Toward Academic Reading (I):

From General Reading to Research Papers in Cell Biology

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Abstract

This paper is an attempt to identify lexicogrammatical characteristics that can cause problems in understanding scientific papers written in English, aiming to help students improve their reading skills. It uses Systemic Functional Linguistics as a research tool and explores two academic papers in cell biology as examples. In reading these papers, the following lexicogrammatical characteristics that can cause difficulty in understanding scientific academic papers are identified: lexical density, syntactic ambiguity, grammatical metaphor, peculiar usage and two types of 'A shows B'. This paper analyzes these characteristics from the Systemic Functional perspective and suggests some reading skills that English teachers can share with their students: 1) the skill to unpack nominalization; 2) the skill to identify logical relations; 3) the skill to recognize ambiguity in text; 4) the skill to identify peculiar usage as technical terms; and 5) the skill to recognize two types of 'A shows B'. It concludes that students have difficulty in reading scientific papers not just because they are not good at English or they do not understand 'special' English, but because they are not familiar with the lexicogrammatical resources of English that scientific discourse tends to exploit.

1. Introduction

The importance of first-year university experience has been increasing these

days, and so has English learning as freshmen. Most freshmen in Japanese universities have studied English for at least six years, but in general their skill seems far below an academic level. Nevertheless, they are required to read academic papers in their fields when they move up to junior (or fifth year in six-year schools).

Liberal arts education provides a variety of English courses for students and many English teachers have devoted themselves to teaching both in and out class. Yet from the viewpoint of academic reading, there is room for disagreement that their efforts have represented sufficient results. This is partly because the policy of liberal arts education is not to improve students' technical knowledge and thinking, but to help students cultivate their basic academic ability, a wide variety of knowledge and sense of values and deep insight (see e.g., Policies of the Division of Liberal Arts and Sciences, Aichi Gakuin University, http://kyouyou.agu.ac.jp/policy/index.html). It seems that this policy is widely accepted, and English teachers generally teach *sougou eigo* (general English) in obligatory courses even though they focus on one or more skills such as listening, speaking, reading and writing. To discuss this matter is not the purpose of this paper, but it is worth emphasizing that English teachers should direct their efforts to students' academic success; reading academic papers is not a job for teachers who conduct English courses in liberal arts, but assisting students in improving their skills to read academic papers can be considered part of their job.

This paper is an attempt to show problems in understanding academic papers on cell biology written in English. Its goal is to help students improve English skills that are instrumental in understanding academic papers. It will start by introducing Systemic Functional Linguistics as a research tool. Then, it will explore two academic papers on cell biology. Finally, it will conclude with what English teachers can share with their students to improve their academic

reading skills (although teaching methods are not the present pursue of this paper).

2. Systemic Functional Linguistics as a Research Tool

This paper uses the theoretical framework of Systemic Functional Linguistics (hereafter, SFL) as a research tool. SFL views language as a meaning-making system and meaning potential (Halliday, 2003) rather than a set of rules. From the Systemic Functional perspective, language is a stratified resource differentiated according to order of abstraction: it is organized into semantics (the system of meaning), lexicogrammar (the system of wording) and phonology (the system of sounding). The relationship between strata is referred to as realization: semantics is realized by lexicogrammar, and lexicogrammar is realized by phonology. For example, *transform* (event) in semantics is congruently realized as a verb (process) in lexicogrammar. However, as we will see in section 3.2, since semantics and lexicogrammar are separate, *transform* can be reconstrued metaphorically as a noun, *transformation* (cf. thing in semantics is congruently realized as a noun). When this shift between categories happens, *transformation* has two statuses, process + thing. This transcategorization and fusion is called grammatical metaphor (Halliday and Matthiessen, 1999).

