

Comparative Study of Nominalization in Applied Linguistics and Biology Books

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Abstract

This study explored nominalized expression types in an applied linguistics book and a biology book as 2 distinct disciplines. The books were carefully read, the nominalized expression types were identified, the frequencies of the nominalization types were counted, and eventually chi-square was administered. Results revealed no significant difference in using nominalization. Furthermore, the density of nominalization was calculated by dividing their frequency by the total number of words. Results acknowledged the greater concentration of nominalization in the applied linguistics book. Furthermore, the proportion of nominalization to grammatical metaphor was calculated. Results demonstrated the greater tendency towards nominalizing scientific information in the applied linguistics book. This research can contribute to a better understanding of nominalization in academic textbooks and, thus, improve English for Specific Purposes learners' use of nominalization in their writing. However, further research is needed to see how nominalization is exploited in other genres and other disciplines.

Keywords: Systemic Functional Linguistics; Grammatical Metaphor; Nominalization

1. Introduction

Systemic functional linguistics (SFL) interprets language as interrelated sets of options for making meanings and seeks to provide a clear relationship between functions and grammatical systems (Halliday, 1994). Systemists focus on "how the grammar of a language serves as a resource for making and exchanging meanings" (Lock, 1996, p. 3). That is, SFL is concerned with the grammatical patterns and lexical items used in texts, as well as choices of those items. Systemists adopt various approaches to text analysis and try to capture the different functions of text served through linguistic elements.

In the functional grammar, the grammatical domain of language is considered an important area of inquiry. This brings Halliday (1994) to what he calls

grammatical metaphor. Grammatical metaphor is defined as “a substitution of one grammatical class, or one grammatical structure by another” (Halliday & Martin, 2005, p. 87). Specialized technical discourse cannot be created without deploying grammatical metaphor (Martin, 1990, as cited in Halliday, 1993).

In the area of grammatical metaphor, for any given semantic configuration, there will be some realization in the lexicogrammar—some wording—that can be considered congruent; there may also be various others that are in some respect “transferred” or “metaphorical” (Halliday, 1994, p. 342). Variation between the different expressions of the same meaning is studied in terms of markedness: Certain forms can be recognized as unmarked expressions of the given meaning, conforming to the “typical ways of saying things” (p. 343). These nonmetaphorical variants are called congruent realizations.

As the most powerful resource for creating grammatical metaphor, construed as nouns instead of verbs and adjectives, nominalization probably has evolved first in scientific and technical register (Halliday, 1993, 1994). As an aspect of complexity in written language (Halliday & Matthiessen, 2004; Heyvaert, 2003), nominalization is used for embedding as much information into a few words as possible. A nominalized structure like *cells are capable of living, growing, and performing*, for instance, is thus viewed as the metaphorical counterpart of the clause *cells can live, grow and perform their special function*. In order to fully grasp the meaning of nominalization as an additional dimension of meaning, the identification and the analysis of both the metaphorical and the congruent realizations are essential (Halliday, 1994; Heyvaert, 2003). Thus, in the following examples, the original words *alcohol* and *extra packer* are displaced by the metaphoric expressions, and so are reduced to modifying these expressions: *Alcohol* becomes a classifier of *impairment*; *an extra packer* goes into the prepositional phrase functioning as qualifier to allocation:

<i>is impaired by alcohol</i>	<i>alcohol impairment</i>
<i>They allocate an extra packer</i>	<i>the allocation of extra packer</i>

The use of nominalization in scientific discourse has been the subject of a wide array of studies in recent years, following the economy principle, for example, the historical origins of nominalization in scientific discourse (Banks, 2005), the realization of grammatical metaphor in modern prose fiction (Farahani & Hadidi, 2008), the contribution of verb-based nominalization to cohesion in 892 pages of history texts (Susinskiene, 2009), nominalization in the writing of six undergraduate students (Baratta, 2010), and the role of nominalization in the English Medical Papers (EMP) produced by native English speakers and Chinese writers (Wenyan, 2012).

