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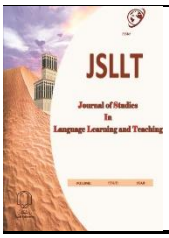

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Lexical Bundles in Biomedical Engineering Research Articles: Investigating Native vs. Nonnative Writers' Preferences

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Abstract

The present research aimed to study how lexical bundles are used in research articles authored by English native and Iranian nonnative writers in the field of biomedical engineering. The type and frequency of lexical bundles employed in the discussion sections of 50 native and 50 nonnative research articles were examined using the AntConc software. The results indicated that, compared to native writers, nonnative ones have a greater tendency to use lexical bundles. In addition, it was found that the variety of the bundles employed in the articles written by nonnative writers is higher. Regarding the type of the bundles, the results revealed that prepositional phrases with of-phrase and other prepositional phrases were more frequent in the native articles, while other prepositional phrases and verb phrases were used more in the nonnative articles. The least frequency in both groups of the articles was related to adverbial clauses. The findings of the present research can be used in syllabus design and materials preparation for academic writing courses.

Keywords: Biomedical engineering, Lexical bundles, Native, Nonnative, Research article.

I | INTRODUCTION

Academic writing in English for researchers means not only familiarity with academic writing conventions but also a good knowledge of their discipline (Durrant, 2017). One important dimension of academic writing is formulaic language, including lexical bundles (Biber & Conrad, 1999).

There are different definitions suggested for lexical bundles (Cortes, 2004; Hyland, 2008). According to Biber et al. (1999) they are "extended collocations: bundles of words that show a statistical tendency to co-occur." (p. 989). Based on this definition, "lexical bundles can be regarded as extended collocations: bundles of words that show a statistical tendency to co-occur." (p. 989). As Biber et al. (2004) suggest, lexical bundles can be categorized according to their functions into three main groups: "stance expressions, discourse organizers, and referential bundles". (p. 384). While stance bundles are mainly employed to show the degree of certainty or the writer's opinion and position, discourse organizers express the connection between prior text and the upcoming one, and referential bundles refer to abstract and physical objects or to the same text (Biber et al., 2004, p. 384).

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Several categorizations have been suggested for lexical bundles (Biber et al., 1999; Cortes, 2004; Biber & Barbieri, 2007; Hyland, 2008). The taxonomy suggested by Biber et al. (1999) was employed in the present research since it is detailed and also appropriate for the aim and corpus of the study. Table 1 shows the structural patterns introduced in their taxonomy.

Table 1. Structural pattern of lexical bundles (Adapted from Biber et al. 1999, pp. 1015-1024)

Structural Pattern	Examples
Noun phrase with of-phrase	*The end of the, the part of the*
Noun phrase with other post-modifiers	*The extent to which, the fact that the*
Prepositional phrase + of-phrase	*As a result of, on the basis of*
Other prepositional phrases	*By the fact that, in addition to the*
Anticipatory it + verb /adjective phrase	*It is difficult to, it has been shown*
Passive verb + prepositional phrase	*Can be found in, is given by the*
Copula be + noun/adjective phrase	*Is one of the, is similar to that*
That-clause fragment	*Should be noted that, that there is a*
To-clause fragment	*Are likely to be, to be able to*
Adverbial clause fragment	*As we have seen, if there is a*
Pronoun/noun phrase + be	*This is not the, there has been a*
Other expressions	*As well as the, than that of the*

There have been some research works on lexical bundles employed in different text types (Breeze, 2013; Kashiha & Chan, 2013; Jalali et al., 2014; Jalali & Moini, 2018; Chen, 2019) but there has been little research about the use of lexical bundles in biomedical engineering texts. Moreover, a gap exists in the research about the way native vs. non-native authors use lexical bundles. Thus, the present study was set to examine the type and frequency of lexical bundles used in the academic articles of biomedical Engineering field authored by English native vs. Iranian non-native researchers. The discussion section of the articles was chosen as the corpus.

II. REVIEW OF LITERATURE

There has been an increasing number of research works related to lexical bundles over the last decades. Biber et al. (1999) examined the interplay between structure and use in grammatical description. As Conrad and Biber (2005) state, the frequency of lexical bundles can be determined by considering various aspects such as "the diversity of lexical bundles, the percentage of lexical bundles in the context, and the frequency of bundles in discourse" (p.7). Conrad and Biber (2005) state "the more frequent structures of lexical bundles employed in academic texts are used for identifying the aspects of information (for example, *as a consequence*)". In addition, they mention that based on their function, lexical bundles can be classified into: "stance expressions, discourse organizers, referential expressions, and special conversational functions" (p. 10). Furthermore, they argue that "most of the four-word lexical bundles used in academic texts are referential expressions" (p. 10).

