaushadegan.ac.ir.

2 English Department, Shadegan Branch, Islamic Azad University, Shadegan, Iran. ORCID : <https://orcid.org/0000-0001-8149-3158>. v.alboghobiesh@iaushadegan.ac.ir.

tema las diferencias son notables. Por consiguiente, se podría concluir que las frecuencias de uso y funciones de los conectores adverbiales vienen impuestas por la naturaleza de la disciplina y del género.

Palabras clave: artículo de investigación, elemento cohesivo, estudio disciplinar, enseñanza de la lengua inglesa, conectores adverbiales, química

Introduction

Nowadays, one of the best ways to exchange information in the academic world is through research articles (RA). They offer a fast and reliable way of accessing updated ideas published in academic journals. Indeed, academic research plays a vital role in spreading knowledge, as it usually involves investigations of scientific, literary, social, and moral issues. RAs typically include for main components, namely: introduction, methodology, results, and discussion. Before being published, the editor of the journal sends the manuscript to experts in the relevant field to assess its quality. The process of “peer review”, along with other editorial procedures, ensures that the content of the article is cohesive and coherent (Jalilifar, 2009; Swales, 1990, 2004). Among the various linguistic tools available to authors, the use of linking adverbials (LAs) is particularly beneficial as they help connect different parts of a discourse. According to Biber et al. (1999, p. 765) LAs as elements that “make explicit the relationship between two units of discourse”. By signaling this relationship, LAs play a crucial role in creating cohesive texts. Their main function is “to state the speaker/writer’s perception of the relationship between two units of discourse” and “to make semantic connections between spans of discourse of varying length” (Biber et al., 1999, p. 875).

In the last two decades, postgraduate students have been asked to publish their RAs in international highly prestigious journals. However, language use (cohesion/coherence), organization, and content problems have led to rejection of most RAs (Jalilifar, 2009). About half of rejected RAs lack cohesion and could benefit from investigations concerning the usage of cohesive

markers in one or more disciplines. Therefore, this study intends to investigate the realizations and discourse functions of LAs in RAs from two different disciplines, namely Chemistry and English Language Teaching (ELT). These disciplines were selected as Chemistry is among the most popular disciplines in an Iranian academic context, and ELT researchers involved in this study currently teach writing courses at the postgraduate level in this discipline. Thus, the findings of this study could assist researchers in teaching writing courses and could also help Chemistry and ELT students in using cohesive RAs.

Literature Review

In recent decades, numerous studies have investigated on the realizations of LAs in different academic genres (Gao, 2016; Lei, 2012; Liu, 2008; Narita et al., 2004; Peacock, 2010; Shi, 2017). This section presents and reviews recent studies on the realizations and functions of LAs in different academic genres.

To start with, Liu (2008) investigated the frequency and usage of English LAs across five registers namely spoken English, academic writing, fiction, news writing, and other writings extracted from British National Corpus (BNC). This study is considered a major and leading contribution to scholarship on LAs, as Liu consulted major English grammar books to produce a comprehensive list of 110 items based on the investigation of BNC for the realizations of the LAs. To identify the LAs, Liu adopted the framework suggested by Celce-Murcia and Larsen-Freeman (1999), which is clear, simple, and comprehensive, and simultaneously correlated with Halliday and Hassan’s (1974) original four-way clarification system. Liu’s model includes four categories: additive, adversative, causal, and sequential. She found that speaking and academic writing registers used LAs differently in the five registers analyzed in her study. Indeed, she noted that some LAs in each category had received different attention and concluded that LAs should be included in students’ instructions, considering their specific learning needs and concrete curriculum’s objectives.

In turn, [Peacock \(2010\)](#) investigated the frequency, form, and function of LAs in RA across eight disciplines to stress interdisciplinary differences. He ran his study on a corpus of 320 RAs, forty from each discipline and analyzed the RAs based on the semantic categories framework suggested by [Biber et al. \(1999\)](#), which includes “contrast/concession”, “result/inference”, “apposition”, and “addition”. Peacock found a total of 23,544 words functioning as LAs, with a frequency of 12,006 per million words or 74 per RA. Moreover, he highlighted that LAs were used in different frequencies across the disciplines. Regarding the four classes, Peacock’s study showed that three categories of contrast/concession, addition, and apposition were found more common than expected. The most frequent LAs were “however”, “rather”, “though”, “in contrast”, and “instead” (contrast/concession); “thus, therefore, so, hence” (result/inference); “also, as well, besides” (addition); and “e.g.”, for example, for instance, such as (apposition). The results indicate no significant differences between disciplines in this regard. However, they suggested that LAs were used to serve specific functions that required in the specific disciplines, such as indicating alternatives, making claims, making results, showing additional units, and reformulating.