These studies have stressed the crucial role played by nominalization in the skillful orchestration of academic discourse. Nevertheless, the realization between discipline specificity, text scientificity, and nominalization has yet to be adequately examined. A possible additional benefit of the current study, which seems to have been underrepresented in the existing literature, is that the study can serve as a starting point for courses in genre analysis of applied linguistics and biology texts with special emphasis on their grammatical metaphor in the form of nominalization which enhances the features of scientific precision and consciousness. Also, an understanding of the functional role and textual consequences of grammatical metaphor is essential for a full understanding of the meaning of any text.

Notwithstanding the aforesaid recent studies on nominalization from various angles, further research is required to find out disciplinary specificity in the use of nominalization. Thus, this study seeks to investigate the variational use of nominalization from the perspective of grammatical metaphor in two academic textbooks in applied linguistics and biology. The analysis of these books involves four steps: The first step of analysis identifies the frequency of nominalized expressions in each scientific text. In the second step, the distribution of nominalization types is explored in the texts. In the third step, the density of nominalization is addressed. In the fourth step, the proportion of grammatical metaphor to nominalization is examined. Accordingly, the following research questions stand out:

1. Is there any significant difference between the sample textbooks in applied linguistics and biology regarding the frequency of nominalization use?
2. What types of nominalization are frequently used in applied linguistics and biology textbooks?
3. Is there any significant difference between the sample textbooks regarding the density of nominalization use?
4. What is the proportion of nominalization to grammatical metaphor in the sample textbooks?

2. Method

2.1 Theoretical Framework

This study is grounded in Halliday's (1994) theory of SFL. In SFL, nominalization is connected to grammatical metaphor used to indicate the process or attribute. Halliday classifies grammatical metaphor into two types: (1) The ideational grammatical metaphor that is closely tied to the transitivity system; (2) the interpersonal grammatical metaphor, accommodated in "the expression of mood and modality" (p. 354). Halliday and Matthiessen (1999) categorize grammatical metaphor into 13 types of which the first four types are classified as nominalization

(see Table 1). This grammar helps “construct a grammar for purposes of text analysis: One that would make it possible to say sensible and useful things about any text, spoken or written, in modern English” (Halliday, 1994, p. xv). Furthermore, it provides a framework for linking language choices with meaning in ways that enable us to analyze language patterns as a means of recognizing how information is presented as well as the author’s purposes and interpretation (Schleppegrell, 2008):

Table 1. *Halliday and Matthiessen’s Classification of Grammatical Metaphor* (1999, pp.246-248)

Type		Grammatical Shift		Example	Semantic Shift	
		Grammatical Class	Grammatical Function		Congruent	metaphoric
1		adjective → noun	epithet/attribute → thing	unstable → instability	quality	thing
		verb → noun			process:	
2	i.		event → thing	transform → transformation	event	
	ii:		auxiliary → thing	will/going to → prospect;can/co uld → probability, potential	tense; modality	
	iii:		catenative → thing	try to → attempt want to → desire	phase; contingency	
3		preposition(al phrase) → noun			circumstance	
	i.	preposition	minor → process thing	with → accompaniment; to → destination	minor process	
	ii:	prepositional phrase	location, extent & c → classifier	(dust is) on the surface → surface dust	minor pocess+thing	

4		conjunction → noun	conjunctive → thing	so → cause, proof if → condition	relator	
5		verb → adjective			Process:	process
	i.		event → epithet/classifier	(poverty) increases → increasing (poverty)	event	
	ii.		auxiliary → epithet/classifier	was/used to → previous; must/will → constant	Tense; modality	
iii.		catenative → epithet/classifier	begin (to) → initial	phase; contingency		
		preposition(al phrase) adjective			circumstance:	
	i.	preposition	minor process → epithet/classifier	with → accompanying	minor process	
	ii.	prepositional phrase	location, extent & c → epithet/classifier	(marks are) on the surface → superficial (marks)	minor process + thing	
		conjunction adjective	conjunctive → epithet/classifier	before → previous; so → resultant	relator	
8		preposition(al phrase) verb			circumstance:	
	i.	preposition	minor process → process	(be)about → concern: (be) → instead of replace	minor process	
	ii.	prepositional phrase	location, extent & c → process	(put) in a box/in house → box/house	minor process+thing	
9		conjunction verb	conjunctive → process	then → follow; so → cause; and complement	relator	

