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COMPLEXITY OF NATURAL PHENOMENA AND LINGUISTIC COHERENCE

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A.E. Chubaryan, R.R. Karapetyan. Complexity of natural phenomena and linguistic coherence. With the progress of science, we observe an unprecedented use of adverbial participles, which come to express increasingly more complex concepts and relations. This tendency is evident not only in the texts of natives, but also of non-natives. The present study examines to what extent non-native speakers of English are influenced by linguistic norms of their native languages when writing academic texts in English. It also focuses on the role of adverbial participles in the syntactic and informative organization of scientific English. The quantitative-qualitative analysis of the material has revealed that the encoding and transmission of complex ideas in scientific English require a high degree of coherence. The results of the paper are sure to contribute to current research in applied and corpus linguistics from the perspective of speakers’ cognitive processes and their linguistic realizations.

Key words: Academic English, adverbial participial clauses, complexity and coherence, quantitative-qualitative analysis, encoding and transmission of information, semantic role.

А.Э. Чубарян, Р.Р. Карапетян. Сложность естественных явлений и лингвистическая когерентность. С развитием науки становится очевидным беспрецедентное употребление деепричастных оборотов, которые выражают все более сложные понятия и отношения. Эта тенденция проявляется в научных текстах, написанных как носителями языка, так и иностранцами, для которых английский язык не родной. В настоящем исследовании анализируется, в какой степени не-носители английского языка находятся под влиянием языковых норм родного языка при написании научных текстов на английском языке. Мы также фокусируемся на роли деепричастий в синтаксической и информативной организации английского научного дискурса и показываем, что для кодирования и передачи сложных идей в научном дискурсе необходима высокая степень когерентности. Результаты исследования показывают, что учет взаимосвязи между когнитивными процессами и их языковыми реализациями является перспективным для дальнейшего развития прикладной и корпусной лингвистики.

Ключевые слова: английский научный дискурс, деепричастный оборот, кодирование и передача информации, количественно-качественный анализ, семантическая роль, сложность и когерентность.

А.Е. Чубарян, Р.Р. Карапетян. Складність природних явищ і лінгвістична когерентність. З розвитком науки стає очевидним безпрецедентне вживання дієприкметникових оборотів, які відображають дедалі складніші поняття і відношення. Ця тенденція проявляється в наукових текстах, написаних як носіями мови, так і іноземцями, для яких англійська мова не є рідна. У цьому дослідженні аналізується, у якій мірі не-носії англійської мови знаходяться під впливом мовних норм рідної мови при написанні наукових текстів англійською мовою. Ми також фокусуємося на ролі дієприслівників у синтаксичній та інформативній організації англійського наукового дискурсу і показуємо, що для кодування і передачі складних ідей в науковому дискурсі необхідна висока ступінь когерентності. Результати дослідження показують, що урахування взаємозв'язку між когнітивними процесами і їх мовними реалізаціями є перспективним для подальшого розвитку прикладної та корпусної лінгвістики.

Ключові слова: англійський науковий дискурс, дієприслівниковий зворот, кодування і передача інформації, кількісно-якісний аналіз, семантична роль, складність і когерентність.

Introduction

The given research seeks to examine the role of adverbial participial – ing clauses (APC), in Academic English, in terms of their semantic variability and the peculiarities of functioning in the register mentioned. Special emphasis is placed on the intercultural aspect. More specifically, it is examined how the units mentioned are used in the speech of Russian and Armenian physicists. This examination (based on the study of numerous scientific papers (accesed through the on-line resource arxiv.org) and aim to uncover the regularities, scope, frequency and inaccuracies of the use of participial -ing clauses encountered in the papers of non-natives. The results of the analysis are backed up by the data collected from the papers of English and American scientists in the same sphere. Preconditioned by their structural incompleteness, participial clauses occupy a unique niche in the syntactic and informative organization of scientific English. Thus, the principles of cognitive and functional linguistics are employed to ensure the topicality of the research and to make the given study more comprehensive. Another approach which proved quite useful to grounding the wide-spread use of participial clauses, as well as to bring in more precision into application of the latter in scientific English, is the concept of complexity and coherence viewed as a paired configuration and regarded as constituting parameters of a 'good' text [Schmied et al. 2007: 1].