[Gao \(2016\)](#) investigated the realizations of LA in the corpus of RAs from four disciplines written by English and Chinese native speakers. She analyzed the corpus based on [Liu’s \(2008\)](#) classifications of LA and found that English native scholars (ENS) used LA items less frequently than Chinese native scholars (CNS). She also declared that based on the chi-square test, the difference was not significant. Regarding the differences of realizations of four classes, the findings show that distributions of causal/resultative and sequential LAs were not significant, while additive and adversative LAs were substantially different. These differences could suggest that ENS and CNS scholars tend to present and develop claims in a different way. An inter-disciplinary comparison of LA revealed that soft disciplines (physics and computer science) showed a different pattern compared to the CNS sub-corpus, with the average frequency per RA in computer science being highest (2.62 per 10000). Gao’s study concludes that cultural and linguistic backgrounds of writers have a significant impact on

the selections of LAs in academic writing and this impact is greater than that caused by the disciplinary conventions of writing.

On the other hand, [Lei \(2012\)](#) studied academic writings of Chinese EFL doctoral students for the use of LAs. She ran her study on a corpus of 20 doctoral dissertations in the discipline of applied linguistics that were all written by native EFL Chinese students and defended in Chinese universities from 2004-2009. She also compiled a control corpus of 120 published RAs in international English language journals. The analysis of the corpus was informed by [Liu’s \(2008\)](#) taxonomy and included the aforementioned categories. The results of this study suggested that the frequency of LAs were similar in doctoral students and control corpora (RAs). The result suggested that both groups of writers used similar proportions of additive LAs and this category was the most frequent among the four categories suggested by [Liu \(2008\)](#). Doctoral students used the adversative LA less frequently than RA writers. The most frequent LAs in both corpora were “also, however, thus, therefore, for example, i.e., so, them, in addition, that is”. She concluded that students might not receive appropriate pieces of advice from teaching practices and teaching materials. Thus, students need to be aware of how LA is used in academic writings.

The reviewed literature indicates that LAs have received noticeable attention in the last two decades. Some of the reviewed studies ([Gao, 2016](#); [Lei, 2012](#)) focused on corpus produced by L1 and L2 students, while other studies focused on the spoken corpus ([Shi, 2017](#)). [Liu \(2008\)](#) selected the corpus of her study from five registers and only [Peacock \(2010\)](#) studied the realizations of LAs across disciplines. Therefore, this study aims to address certain issues that have been neglected in the literature, such as a focus on research articles from two disciplines based on [Liu’s \(2008\)](#) taxonomy. Hence, the study seeks to answer the following research questions:

1. What are the LAs used in ELT and Chemistry Ras, their frequency and discourse functions?
2. What are the similarities and differences between two disciplines concerning LAs frequencies and discourse functions?

Methodology

Corpus compilation

The corpus of this study consisted of 40 RAs from the discipline of Chemistry and an additional 40 research articles from the discipline of ELT. To compile the corpus, the researchers selected two disciplines (ELT and Chemistry) to represent the classification of hard and soft science disciplines. Thus, the findings of this study could have a noticeable contribution to writers in these two disciplines. After selecting the disciplines, two journals from each field were chosen, following experts' recommendations. For Chemistry, the journals *Chemical Engineering Science* and *Applied Thermal Engineering* were selected, considering the insights provided by some faculty members from the Department of Chemistry. For applied language studies, the researchers of this study selected two journals, considering their own academic background in ELT: *English for Specific Purposes* and the *Journal of English for Academic Purpose*. Next, the researchers selected research articles published in the period 2018-2019. [Table 1](#) breaks down the corpus selection.

Table 1. *Corpus Details*

Disciplines	Chemistry	English Language Teaching (ELT)
Number of RA	40	40
Journals	<ul style="list-style-type: none"> Chemical Engineering Science Applied Thermal Engineering 	<ul style="list-style-type: none"> English for Specific Purposes Journal of English for Academic Purposes
Years of Publication	2018-2019	2018-2019
Word Count	304469	423867

Taxonomy

In this study, we used the taxonomy of LAs developed by [Liu \(2008\)](#) (see [Appendix 1](#)) for the analysis due to the following two reasons: first, Liu (2008) developed the taxonomy and the list of LAs based on the two existing lists suggested by [Celce-Murcia and Larsen-Freeman \(1983, 1999\)](#) and [Quirk et al. \(1985\)](#), as well as other lists suggested

in grammar books. Second, [Liu \(2008\)](#) developed the list of LAs items based on a systematic analysis of a corpus of the BNC. The taxonomy of the LAs is presented in [Table 2](#).