10		conjunction → preposition preposition(al phrase)			relator	circumstance:
	i.	preposition	conjunctive → minor process	when → in times of; → because because of		minor process
	ii.	prepositional phrase	conjunctive → location, extent & c	so → as a result, in consequence; if {it snows} → under/in [snow(y)] conditions		minor process + thing
11		+noun	+thing	{x} → the fact/ phenomenon of {x}	(none)	thing
12		+verb	+process			process
	i.	+verb		{x} → {x} occurs / → exists; {x} have; → do {x} (e.g., impact; have an impact)	(none)	
	ii.	+(causative & c) verb		Make {x:y} → impose [y on x]	(agency & c)	
	iii.	+(phrasal & c) verb		started/wanted (to survey) → started/ wanted (a survey)	(phrase & c)	
13	i.	noun → (various)	thing →	the → government (decided)	thing	expansion of thing:

		(a) qualifier	(decision) of/by the government		(qualifying)	
		(b) possessive diectic	the government's (decision)		(possessive)	
		(c) classifier	government(al) (decision)		(classifying)	
	=:	adverb → adjective	manner → epithet	(decided) hastily → hasty (decision)	circumstance	expansion of thing: (descriptive)
		prepositional phrase → adjective	Location, extent & c → epithet	(argued) for a long time → lengthy (argument)		
		adverb → (various)	location, extent & c → possessive	(announced) yesterday → yesterday's announcement)		
		prepositional phrase → (various)	location, extent & c → qualifier	(departed) for the airport → (departure) for the airport		

2.2 Materials

The materials were selected from two applied linguistics and biology textbooks. The selection was motivated with the aim of building the materials representative of applied linguistics and biology books taught in Iranian universities at the undergraduate level. These two disciplines are assumed to represent soft and hard sciences, respectively. Decision on each book was made by consulting five experts in each discipline. To this aim, the university professors in the related departments at Shahid Chamran University of Ahvaz were met, and they were requested to recommend the most key textbooks in their own disciplines. Different books were suggested by these experts, and their suggestions were, then, juxtaposed to arrive at a final decision on the selected materials for the analysis. Based on the

recency of publications, the formality, the content, and the author of the books, only one major textbook from each discipline was selected as the material for analysis. Accordingly, applied linguistics was represented by *Approaches and Methods in Language Teaching* (Richards & Rodgers, 2001) and biology was exemplified by *Textbook of Medical Physiology* (Guyton & Hall, 2006), abbreviated as AM and MP, respectively.

2.3 Procedure

Prior to analyzing the data, the definition of clause complex, that is, the unit of analysis, should be taken into account. Clause complexes show “how the flow of events is construed in the development of text at the level of semantics” (Halliday & Matthiessen, 2004, p. 63). Eggins (2004) defines clause complex as a “grammatical and semantic unit formed when two or more clauses are linked together in certain systematic and meaningful way” (p. 255). In clause complexes, the relationship of equality and independence is called *parataxis*, and the relationship of dependency is called *hypotaxis*, as shown in the following examples:

- **Example 1.** [Latin was said to develop intellectual abilities][, and the study of Latin grammar became an end in itself.] (cl,41-42,AM, p.4)
- **Example 2.** [Essentially all organs and tissues of the body perform functions] [that help maintain these constant conditions.] (cl, 56-57, MP, p.4)

The main reason for choosing clause complex as the unit of analysis was that nominal expressions, as an important ingredient of clause complex, occur both in dependent and independent clauses. Eggins (2004) believes that “understanding how the natural logic of English works to form clause complexes can thus help us understand the basic process of complexing: How language offers us the creative potential to blow out or develop on the meaning in any grammatical unit” (p. 256). The clauses were coded in each text, for instance, cl, 56-57 MP means clause 56-57 *Medical Physiology*.