A group of studies in the literature deal with different patterns of lexical bundles used in different texts related to different fields. For example, in the study by Breeze (2013), the most common lexical bundles in legal texts were examined and it was found that in legislation documents numerous noun bundles, prepositional phrases and verb phrase bundles of various lengths are used. Kashiha and Chan (2013) examined academic lectures and found that in humanities, nouns and prepositional phrases were the most frequent structures. Jalali et al., (2014) studied lexical bundles used in medicine papers and the results indicated that the writers of those articles tend to use prepositional phrases the most and the *verb phrase + that clause* the least. The study by Jalali and Moini (2018) revealed that lexical bundles including noun-phrases and phrasal bundles were found to be more frequent. Chen (2019) argues that most of the bundles used in the introductory part of the textbooks related to electrical engineering and business are referential bundles.

Some other studies concentrate on the way lexical bundles are employed by native vs. nonnative authors. They are summarized in the following.

A comparative study of lexical bundles employed in three text groups, namely, native experts' writings, native students' writings, and L2 students' writings was done by Chen and Baker (2010). They found that lexical bundles employed by both groups of nonnative and native students have similar structural and functional characteristics. Referential bundles were very frequent in expert texts.

Shahriari Ahmadi et al. (2013) studied lexical bundles in the abstract part of applied linguistic research papers authored by Iranian and English native authors. According to the findings of their study, advanced writers are more likely to use more bundles, especially the ones related to a specific genre. In addition, Iranian authors used more clausal fragments and subordinations in their abstracts. In both sub-corpora, most of the bundles used by the writers were phrasal, mostly verb phrasal elements followed by dependent clauses and verb phrase fragments.

Karabacaka and Qin (2013) investigated different nationalities. The corpus was compiled from the argumentative term papers written by Chinese, Turkish and American students. The reference corpus which was used for comparison included one million words from two American newspapers. According to the findings of their study, American students used almost 60 bundles that were not observed in the writings of Turkish and Chinese students. Karabacaka and Qin (2013) indicate that there are three reasons which can explain this result: first, the topic of the writing is very important in using certain lexical bundles as the American students used the bundles related to the U.S. topics but the other students didn't use. Second, non-native students are not familiar with most bundles and they do not use them in their texts. Third, the non-native students may know about the existence of different bundles or they may have read them in various texts but they are not able to produce them due to the lack of complete linguistic knowledge. For example, they may miss an article or other linguistic item and as a result, they fail to produce a complete and appropriate bundle. The results were similar to the ones reported by Chen and Baker (2010). They state that even advanced students may not employ the appropriate lexical bundles in their texts. For example, the native writers used specific lexical bundles in the text because of their complete familiarity with them but they did not take risk to make new lexical bundles.

Heng et al. (2014) examined bundles used by the members of discussion groups in a university setting. The results of their research show that the students prefer to use three and 4-word bundles in their group talks rather than 5-word bundles. Thus, teachers should focus on these strings of words when teaching speaking English. Moreover, the results of structural distribution presented in their study revealed that the students use various structures to generate bundles in their talks. Also, the students have a tendency to use phrasal rather than clausal lexical bundles as they consist of either prepositional, noun, or verb phrases.

Another study was conducted by Nam (2017). They compared the functional distribution of bundles used in texts written by Korean and native English college students. It was found that compared to the Korean students, the native students tend to use more referential bundles and less expression bundles in the writings they developed. On the other hand, the Korean students used a higher amount of stance bundles and discourse organizers in their argumentative texts. In general, native students used referential bundles to make reference to entities and contexts; however, Korean students focused on stance bundles to mention their judgments and evaluations as well as discourse organizers to structure their writings. As Korean students preferred to use a large number of conversational bundles, but native students did not, he concluded that this fact affects the formality and expertness of Koreans' texts. Also, Korean students used a narrow range of bundles which made their essays repetitive and simple. However, the native students used a wide range of bundles which made their texts unique.

Rahimi Azad and Modarres Khiabani (2018) studied the syntactic patterns of bundles used in the abstract section of academic articles belonging to three fields of study: business, history, and linguistics. It was indicated that both similarities and differences exist between the two sets of texts regarding the patterns

employed. The nonnative authors used plenty of frequent lexical bundles but the variety of the bundles used was lesser. Moreover, the Iranian nonnative authors used a restricted number of passive bundles because they mainly have problems with this structure. Since passive bundles are important in persuading the readers, conveying the stance of the author, and engaging the readers, the instructors of advanced writing courses have to emphasize the use of passive bundles in their classes.