Table 2. *Taxonomy of the LAs*

Type	Subcategory	Examples
Additive	Emphatic	<i>also, as well</i>
	Appositional-reformulation	<i>for example, that is</i>
	Similarity comparative	<i>alternatively</i>
Adversative	Proper adversative/concessive	<i>however, nevertheless</i>
	Contrastive	<i>actually, in comparison</i>
	Correction	<i>instead, rather</i>
	Dismissal	<i>despite, at the same time</i>
Causal/resultative	General causal	<i>consequently, as a result</i>
	Conditional causal	<i>otherwise, then</i>
Sequential	Enumerative/listing	<i>first, second</i>
	Simultaneous	<i>at the same time</i>
	Summative	<i>in sum, to summarize</i>
	Transitional to another topic	<i>incidentally</i>

Note. Adapted from [Liu \(2008, P.22\)](#)

Procedure

To conduct this study, we followed the procedures outlined below. First, we employed [Liu's \(2008\)](#) taxonomy of LAs to analyze the corpus for the LAs, since Liu's list is considered to be one of the most comprehensive and preferred taxonomy in the reviewed literature (e.g., [Lei, 2012](#); [Gao, 2016](#)). Besides, this taxonomy has been examined systematically in different studies for the analysis of different corpora, such as the British National Corpus (BNC), which ensures its validity. Thus, we considered Liu's four categories and thirteen subcategories for the analysis. Second, we searched the RAs for the 110 LA items using the search function of a word processor and then we examined LAs in the RAs to make sure that the found LAs functions as an LA or not and those not functioning as an LA were discarded, as some items are not always functioning as LAs. The items selected are as follows:

1. Though ("though indirectly")
2. Instead ("instead of")

3. Rather (“rather comparable”)
4. Yet (“Yet we were”)
5. Too (“too complicated”)
6. Besides (“besides non the al emission”)
7. Similarly (“similarly modified”)
8. As well (“as well as”)
9. Further (“further analysis”)
10. First (“in the first part”)
11. Second (the second section”)
12. Third (“about one third”)
13. Fourth (“the fourth column”)
14. Last (“at least”)
15. Next (“the next generation”)

Third, as the two sets of RAs were not equal in size (ELT, 423867 words and Chemistry, 304469 words), the frequencies of LAs were normalized per 10000 words. This makes the comparison between the two sets of RAs, as well as with the findings reported in the literature, to be more meaningful and possible. Fourth, the frequency and functional differences of LAs between the two sets of RAs were presented, compared with the findings presented in the literature, and discussed to reach final concluding remarks.

Results and Discussion

The data were analyzed for the realizations of LA items and a total number of 9131 LAs were identified. ELT RA writers used 6237(147.14 per 10000 words) and Chemistry writers of RAs used 2894 (94.12 per 10000 words) LAs (see [Table 3](#)). This difference is compatible with the findings of [Peacock \(2010\)](#) if we consider ELT and Chemistry to be representatives of the hard and soft sciences respectively. Indeed, [Peacock](#) reported that non-science writers use a greater number of LAs compared with science writers. He attributes this difference to the fact that writers tend to present and develop claims in a less argumentative way.

They prefer to deal with their research justification, methods, procedures, results, and discussion as narrative and descriptive discourse. Moreover, they show a preference for describing these sections step by step and one by one and expect readers to work out their claims. A closer look at [Table 2](#) displays the differences concerning the frequencies of LAs between the findings of this study and [Gao \(2016\)](#), [Lei \(2012\)](#), [Liu \(2008\)](#), and [Peacock \(2010\)](#). The difference could be justified as in this study RAs were analyzed while in [Liu \(2008\)](#) a variety of written academic texts were analyzed.

Speakers

The use of linguistic devices known as LAs varied between the two groups of research articles (RAs), and these differences can be justified by considering the specific goals of Chemistry RAs. In Chemistry, the writers aim to present the sequence of events, believing that a clear order of procedures, results, and discussions is sufficient for readers to comprehend the claims, arguments, and facts presented in an article. Consequently, these writers do not perceive the need to restate, exemplify, or reformulate their discourse by effectively utilizing LA items. On the other hand, ELT RAs exhibit a greater use of LAs, which could be attributed to their inclusion of more written discourse or the fact that the topics addressed in these RAs necessitate extensive writing. Texts with longer sentences require a higher number of LA items as cohesive markers ([Chen, 2006](#)). The findings of this study have the potential to benefit EFL students, allowing them to observe how disciplinary conventions influence the usage of LAs in RAs. Therefore, it is crucial for instructors and postgraduate students to recognize that disciplinary conventions should be taken into consideration when employing LAs in their writing.

Table 3. *Frequencies of LAs in current study and studies from literature*

	Current study		Peacock (2010)		Lei (2012)		Gao (2016)		Liu (2008)
	ELT RA	Che RA	Science RA	Non-science RA	ELT PhD Dissertations	ELT RAs	RAs by *ENSs	RAs by *CNSs	BNC corpus
*LA	147.14	94.83	119.35	150.55	125.39	117.70	132.6	123	72.91

The results in [Table 4](#) suggest the existence of disciplinary differences in relation to usage of subcategories of LAs. For instance, the uses of “additive” LA differs between ELT and Chemistry. According to this, ELT writers prefer to “introduce explanatory information regarding the topic of discussion” ([Gao, 2016](#)). [Ishikawa \(2016\)](#) believes that the greater use of “additive” LAs helps writers to introduce additional information that intensifies meanings. These study results align with the findings of [Lei \(2012\)](#) and [Liu \(2008\)](#), which may be attributed to the similarities of the analyzed corpora in these studies, both of which focused on academic writing genres.