Methods

As is known, contemporary science requires that the language, meant for the transfer of scientific knowledge, be compendious, logically constructed and capable of transferring more information in less linguistic volume. The grammatical category of compressed syntactic units under discussion is gaining ground in scientific English particularly due to its information-efficient attribute. It is worth mentioning that it took centuries for non-finite clauses to work their way into language, and later become an indispensable, albeit an ambivalent constituent of scientific English. In fact, from the diachronic perspective non-finite clauses, and adverbial -ing participial clauses, respectively, are innovations in English syntax, which is measured in centuries rather than decades. In Old English, with very few exceptions, finite complement clauses were the norm. In those cases in which there is a choice between finite and infinitival clauses, finite wh-complement clauses remained common well into the nineteenth century [Leech 2009: 183]. Thus, at least at face value, it might be presupposed that the scientific and technological breakthrough correlates with the propagation of more 'scientifically-oriented' language.

Adverbial –ing clauses are of wide and prolific exploitation in scientific English, expressing a diverse spectrum of semantic relationships, which can be quite explicit, or left implicit. But in comparison to its finite alternative, it (non-finite) saves the speaker the trouble of redundantly repeating a constituent of the main clause [Leech 2009: 184]. This property calls for the two-fold use of these units quite often, but requires a very accurate treatment in order to avoid the danger of 'dangling' or 'unattached' participles, which are condemned in all grammars and writing textbooks, for native and non-native speakers alike [Granger 1997: 187]. On the one hand, the clauses under consideration, being compressed and laconic transmitters of information and relationship between concepts, represent a highly favourable asset of scientific English. On the other hand, the absence of the finite verb in adverbial participle clauses and the corresponding subordinators signaling the semantic relation between ideas expressed, makes the sentences with non-finite clauses quite hard and vague to interpret. This particularly applies to scientific English which does not permit dual interpretation of rigid scientific data, as in

(1) *...that a simple renormalizable extension of the Minimal Standard Model, containing three right-handed neutrinos N_1 of masses smaller than the electroweak scale,..., can explain simultaneously dark matter and the baryon asymmetry of the Universe, <u>being consistent with neutrino and mixings observed experimentally.</u>* (Shaposhnikov, 2)

(2) *Begin by defining an initial Calabi-Yau three-fold X and a holomorphic vector bundle V over X by specifying the complex structure.*..(Anderson, 8)

(3) *Hence, the vanishing of the D-term required by supersymmetry forces the* C^L *field vevs to vanish - taking us precisely to the split point in bundle moduli space.* (Anderson, 25)

(4) *Indeed, the relation ZZ =* $\sqrt{}$*pipi, upon fixing of value* $\bar{}$ *ZZ = p0 = const, yields the fibration corresponding to the first Hopf map S3/S1 = S2.* (Mkrtchyan, 5)

The semantic interpretations of the clauses underlined are quite intricate, and require professional background in the sphere. Moreover, these clauses are not isolated concepts, but rather complex scientific ideas in sophisticated implicit relationship with the meanings in the preceding and succeeding clauses. Thus, in (1) the semantic interpretation of the adverbial participial is that of cause, in (3) we have the semantic relation of consequence and in (4) that of condition. Sentence (2) is a more complicated example of the use of adverbial participial – namely *a string of non-finite clauses (my term*), the types and functioning of which will be considered in detail in this study. It will be shown to what extent the high complexity of scientific data is balanced out by appropriate coherence in the texts of native and non-native speakers.

In linguistic analysis, any structure is supposed to consist of form and function. An important property of language is the fact that there is no one-to-one correspondence between the class of unit and its function. While it is true that certain classes of unit typically realise certain functions, it is nevertheless also true that many classes of unit can fulfil many different functions, and different functions are realised by many different classes of unit [Downing, Locke 2006: 19]. It is to be noted that the structural and functional-pragmatic aspects of finite clauses have been examined and the topic received a wide coverage. There is an extensive form-based grammar literature which deals with non-finites, including the adverbial -ing participles as well. Meanwhile, function-based grammars provide a solid analysis of the semantic roles of non-finites and the latter are found in diverse sections such as development of the message, supplementive clauses: specifying and commenting, enhancing a message [Downing, Locke 2006: 108, 284].