Another perspective on language is metafunction: ideational metafunction is concerned with construing experience; interpersonal metafunction is concerned with enacting interpersonal relations through language; and textual metafunction is concerned with organizing text (Halliday, 1994; Halliday and Matthiessen, 1999). Text analysis conducted in this paper focuses on ideational metafunction. SFL is also a theory that has been applied to a wide variety

of purposes (Halliday, 1994: xxix-xxx), one of which is analyzing scientific discourse.

A large number of studies have been conducted on the language of science from the Systemic Functional perspective (e.g., Banks, 2008; Halliday, 2003; Halliday and Martin, 1993; Lemke, 1990; Martin and Rose, 1998). Halliday's (1993) discussion identifies the difficulties in learning the language of science. He argues that "(t)he difficulty lies more with the grammar than the vocabulary", suggesting seven headings in order to illustrate and discuss difficulties in scientific English: 1) interlocking definitions; 2) technical taxonomies; 3) special expressions; 4) lexical density; 5) syntactic ambiguity; 6) grammatical metaphor; and 7) semantic discontinuity. These headings may apply to the language of science in general. However, since science includes a wide range of genres (Martin, 1992; Martin and Rose, 2006) —from primary-school mathematical textbooks to technical books and research papers—, it is not certain whether or not these characteristics apply to academic papers. Thus, it seems reasonable to focus on academic papers and reconsider the headings.

In reading two research papers on cell biology, the following characteristics that may cause difficulty were identified (three of which apply to Halliday's (1993) study):

lexical density
syntactic ambiguity
grammatical metaphor
peculiar usage
two types of 'A shows B'

These characteristics are generally identified across texts. As we will see, they are interrelated and keep laypersons away while contributing to organizing text and constructing knowledge.

3. Analyzing Research Papers

In this section, I will illustrate characteristics that can make it difficult to understand research papers by exploring the summaries from two research papers: Cosgrove, B. D. et al. (2016) 'N-cadherin adhesive interactions modulate matrix mechanosensing and fate commitment of mesenchymal stem cells' (Extract 1) and Gan, W. J. et al. (2018) 'Local Integrin Activation in Pancreatic β Cells Targets Insulin Secretion to the Vasculature' (Extract 2), both of which were read in classes of a foreign book reading course for fifth year pharmaceutical students at Aichi Gakuin University in the 2019 academic year.

Extract 1

During mesenchymal development, the microenvironment gradually transitions from one that is rich in cell-cell interactions to one that is dominated by cell-ECM (extracellular matrix) interactions. Because these cues cannot readily be decoupled *in vitro* or *in vivo*, how they converge to regulate mesenchymal stem cell (MSC) mechanosensing is not fully understood. Here, we show that a hyaluronic acid hydrogel system enables, across a physiological range of ECM stiffness, the independent co-presentation of the HAVDI adhesive motif from the EC1 domain of N-cadherin and the RGD adhesive motif from fibronectin. Decoupled presentation of these cues revealed that HAVDI ligation (at constant RGD ligation) reduced the contractile state and thereby nuclear YAP/TAZ localization in MSCs, resulting in altered interpretation of ECM stiffness and subsequent changes in downstream cell proliferation and differentiation. Our findings reveal that, in an evolving developmental context, HAVDI/N-cadherin interactions can alter stem cell perception of the stiffening extracellular microenvironment [from Cosgrove, B. D. et al. (2016)]

Extract 2

The extracellular matrix (ECM) critically affects β cell functions via integrin activation. But whether these ECM actions drive the spatial organization of β cells, as they do in epithelial cells, is unknown. Here, we show that within islets of Langerhans, focal adhesion activation in β cells occurs exclusively where they contact the capillary ECM (vascular face). In cultured β cells, 3D mapping shows enriched insulin granule fusion where the cells contact ECM-coated coverslips, which depends on β1 integrin receptor activation. Culture on micro-contact printed stripes of E-cadherin and fibronectin shows that β cell contact at the fibronectin stripe selectively activates focal adhesions and enriches exocytic machinery and insulin granule fusion. Culture of cells in high glucose, as a model of glucotoxicity, abolishes granule targeting. We conclude that local integrin activation targets insulin secretion to the islet capillaries. This mechanism might be important for islet function and may change in disease. [from Gan, W. J. et al. (2018)]

3.1 Lexical Density

In both extracts, structures of clauses and clause complexes are relatively simple. For example, the second sentence from Extract 1 and the third sentence from Extract 2, one of the most intricate sentences in each extract, can be analyzed as follows.