Table 4. *Frequencies and percentage of categories of LA*

	ELT RAs		Chemistry RA	
	Frequency	Percentage	Frequency	Percentage
Additive	2298	36.85	1024	35.45
Adversative	1336	21.42	484	16.75
Causal / resultative	987	15.82	681	23.58
Sequential	1616	25.91	699	24.22
Total	6237	100	2888	100

Next in the list is the “sequential” LAs based on its frequency of usage. The difference concerning the use of this category indicates that ELT writers treat their studies as narratives that require presenting sequences of events ([Liu, 2008](#)). It seems that in hard science disciplines, Chemistry in this case, writers do not prefer to introduce parallels and the sequential information, which in turn could favor the cohesiveness of those articles.

The “adversative” LAs were more frequent in ELT RAs than in Chemistry RAs. This coincides with [Liu’ \(2008\)](#) observations. The usage of this LA in Chemistry RAs could suggest that chemistry writers prefer to avoid the adversative LAs, as they function as a marker of “compatibility between information in different discourse unit and signal concessive relationships” ([Biber et al., 1999: 878](#)). This function creates a text with more clear connections between units of information, resulting in a to easy-to-follow text.

The usage of the causal/resultative LAs in both disciplines was very similar. The result is comparable to those in studies carried out by [Lei \(2012\)](#), [Gao \(2016\)](#), and [Liu \(2008\)](#). The findings can be explained if we consider that a causal/resultative structure is not required in all the four sections of RA. In general, readers expect to have causal /resultative structures in the sections where a RA presents results and discussions.

[Table 5](#) presents the findings concerning the frequency and the percentage of the usage of subcategories of additive LAs.

Table 5. *Frequencies and percentages of additive subcategory*

	ELT RAs		Chemistry RAs	
	Frequency	Percentage	Frequency	Percentage
Emphatic	1653	72%	839	81%
Apposition/ comparative	620	27%	164	16%?
Similarity comparative	25	1%	24	3%
Total	2298	100%	1027	100%

It is apparent that both sets of research articles (RAs) have given considerable attention to the subcategories of additive linking adverbials (LAs), with a significant emphasis on the realization of emphatic functions (Examples 1-2) and relatively less attention to similarity/comparative functions (Examples 3-4). Noteworthy focus has also been placed on the realizations of apposition/ reformulation functions (Examples 5-6). These findings are consistent with the results reported in the studies conducted by [Peacock \(2010\)](#) and [Ishikawa \(2010\)](#).

The higher frequency of emphatic linking adverbials (LAs) in both disciplines suggests that the writers aim to offer additional supportive information and details, making their statements or claims more comprehensible.

Example 1: **Additionally**, by examining the imitative learning process, instructors can gauge whether genre exemplars reside in students’ ZPD

and ascertain the mediating effect of exemplars. (ELT RAs)

Example 2: **In addition**, the multiple core-shell structures can provide a larger contact area between the catalyst and reactants. (Che RAs)

Example 3: **Alternatively**, students may simply lack awareness of how to express authorial responsibility for propositions such as staking a claim or exercising a critique with an appropriate level of confidence or directness. (ELT RAs)

Example 4: **Alternatively**, the use of long-distance super grid infrastructure to transmit electricity from western states such as Nevada or Utah to population centers of the east coast would be tremendously expensive with logistical challenges and security risks as it travels thousands of miles. (Che RAs)

Example 5: Previous research shows that two types of verb forms are especially meaningful to academic writing in L2 English, **namely** tense and passive voice. (ELT RAs)

Example 6: To quantitatively investigate the growth behavior of the frost layer according to the four operating conditions, **namely**, cooling surface temperature, absolute humidity, air velocity, and air temperature, the average frost thickness on the entire cooling surface was monitored. (Che RAs)

Disciplinary differences were observed in the usage proportions of subcategories of adversative linking adverbials (LAs), as outlined in [Table 6](#). In ELT RAs, three-quarters of the LAs in this category signaled contrast and adversative functions (Example 7). Conversely, in Chemistry RAs, 60% of the LAs in this category were dedicated to presenting a concessive relation between ideas and information (Example 8). Consequently, it can be inferred that the increased use of adversative LAs assists in supporting claims, arguments, and information by juxtaposing them with other conflicting claims, arguments, and information within the same study. In Chemistry RAs, where the focus lies on hard science disciplines and their statistical nature,

writers do not seek validation. Instead, they utilize appropriate adversative linkers to create a cohesive text (Examples 7-8).

