Cognitive implications of nominalizations in the advancement of scientific discourse

IRIA BELLO*
Heidelberg University

ABSTRACT
Nominalizations are well-known features of scientific writing. Scholars have been intrigued by their form and by their functions. While these features have been widely studied, the cognitive side of nominalizations in scientific texts still needs further attention. Nominalizations contribute to the advancement of discourse and at the same time add abstraction to the processes they convey and make them become more reified in the eyes of the reader. They are not mere verbal transformations as they change completely the cognitive configuration of the process they express. With examples retrieved from the astronomy subcorpus (*CETA*, 2012) of the *Coruña Corpus* the aim is to study nominalizations in the interface between cognition and language. The ultimate goal is to complement all the theoretical-descriptive studies on the topic by approaching the cognitive dimension and build a bridge for studies on the production and understanding of English scientific register.

KEYWORDS: English scientific register, nominalizations, cognitive linguistics, corpus linguistics, information structure.

1. NOMINALIZATIONS AND THE LANGUAGE OF SCIENCE

The difficulty of the language of science is not reduced only to vocabulary. Writers and readers have to be trained to use a series of lexicogrammatical features, namely passives and nominalizations (Albentosa Hernández, 1997; Albentosa Hernández & Moya Guijaro, 2000; Banks 2001, 2003, 2005a, 2005b, 2007, 2008; Halliday, 1985, 2004; Halliday & Martin, 1993; Sušinskienė, 2004, 2009, 2010a, 2010b, 2012; Vázquez Orta, 2006) that add complexity to the prose and delimit the discourse community they are aiming at.

*****Address for correspondence**: Dr. Iria Bello. Institut für Übersetzen und Dolmetschen, Heidelberg University, Plöck 57a, 69117 Heidelberg, Germany; e-mail: iria.bello@iued.uni-heidelberg.de.

Nominalizations are a concise way of expressing linguistically the conceptualization of a process or state of affairs in a nominal form. According to Downing (1997: 147), situations and processes can be expressed through nominalizations, as in (1),

(1)   From whence it is gathered, that **the apparent progreſſive Motion of the Fixed Stars** hath gone forward one Degree towards the conſequent Signs, in about Seventy Years ſpace (Whiston, 1715: 14; emphasis added).

or through finite sentences, as in (2):

(2)   Aſtronomers know that not only the 12 Conſtellations of the Zodiac, but alſo **all the fix'd Stars move from the Weſt toward the Eaſt** about 50" in a Year, or one Degree in 71 Years, in Circles parallel to the Ecliptick (Watts, 1726: 34; emphasis added).

Obviously, although in general terms they convey the same meaning, each of these two linguistic encodings has a different structure and fulfills different functions in texts. In (2) *move* controls the syntax of the whole sentence through a system of obligatory valencies and optional adjuncts. Thus, the agent (*Conſtellations of the Zodiac, but alſo all the fix'd Stars*) is expressed in the subject. The direction of the movement (*from the Weſt toward the Eaſt*) is made explicit and we are also given information on how (*in Circles parallel to the Ecliptick*) and how much (*about 50" in a Year, or one Degree in 71 Years*) constellations and stars move. Similarly, in (1) *motion* also exerts control over its phrase but it is inserted into a larger sentence. Structure is not so rigid in this case as, by definition, all elements in the noun phrase with exception of the head are optional. This allows a more complex arrangement. Thus, in (1) information about the agent (*of the Fixed Stars*) and how (*progressive*) the motion is performed is contained in the post- and pre-modifying fields of *motion*, respectively. In this particular example, additional information about the process is also found in the verb phrase: as in (2), we are also given information about how much the stars moved (*one Degree*) and in what direction (*towards the conſequent Signs, in about Seventy Years ſpace*).

Functionally, the expression of the process as a verb in (2) may be nearer the speaker's experience in terms of chronological sequencing and experience of reality. All the information about the process is kept near the verb. However, the configuration of (1) allows the presentation of the process of moving not as a simple account of reality but as a reified consequence of previous discourse. To illustrate this point, it may be necessary to have a look at the context in which (1) was inserted:

(1a) Beſides this general apparent **Motion**, which is perform'd in well nigh the Space of 24 Hours, in a perpetual Succeſſion, the Fixed Stars ſeem **to be moved** with another Motion alſo almoſt quite contrary to the former; for they are found to change and enlarge their Longitudes, that is, their Diſtances from the beginning of Aries, reckoned along the Ecliptic, or towards the conſequent Signs. For what Fixed Stars appeared in Hipparchus's, or even Ptolemy's time, in that Dodecatomorium, or Twelfth Part of the Zodiack called Aries, appear now in the Sign Taurus. What Stars were reckoned in time paſt as belonging to Taurus are now aſcribed to Gemini, and ſo on: From whence it is gathered, that **the apparent progreſſive Motion of the Fixed Stars** hath gone forward one Degree towards the conſequent Signs, in about Seventy Years ſpace; and that with an even Velocity (Whiston, 1715: 14; emphasis added).

The position of *the apparent progreſſive Motion of the Fixed Stars* at the end of the paragraph, together with the first part of the sentence in which it is inserted (*From whence it is gathered, that*), may point out that the process presented in *motion* is not a changeable situation but rather a reified element that serves as a recapitulation of the contents that were previously presented. Not all nominalizations introduce this type of relationship. However, they generally serve as functional guidelines which help organize information in the mind of the reader.

According to Downing (1997: 151), nominalizations tend to appear in written genres because they can establish abstractions, objectivize and stratify the processes they refer to. Their abundance in modern scientific register has thus been seen as a sign of the augmentation of abstraction in modern scientific register (Halliday & Martin, 1993). According to Halliday (2004: 175), in the last 400 or 500 years the language of science in English has developed into more complex ways of nominalizing processes. Verbs no longer express processes or actions, as this function has been progressively taken up by nominal groups. The unmarked clausal pattern in scientific register is now composed of two processes (one with given information, one with new information) expressed through nominal groups and linked through a verb phrase. The tendency is to nominalize as much as possible and to increase the relational aspect of nominalizations, or, as Halliday (2004: 174) claimed, to favor a "steady drift towards the nominalizing region".