All in all, the above literature review indicates that few research works addressed biomedical engineering research articles. Moreover, the way English native vs. Iranian nonnative writers of academic texts employ lexical bundles in biomedical engineering field has not been investigated yet. Considering the above-mentioned gaps, the present research aimed to study lexical bundles in research articles related to biomedical engineering and the cross-cultural variations observed in the written production of English native vs. Iranian nonnative researchers. The research question addressed was:

> - What are the frequency and types of lexical bundles used in the discussion section of the biomedical engineering research articles written by English native and Iranian nonnative writers?

Regarding a growing interest for writing research articles in English, it is important for nonnative writers to know how various linguistic element including bundles are employed by English native writers. The findings are hoped to be useful in syllabus design and materials preparation for writing courses to familiarize novice nonnative writers with the way different types of lexical bundles are employed in research papers.

III. METHODOLOGY

1. Corpus

The texts investigated in the present research include 100 research articles from biomedical engineering field, 50 articles authored by English native writers and 50 articles written by Iranian nonnative authors.

The articles by native writers were chosen from Elsevier's journals (Appendix 1*)*. The articles authored by Iranian nonnative writers were chosen from a well-known and reliable journal on biomedical engineering published by an Iranian medical university (Appendix 2). A 10-year time span (2010-2021) was observed for selecting the texts. The present study concentrated on the discussion part of the articles because in this part, the researchers contextualize their findings, explain expected/unexpected results, evaluate their significance, and consider possible alternative explanations.

In the process of text selection, some articles were discarded and replaced due to several reasons. First, in some native articles, the corresponding author was an Iranian researcher while based on our criteria, the corresponding writer of native corpus had to be a non-Iranian researcher who was professional in English. Second, the discussion section of several articles was less than 500 (±10) words, so they did not meet our criteria and had to be replaced. Finally, in some articles, the discussion and conclusion parts were merged and it was almost impossible to distinguish their border line. As a result, in order to be more precise, these articles were replaced with the ones which had separated discussion and conclusion parts.

2. Data Analysis

First, the first 500 (±10) words of the discussion part of the articles were selected and examined using software AntConc version 3.5.8. Generally, the length of lexical bundles varies from 3 words to 9 words (Biber et al., 1999, 2004a; Cortes, 2013). In this research, the length of lexical bundles was set

as "four because four-word bundles offer a wider variety of structure and function to analyze" (Hyland, 2012, p.151). Moreover, four-word lexical bundles embrace many of three-word bundles (Cortes, 2004; Hyland, 2008). Also, the range of lexical bundles was set as two. It means that the bundles had to be seen in at least two various papers in order to be considered in the analysis.

After the identification phase, the bundles were analyzed and categorized based on their grammatical patterns and discourse functions as suggested in the categorization of lexical bundles by Biber et al. (1999) (Table 3). Then, their frequencies were calculated. In order to be reliable, after a time lapse of 10 days, the corpus was checked again. Also, some texts were rechecked manually by the researchers to establish reliability.

IV. RESULTS

In Table 2, the frequency and percentage of lexical bundles used by Iranian nonnative writers of biomedical articles are presented.

Table 2. Frequency and percentage of lexical bundles in nonnative biomedical articles.

Type of bundle	Frequency	Percentage
NP with of-phrase	29	%14.6
NP with other post modifiers	5	%2.5
Prepositional phrase with of-phrase	22	%11.11
Other prepositional phrases	44	%22.22
Anticipatory it + VP/adj phrase	22	%11.11
Passive verb + prep phrase	6	%3
Copula be + NP/adj phrase	14	%7
VP + that-clause	33	%16.6
VP/adj phrase + to-clause	16	%8
Adverbial clause	0	%0
Pronoun phrase / NP + be	3	%1.5
Other expressions	4	%2

As Table 2 indicates, the most frequent type of bundle used in nonnative biomedical engineering is other prepositional phrases with the percentage of 22 and after that, VP followed by that clause are frequent. In contrast, the least frequent type of bundle in biomedical engineering articles was adverbial clause with the percentage of zero.