Example 7: **In contrast**, rhetorical functions and hedging/ boosting are typically expressed in the sentential co-text rather than self-mention pronouns or person marking. (ELT RAs)

Example 8: **Nevertheless**, before being able to evaluate a solvent on a complete flow sheet basis including primary distillation and recovery operation, it is necessary to obtain insight in the vapor-liquid equilibrium. (Che RAs)

It is worth mentioning that in ELT RAs writers see a room for correction, while in Chemistry RAs writers typically treat their study as inherently valid and feel no need for correction.

Table 6. *Frequencies and percentages of adversative subcategory*

	ELT RAs		Chemistry RAs	
	Frequency	Percentage	Frequency	Percentage
Proper adversative/ concessive	504	37%	299	60%
Constatative	466	35%	64	14%
Correction	240	18%	40	8%
Dismissal	126	10%	89	18%
Total	1336	100%	487	100%

Regarding the subcategories of causal LAs, it is apparent that writers in both sets of research articles primarily utilize LAs to express general causes (Examples 9-10), with approximately 25% of LAs employed to introduce conditional causals (Examples 11-12) (refer to [Table 7](#)). These findings align with the studies conducted by [Parrot \(2010\)](#) and [Liu \(2008\)](#). The use of such LAs aids in effectively presenting information in a clear and resultative manner.

Example 9: **As a result**, they do not see any benefit in adopting an additional role and becoming an EAP practitioner-researcher. (ELT RAs)

Example 10: **As a result**, the LEPw of membrane M-40H was lower than the membrane M-60. (Che RAs)

Example 11: Situating themselves in many different contexts, students perceive a broad range in the application of the concepts and skills, **otherwise** understood as a static property, and make educated guesses regarding how much formal, rhetorical, and procedural maneuvering is needed. (ELT RAs)

Example 12: Of course, it is essential to do a proper ESE analysis by choosing the system boundary as well as the inputs and outputs carefully; **otherwise**, it will result in suboptimal answers. (Che RAs)

Table 7. *Frequencies and Percentages of causal subcategory*

	ELT RAs		Chemistry RAs	
	Frequency	Percentage	Frequency	Percentage
General causal	743	75%	504	74%
Conditional causal	244	25%	177	26%
Total	987	100%	681	100%

[Table 8](#) illustrates the frequencies and percentages of categories of sequential linking adverbials. In both sets of research articles, writers extensively utilized LAs to demonstrate the order of information (Examples 13-14), the time sequence of actions (Examples 15-16), and the logical relation between pieces of information (Examples 17-18). These findings align with the results found in the studies conducted by [Gao \(2016\)](#) and [Liu \(2008\)](#). Therefore, it can be concluded that both sets of writers prioritize presenting sequences of actions, information, or claims in a manner that enhances readers' understanding and contributes to the overall cohesiveness of the text.

Example 13: **First**, the transfer practice, as evidenced in two students' writing, may not be generalizable and only represents a part of what learning transfer entails. **Second**, this study examines learning outcomes targeted

in ESL-FYC courses as the primary source for the students' prior writing knowledge. (ELT RAs)

Example 14: **First**, through early analysis, it became clear that the generation and use of electricity would dominate a solar economy. (Che RAs)

Example 15: There are three linguistic devices which are discussed in Koester (2010) but not found at all in any of the four textbooks; they are vague language (for showing and building shared knowledge), emotive verbs (for showing empathy and solidarity), and humor (for showing empathy and solidarity). **At the same time**, there are three linguistic devices that are identified in our study but not found in Koester (2010). (ELT RAs)

Example 16: **At the same time**, it is further explained that CaO has a stronger effect on coal ash system structure than MgO. (Che RAs)

Example 17: **In summary**, the studies have generated mixed results regarding Themes, specifically textual and interpersonal Themes, in students' academic writing. (ELT RAs)

Example 18: **In summary**, it was found that the circuitry design of 5-4-3 was the most suitable one. (Che RAs)

Table 8. *Frequencies and percentages of sequential category*

	ELT RAs		Chemistry RAs	
	Frequency	Percentage	Frequency	Percentage
Enumerative/listing	1546	95%	643	92%
Simultaneous	30	2%	47	7%
Summative	34	2%	9	1%
Transitional	3	1%	-	-
Total	1616	100%	699	100%

In the [Table 9](#), we can see the most frequent LA items found in this study and those reported in the studies in the literature.