Albentosa Hernández (1997) also referred to the impact of conciseness and Downing (1997) referred to nominalizations as "encapsulators of discourse", which adds to the consideration of nominalizations as cohesive devices contributing to coherence and discourse organization (Sušinskienė, 2004, 2009, 2010a, 2010b, 2012). Again, the rhetorical purposes of nominalizations as concise structures that allow backgrounding of information and advancement of discourse are evident in Halliday's (2004: 169) words:

> Thus the device of nominalizing, far from being an arbitrary or ritualistic feature, is an essential resource for constructing scientific discourse. We see it emerging in the language of this period, when the foundations of an effective register for codifying, transmitting and extending the 'new learning' are rapidly being laid down.

Nominalizations were a linguistic feature chosen by a discourse community to fulfill a function. The establishment of the "new learning" also implied the establishment of a new community of practice, who constituted a new discourse community[1] that adopted a "new language". About the establishment of the Royal Society, the main institution of the academicist movement in the United Kingdom, as a community of practice and discourse, Gotti (2013: 282) claimed that, unlike other scientific or pseudoscientific societies like alchemists, members of the Royal Society emphasized the publicity of their work, which, of course, proved very important for the establishment of their linguistic practices as a new linguistic canon. The socio-historical component can therefore also be added to explain why the linguistic practices and academic aspirations of a new group of researchers resulted in the establishment of nominalizations as indicators of scientific discourse.

The first remarks about the functions of nominalizations in language were scarce. Chomsky (1970) claimed that they were mainly a stylistic choice to avoid repetition. Later, functionalists paid much more detailed attention to explain why verb processes are encoded into a nominal form (Banks, 2003, 2005a, 2005b; Guillén Calve, 1998; Halliday 1985, 2004; Ravelli, 1988; Ventola, 1996). Based mainly on the scientific and journalistic registers, most scholars highlighted the positive impact on texts, as nominalizations were believed to increase lexical cohesion and coherence of ideas, which eventually result in benefits for texts structure. Similarly, the substantivization process (Dik, 1985), which stresses abstraction and reification, has been considered very positive for the assimilation of new ideas. The attributed factuality of reified nominalization proves very useful in the transmission and extension of scientific knowledge because language becomes more compact, more direct to the specialist (Briones, Fortuny, Sastre & Botto de Porcovi, 2003; Martin, 1993). The scientific activity is thus conceptualized and perceived as an object (Banks, 2001), which reinforces the unquestionability of the concepts exposed and facilitates their assimilation by the reader: "nominalization allows to present realities, facts or statements as unalterable or at least indisputable", claimed Albentosa Hernández and Moya Guijarro (2000: 459; own translation). In scientific discourse, nominalizations are, therefore, a "resource for the construction and transmission of knowledge" (Halliday, 2004: 170). However, abstraction is usually correlated with valency reduction, and this has been signaled as an important ambiguity booster causing great difficulty for readers, especially non-specialists. In the same light, critical discourse analysts have also interpreted nominalization as a vilifying linguistic device that is used to hide agency, reproduce a certain ideology and perpetuate unbalanced power relationships (Billig, 2008; Fairclough, 1992; Fowler, 1991).

2. NOMINALIZATIONS AND THE ADVANCEMENT OF DISCOURSE

As Halliday (cited in Guillén Calve, 1998: 371) claimed, nominalizations "made it possible on the one hand to construct hierarchies of technical terms, and on the other hand to develop an argument step by step, using complex passages 'packaged' in nominal forms as Themes". Thematization, a focal point development of information systems in the text, lies so close to nominalizations that Sušinskienė (2009: 87) claimed that they were a "morphologicotextual phenomenon", and Albentosa Hernández and Moya Guijarro (2000: 461) referred to them as "architects of the written text".

The theme, the first element in the clause, states the point from which the clause is developed into the rheme. There is a narrow relationship between theme/rheme and Given/New information. The basic function of these two information units is to organize the discourse in terms of information recoverable from previous parts of the text and new pieces of information. The function Given is assigned to what remains outside the range of the New. As Halliday (2004: 170) pointed out, "New is that which the speaker marks out for interpretation as non-derivable information, either cumulative to or contrastive with what has preceded; the Given is offered as recoverable anaphorically or situationally". In unmarked constructions the theme presents given information before proceeding into the rheme, where new information is included. In these constructions, themes are used as short summaries of what has been said before going on to give new information about the topic. Nominalizations are potentially very useful to meet this quality of anaphoric encapsulation that unmarked given themes seem to enjoy because they elaborate on previous contents. The intrinsic anaphoric property of nominalizations implies that what was a new rheme in the previous sentence becomes a given theme in the new sentence. Even if this violates the end-weight principle (shortest first, longest last) (Albentosa Hernández & Moya Guijarro, 2000), scholars seem to focus rather on the fact that nominalizations are a "story in microcosm" (Bell, cited in Downing, 1997: 147) and on textual implications.

The effects of nominalizations also tend to smooth the transition from clear-cut steps by merging them into a dynamic structure: the information of previous sentences is summarized into a nominal group and given as background information in order to facilitate the assimilation of new information in the second part of the clause. In (3),

(3) The orbit of every planet is in a plane paſſing through the ſun, which planes **are inclined** to one another: thus in fig. 4. let ABCD repreſent the earth's orbit, or plane of the ecliptic; this is taken for a ſtandard, from which the **inclination** of each orbit of the planets, as EDFB, is meaſured. The **inclination** of the orbit of Mercury is 6°,52' that of Venus 3°,33', of Mars 1°,52' of Jupiter 1°,30', and of Saturn 2°,30' (Adams, 1777: 5; emphasis added).

the backgrounding of information is evident looking at word class choice. In the first sentence, new information (that planes are inclined to one another) is introduced in the paragraph. Then, the process appears in a nominalized form (*inclination*) at the end of the sentence, which allows the assemblage of background and new information. Finally, in the next sentence, the same nominalization (*inclination*) appears again, this time as theme of the new sentence. The backgrounding of information is complete and now this is already given information that can develop into the rheme.