Examples of other prepositional phrases used in nonnative articles are mentioned in the following:

1) *To the best of our knowledge, this study,* ***for the first time****, assesses the diagnostic utility of HDAC8, as a potential tumor marker for differentiation of TNBC from nTNBC subjects.*
2) *These findings are* ***in accordance with the*** *results of a previous study implying that a high percentage of phospholipase production (53.8- 74%) by C. albicans isolates.*

Examples of that-clause fragment employed in nonnative articles are given in the following:

3) *Several studies* ***have demonstrated that the*** *overall level of protein production is reduced with age.*
4) *Some studies* ***have reported that the*** *expression of PSMA further enhances in high-grade, metastatic, and castration-resistant prostate cancer.*

Table 3 demonstrates the frequency and percentage of lexical bundles used in native biomedical articles.

Table 3. Frequency and percentage of lexical bundles in native biomedical articles.

Type of bundle	Frequency	Percentage
NP with of-phrase	1	%0.8
NP with other post modifiers	2	%1.6
Prepositional phrase with of-phrase	32	%26.4
Other prepositional phrases	19	%15.7
Anticipatory it + VP/adj phrase	13	%10.7
Passive verb + prep phrase	11	%9
Copula be + NP/adj phrase	10	%8.2
VP + that-clause	10	%8.2
VP/adj phrase + to-clause	13	%10.7
Adverbial clause	0	%0
Pronoun phrase / NP + be	5	%4.1
Other expressions	5	%4.1

As is illustrated in Table 3, in native biomedical engineering articles, the most frequent types of lexical bundle are prepositional phrase with of-phrase with the percentage of 26.4. However, the least frequent type of bundles is adverbial clauses with percentage of zero.

Examples of prepositional phrase with of-phrase used in native articles are mentioned in the following:

5) ***In the case of*** *FHR-A2 signals, the literature algorithms CM-1 and CM-2, had a tendency to increase signal duration - Time T.*
6) *The spermatozoa membranes are rich in polyunsaturated fatty acids, so they are susceptible to ROS attack and lipid peroxidation* ***as a result of*** *exposure to mercury.*

Examples of other prepositional phrases include in the native articles are given in the following:

7) *Most studies reported the use of a CAD/CAM surgical splint without further modification, and concluded that it was a reliable substitute for the laboratory-fabricated occlusal splints* ***with respect to the*** *accuracy of occlusal fitting.*
8) ***In the present study****, administration of clomiphene citrate increased the activity levels of 3b-HSD and 17b-HSD in rats, indicating increased steroidogenesis and function of Leydig cells.*

The frequencies obtained were checked to know whether the observed frequency in each variable is equal to the expected frequency or not. In doing so, chi-square test for the distribution of frequency of lexical bundles was used and the following results were derived.

In Tables 4-5, the observed and expected frequencies of lexical bundles as well as their residuals in native biomedical engineering are presented.

Table 4. Observed and expected frequencies of lexical bundles in native biomedical engineering.

	Observed N	Expected N	Residual
1	1	15.1	-14.1
2	2	15.1	-13.1
5	10	15.1	-5.1
10	20	15.1	4.9
11	11	15.1	-4.1
13	26	15.1	10.9
19	19	15.1	3.9
32	32	15.1	16.9
Total	121		

Table 5. Test Statistics of Native Biomedical Engineering.

	Native biomedical engineering
Chi-Square	56.653[a]
df	7
Asymp. Sig.	.000
a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 15.1.	

As Tables 4 and 5 indicate, the p-value of the native biomedical engineering corpus is .000, its degree of freedom is 7, and its chi-square is 56. Since 0.000 is lower than the significance level of 0.05, from the data available, it can be concluded that the frequency observed for this variable is not equal to the expected frequency.

Tables 6-7 shows the observed and expected frequencies of lexical bundles as well as their residuals in Iranian non-native biomedical engineering articles.

Table 6. Observed and expected frequencies of lexical bundles in Iranian non-native biomedical engineering.

	Observed N	Expected N	Residual
3	3	19.8	-16.8
4	4	19.8	-15.8
5	5	19.8	-14.8
6	6	19.8	-13.8
14	14	19.8	-5.8
16	16	19.8	-3.8
22	44	19.8	24.2
29	29	19.8	9.2
33	33	19.8	13.2
44	44	19.8	24.2
Total	198		

Table 7. Test Statistics of non-native biomedical engineering.

Chi-Square	122.202[a]
df	9
Asymp. Sig.	.000
a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 19.8.	

As Tables 6 and 7 show, the p-value of the given corpus is 0.000, its degree of freedom is 9, and its chi-square is 122. Since 0.000 is lower than the significance level of 0.05, the expected frequency is not equal to the observed frequency.