Table 9. Ten most frequent LA items in current study and studies from literature

ELT RAs	Chemistry RAs	Lie 2013		Gao 2016	
		Dissertation	RAs	English L1 writing	Chinese L2 Writings
<i>Also</i> 887					
First 548	<i>Also</i> 388	<i>Also</i>	<i>Also</i>	<i>Also</i>	<i>Also</i>
Second 501	<i>However</i> 238	<i>However</i>	<i>However</i>	<i>However</i>	<i>However</i>
<i>However</i> 433	<i>Therefore</i> 226	<i>Thus</i>	<i>Thus</i>	<i>Thus</i>	<i>Thus</i>
<i>So</i> 334	First 173	<i>Therefore</i>	For example	Then	Then
For example 294	Further 143	For example	i.e.	For example	<i>Therefore</i>
Than 223	Then 161	i.e.	<i>Therefore</i>	<i>So</i>	i.e.
Rather 223	Second 107	<i>So</i>	In addition	<i>Therefore</i>	<i>So</i>
<i>Therefore</i> 215	<i>Thus</i> 94	Then	That is	i.e.	For example
<i>Thus</i> 200	In addition 81	In addition	Again	In addition	In addition
	<i>So</i> 79	That is	<i>So</i>	Finally	Still

Based on the findings presented in [Table 9](#), the analysis focuses on five of the most frequently used linking adverbial items identified in this study and the literature review. The results in [Table 8](#) demonstrate that the LA item “therefore” serves as a general causal indicator in both sets of research articles, with a higher frequency of occurrence in Chemistry RAs (7.35 per 10,000 words) compared to ELT RAs (5.07 per 10,000 words). These results are consistent with the findings of the reviewed studies in the literature. Notably, the results indicate that “therefore” is predominantly used in the initial position of a sentence (Examples 19-20), which aligns with the research conducted by [Narita et al. \(2004\)](#). This preference can be attributed to the writers’ efforts to establish cohesive connections between two sentences ([Narita et al., 2004, p. 1174](#)), thereby emphasizing Chemistry writers’ inclination to create clear linkages between sentence structures or clauses. Furthermore, the use of “therefore” is reinforced by its function as a formal LA indicating a causal or resultative relationship.

Example 19: However, Aviation English is mandated for all pilots and ATCOs in international airspace who do not share a first language. **Therefore**, the assumption that Standard English will be a reliable form of communication may be inaccurate. (ELT RAs)

Example 20: Usually, several streams enter or leave a component and the numbers of unknowns are more than the numbers of equations. **Therefore**, the auxiliary equations are used to solve the set of equations. (Che RAs)

The results in [Table 9](#) suggest that “also” was the most frequent additive LA in both sets of RAs. The frequency of the differences between the two sets of RAs was statically significant suggesting that ELT RA writers favor adding info and make component sentences using “also” to directly show this function. (Example 21-22).

Example 21: As predicted in Section 1.5, Aviation English had less variable vowel interval durations and a higher proportion of vowel than Standard English. Aviation English **also** had less variable consonant interval durations than Standard English. (ELT RAs)

Example 22: As it is clear from Table 2, the capital costs of the compressor and expander are in terms of the consumed or generated electricity works of these components. **Also**, for gas cooler and IHE, the capital costs are calculated based on their heat transfer areas. (Che RAs)

The usage of “also” predominantly appeared in sentence-initial positions, a pattern commonly

avored in conversational discourse. However, it appears that in both sets of research articles (RAs) analyzed in this study, the writers preferred to introduce new ideas within the course of the discourse.

It is important to remind the students about how the information in the discourse could be added by using LAs other than “also” that, in academic writing, are mostly used. [Biber et al. \(1999\)](#) say that “also” is a LA that functions to show that the next unit is additional. In other words, “also” often appears in claims. [Peacock \(2010\)](#), in turn, claims that “also” mostly is used to help presenting claims in an additional structure.

The results (see [Table 9](#)) showed that in both sets of RAs, writers favor using the item “so” (Example 23-24). The differences are statically significant. The use of “so” by Chemistry RA writers could be due to the fact that “so” is more frequently used in the spoken genres ([Liu, 2008](#)). The other justification could be that ELT writers seek to cleanly link their sentences by “so” which serve multi discourse functions. To name some, “to introduce summary”, “to introduce new section”, “introduce elaboration”.

Example 23: The real-life reviewers are anonymous **so** could not be asked for permission to use their reports. (ELT RAs)

Example 24: **So**, the nature of the variation of the PV module temperature at its top and back surface has been studied for various airflow rates and is plotted in Figs. 4 and 5. (Che RAs)

The result suggests that there were disciplinary differences concerning the usage of “however” as an LA item (see [Table 9](#)). Both groups of writers preferred showing the adversative relation between two clauses in the sentence initial position (Examples 25-26). This use could facilitate the reader’s interpretation of the discourse. The greater use of LAs such as “however” could be understood as that writers’ preference for joining the text parts to create surface logicity.