The advancement of discourse constitutes the logical consequence of the backgrounding of information. Once the rhetorical and informational structures of the sentences have been developed, it is reasonable that some functional meaning might be extracted from it. The methodical backgrounding of information through nominalized processes allows some degree of systematicity in the balance of backgrounded and foregrounded information. As Halliday (2004: 172) remarked, nominalizations are used "to create a discourse that moves forward by logical and coherent steps, each building on what has gone before". The dynamism of nominalizations is not restricted to the limits of the clause in which they are used, since it also provides functional guidelines to facilitate the decoding of the text as a single unit. In (4),

(4)   The time of high water is principally regulated by the position of the moon, and in general, in the open sea, is from two to three hours after that body **has passed** the meridian, either above or below the horizon. But on the shores of the larger continents, and where there are shallows and obstructions to the motion of the water, the interval between the time of the **moon's passage of the meridian**, and the time of high water, is very different at different places. The difference is so great, that at many places the time of high water seems to precede **the moon's passage**. For any given place, the time of high water is always nearly at the same distance from that of **the moon's passage over the meridian** (Gummere, 1822: 237; emphasis added).

nominalizations are used as lexical devices, summarizing the text and making discourse advance smoothly. In the first sentences of the paragraph, meanings of "process" appear in verbal encodings. Once the first nominalization is introduced in the fourth sentence, all processes appear in nominalizations and verbs become semantically empty. It is a different configuration of the sentence that responds mainly to stylistic and cognitive concerns. Cognitively, the second part of the paragraph is built on the foundations laid in the first part. If verbs are presented in a middle position in regular standard English, by putting them in a previous position we are copying the kind of movement we want to emulate in the readers' minds.

The reasons why writers might want to achieve this sense of advancement of discourse, which is related to their choice of nominalizations altogether, may be explained using some of the basic claims of cognitive linguistics. Idealized Cognitive Models (ICMs henceforth) provide stable ground for categorization of knowledge in our minds (Evans, Bergen & Zinken, 2007).[2] Derived from sensorial experience, they help conceptualize reality and eventually they have some influence on language. Conceptual metaphors are a type of ICMs in which a source domain is mapped onto a target domain. This affects our conceptualization. Lakoff (1987) introduced a series of conceptual metaphors: LIFE IS A JOURNEY, CLASSICAL CATEGORIES ARE CONTAINERS, ACTIONS ARE TRANSFERS. The understanding of science in Western society is shaped according to a mix of all these, which could be summarized as SCIENCE IS A JOURNEY. Thus, the scientist is a traveler, purposes are destinations, methodologies are routes, difficulties are obstacles, counselors are guides, achievements are landmarks and choices are crossroads. As a result, we do not understand science and knowledge as a static enterprise. On the contrary, we expect some kind of progression from them. In addition, time in English is conceptualized in terms of space (Lakoff, 2007: 280) in the conceptual metaphor TIME PASSING IS MOTION.

From this, it can be derived that time is things, the passing of time is motion, future times are in front of the observer and past times are behind him/her. This is connected to the idea of the advancement of discourse because the longer we devote to reading a scientific text, the bigger the progression we expect to achieve. Science develops, improves and turns what is new into the foundation of its subsequent progress. It never stops. It is this unceasing quest for constant progress and self-amelioration that catches the attention and imagination of scientists. This applies also to scientific works. Our expectations about scientific articles and books lie close to this idea of "moving forward". Both learned and learning audiences expect some movement from "not knowing" to "knowing a bit more" when reading scientific writings. Hence the appropriateness of SCIENCE IS A JOURNEY. Given that ICMs pervade and shape our understanding of human experience, all the features associated with journeys are mapped onto our categorization of science as well and a series of correspondences are accordingly drawn.

In the case of scientific writing, the reader becomes the writer and the author of the book acts as the captain of the vehicle that is transporting us to our destination. The tension created between verbs and nominalizations satisfies this expectation of forward progression. Visually, the advancement of discourse is achieved by the use of verbs, occupying a middle position in the sentence combined with a use of nominalizations starting the sentences in the second part of the paragraph. The root of the word is kept, which clearly facilitates the task of assimilating both verbs and nominalizations as derived from the same word. The movement from central to initial position has clear cognitive implications, as it accompanies readers in the process of assimilating new concepts and preparing them to build on those concepts to proceed further. Eventually, the "moving forward" expectation is fulfilled.

3. NOMINALIZATIONS AND ABSTRACTION

Nominalizations are a result of objective thought. Unlike finite clauses, which are near the speaker/listener's perspective because they require chronological sequencing, tense and overt agency expression, nominalizations allow the presentation of abstract ideas and the expression of reason and causality (Downing, 1997, 2000; Eggins 1994). According to Albentosa Hernández and Moya Guijarro (2000), passives and nominalizations are clear objectivity facilitators causing abstract thought, which in the domain of child language acquisition is believed to be one of the indicators of the transition between the last stage of cognitive development and adult thought (Inhelder & Piaget, 1958). In adult speech, this abstraction creates detachment, which has direct cognitive implications, as it allows presenting processes as undeniable events.