However we find it necessary to fill a specific lacuna and elucidate the unique niche which these structures occupy in the syntactic and informative organization of scientific English. With the progress of science we observe an unprecedented use of adverbial participles, which come to express increasingly more complex concepts and relations. This tendency is evident not only in the texts of natives, but also of non-natives. Thus, it is of paramount importance to examine and classify all the peculiarities of the use of the units mentioned across cultures with the aim of guaranteeing the balance of complexity and coherence in scientific communication [Schmied et al. 2007: 1]. The qualitative-quantitative approach to the problem and the results it yielded permits the use of the data in the sphere of corpus linguistics. As is stated by Leech: "Non-finite clauses represent a strengthened grammatical category in Present-Day English—displaying more structural diversity, greater functional range and higher discourse frequencies than in earlier stages of the language" [Leech 2009: 204]. Below we make an attempt to delve into each of these aspects, and demonstrate the feasibility of this statement for scientific English within the outlined principles.

Semantic-functional properties of APCs in Academic English

The growing importance and axial position of adverbial participle clauses in transmitting complex notions, and rather sophisticated relations between the latter, is currently beyond any doubt. Sentences with adverbial clauses semantically present the situation wherein two connected events are more closely united than the events described in the clauses of composite sentences. The unique niche of the units under consideration is ascribed by this property of adverbial clauses, permitting of smooth and natural flow of intrinsically indivisible relations of natural phenomena in the linguistic context. But on account of the grammatically fragmentary character, adverbial participial clauses

require reflection of mental and situational contexts in order to be successfully perceived. As is witnessed by empirical data, the wide semantic capacity and structural laconism of adverbial participles in scientific English have eventually dominated over their ambivalence, which is well corroborated by the results of the statistical analysis shown below.

Table 1

	Number of APC	Number of pages analyzed
Native speakers of English	162	108
Armenian physicists	128	90
Russian physicists	122	87

It is noteworthy that here we present the figures obtained not only from the research articles of native speakers, but also of non-natives. The numerical analysis reveals the frequency of adverbial participle clauses is nearly equivalent for natives and non-natives in the texts of scientific English. This comes to convincingly demonstrate the steady propagation of adverbial participial clauses regardless of their structural incompleteness. In other words, currently in the field of professional literacy clauses with unexpressed and to-be-inferred elements, which designate complex scientific relations and events, prevail over bulky linguistic units with all the elements explicit. The problem at this stage lies already in the domain of the 'qualitative', rather than 'quantitative'.

As was demonstrated in (1)-(4) adverbial participial clauses can fulfill numerous functions the most common of which is that of manner. It is to be stipulated that this kind of relation is quite frequently encountered in scientific English as expressed via adverbial participial clause in the research articles of both native and non-native speakers equivalently:

(5) *Furthermore, by analyzing the Tr(ga¯b Fa¯b)2 term in (1.3), we were able to show that it is equivalent to D-term contributions to the four-dimensional potential energy, where the D-terms are associated with the anomalous U(1) gauge factors.* (Anderson, 4)

(6) *One can also modify the lattice action to improve the numerical performance by reducing lattice artifacts etc.* (Rychkov, 4)

(7) *The developed theory utilizes the graded R operator formalism [26,27,28,29,3] and allows the generalization to other integrable models, which is demonstrated in this work by operating with rather general R operator.* (Khachatyran, 1)

The sentences above represent an easily traced semantic relation of manner, which is made more evident by the use of the preposition *by.* It can also be assumed that no drastic differences are found in this case between native and non-native scholars who transmit the relation of manner via adverbial participles. This semantic relation is the most oft-encountered one.

However, more complex and contextually, as well as conceptually dependent cases of the use of adverbial participial clauses in the scientific English comprise the scope of our interest. In the given paper we proceed from the notion of cognitive complexity, which definitely results in linguistic complexity. But what is complexity, how is it defined and what categories and principles lie behind this notion, be it cognitive or linguistic? Why have we arrived at investigating adverbial

participial clauses from the perspective of complexity and coherence duality? The underpinning definition of complexity adopted in the given research is based on the one outlined by J. Schmied et al. as "...complexity is not necessarily difficulty and complex means not necessarily complicated…A preliminary working definition would therefore describe the complexity of a linguistic object as the sum of its elements at various levels of consideration and the possible (i.e. permitted) relationships between them" [Schmied, Haase & Povolna 2007: 2]. In the case of the units mentioned, we have a sophisticated combination of cognitively complicated phenomena of the natural world expressed by complicated syntactic structures with the to-be-inferred elements and the complex (quite often implicit) relationship between the clauses considered with the main clauses. Such semantic concepts as consequence, condition, concession, cause-effect, purpose and temporality play a pivotal role for the transmission and dissemination of scientific knowledge, and represent a vivid example of high cognitive and linguistic complexity. Provided this complexity is linguistically well-organized, the use of structurally incomplete units under discussion is absolutely justified:

(8) *Now, suppose that we begin with a supersymmetric field configuration, and then vary the Kahler moduli while keeping the other moduli fixed. (Anderson,2)*

(9) *At a typical non-symmetric point in field space, the ratio of this potential to the fourth power of a typical mass of a heavy gauge sector state is of order s, the dilaton, when working in in string units.* (Anderson, 22)

(10) *The $C_2^P = 0$ vevs thus spontaneously break U(1), reducing the symmetry to a pure E_6 gauge theory.* (Anderson, 12)

(11) *Integrating out the heavy U (1) gauge boson, the -3 charge of the remaining 20 C_2 fields can be ignored*. (Anderson, 13)

The semantic relations of concession (8), time (9), consequence (10) and condition (11) are obvious and extremely clear-cut in the sentences provided. It was observed that the relative pronoun *when* with an adverbial participial clause (9) is rather common in the texts by native speaking scientists, whereas in the texts of non-natives speakers it has not been observed, at least in the material analyzed. This can be accounted for by the absence of such a structure (*when* with an adverbial participial clause) both in the Armenian and Russian (in most cases though, the given pronoun comes to differentiate the semantic relation of time and condition). As a consequence, its omission in the texts of non-native speakers calls for ambiguity and the absence of coherence. Meanwhile the sentences above have been written by native speaking scientists and can be considered as a successful example of a paired configuration of complexity and coherence. As is stated by J. Schmied et al. "A 'good' text can be complex if complexity is structured as to satisfy coherence expectations and demands of a reader/listener" [Schmied et al. 2007: 1]. There are, however, numerous cases when the isomorphism between the linguistic complexity and coherence is broken by the inadequate use and structure of linguistic units. This mostly applies to the texts by non-natives and can in some cases be unacceptably confusing, especially considering that in scientific speech ambivalence should be reduced to the minimal level. Below are the cases of the kind:

(12) *Indeed, the relation ZZ = √pipi,, upon fixing of value of ZZ = p0 = const, yields the fibration corresponding to the first Hopf map S3/S1 = S2* (Mkrtchyan, 5)

(13) *Then, after performing the integration, we obtain*…….(Khachatryan, 9)

(14) *After reducing the modified Bessel functions, this leads to the final expression* ……..(Saharian, 8).

(15) *Coming back to Composite Higgs models, they allow for an honest and rather complete discussion of expected flavor effects, which are typically safely below the experimental bounds.* (Rychkov, 9)

All the sentences considered are taken from the papers by Armenian and Russian scientists and stand for numerous similar cases of inadequate use of complex linguistic structures, breaking the complexity/coherence configuration. Thus, in (12) the adverbial participial clause expressing condition is introduced by the inappropriate conjunction *upon*, thus shifting its interpretation to the temporal, which is not intended here. Moreover in the given sentence an obvious confusion of the gerund and participle is observed. In (13) again the conjunction expressing the concept of temporality is used to introduce the semantic relation of manner. It might be concluded here that the complex relations between the linguistic elements are distorted and the text fails to meet the coherence needs of a reader/listener. Such cases can be found in abundance in the texts of non-native speaking scientists. Another striking peculiarity of the unsuccessful use of complex linguistic structures among non-native speakers is the loose and unclear connection between the elements of the clauses. In (14) and (15) it is seen that none of the elements in the adverbial participial clauses can be correlated to any of the elements in the main clause. The situation could become better, were the adverbial participial clauses used in the post-position to the main clauses. But here again we observe a clear-cut exemplification of complexity/coherence inadequacy. Statistical data in succeeding part demonstrates that adverbial participial clauses designating such complex relations are much more rarely used among non-native speakers. And it might be assumed that reason for this lies in this incoherence of complex linguistic structures, which is natural for non-native speakers.