Example 25: This literature review has shown that existing studies have provided information

in varying degrees of detail about different aspects of the workplace communication needs of Hong Kong people. **However**, no studies have yet provided a long-term and holistic view of professionals’ workplace communication needs at different stages of their careers. (ELT RAs)

Example 26: In the cited works, the authors determined the values of the Peclet number for the entire apparatus and for its individual zones. **However**, for the hybrid fluidized-bed airlift apparatuses, no such studies have been carried out so far. (Che RAs)

The results suggested that there are the discipline differences between the two sets of RA concerning the use of “thus” LA item. “Thus” in some genres was treated as the most frequent LA, indicating a “cause /result” in academic writing (Examples 27-28).

Example 25: One major difficulty lies in recruiting participants who can serve as informants for years or even decades, **thus** enabling the researcher to collect real-time data related to their use of English as their careers proceed. (ELT RAs)

Example 26: It can be seen that this solution accurately describes changes in the tracer concentration in an apparatus with liquid circulation, **thus** it can be used both for the determination of Pe and mix. (Che RAs)

The results are presented in this section and discussed by referring to some examples from the corpus. In the next section, general conclusions are stated and recommendations for further studies are stated as well.

Conclusion

This research intended to report the frequencies and the functions of LAs across the two sets of RAs published in two disciplines namely ELT and Chemistry. The data were analyzed based on [Liu’s \(2008\)](#) taxonomy. From the results, the following conclusions can be drawn. First, there were differences between the two sets of RAs

concerning frequencies of LA items. As a result, in a soft discipline as ELT, writers use more LA items to argumentatively present and develop the claims. Thus, the frequency of LA items seems to be imposed by the nature of the discipline and we need to increase the awareness of ELT and non-science writers to this concluding remark. Second, concerning the categories of LA, we see that “additive” was the most frequent LA in both sets of RAs, while “causal/resultative” and “adversative” were the least frequent in ELT and Chemistry RAs respectively. These similarities and differences could help us reach the conclusion that writers need to know about the LA items that are required to be used based on the nature of genre (RA in this study) or disciplines. Third, as to the subcategories of LA, it seems that mostly the frequency and functions are imposed by the nature of RAs as the genre of study. Fourth, some of LA items, in both sets of RAs were used more frequent than other LAs and RA writers need to be aware of the frequent LA items. Finally, it could be mentioned that the academic writers need to be aware of the importance of LA items in their academic writing genres. Therefore, there is a need to consider the most frequent LA items, categories, and subcategories that could help writing become more cohesive. Thus, it seems necessary to include such an information on LA items in syllabus developed for teaching RA. Examples concerning the use and functions of LA items should be given to the students to help better understand and use when reading and writing RA.

Future research on this subject could focus on the following suggestions. First, as it was evident in the current study that LAs selections were imposed by the nature of RA and the nature of the disciplinary conventions of writing. Such a list could help in guiding students in developing RAs. This study showed the importance of LA items in RAs from two disciplines. It is suggested that LA items are important in RAs as they act as signals and cohesive devices that help writers maneuver more effectively to make and/ or so to strengthen the claims and the arguments. This is achieved in significantly different ways in different disciplines suggesting the disciplinary difference in this regard. Since the present study is quantitative in nature and mostly focused on the realizations of LA items in RAs, it

seems necessary to suggest further research studies that explore the realizations of LA syntactically and semantically. Also, this study is limited as it only focused on one type of academic written text, RAs, thus, it is suggested that a further research cover other types of academic writings such as term papers, MA theses, PhD dissertations, and essays. Research studies of this type could provide us with a complete list of LA items in academic genres.

References

- Biber, D., Johansson, S., Leech, G., Conrad, S., & Finegan, E. (1999). *Longman grammar of spoken and written English*. Longman.
- Celce-Murcia, M., & Larsen-Freeman, D. (1983). *The grammar book: An ESL/EFL teacher's course*. Newbury House.
- Celce-Murcia, M., & Larsen-Freeman, D. (1999). *The grammar book: An ESL/EFL teacher's course* (2nd ed.). Heinle & Heinle.
- Chen, C. (2006). The use of connective adverbials in the academic papers of advanced Taiwanese EFL learners. *International Journal of Corpus Linguistics*, 11 (1), 113–130.
- Gao, X. (2016). A cross-disciplinary corpus-based study on English and Chinese native speakers' use of linking adverbials in academic writing. *Journal of English for Academic Purposes*, 24, 14-28.
- Halliday, M. A. K., & Hasan, R. (1974). *Cohesion in English*. Routledge.
- Ishikawa, S. I. (2010). A corpus-based study on Asian learners' use of English linking adverbials. *Themes in Science and Technology Education*, 3(1-2), 139-157.
- Jalilifar, A. R. (2009). *Research article in Applied Linguistics: A gender-based writing guide*. Ahwaz: Shahid Chamran University Press.
- Lei, L. (2012). Linking adverbials in academic writing on applied linguistics by Chinese doctoral students. *Journal of English for Academic Purposes*, 11(3), 267-275.
- Liu, D. (2008). LAs: an across-register corpus study and its implications. *International Journal of Corpus Linguistics*, 13(4), 491–518.
- Narita, M., Sato, C., & Sugiura, M. (2004). Connector Usage in the English Essay Writing of Japanese EFL Learners. *LREC*, 27, 1171-1174.