Sušinskienė (2009: 84) claimed that "nominalization generally invokes an impression of abstraction in texts: they help us to create more distance between the event and the participants by removing the agents of actions". She therefore linked the impression of abstraction to valency reduction. Her view is shared by many scholars that consider nominalizations one of the main transcategorial operations (Mackenzie, 1985; Malchukov, 2006; Sušinskienė, 2012) that consists of two independent, though complementary, processes: detransitivization (Albentosa Hernández & Moya Guijarro, 2000; Givón, 1995; Hopper & Thompson, 1980) and substantivization (Dik, 1985). Detransitivization implies the loss of verb valencies and other morphosyntactic properties of verbs (aspect, voice, tense and mood). Substantivization involves the acquisition of extended functions; that is, the functions of nouns, the category to which nominalizations properly belong. One of the effects of valency reduction is that it increases the level of implicit communication (Mackenzie, 2007) as a result of a different linguistic expression of a process which favors the formulation of reified ideas over inclusion of agency and chronological sequencing (Downing, 1997). The two following points are the consequence of the two processes involved in the transcategorial operation: detransitivization creates in most cases desagentivation and what has been called "mystification" by critical discourse analysis scholars. On the other hand, substantivization results in reification, a useful feature for science transmission.

Reification refers to the attribution of factual, fixed properties to processes (Banks, 2005b: 349). When nominalized, processes tend to lose their dynamic nature and become somewhat more solid, static facts (Albentosa, 1997; Cademartori, Parodi & Venegas, 2006; Ciapuscio, 1992). In the process of substantivization, nominalizations acquire semantic features of nouns, the category they belong to. If the expression of a process through nominalization implies valency reduction (Mackenzie, 1985) and suppression of tense, aspect and chronological sequencing (Downing, 1997), "once verbs and adjectives have been nominalized they can be talked about in more 'material' terms, as having taken place, occurred, etc." (Sušinskienė, 2009: 85), which can be considered a lexical extension resource,

indispensable for transmission of abstract thought. Nominalizations, therefore, are presented not as language specific but rather as a universal device related to the classifying of our experience of life that draws relations between things and processes (Sušinskienė, 2009). This can be put in relation to Fauconnier's (1994) mental spaces theory. Mental spaces are defined by Evans et al. (2007: 18) as "partial structures that proliferate when we think and talk, allowing a fine-grained partitioning of our discourse and knowledge structures". By reifying a process and presenting it as a material term, we are in some way creating a representation of reality and bringing it closer to our human experience. As reified entities, processes can be thought of as agents or circumstances within other processes. This phenomenon can be seen as a disruption of congruency (Halliday, 1985) or a reflection of the dynamism of meaning construction processes involving the integration of structures across mental spaces (Fauconnier & Turner, 2002).[3] In any case, what seems clear is that nominalizations are central to human thought and imagination.

The implications and effects of reification can be multiple. On the one hand, it may be effective at the persuasive dimension, as the formulation of processes as reified nominalizations favors their acceptance as immutable truth or, at least, possible immutable truths (Downing, 1997: 152; van Dijk, 1988).[4] This enables evaluation, which can be either positive or negative (Billig, 2008; Fowler, 1991). Once reified, "processes and qualities assume the status of things: impersonal, inanimate, capable of being amassed and counted like capital, paraded like possessions" (Fowler, 1991: 80), which offers opportunities for deleting information.

Another implication of reification involves the consideration of nominalizations as focalizers of information. In this study nominalizations are understood as functional linguistic guidelines for the listener/reader to process information. By drawing attention on the process, reified nominalizations are crucial for explaining relations between processes and "appropriately parceling out information as peaks of thematic prominence, providing readers with an angle on the field and peaks of new building on from what can be assumed" (Martin, 2008: 804).

4. CORPUS AND METHODOLOGY

The corpus material for this study was taken from one of the subcorpora of the *Coruña Corpus* (*CC*): the *Corpus of English Texts on Astronomy* (*CETA*) (Moskowich, Lareo, Camiña Rioboo & Crespo, 2012). The *CC* was designed for diachronic linguistic study and it is made up of several subcorpora of different scientific disciplines. Its timespan covers the 18th and 19th centuries and each corpus contains two texts per decade written by native English-speaking authors. Each sample text has approximately 10,000 words, which makes

up a total of approximately 400,000 analyzable words per subcorpus (Table 1). For the present work, *CETA* (Moskowich et al., 2012), the astronomy subcorpus, was chosen. This choice was dictated by the leading role of the discipline in the period under study. Astronomy was perhaps one of the most established scientific disciplines when the Scientific Revolution took place in the 17th century and experimented like no other the shift in focus that the revolution brought:

CENTURY	WORD COUNT
18th century	208,083
19th century	202,403
TOTAL	**410,486**

Table 1. Number of words in *CETA*.

This study deals with deverbal nominalizations formed by suffixation. The first stage in the study was the search of the nominalizations in the corpus, which was carried out with the help of the *Coruña Corpus Tool* (*CCT*), a search engine that has been designed for joint use with the *CC*. The *CCT* does not recognize suffixes but strings of words. Hence, the concordances generated included also gerunds and other words ending with these letters. The first disambiguation was based on word class criteria and eliminated those words that were not nouns. Context reading and semantic disambiguation were carried out at the second stage to sort out the final number of nominalizations considered for study: 8,446.

5. DATA ANALYSIS

After corpus exploitation, the total number of nominalizations considered for analysis has been 8,446, which represents 4.17% of the 410,486 words contained in *CETA*. Table 2 shows the distribution according to the corpus analyzed:

CENTURY	RAW FREQUENCY	NF (10,000)
18th century	3,472	166
19th century	4,974	245
TOTAL	**8,446**	**203**

Table 2. Nominalization frequency.