Another peculiar and quite sophisticated use of adverbial participles which involves a good deal of cognitive complexity, necessity to analyze, synthesize and conceive the scientific information before framing it into the linguistically complex and simultaneously coherent structures, are the so-called strings. These can be of two types, namely chains of participial clauses following each other and participial clauses complicated by subordinate clauses. Definitely, in this case the semantic relations between the elements become quite multi-layered and represent an extremely complicated kind of linguistic complexity, which must be coherently structured to avoid any inadequacies. The analysis of the empirical material revealed the wide-spread character of the latter in the scientific writing. And again this popularity can be ascribed to the structural peculiarities of the structures investigated. The sentences below come to manifest it:

(16) *This can be imposed by demanding that the ten-dimensional gaugino supersymmetry variations vanish.* (Anderson, 2)

(17) *Instead of first computing the details of a compactification, calculating the Yukawa couplings and discovering, for example, that the top quark mass vanishes, one can analyze the broad features of the allowed interactions at the start to see if the model has any possibility of being phenomenologically viable.*(Anderson, 4)

(18) *In deriving the WMAP+SADD constraints which are shown in this figure, it was assumed that the universe is spatially flat.* (Tkachev, 19)

In sentence (16) we have the second type of the string. Sentence (17), being extremely complex both in cognitive and linguistic sense, is, nevertheless, ideally structured to convey all the nuances of semantic relations between the elements within the adverbial participial clause, as well as its relation with main clause. Here we have a combination of both types of string: parallel clauses, with one of them complicated by the subordinate object clause. Sentence (18) again demonstrates a very pertinent use of the preposition *in* introducing the adverbial participial clause with the subsequent subordinate clause. All the norms of coherent structuring of the linguistic complexity are observed in this passage by a non-native speaker. In contrast to this coherently structured linguistic complexity, one can also come across such examples as,

(19) *By taking into account the expressions (13) and (14) for the components of the vector potential, after averaging over the phase α1 of particle flight into the plate, for the*

spectral-angular density of the radiated energy in the angular region, we find that….. (Mkrtchyan, 4)

In the sentence above we have 2 parallel adverbial clauses, but the cognitive, logical and linguistic parallelism here is violated because of the infelicitous alternation of the conjunctions *by* and *after*.

Discussion of the statistical data

Presented below is the detailed analysis of the statistical data concerning the use frequency and specific features of functioning of adverbial participial clauses from the cross-linguistic perspective.

Table 2

Native speakers (English and American scientists)

Adverbial participial clauses	Total – 162 examples for 108 pages	Introduced syndetically	Introduced asyndetically
Manner	95	43	52
Consequence	13	3	10
Condition	11	1	10
Concession	8	8	0
Temporal	9	8	1
Specification/additional information	6	0	6
Strings	20	–	–

Table 3

Non-natives (Armenian scientists)

Adverbial participial clauses	128 examples for 90 pages	Introduced syndetically	Introduced asyndetically
Manner	86	21	65
Condition	7	6	1
consequence	1	1	0
Temporal	2	2	0
specification/additional information	6	0	6
Strings	26	–	–

Table 4

Non-natives (Russian scientists)

Adverbial participial clauses	122 examples for 87 pages	Introduced syndetically	Introduced asyndetically
Manner	61	15	46
Consequence	6	0	6
Condition	15	0	15
Concession	2	1	1
Cause	6	0	6
Temporal	5	4	1
Purpose	1	1	0
specification/additional information	18	0	18
Strings	8	–	–

As is seen from the tables, there is no substantial difference in the use of adverbial participial clauses between the native and non-native speakers on the quantitative plane. This dynamic is accounted for by the appropriateness of the aforementioned units to transfer complex information in a compressed way, a highly valued skill in the sphere of academic literacy, irrespective of the nationality.

An interesting and indicative observation deduced from the figures in the tables concerns the distribution and the number of adverbial participles used for the conveyance of more subtle and complex linguistic elements and relations. Thus, Armenian scientists demonstrate quite a restricted range of semantic relations expressed by the constructions under consideration. Moreover, even when they do so, it constitutes a very small amount as compared to natives and Russian scientists. It should be noted that, contrary to Armenian scientists, Russian scientists, exploit theses constructions to the full extent, and even more widely than native speakers in the sense of semantic interpretation. This might be due to the fact that the Russian language has quite an elaborate and extensive range of participial clauses in general, while the Armenian language is not as flexible, and in certain cases is quite rigid, which, in its turn, is reflected in the use of the same constructions in a foreign language.

Conclusion

It is a widely accepted fact that "…language allows quick and effective expression, and provides a well developed means of **encoding and transmitting** complex and subtle ideas" [Evans, Green, 2006: 6]. In this paper we viewed adverbial participial clauses from the standpoint of this principle of cognitive linguistics and arrived to show that the encoding and transmission of complex ideas in scientific English requires a high degree of coherence. The results and the ensuing analysis of other structures from the same perspective can yield valuable results both for applied and corpus linguistics.

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