(1)

Because these cues cannot readily be decoupled in vitro or in vivo,
dependent clause

[[how they converge to regulate mesenchymal stem cell (MSC) mechanosensing]] is not fully understood.
dominant clause

(2)

Here, we show
dominant clause

that within islets of Langerhans, focal adhesion activation in β cells occurs exclusively [[where they contact the capillary ECM (vascular face)]].
dependent clause

(1) is structured as dependent clause + dominant clause. The dependent clause is passive, and in the dominant clause, a rankshifted clause (enclosed in brackets) serves as if it were a noun. (2) is structured as dominant clause + dependent clause, and in the dependent clause, a rankshifted clause acts as if it were a prepositional phrase. They are not intricate compared with sentences in English textbooks for Japanese high school students.

Instead, lexical density is high in both extracts. Lexical density "is a measure of the density of information in any passage of text, according to how tightly the lexical items (content words) have been packed into the grammatical structure" (Halliday, 1993: 76). It can be measured as the number of lexical words per clause. On an average, the score is around 1-2 in casual speech and around 6-10 in technical writings (Halliday, 2002; Halliday, 2004b). For example, since the first sentence in Extract 2 include 10 lexical words and a clause, its lexical density is 10. Average score of lexical density in Extract 1 is 7.9 and in Extract 2, it is 6.4. This is no wonder because when we move from everyday discourse to technical writings, grammatical intricacy tends to decrease, while lexical

density tends to increase. However, this can be a problem in reading texts. As Halliday (1993: 76) points out, the difficulty in the language of science depends not only on the particular lexical items but also the lexical density in that it can cause grammatical ambiguity. For example, *integrin activation* in the first sentence from Extract 1 can mean 'integrin activates something', 'integrin is activated by something' or 'integrin activates itself'. Another example is even trickier; *enriched insulin granule fusion* in the fourth sentence from Extract 2 can mean 'more insulin granule fuse into something', 'something is increasingly fused into insulin granule', 'insulin granule fuse into something more quickly', 'something is fused into insulin granule more quickly', 'more insulin granule fuse into something more quickly' or 'something is increasingly fused into insulin granule more quickly'. There are various reasons for the ambiguity, but the main cause is, as already illustrated, that clauses are turned into nouns (Halliday, 1993: 78). This issue is deeply related to grammatical metaphor, which we will explore in the next section.

3.2 Grammatical Metaphor

As briefly mentioned earlier, grammatical metaphor is the expansion of meaning by choosing different options in realization: choices in semantics and lexicogrammar can be congruent or metaphoric. For instance, a sequence (a representation of a series of related experience) is realized by a clause complex congruently, but it can also be realized by a clause metaphorically. Figure 1 shows the congruent pattern of realization:

Figure 1: The congruent pattern of realization

semantic unit	is realized by	grammatical class	example
sequence	↘	clause complex	John stayed home because it was rainy.
figure	↘	clause	John stayed home.
process	↘	verbal group	John
participant	↘	nominal group	stayed
logical relation	↘	conjunction	because

adapted from Halliday and Matthiessen (1999: 236), examples by the author

Grammatical metaphor includes both class shift (shift between grammatical classes, e.g. a process that is metaphorically realized by a nominal group instead of a verbal group) and rank shift[1] (shift between grammatical units, e.g. a sequence that is metaphorically realized by a clause instead of a clause complex). For example, since *culture of cells in high glucose* in the seventh sentence in Extract 2 is construed as a figure, it is congruently realized by a clause, but actually, it is metaphorically realized by a nominal group; the process *culture* is metaphorically realized by a noun; *cells* that serves as participant is metaphorically realized by prepositional phrase instead of a noun and serves as Qualifier[2] of the nominal group *culture of cells*; and *in high glucose* metaphorically functions as Qualifier instead of congruently functioning as circumstance of a clause.