Concerning the evolution in the frequency of use of nominalizations across the two centuries under study, the tendency is that of a slight increase, as Figure 1 shows:
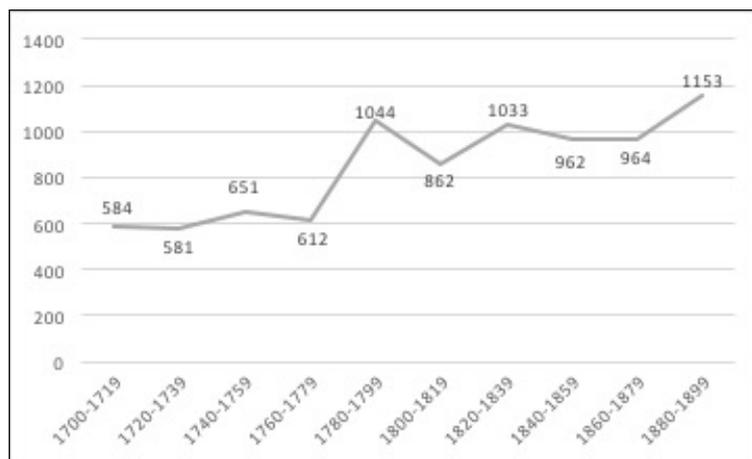
Figure 1. Evolution in the use of nominalizations.

There is no apparent reason to believe that this change was motivated by the subject of study itself. Nominalizations are complex linguistic devices (Halliday, 1985, 2004; Ventola, 1996). Hence, it would be reasonable to expect that the increase in the complexity of the scientific topics discussed in texts could be linked to the increase in the use of complex linguistic structures. However, it would be very risky to claim that the use of nominalizations is linked to the complexity of the topics of the texts and that texts from the 19th century are more complex than those from the 18th century. Although they are from different centuries, (5) and (6) may be said to be similar in form—with minor spelling differences—, function and meaning:

(5)   Let me warm you a little with this **Defcription** of thefe Zones given by Mr. Dryden […] (Harris, 1719: 44; emphasis added).

(6)   But before proceeding further with a **description** of these Martian phenomena, the history of their discovery deserves to be sketched […] (Lowell, 1895: 109; emphasis added).

In both cases, the nominalization appears in a PP functioning as adjunct and is pre-modified by a single determiner. Additionally, both examples have a post-modifying PP that contains the object of the process expressed in the nominalization. The explanation for this progressive rise in frequency is to be found in the sophistication of their cohesive and cognitive properties, which enabled this new scientific community to develop a new way of constructing their discourse and consequently became a standard as the Scientific Revolution became institutionalized.

5.1. Transfer of verbal valencies

Figure 2 shows the inclusion of transferred verbal valencies in NPs governed by nominalizations, both in the pre- and in the post-modifying fields:
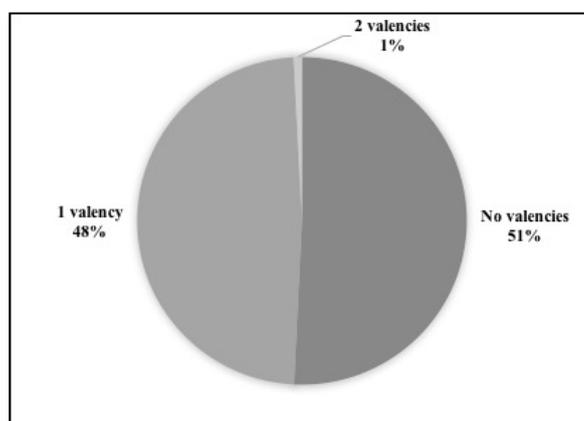

Figure 2. Verbal valencies transferred into nominalization.

In Figure 2 it can be seen that 51% of nominalizations in the corpus (4,210 tokens) appear without any verbal valency. In these cases there may be other words accompanying the nominalization but the function of these words may have no connection to verbal patterns whatsoever. In (7),

(7)   The following **quotations** furniſh us with a remarkable inſtance of this, and will ſerve to give us a view of the ideas, which he came to entertain upon theſe ſubjecʈs (Wilson, 1773: 4; emphasis added).

both the determiner and the adjective accompanying the nominalization cannot be re-accommodated in a verbal reading.[5]

One-valency transference (48%, 4,162 tokens) is almost as frequent as non-valency inclusion (51%, 4,210 tokens). Falling into this group, it is possible to find both pre- and post-modifying subjects, as in (9) and (10), respectively,

(9)   The direction of the meridian may be secured at every instant by observations, and although local difficulties may oblige us to deviate in **our measurement** from this exact direction, [...] (Bradford, 1845: 90; emphasis added).

(10)   The fixed ſtars are diſtinguiſhed from the planets by being more bright and luminous, and by continually exhibiting that appearance which we call the **ſcintillation, or twinkling of the ſtars** (Bonnycastle, 1786: 44; emphasis added).

and also direct objects, as in (11):

(11) CHAPTER IV. FURTHER **STATEMENT OF THE DIFFICULTY** (Whewell, 1858: 48; emphasis added).

The scarcity of two-valency transformations (1%, 74 tokens) may be due to the fact that not all types of nominalizations can admit long NPs. In (12),

(12) We have [Mr]. Flamſteed [...] fully confirming the ſaid Parallax, both by **his Correction of [Dr]. Hook's Obſervations**, and by a greater Number of accurate Obſervations of his own (Whiston, 1715: 30; emphasis added).

the inclusion of both the subject and direct object is clearly a way to avoid ambiguity, which due to the high number of human referents that are mentioned in the paragraph is highly expectable. In (13),

(13) To spectators situated somewhere on these parallels, the sun will be vertical, or in the zenith, twice in the course of **one revolution of the earth about the sun** (Bartlett, 1855: 32; emphasis added).

however, there seems to be no direct reason to include both valencies. It is well-known—now and at the time Bartlett published his book—that the Earth revolves around the Sun, therefore the inclusion of the second complement may be only the result of the author's wordiness. These data can show that nominalizations are indeed more flexible in terms of structure as they allow the inclusion or exclusion of information that becomes obligatory in case of verbal realizations.