Analysis began with the identification of nominalized expressions and continued until the diversity of the expressions was found to be clear and consistent, and dominant patterns could be identified. Accordingly, this led to the analysis of about 27 pages from each book which resulted in data saturation. In the first step, the frequency of nominalized expressions from the perspective of grammatical metaphor was obtained through the division of nominalization instances by the total words in the 27 pages. In the second step, the various types of nominalizations used in the two texts were identified. In the third step, the density of nominalization in the texts was estimated by dividing the total number of nominalized expressions to the

number of clauses. In the fourth step, the proportion of grammatical metaphor to nominalization was calculated.

After about one month interval, we reexamined the data separately, and discrepancies on the method of analysis were resolved. Considering interrater reliability, the data were cross-checked by another linguist to verify the accuracy of categorization of strategies. Then, to calculate the amount of interrater and intrarater reliabilities, Phi correlation was employed twice. The indices obtained were 0.92 and 0.84, respectively. What follows provides quantitative and qualitative analyses of the materials.

3. Qualitative Analysis

In both text types, type 2 (i.e., conversion of process to noun) was more prevalent than other types of nominal expressions. There were patterns in which type 2 occurred. In the following, these patterns are explained in order of frequency:

1. nominalization + qualifier

Note the examples below. The congruent form of the first example is *the blood moves through the body . . . the fluid moves between the blood capillaries*, and the congruent form of the second example is *the audiolingual method and situational method emerged*. The words *move* and *emergence* function as things in these nominal expressions, and the words *blood*, *fluid*, *audiolingual method* and *situational method* which serve as qualifier in metaphoric forms, are, in fact, the head of material processes in their congruent realization. Therefore, they belong to the ideational grammatical metaphor because their grammatical functions are transferred from Head to Qualifier:

1. The first stage is *movement of blood* through the body, and the second is *movement of fluid* between the blood capillaries. (cl, 69, MP, p. 4)
2. 1960s saw the *emergence of the audiolingual method and situational method*, which were both superseded (cl, 399, MP, p. 15)

In some cases, from the grammatical point of view, nominalizing a process allows the addition of both modifiers and qualifiers with or without prepositions. Note the following examples:

3. The *whiplike motion of cilia* causes a layer of (cl, 2033, MP, p. 25)
4. focus was on the *exclusive use of the target language in the classroom*. (cl, 398, AM, p. 13)

In Example 3, the word *whiplike* is considered as the premodifier, and the word *cilia* functions as the qualifier in this nominal group. The typical form of this clause is *cilia moves like whip*. In Example 4, the word *exclusive* acts as the premodifier and the word *target language* functions as the qualifier. The clause is represented congruently as *the way target language is used in the classroom*. In this pattern, the writer is able to pack the flow of information by means of modifiers and qualifiers in to fewer words.

2. preposition + nominalization

Nominal expressions may occur after preposition, as indicated below:

5. Cells are capable *of living, growing, and performing* their special (cl, 42, MP, p. 4)
6. that were used *for teaching* Latin. (cl, 53, AM, p. 4)

In Example 5, the conversion of process to noun happens after preposition. The congruent form is *cells can live, grow and perform their special function*. Similarly, in Example 6, *for teaching Latin* is congruently represented as *to teach Latin*.

The prepositions that mainly precede nominalizations in AM and MP include *for, in, and by*. The latter preposition seems to be characteristic of MP rather than AM, as illustrated in the examples below:

7. *And for changes* in the way Latin (cl, 37, AM, p. 4)
8. his frustration *in observanga* teacher (cl, 380, AM, p. 13)
9. British approach *to teaching* English as a foreign language. (cl, 344, AM, p. 14)
10. their functions *by first filtering large quantities of* plasma. (cl, 96, MP, p. 5)
11. 100 percent effective *in preventing* change. (cl, 357, MP, p. 8)
12. provides motility *for protection*. (cl, 110, MP, p. 5)

3. a/an/the + nominalization

13. *A study* began in 1923 (cl, 386, MA, p. 13)
14. Conversely, *a decrease* in arterial pressure below (cl, 208, MP, p. 7)

This pattern mostly occurs at the beginning of the clause. In Example 13, nominalization is an objective expression because there is no personal agent in this pattern, and the reader may not know who began the study. However, in Example

14, *a decrease* comes first followed by the head *in arterial pressure*, insinuating that in the biology text, this strategy might be adopted even when the agent is clear to the reader.