- Parrott, M. (2010). *Grammar for English Language Teachers: with exercises and a key*. Ernst Klett Sprachen.
- Peacock, M. (2010). Linking adverbials in research articles across eight disciplines. *Ibérica: revista de la asociación Europea de lenguas para fines específicos*, 20, 9-34.
- Quirk, R., Greenbaum, G., Leech, G., & Svartvik, J. (1985). *A comprehensive grammar of the English language*. Longman.
- Shi, J. (2017). A corpus-based study of contrastive/concessive linking adverbials in spoken English of Chinese EFL learners. *Studies in Literature and Language*, 14(2), 17-25.
- Swales, J. M. (1990). *Genre analysis: English in academic and research setting*. Cambridge: Cambridge University Press.
- Swales, J. M. (2004). *Research genres: Explorations and applications*. Cambridge: Cambridge University Press.



Appendices

Appendix 1. Frequencies of linking adverbials

Linking adverbial	ELT	Chemistry
Additive LAs (emphatic)		
Above all	0	0
additionally	26	36
Also	825	376
And also	25	12
But also	84	18
As well	142	69
As i	10	1
As they	61	2
You say	0	0
As a matter of fact	0	0
again	54	12
beside	1	1
In additon	104	77
Inaddition to	39	15
further	176	143
Further more	0	0
moreover	55	64
Not to	28	2
Of course	15	6
Not to mention	0	2
To cap it all	0	0
To crown it all	0	0
What is more	0	0
Too	8	3
subtotal	1653	839
Apposition/ Refurmulation		
i.e.	85	53
That is	118	43
That is to say	1	1
In other word	0	0
For example	289	39
For instance	89	11
For one thing	1	0
namely	37	17
To put it another way	0	0
To put it bluntly/mildly	0	0
What im saying is	0	0
What i mean is	0	0
Which is to say	0	0
subtotal	620	164

Similarity Comparative		
Alternatively	10	2
By the same token	0	0
correspondingly	2	2
likewise	13	1
similary	0	19
Subtotal	25	24
total	2298	1027
Adversative LAs		
Properessiveadversativeve/ concessive		
At the same time	22	18
however	382	226
nevertheless	34	11
nonetheless	10	1
Of course	15	6
Then again	0	0
though	54	18
Yet	67	14
Subtotal	584	294
Contrastive		
Actually	43	1
As a matter of fact	2	0
conversely	3	1
In/ by comparison	7 / 22	19 / 1
In /by contrast	22 /38	11 / 4
In fact	57	5
In reality	1	0
On the other hand	61	22
Subtotal	256	64
Correction		
Instead	6	90
On the contrary	4	4
rather	211	14
Subtotal	305	40
dismissal		
Adimittedly	0	0
After all	7	2
At the same time	22	18
Any how	0	0
Any way	2	0
At any rate	0	0
despite	69	17
Despite this	4	0
Despite that	0	0

In any case	1	1
In spite of this/that	0 / 2	1 / 0
still	84	50
Subtotal	191	89
Total	1336	487
Causal/ Resultative LAs		
General causal		
Accordingly	14	4
As a result	32	31
As a consequence	0	0
Because of it/this/that	0	0
consequently	23	33
In consequence	1	3
Naturally	8	2
Hence	49	36
So	211	79
And so	30	4
Therefore	192	221
Thus	183	91
Subtotal	743	504
Conditional causal		
All thing considered	0	0
In such a case/cases	0	4 / 0
In that case	1	7
Otherwise	25	5
Then	218	161
subtotal	244	177
total	987	681
Sequential LAs		
Enumerative/listing		
Afterward	0	4
Eventually	11	4
first	446	153
firstly	13	11
First and foremost	4	0
First of all	1	0
In the first place	2	0
To begin with	2	1
second	501	86
secondly	10	7
third	83	37
Thirdly	1	3
Fourth/fourthly	0 / 20	1 / 1
finally	90	52
Last	22	25
lastly	12	3
Last of all	0	0

Next	52	43
then	218	158
And then	58	54
Subtotal	1546	643
simultaneous		
At the same time	22	18
In the meaning	2	0
meanwhile	6	29
Subtotal	30	47
Summative		
In sum	10	1
In summary	9	5
All in all	0	0
In a word	0	0
In conclusion	1	2
To conclude	8	0
To sum up	2	0
To summarize	7	0
In short	0	1
Subtotal	37	9
Transitional to another topic ,etc.		
By the by	0	0
By the way	0	0
Incidentally	3	0
Subtotal	3	0
Total	1616	699
TOTAL	6237	2894