5.2. Function of post-modifying PPs

Given that PPs modifying nominalizations are the most common way of encoding information about the process,[6] special attention has been paid to their study. Results are shown in Figure 3:
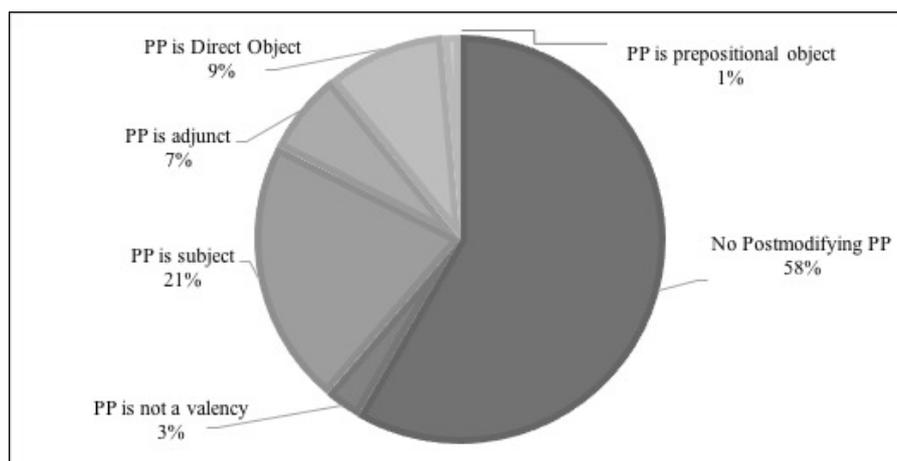
Figure 3. Hypothetical function of post-modifying PP in nominalization NPs.

The percentage of post-modifying PPs that would function as direct objects in a verbal realization (9%, 787 tokens) is lower than those modifiers that would function as subjects (21%, 1,809 tokens). As far as word order is concerned, the duet *nominalized verb + direct object in Prepositional Phrase* parallels the canonical structure of verb and its complements. Also the post-modifying PP is usually paired with a possessive pre-modifying structure that provides an agent responsible for the action expressed in the nominalization, completing the SVO structure (Bello, 2016). This can be clearly seen in (14),

(14)   This decision was fully borne out by **Dr. Huggins's spectroscopic observation of the disappearance behind the moon's limb of the small star Piscium, January 4, 1865** (Clerke, 1893: 324; emphasis added).

which could be rewritten as *On January 4, 1865, the small star Piscium disappeared behind the moon's limb. Dr. Huggins observed this with his spectroscope.* Frequency data show, however, that no matter how appropriate this structure would be to respect word order patterns, this is not the most frequent complement.[7]

Concerning other verbal complements, prepositional complements (3%, 116 tokens) are also present in post-modifying PPs. The frequency of post-modifying PPs that might function as adjuncts (7%, 552 tokens) is high if we consider that, as optional modifiers in the VP, they could be easily left out, as can be seen in the PP *at the present period* in (15):

(15)   The **diminution at the present period** is about 52" in a century (Gummere, 1822: 235; emphasis added).

However, in this case again, the fact that adjuncts are included may indicate a difference in the construction of NPs with a nominalization as head.

Subject (21%, 1,809 tokens) is the most frequently included valency in NPs containing a nominalization, partly because this is the only valency common to all verb subcategorizations. More than half of the post-modifying PPs are agency indicators. In (16),

(16) The next announcement of the discovery of "Vulcan" was on the occasion of the total solar eclipse of July 29, 1878. [...] This time it was stated to have been seen at some distance south-west of the obscured sun [...] and **its simultaneous detection by two observers** —the late Professor James [C]. Watson, stationed at Rawlins (Wyoming Territory), and Professor Lewis Swift at Denver (Colorado)— was at first readily admitted (Clerke, 1893: 307; emphasis added).

the PP *by two observers* could be clearly rewritten as *two observers detected this fact*. The whole paragraph could be also rewritten as: *Vulcan was at the South-West of the sun during the total solar eclipse of July 29, 1878. Two observers detected this fact. The scientific community admitted and announced the event.* In this case, the use of the nominalization was conditioned by the decision of situating this process at the beginning of a sentence to proceed later to validate it ("the detection [...] was admitted"). Thus, by reorganizing all the elements around the process in an NP, the process expressed in *detection* is no longer perceived as an ongoing process but as a reified entity that can be admitted.

5.3. Agent inclusion

Given their presence both as pre- and post-modifiers and their high percentage of inclusion, an analysis of the presence or absence of agents together with their position in the phrase was extremely desirable. Figure 4 informs about the presence and position of agents in nominalization NPs. It shows that nominalizations indeed tend to occur without their subject being directly included (62%, 5,244 tokens):[8]
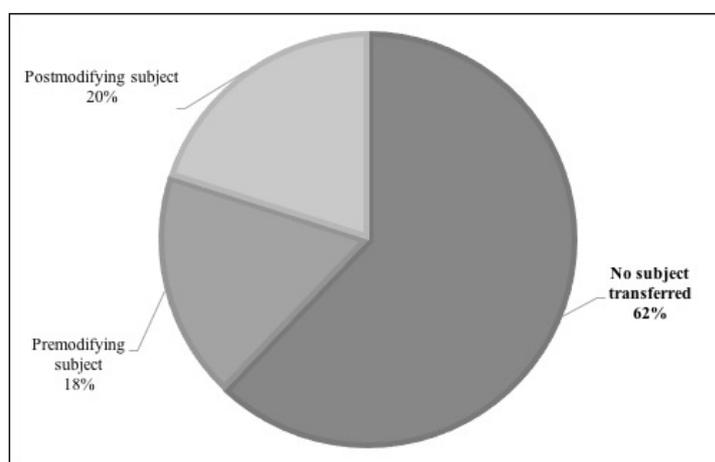

Figure 4. Agent inclusion in nominalization NPs.