The two types of grammatical metaphor, nominalization and metaphorical shift from logical relations characterize both Extract 1 and 2. Here, I will briefly describe these phenomena and analyze the texts.

i) Nominalization

Nominalization is a shift to thing: quality, event and even a series of events are ‘packed’ into a nominal group. Halliday (1994: 352) explains nominalization as follows:

> Nominalizing is the most powerful resource for creating grammatical metaphor. By this device, processes (congruently worded as verbs) and properties (congruently worded as adjectives) are reworded metaphorically as nouns; instead of functioning in the clause, as Process or Attribute, they function as Thing in the nominal group.

Types of grammatical metaphor in which elements are realized as noun is given in Figure 2.

Figure 2: Types of grammatical metaphor (shift to noun)

semantic element	grammatical class	example
quality to entity	adjective to noun	unstable = instability
process to entity (i)	verb to noun	transform = transformation
process to entity (ii)	verb (auxiliary) to noun	will = prospect, try to = attempt, can = possibility/ potential
circumstance to entity	preposition to noun	with = accompaniment, to = destination
relator to entity	conjunction to noun	so = cause/ proof, if = condition

adapted from Halliday (2004: 41–42)

As has already been pointed out (e.g. Halliday, 1993; Halliday, 2004b; Martin and Veel, 1998), nominalization is a characteristic in the language of science. It can be a problem in that it increases lexical density and ambiguity, but it also makes a significant contribution to organizing scientific writing.

A way to ease this difficulty is ‘unpacking’: the process that re-words metaphorical wordings into more congruent wordings. For example, *culture of cells in high glucose* illustrated above can be unpacked as the following clauses[3]: *someone cultures cells in high glucose* or *cells are cultured in high glucose*. Figure 3 shows the analysis.

Figure 3: Example of unpacking text

original text	*culture*	*of cells*	*in high glucose*
grammatical class/ grammatical function (metaphorical form)	nominal group		
	noun/ Thing	prepositional phrase/ Qualifier	prepositional phrase/ Qualifier
grammatical class/ grammatical function (congruent form)	clause		
	verb/ Process	noun/ participant (Goal)	prepositional phrase/ circumstance (Location)
unpacked text: example	*someone cultures cells in high glucose* *cells are cultured in high glucose*		

It may be noticed that unpacked text does not have the same meaning as the original one and looks clumsy. It is not the case that congruent forms are the orthodox, unmarked way of meaning; grammatical metaphor is not just an additional, different way of meaning but it is an inherent resource in language.

Nominalization works in combination with other phenomena in grammatical metaphor. The next section will observe how nominalization and metaphorically realized logical relations work together.

ii) Obscure Logical Relations

Through grammatical metaphor, logical relations which are congruently realized by conjunction can be realized by other grammatical classes. For example:

> Excessive consumption of alcohol is a major cause of motor vehicle accidents. (adopted from Butt et al., 2012: 97)

In this clause, a logical relation is realized by a noun *cause*. Here, this message includes two nominalizations *Excessive consumption of alcohol* and *a major cause of motor vehicle accidents*. The logical relation can be realized as a verb and of course congruently as a conjunction:

People who drink too much alcohol and drive often cause motor vehicle accidents.

If you drink too much alcohol when you drive your car, you are likely to have an accident. (adopted from Butt et al., 2012: 98)

It should be noticed that in these clause complexes, nominalized events are 'unpacked' (Halliday, 2004b) and realized in more congruent forms. Grammatical features including grammatical metaphor tend to work together rather than happen as a single phenomenon to form a semantic tendency.