4. there/is/was/were + nominalization

As shown in Example 15, this pattern mostly occurs at the beginning of the clause; the agent is not mentioned and the participant is defocused. The actional component is obscured, and the event is presented as *fact*, whereas in Example 16, the participant *in the cell* immediately follows the verb, showing that in both examples the emphasis is laid on the event rather than the participants:

15. *There were occasional attempts* to promote alternative (cl, 32, MA, p. 4)
16. Whenever *there is a need* in the cell for (cl, 925, MP, p. 17)

4. Quantitative Analysis

In order to be consistent in our analysis, word count was run, and the data were normalized afterwards because the number of clauses in each book was different. The nominalized expressions were, then, counted. Generally speaking, a glance at Table 2 reveals that the nominalized expressions in AM representing applied linguistics almost double the corresponding expressions in MP representing biology:

Table 2. *Nominalized Expressions Used in Applied Linguistics and Biology Books*

	Applied Linguistics		Biology	
	<i>F</i>	(%)	<i>F</i>	(%)
Nominalized expressions	797	6.93	797	6.93
Total words	11499		13039	
Clauses	1084		2160	
Grammatical metaphors	1326		1020	

Table 2 demonstrates the total number of the nominalized expressions in the analyzed texts. The dominance of nominalization in the categories of grammatical metaphor evinces the valuable role that this strategy plays in formulating scientific discourse. To compare the use of nominalization (i.e., adjective to noun, verb to noun, preposition to noun, and conjunction to noun) in detail, we counted the frequency of each nominalized phrase and put it in appropriate categories and then normalized the data (see Table 3):

Table 3. *The Nominalized Expressions in Applied Linguistics and Biology Books*

	Applied Linguistics		Biology		<i>df</i>	χ^2	<i>p</i> value
	<i>F</i>	(%)	<i>F</i>	(%)			
1. Adjective to noun	50	6.28	32	6.57	1	0.039	0.843
2. Verb to noun	721	90.7	433	88.9	1	0.085	0.771
3. Preposition to noun	24	3.0	20	4.0	1	1.143	0.285
4. Conjunction to noun	2	0.3	2	0.4	1	0.200	0.655

Table 3 reveals the most and the least nominalized expressions used in the applied linguistics and biology books. That is, verb to noun was extremely common and unmarked in the two academic textbooks. Adjective to noun ranked second in order of frequency in these academic texts. Though not significantly different as shown by the chi-square, preposition to noun was used more frequently in MP than in AM. And finally, conjunction to noun was very scant in the two texts for analysis. The results mark V + N to be characteristic of academic discourse represented by AM and MP. The chi-square result did not show any significant difference.

Table 4. *Density of Nominalized Expressions in the Textbooks*

	Applied Linguistics		Biology		χ^2	<i>p</i> value
	<i>F</i>	(%)	<i>F</i>	(%)		
Nominalized expressions	1588	73.51	487	22.54	95.066	0
Number of clauses	2160	2160				

Table 4 demonstrates the density of the nominalized expressions in the clauses in the two academic textbooks after normalization. The chi-square revealed a statistically significant difference with regard to the density of the nominalized expressions in the books. That is, the amount of the chi-square was higher than the critical value (3.84) at the level of $p < 0.05$. The density of the nominalized expressions in AM exceeded the density of the nominalized expressions in MP, showing that the writers in AM tend to condense a larger amount of information into single lexical items than in MP.

Table 5. *Nominalized Expressions and Grammatical Metaphors Used in the Applied Linguistics and Biology Books*

	Applied Linguistics		Biology		χ^2	p value
	F	(%)	F	(%)		
Nominalized expressions	797	60.10	633	47.73	18.808	0
Grammatical metaphors	1326	1326				

Table 5 reveals the proportion of the normalized nominalized expressions to the total number of grammatical metaphors. The chi-square statistics revealed a statistically significant difference ($\chi^2 = 3.84$ at $p < 0.05$). The nominalized expressions in AM were more prevalent than in MP. This shows that the presentation of information in AM is facilitated more by the use of nominalized expressions through the expansion and elaboration of nominal elements than in MP.