Figure 4 shows that there is a slight tendency to accommodate agents in a post-modifying position through PPs (20%, 1,892 tokens) even if the pre-modifying field has more options for agent inclusion in terms of grammatical category. This fact points out that nominalizations have indeed more flexibility when it comes to organizing agents in the phrase. The almost 1,900 instances of post-modifying agents all resemble the structure of (19),

(19)   Still minuter enquiry, however, detects yet smaller deviations again from this form and from these laws, of which we have a specimen in the slow **motion of the axis of the orbit** spoken of in [art]. 318 (Herschel, 1833: 206; emphasis added).

where the subject is contained in a PP introduced by the preposition *of*. On the contrary, the pre-modifying elements are very flexible and admit multiple subject transformations. In most cases the pre-modifying subject becomes a possessive and is expressed through a possessive determiner, as in (20),[9]

(20)   The periods of comets in **their revolutions** around the sun are equally various (Olmsted, 1841: 316; emphasis added).

where the referent has already been made explicit previously. If the referent needs to be specified, a Saxon genitive construction may be preferred, as in (21):

(21)   [...] and in uſing the Hour Index for **the Sun's riſing and ſetting**, as before, the time of **Moon riſing and ſetting** will appear [...] (Charlton, 1735: 41; emphasis added).

Another option can be to include either a noun, as in *Moon rising* in (21), or an adjective, as in (22):

(22)   Unquestionably, the study of morals and the principles of **human action**, is at once the most important and dignified (Garland, 1838: 124; emphasis added).

These two last types are overtly less frequent in use, which indicates that the possessive element present in Saxon constructions and pronouns is a nuance in meaning that is favored and wanted. In some cases this could be refuted by pointing out that possessive pronouns usually fulfill a deictic function and are very useful devices for text cohesion. Even if this is undoubtedly true, examples like (21) show to which point the Saxon genitive and the nominal pre-modification are very similar in form and can co-occur in the same sentence. Despite this,

nominal pre-modification is quite rare and actually in (21) it may have been used for stylistic reasons.

5.4. Circumstance inclusion

Regarding the inclusion of circumstances in nominalizations NPs, the 1,788 instances in which we can find circumstances may be considered as an indicator that phrases constructed around nominalizations do not necessarily share the properties of VPs, as a different configuration of the elements taking part in the process can be expressed:
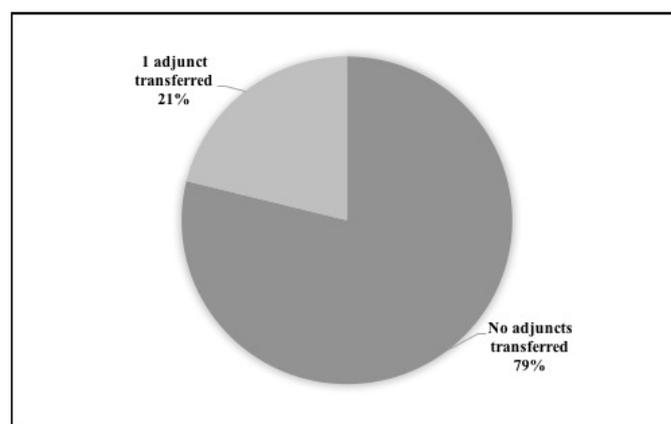

Figure 5. Circumstance inclusion in nominalization NPs.

The existence of a post-modifying adjunct is not necessarily associated with the inclusion of any other verbal valency and, as a consequence, there are some examples in which the adjunct PP appears with another verbal valency, either an agent, as in (23),

(23) Near this Conſtellation there are ſeveral unformed Stars, which in the year 1679. Mr. Edmund Hally, in memory of Charles II. King of Great Britain, &c. who was preſerved by **his Hiding in an Oak**, reduced them into a Conſtellation, and called it Robur Carolinum (Morden, 1702: 36; emphasis added).

or an object, as in (24),

(24) [...] 59 Seconds, will be the mean Motion for two Days, which ſtands againſt the 2d of January, and thus by the **continual Addition of 4 Minutes, 59 Seconds, 18 Thirds**, the mean Motion of the preceding Day, you will have the mean Motion of the ſucceeding Day [...] (Hodgson, 1749: 88; emphasis added).

while in others, the adjunct is the only modifier of the nominalization, as in (25):

(25) All the **appearances in the heaven**, both at land and ſea, are the ſame, as they
would be, if the earth were a globe, which proves it to be of that ſhape [...] (Long,
1742: 63; emphasis added).

In the case of co-occurrence, there seems to be no restrictions regarding the position of
the agent. Consequently, in (21) we find a pre-modifying possessive agent, whereas in (26)

(26) [...] in like manner, if the earth, which we conſider as always in the center of the
ſphere of the heaven, has a rotation round its axis, ſuch a motion will cauſe to all
the inhabitants of the earth an **apparent revolution of the ſphere of the heaven**,
the contrary way, round the axis of the earth produced (Long, 1742: 71; emphasis
added).

the agent is postponed and introduced by a preposition.

Perhaps one of the reasons for the high frequency of circumstance inclusion is
connected to its adaptability to different realizations. Thus, circumstances can appear as APs
in pre-modifying structures as in (24) and (26) or as PPs as in (23), (25), (27) and (28). Its co-
occurrence with agents is then mutually determined and it is probably related to the need of
specification of the agent. Hence, if it can be condensed in a possessive construction, either as
a pronoun (23) or a Saxon genitive, as in (27),

(27) And, therefore, the difference of **the Sun's attraction on the sides of the Earth
under and opposite to him**, is much less than the difference of **the Moon's
attraction on the sides of the Earth under and opposite to her**: [...] (Brewster,
1811: 263; emphasis added).

the circumstance can occupy a post-modifying position. In the case of (23), *his* refers to King
Charles II and the substitution of the referent by a determiner has direct deictic and cohesive
implications. In those cases in which the agent is made explicit through a PP, the adjunct is
more likely to appear as an adjective before the nominalization (26), although it is possible to
find instances of double post-modification, as in (28):

(28) The unbounded view of nature, which I have laid open in my laſt letter, **and the
wonderful operations of the Deity in every part of this ſtupendous fabric**, will
not only ennoble the mind and ſtrengthen the underſtanding, [...] (Bonnycastle,
1786: 51; emphasis added).