In Table 8, the chi-square test results for the variables are presented.

Table 8. Results of chi-square test.

	Non-native biomedical engineering	Native biomedical engineering
Chi-square	122.202	56.653
df	9	7
Asymp. Sig	.000	.000

As Table 8 indicates, the frequency of bundles in native biomedical articles is 121 and in non-native ones is 198. However, the relationship between these two variables is not significant, as it is shown in Table 4.15. The p-value of this relationship is 0.476 which means it is in a negative direction and there is no relationship between them.

Table 9 presents the total number of frequencies as well as the most and the least frequent type of bundle in each group of articles.

Table 9. Total number of frequencies and the most and least frequent type of bundles.

	Native biomedical engineering	Non-native biomedical engineering
Frequency	121	198
The most frequent type of bundle	*Prepositional phrase with of-phrase*	*Other prepositional phrases*
The least frequent type of bundle	*Adverbial clause*	*Adverbial clause*

Some lexical bundles were more frequent in the texts under investigation. The most frequent structures are presented in the following.

Examples of frequent prepositional phrases in native biomedical engineering articles:

9) ***In the case of*** *the DATA2, since the reference time series of events were available, it was possible to analyze erroneous corrections at the level of particular heart cycles.*
10) *In analysis of instantaneous FHR variability, the most clinically important are quantitative indices which were already defined in early 60 s, and were based on invasive fetal electrocardiography providing the FHR signal* ***in a form of*** *time series of events.*
11) ***In the present study****, administration of clomiphene citrate increased the activity levels of 3b-HSD and 17b-HSD in rats, indicating increased steroidogenesis and function of Leydig cells.*
12) ***In addition to the*** *data on the transport across cell membrane, the measurements of their permeability across dialyzer membrane for the particular dialyzer need to be performed as this parameter for such solutes is not generally known.*

Examples of frequent prepositional phrases in nonnative biomedical engineering articles:

13) ***On the other hand****, the late diagnosis of TNBC increases the complexity of treatment, providing a poor prognosis for this type of cancer.*
14) ***For the first time****, the results of our study showed anti-proliferative and suppressive ability of P. chenur methanolic extract on human colon cancer HCT-116 cells, while under the same condition, it did not inhibit cell proliferation of Vero cells (IC50 value at concentration of 182.1 µg vs. 517.9 µg, respectively).*
15) ***In the absence of*** *apoptosis stimulator, BCL-2 is activated and prevents all of these events and causes cell survival.*
16) *Our results are* ***in agreement with a*** *previous finding that demonstrated MMP-9 involvement in the pathogenesis of brain injuries and cognitive disorders.*

Examples of frequent verb-phrase bundles in native and nonnative biomedical engineering articles:

17) *Although PARP inhibitors* ***have been found to*** *be synthetically lethal in cells not expressing BRCA1/2, such mutations are not frequent in many tumors, including PCa malignant cells.*
18) *Some* ***studies have reported that*** *the expression of PSMA further enhances in high-grade, metastatic, and castration-resistant prostate cancer.*
19) *This observation may partly* ***be due to the*** *discrepancies between the enzymatic activity and gene expression of MMP-9.*
20) *The intuition* ***is related to the*** *whole flow of water in blood.*
21) *The LCD* ***is based on the*** *fractal dimension concept that represents the number of effective DoFs.*
22) *Sampen* ***was considered to be*** *particularly suitable for revealing EHG changes in relation to pregnancy progression and labor.*

Examples of frequent noun-phrase bundles in both native and nonnative biomedical engineering articles:

23) ***The relationship between the*** *expression of mi*R-95-3p *and serum CEA levels suggests that mi*R-95-3p *may be a potential biomarker in the diagnosis of CRC.*

24) ***One of the reasons*** *that we did not find statistically significant differences between pooling sensitivity and specificity and pooling predictive values may be the relatively low number of studies per meta-analyses.*
25) ***The expression level of*** *rec-tPA in transfected L. tarentolae P10 was achieved up to 0.17 µg/ml equal to 70 IU/ml.*
26) *Since keratinocytes play* ***an important role in*** *wound healing, committing stem cells to the keratinocyte lineage could be feasible by various strategies.*
27) ***The results of the*** *HFSCs treatment on the re epithelialization process revealed that the length of the newly regenerated epidermal layer and epidermal thickness were significantly elevated.*
28) *This result was expected because* ***the expression of the*** *two reporter genes in L. major had previously been shown to increase swelling in the footpad.*

V. DISCUSSION

According to the results of this study, generally, the native authors of academic texts, compared to the nonnative writers, employed less lexical bundles. Furthermore, the native writers used a series of bundles which were not found in the articles of nonnative writers. This finding shows that native writers have a greater tendency to use a wide range of bundles possibly due to the constant exposure they have to English but they use less of them in order to make their texts more formal.