5. Discussion

As revealed by the results of the study, the marked difference in the frequency of nominalization used in the two text types is likely to illustrate different tendencies for packaging the information in academic texts which involve fluctuation over the use of this strategy in the two types of texts. That is, information density, partly revealed in grammatical metaphor, is intimately tied to disciplinary characteristics. Grammatical metaphor in the form of nominalized process is widely recognized as an important feature of scientific text developed in modern English scientific writing (Halliday & Martin, 2005). The main function of nominalization is thus to provide an efficient and easily referable description of complex physical processes in modern scientific practice. In this respect, grammatical metaphor is a resource that language uses to condense information by expressing concepts in an incongruent form which is very valued in scientific registers as a way of expressing “objectification” and “abstraction” (Halliday & Martin, 2005, p. 33). However, unlike other studies (Halliday, 1994; Halliday & Martin, 2005; Xue-feng, 2010), the writers in both texts put ideas into abstract forms variably and thus, at the level of lexicogrammar, the disciplinary distinction is manifested in the degree of the nominal phrases used.

5.1 Shared Nominalization Patterns

The major type of nominalization that makes the texts in AM and MP abstract and formal is nominalization of process which culminates in lexical text condensation. The dense clauses are usually formed by nouns with multiple premodifiers and postmodifiers. This, in effect, creates a text that is tightly packed

with information in the form of nominal phrases rather than clauses to add information (Gray & Biber, 2010).

Nominalization depicts an original pioneering contribution that helps to assign a greater degree of objectivity, which is especially significant with regard to scientific discourse. The frequent use of this form satisfies the need for the depersonalization of the discourse by the specialist who is more interested in underlining the effects and results of an action than in stressing who the author of the action is. It is for this reason that the agent is seldom expressed, even though scientific writers do not always prefer impersonal forms. One reason why nominalization is in harmony with the ideology of scientific, academic, and formal writing, in general, is that it makes it easy for process to be objectified (Briones, 2003). Thus, voice is, in fact, one of the efficient linguistic devices used to present a discourse in such a way as if human agency is not part of the action, leading to objectification and theorization.

The second type of frequently used nominalized expressions in AM and MP is nominalization of adjectives. This type of nominalization arises when an attribute, originally realized by an adjective, is expressed in the form of a noun functioning grammatically as a participant of the clause. In Example 17, the nominal group *meaning in learning* is the qualifier of the whole phrase, and the word *importance* functions as the nominalised form of *important*. The congruent form of this example is *meaning in learning is important*. In Example 18, whereas the words *phospholipids* and *cholesterol* serve as qualifiers and the word *significance* as the nominal phrase, the congruent form of this phrase is *phospholipids and cholesterol are significant*.

17. The Frenchman C. Marcel (1793-1896) referred to child language learning as a model for language teaching, emphasized *the importance of meaning in learning*. (cl, 174, AM, p. 7)
18. *The significance of phospholipids and cholesterol* is that they are mainly insoluble in water. (cl, 511, MP, p. 12)

In some cases, nominalization of adjectives occurs with a premodifier and a qualifier, as shown in the following examples:

19. The limited skills of teachers, and the *perceived irrelevance of conversation skills* in a foreign language. (cl, 388, AM, p. 13)
20. Thus, the extracellular fluid everywhere in the body, both that of plasma and that of the interstitial fluid, is continually being mixed, thereby maintaining almost *complete homogeneity of the extracellular fluid* throughout the body. (cl, 90, MP, p. 5)

In some cases, nominalization of adjectives occurs after a preposition as exemplified below:

21. Although Antony's model proposal has the advantage of *simplicity and comprehensiveness*. (cl, 533, AM, p. 20)
22. This occurs in uterus *after pregnancy*, in muscles during long periods of *inactivity*. (cl, 1084, MP, p. 20)

In the third type of nominalized expressions, which mostly occur in AM and MP, the prepositional phrase in the clause is metaphorically realized as noun in a noun phrase. Prepositional phrases often concern information about time and place; in other words, they deal with the circumstances of the events or states described in the text, hence called "circumstantial adjuncts" (Bloor & Bloor, 2004, p. 53). However, when they change into nouns metaphorically, they become the classifier of nominal groups. Consider the following examples:

23. *Nineteenth-century* textbook compilers were mainly determined to codify the foreign language into frozen rules of morphology. (cl,54, MA, p. 5)
24. Genes also control *day-to-day functions* of all the body's cell. (cl, 2084, MP, p. 27)

In some cases, the prepositional phrase in congruent form is converted to the classifier of noun phrase. Note the following examples:

25. Technique is the level at which *classroom procedures* are described; (cl,576, AM, p. 19)
26. Most *human cells* do not maintain large stores of carbohydrates. (cl, 519, MP, p. 12)

The fourth type, nominalization of conjunction, the clausal relation, which is congruently presented by a conjunction, is metaphorically realized by a noun functioning as a participant in the clause. The only pattern manifesting this type of nominalization is as follows:

27. Such syllabuses are usually determined in advance of teaching and *for this reason* have been referred to as "a priori syllabus." (cl,754, MA, p. 25)
28. Thus, all cells live in essentially the same environment—the extracellular fluid. *For this reason*, the extracellular fluid is also called the *internal environment* of the body, or the *milieu intérieur*. (cl, 40, MP, p. 4)

In the above examples, the entity *reason* is transferred from the relator *because*. The element *reason* is the metaphorical realization of the clause *because such syllabuses are usually . . .* and *because all cells live in essentially . . .*

5.2 Nominalization Patterns Exclusive to AM and MP

Besides the density of nominal phrases that distinguishes the two disciplines, there were a few patterns that make the AM text distinct from the MP text. For instance, adjective-derived nominalization in AM mostly occurs in the clause initial position. In the following example, the writer explains why students are required to be accurate to emphasize accuracy in the next clause:

29. *Accuracy* is emphasized. Students are expected to attain high standards in translation, because of the high priority attached to meticulous standards of *accuracy*. (cl, 117, AM, p. 6)

Another recurring pattern characterizing AM is the nominalization of adjective and qualifier or nominalization of adjective with another adjective as illustrated below:

30. Gradation is generally determined according to *the difficulty of the items and their frequency*. (cl, 745, AM, p. 25)

The pattern exclusive to MP, which establishes the cause and effect relationship between the nominal groups, is of simple construction, with one nominal group clause initially, *the importance of DNA*, one nominal group clause finally, *its ability*, and one verbal group, *lies in*, pushed in between indicating the logical relation between the two phenomena. Note the following example which is congruently taken to be *because DNA it is able to control the formation of cell, it is important*:

31. *The importance of DNA lies in its ability* to control the formation of proteins in the cell. (cl, 2128, MP, p. 29)

A noticeable difference in the use of prepositional nominalization in AM and MP is revealed in the next two examples. In AM, nominalization of preposition occurs before nominalization of process. In this case, the writers use two types of nominalization, respectively, whereas, in MP, the nominalization of preposition occurs with nominalization of process and qualifier:

32. *School learning* must have been a *deadening experience* for children. (cl, 30, AM, p. 4)
33. About 60 percent of the adult human body is fluid, mainly a *water solution of ions and other substances*. (cl,32, MP, p. 3)

Drawing on the third question of our analysis, the greater density of nominalization in AM than MP reveals that in formal written language, there are fewer clauses, as the ideational information of two or more clauses may be realized as one. Thus, the possibility of two or more cases of grammatical metaphor being combined in the same nominal group would mean that two or more clauses are being

expressed as a single participant. This feature prevails in AM because the writers tend to put the focus on objects, states, and process all encoded by nouns rather than human agents and their actions which are, in turn, encoded by verbs. Thus, it seems reasonable to assume that information density, partly reflected in grammatical metaphor, is closely related to disciplinary characteristics.