6. CONCLUSION

Nominalizations are complex structures that encode processes into nouns. When nominalizing, semantic information is usually left out, which increases the degree of ambiguity and the difficulty of correctly decoding the message. However, nominalizations are concise, economic devices to pack information. The repetition of the same processes in verb and nominal forms adds to the lexical cohesion of texts. On the other hand, their functionality for information structure in texts lies close to thematization and backgrounding strategies. In some way, they all complement each other. Behind all these, the prevailing idea is that nominalizations are a concise way of expressing linguistically the conceptualization of a process. When compared with verbs, nominalizations can be more ambiguous due to valency reduction but they also provide valuable opportunities to organize discourse and express abstract relations among processes in a more efficient way. They are an expression of adult abstract thought and, therefore, they are a very common linguistic feature in any type of adult speech. It has also been showed that cognitive issues proved relevant for the high frequency of nominalizations in scientific discourse when the register originated in the late 17th century as a consequence of the Scientific Revolution as well as their steady increase from that moment. In this sense, the systematic backgrounding of information created by the alternation of verbs and nominalizations allows for the advancement of discourse and serves as a powerful categorizator of knowledge. Similarly, the detransitivization and substantivization processes undergone by many nominalizations favor the presentation of abstract ideas and the expression of causality, reason, and other complex relations between processes without compromising language economy.

Data analysis has shown that the claim made by Halliday (2004: 172) that the use of nominalizations and other scientific discourse markers is a result of an ongoing process that started 400 or 500 years ago is consistent with data found in *CETA*. The tendency observed in frequency rates along the two centuries in the corpus analyzed shows a slight, steady increase. After discarding an explanation based on the complexity in the topic of texts, the cause of this increment could be the consolidation of nominalizations as features of scientific register in English, which led to their association with the new model of science and the practices performed by the discourse community of the new men of science. The institutionalization movement that took place in the 18th century and the professionalization of science that happened in the 19th century strengthened the position of science in society and, consequently, also that of its practitioners and its language.

The analysis of the form and structure of phrases governed by nominalizations shows that nominalizations present a different, more flexible configuration of elements than VPs. Nominalizations may omit obligatory verbal valencies and the NP offers more flexibility for the inclusion of information on participants, agents and circumstances, as these can appear in the pre- or post-modifying field. Even if word order would make it plausible to find a high

frequency of direct objects accommodated in the post-modifying field, there is a higher frequency of agents in this position. As far as agent inclusion is concerned, most nominalizations (62%) appear without agency specification. When they are included in the NP, agents seem to be accommodated quite flexibly, both in the pre- and post-modifying fields. Similarly, information about circumstances surrounding the process, which would be codified as optional adjuncts in the VP, is quite frequent in NPs governed by nominalizations. All these differences may result in a more complex arrangement of information within the phrase, which may be used to establish abstractions, objectivize and stratify the processes that nominalizations communicate.

NOTES

1   See Swales (1990) for a deeper understanding of "discourse community".
2   ICMs were first introduced by Lakoff (1987). They are similar to Fillmore's (1975) semantic frames, which are schematizations of experience, represented at the conceptual level that relates all the elements in a scene to human experience. Langacker (1987), in his theory of domains, also provided a similar definition and, like Lakoff (1987) and Fillmore (1975), he pointed out at the impossibility of separating lexical elements from their corresponding domains.
3   The Conceptual Blending Theory (Fauconnier & Turner, 2002) is concerned with how we conceptualize knowledge and create meaning. Unlike systemic functional linguistics, infinite meaning construction is not seen as a disruption of a "pure" congruent form but rather as an integrative, dynamic process in which the emergent structure—in this case the nominalization used as participant or circumstance in another process—is more than the sum of its parts (Evans et al., 2007).
4   It may be noted that van Dijk (1988) and Downing (1997) refer to the journalistic register, although it is believed that their claims can be applied to the scientific register and, in some way, to any register.
5   The distinction between verbal adjuncts and nominal modifiers is, however, a difficult task. The fuzzy interconnections between morphology, syntax and semantics are clearly exposed in (8):

   (8)   If the mass of the earth be denoted by 1, the mass of the moon, according to **the most accurate determination**, is 1/68.50 (Gummere, 1822: 217; emphasis added).

   In this example, the pre-modifying AP could be possibly rewritten as a verbal modifier *X determined the mass of the earth accurately*. It is also possible that *determination* once nominalized and reified acquired all noun features and consequently could be given the quality of *accurate, more accurate than* or *the most accurate (of all determinations of the mass of the earth that have been made by scientists)*.
6   84% of post-modifiers in nominalization NPs in this corpus are PPs (Bello, 2014: 263). The most frequent post-modifiers after PPs are relative clauses (12%).
7   Of course, it is necessary to take into account that, unlike objects, subjects are obligatory verbal valencies in English. Verb subcategorization was not included in this analysis because of the ambiguity it would entail. As Downing (1992: 72) remarked, verbs can have more than one type of subcategorization and by definition verb subcategorization is made according to the elements that appear in the Verb Phrase (Burton-Roberts, 1998: 80).
8   These data reflect direct agency inclusion into the pre- and post-modifying fields of the nominalization NP. There may be other types of agency inclusion that have not been accounted for and fall within the *no subject transference* group. This is the case in (17),

(17)　These seem to have been the motives by which **Copernicus** was led to conceive the bold design of attributing motion to the earth [...]. This **attachment** indeed to the doctrines of uniform circular motion, which made him reject the excentric of Ptolemy, was merely a prejudice connected with the imperfect state of physical knowledge (Small, 1804: 84; emphasis added).

where the agent of *attachment* can be retrieved from the text some lines before. In other cases, the subject cannot be found in the text but it can be understood following our shared knowledge of the world and does not need to be specified in the text, as in (18),

(18)　For the better **underſtanding** of this Matter, we will explain it by [Fig]. 13. Plate 6 (Gordon, 1726: 104; emphasis added).

where it is clear that the agent of *understanding* is *the reader of the book*.

9　For a deeper study of possessives and determiners in this corpus, see Bello (2016).

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