This result is in keeping with those obtained in the study by Karabacaka and Qin (2012) which indicated that the nonnative writers do not have a complete familiarity with most bundles so they do not use them in their texts; or, they may know the existence of different bundles or they may have read them in different texts but they are not able to produce them because of the lack of complete linguistic knowledge. However, native writers use a wide range of bundles since they were exposed to them throughout their life.

Moreover, the findings of the present research are similar to the results of Nam (2017) and Hadizadeh and Jahangirian (2022) which indicated that the nonnative students employed more bundles than the native ones. Nam (2017) believes that this fact affects the proficiency level and formality of nonnative's texts. Also, the nonnative students employed a narrow range of lexical bundles which made their texts simple and repetitive. Also, the native authors used a variety of lexical bundle patterns which made their texts more formal and unique.

In addition, the findings of the present study are in conformity with the those reported by Rahimi Azad and Modarres Khiabani (2018) as they state that nonnative authors use complete noun phrases as well as noun phrases followed by of-phrase fragments the most. The results of the present study revealed that adverbial clauses (for e.g., *as we shall see, if there is a, as displayed in table*) have been used less frequently in the two sub-corpora. Furthermore, this finding is in line with the findings of Rahimi Azad and Modarres Khiabani (2018) which indicate that adverbial clauses and that-cluses are the least-used structures in the writings of Iranian nonnative authors.

VI. CONCLUSIONS, IMPLICATIONS AND LIMITATIONS

The results of the present research indicated that there is a relationship between nonnative writers' L1 writing background and the tendency to employ more bundles. Also, it was found that native researchers use fewer lexical bundles in their texts, but the variety of their lexical bundles is higher. Furthermore, it was found that, in biomedical engineering research articles, of-phrases and other prepositional phrases are more frequent. Another finding was that prepositional phrases other than of-phrases and verb phrases were used the most in nonnative articles. In addition, it was revealed that adverbial clauses are the least frequent type of bundles. The most frequent lexical bundles were also identified in the articles developed

by native vs. nonnative writers. These two sets of lexical bundles are important because they reflect an important aspect of the writers' knowledge of the discipline. The ones frequently employed by native writers can be included and emphasized in the materials developed for ESP/EAP purposes to help researchers establish a better relationship with the other members of the scientific community.

As previous researchers such as Chen and Baker (2010) and Cortes (2004) suggest, the bundles that nonnative authors use are different from the ones used by native writers. However, what demarcates professional writers from novices is their lexical competence and the use of formulaic language. Many nonnative writers have difficulty using formulaic language because they do not possess the required linguistic knowledge (Wei, 2009) or they lack proper education in this field (Cortes, 2004). Also, many native writers use specific lexical bundles in their writings due to their familiarity with them, but they cannot make new lexical bundles because of the lack of required knowledge. So, the results of the present research can help researchers and students of biomedical engineering to increase their awareness about the structure of bundles used in this discipline. Also, they can get acquainted with discipline-specific bundles.

Moreover, the findings of the present study can help syllabus developers design proper materials in which the importance of bundles is highlighted. As a result, non-native authors will be able to produce more native-like texts, and native authors can make their texts more formal and unique. In general, by learning how and when to use lexical bundles, writers can organize their texts, control the flow of the texts, and show their attitudes and stances in more efficiently.

In addition, teachers of writing courses can highlight the significance of discipline-specific bundles in the field by showing the students how these formulaic sequences are used in the sentence to determine moves, steps, and attitudes. Reading teachers can also benefit from the findings of this study to help the students facilitate their reading by recognizing the function of each set of bundles. For instance, they can teach students what bundles are used to introduce a statement that contrasts with a previous statement or what bundles are used to show the relation.

As a limitation, the focus of the present study was on the discussion part of the articles. However, future studies may concentrate on other the parts of articles such as introduction sections. In this research, the lexical bundles employed in native writers' articles were compared to the bundles used by Iranian nonnatives. Research articles written by those of nationalities with a different L1 writing background culture can be investigated too. In addition, this study, used research articles for analysis, but future studies can examine other academic texts such as textbooks.

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Appendix 1. Biomedical engineering articles written by English native writers

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