Figure 4 shows types of grammatical metaphor in which logical relations are metaphorically realized.

Figure 4: Types of grammatical metaphor (shift from relator)

semantic element	grammatical class	example
relator to entity	conjunction to noun	so = cause/ proof, if = condition
relator to quality	conjunction to adjective	then = subsequent, so = resulting
relator to process	conjunction to verb	then = follow, so = cause, and = complement
relator to circumstance	conjunction to preposition/ prepositional group	when = in times of, if = under conditions of

adapted from Halliday (2004: 41-42)

Other elements may be metaphorically realized. Figure 5 shows the principle of metaphoric shit.

Having overviewed the phenomena of transcategorization concerning grammatical metaphor, it should now be possible to illustrate unpacking texts. The following analysis may serve as an example:

> Decoupled presentation of these cues revealed that HAVDI ligation (at constant RGD ligation) reduced the contractile state and thereby nuclear YAP/TAZ localization in MSCs, resulting in altered interpretation of ECM stiffness and subsequent changes in downstream cell proliferation and differentiation. (from Extract 1)

In this sentence, seven nominalized expressions are found: *Decoupled presentation of these cues*, *HAVDI ligation*, *constant RGD ligation*, *contractile state*, *nuclear YAP/TAZ localization in MSCs*, *altered interpretation of ECM stiffness*, and *subsequent changes in downstream cell proliferation and differentiation*. In addition, it includes three logical relations that are

Figure 5: Direction of Metaphorization

relator	circumstance	process	quality	thing	example
			congruent	metaphorical	*quickly → speed*
		congruent		metaphorical	*transform → transformation*
	congruent			metaphorical	*with → accompaniment*
congruent				metaphorical	*so → cause, proof*
		congruent	metaphorical	congruent	*was/ used to → previous government → governmental*
	congruent		metaphorical		*with → accompanying*
congruent			metaphorical		*before → previous*
	congruent	metaphorical			*instead of → replace*
congruent		metaphorical			*so → cause*
congruent	metaphorical				*when → in times of*

adapted from Halliday and Matthiessen (1999; 246-247, 264)

metaphorically realized: *revealed*, *thereby*, *resulting in* and *subsequent*.

It has to be mentioned here that technical terms are not metaphorical form but congruent form of wordings; they are complex virtual things whose metaphors are dead and cannot be unpacked (Halliday and Matthiessen, 1999: 261; Halliday, 2004b: 38-39). For example, *ligation* is a technical term that is, for example, defined as "the joining of two DNA strands or other molecules by a phosphorate ester linkage[4]". Thus, its agnate terms *HAVDI ligation* and *constant RGD ligation* are regarded as technical terms and cannot be unpacked.

The following shows the result of unpacking (Figure 6).

Figure 6: Unpacking nominalizations in Extract 1

Key to figure:

original text
grammatical class/ grammatical function (metaphorical form)
grammatical class/ grammatical function (congruent form)
unpacked text: example

Decoupled	*presentation*	*of these cues*
past participle/ Classifier	noun/ Thing	prepositional phrase/ Qualifier
adverb/ circumstantial (Manner)	verb/ Process	noun/ participant (Goal)
these cues are presented (to cells) separately		

revealed
verb/ Process
conjunction/ Conjunctive
since/ because

reduced
verb/ Process
adverb/ circumstantial (Quality), adjective/ Numerative in nominal group
less (adverb)/ *less* (adjective)

contractile	*state*
adjective/ Classifier	noun/ Thing
adjective/ participant (Attribute)	verb/ Process
become contractile	

thereby	*nuclear*	*YAP/TAZ*	*localization*	*in MSCs*
adverb/ circumstance	adjective/ Classifier	noun/ Classifier	noun/ Thing	prepositional phrase/ Qualifier
conjunction/ Conjunctive	prepositional phrase/ circumstantial (Location)	noun/ Actor	verb/ Process	prepositional phrase/ circumstantial (Location)
so YAP/TAZ localizes in nucleus in MSCs				