Previous studies (e.g., Galve, 1998; Halliday, 1994) measured lexical density by dividing the number of lexical items to the number of ranking clauses. Galve (1998) argued that when a language is more planned and more formal, lexical density is higher (over 0.40 per clause) and language tends to be somewhat denser, often having around six lexical words per clause. However, when lexical density goes up to 55- 75, a passage of text may become difficult to read. This means that readers have to process more ideas per clause when they read a text. When processes are repacked as participants, academic texts become more abstract and complex, and much of the complexity is due to the nominal group structure which allows an extended explanation to be condensed into a complex phrase, as depicted in the following example:

34. Phonetics, *the scientific analysis and description of the sound system of languages*, was established. (cl, 249, AM, p. 9)

Therefore, writers and speakers make choices from the various options that language makes available, according to the social and cultural context in which meaning is exchanged. As an interlocking set of grammatical systems, language enables its users to make different kinds of meaning for different purposes and contexts. Schleppegrell (2001) argues that register differences manifest themselves both in choice of words or phrases and also in the way that clauses are constructed and linked. The configurations of linguistic features which make up particular registers enable us to hear or read a text and form an impression of the context in which and for which the text was created. Therefore, the higher proportion of lexical density in AM in comparison to MP reveals that the language that constructs knowledge is subject to disciplinary specificities. The choice of different lexical and grammatical options is related to the functional purposes that are foregrounded by the writers of different disciplines. Lexical density is one way of qualifying the differences in lexical choices.

6. Conclusion

A typical characteristic of scientific discourse is the use of nominalization, where processes and properties are metaphorically reconstrued as nouns. For this reason, nominalization, as a major category of grammatical metaphor, is regarded as a proper linguistic feature for characterizing academic textbooks. The occurrence of nominalization greatly increases the general information load the clause states. Thus,

grammatical metaphor is fundamental and ideal for the scientific genre which places a premium on the transmission of information in an economical and compendious way (Kazemian, 2013). Quantitative analysis of the present study showed that the frequency of occurrence of nominalization in AM and PM is fairly similar because the two represent disciplines in written academic discourse.

The research undertaken in this study can contribute to better understanding of nominalization in academic textbooks. In this regard, it can help those who attempt to know the role and function of nominalization from the perspective of grammatical metaphor in scientific writing. Nominalization as an important factor for creating grammatical metaphor is a writing style of academic discourse. Therefore, this linguistic device helps writers of scientific textbooks to reduce the number of clauses in their writing and compress more information into each nominal group. This feature of scientific writing is closely linked to the principles of economy. Zhou (2012) defined the linguistic economy principle as one of the generally recognized mechanisms, the objective of which is to save more time and energy by conveying more information with less effort. Being a form of condensation of information, nominalization is a very efficient means of bundling information and consequently frequently used in formal writing. Furthermore, in the domain of pedagogy, teachers can make students aware of the complexity of language and how language works to compress various meanings in a sentence. Instruction of such rhetorical strategies can create an awareness of how by use of nominalization a single clause compact several complex abstract ideas and makes language complex for the students. Thus, they need to learn a basic knowledge of grammatical metaphor and the different ways it is expressed in academic discourse.

There are certainly limitations to this study which might be eschewed in future investigations. First, only parts of two academic textbooks were analyzed for the occurrence of nominalization which might by no means represent the disciplines, especially because a discipline is represented by different genres not only a single genre textbook. As a result, the way nominalization is metaphorically expressed in different genres is likely to vary. Second, the corpus used in this study is hardly adequate to make valid generalizations about the nominalized features of academic discourse. Thus, in order to achieve more in the domain of nominalization, the same study can be replicated using larger and more representative data. Third, in this study, the role of nominalization was explored in parts of two academic textbooks, giving us a distributed image of how grammatical metaphor is revealed in samples of this genre. Further comprehensive studies are needed to encompass other categories of grammatical metaphor so that we can develop a more complete image of academic textbooks.

The present study investigated the role of nominalization in AM and MP textbooks based on the grammatical metaphor model proposed by Halliday and Mathiessen (1999). Further studies, working on other disciplines such as physics, psychology, or math following this framework, can create opportunities for researchers to reflect on disciplinary characteristics. Nominalization can also be examined in other genres such as research articles, theses, or newspapers to determine the way nominal items are realized in different contexts. Furthermore, our knowledge of nominalization in Persian academic discourse is very sparse. To offset the balance, the nominal expression types used in English scientific discourse can be compared with those used in Persian scientific discourse to see how cross-cultural differences might play a role in using this feature of language which leads to concomitant decisions on the text texture.

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