resulting in
preposition/ Minor Process
conjunction/ Conjunctive
so

altered	*interpretation*	*of ECM stiffness*	
past participle/ Classifier	noun/ Thing	prepositional phrase/ Qualifier	
adverb/ circumstantial (Manner)	verb/ Process	noun/ participant (Carrier)	adjective/ participant (Attribute)
(cells) interpret how much ECM is stiff in a different way			

subsequent	*changes*	*in*	*downstream*	*cell*	*proliferation and differentiation*
adjective/ Classifier	noun/ Thing	prepositional phrase/ Qualifier			
			adjective/ Classifier	noun/ Classifier	noun/ Thing
conjunction/ Conjunctive	verb/ Process		conjunction/ Conjunctive	noun/ participant (Actor)	verb/ Process
then so how cells proliferate and differentiate change					

As a result of the analysis, the sentence may be reworded as:

> Since these cues were presented to cells separately, (we saw the followings): HAVDI ligation (at constant RGB ligation) becomes less contractile, so less YAP/TAZ localizes in nuclear in MSCs; so cells interpret how much ECM is stiff in a different way; then so, how cells proliferate and differentiate change.

This looks clumsy and unnatural and does not keep the meaning that the original text has. Experts do not need the process of unpacking. However, this process can be a solution to the problems that students face when they read scientific papers on, for example, cell biology in English.

3.3 Peculiar Usage

Technical discourse tends to use general words as technical terms. Since specialists are too familiar with these usages, they often seem unaware of them. Perhaps these usages might be unconscious technical terms. Examples identified in the two papers are shown in Figure 7.

This may be not a matter of English teachers, but they can at least encourage their students to consult with science dictionaries or to ask questions to their teachers in their field when they come across the words that look general, but the usage is peculiar to a given field.

Figure 7: Words whose usage is peculiar to (cell) biology

item	definition in the field of cell biology
development	the process by which a multicellular organism, beginning with a single cell, goes through a series of changes, taking on the successive forms that characterize its life cycle[5]
presentation	effect/ action that specific stimuli produce (a possible interpretation)[6]
interpretation	response to specific stimuli or matters (a possible interpretation)[7]
differentiation	the process by which different types of cells arise, leading to cells with specific structures and functions[8]

3.4 Two types of 'A shows B'

Research papers often use such sentences starting with: *we show …*, *we conclude …*, and *our findings reveal …* in order to present their aims and contributions. For example, the third sentence from Extract 2 can be analyzed as:

(3)

Here,	*we*	*show*
	participant (Sayer)	Process: verbal
dominant clause		

that within islets of Langerhans,	*focal adhesion activation in β cells*	*occurs*	*exclusively where they contact the capillary ECM (vascular face)*
circumstance	participant (Actor)	Process	circumstance
dependent clause (Projection)			

This type of relationship between clauses are called Projection: dependent clause is 'projected' through dominant clause.

Howerer, this type of verbs may function as a different process. For example, *The graph shows the result of the final exam.* can be analyzed as:

(4)

The graph	*shows*	*the result of the final exam*
participant (Identified)	Process: relational	participant (Identifier)

In (3), the process *show* functions as verbal; processes of saying with dependent clause as projected idea, while in (4), the process *shows* functions as relational: processes of being. A significant difference between the two is that (4) indicates a relation between the two entities (*the graph* is a sign of *the result of the final exam*), whereas (3) does not.

These different usages of 'A shows B' are identified in Extract 1. The fourth sentence from Extract 1 can be analyzed as:

(5)

Decoupled presentation of these cues	*revealed*	*that HAVDI ligation (at constant RGD ligation) reduced the contractile state and thereby nuclear YAP/ TAZ localization in MSCs,*	*resulting in altered interpretation of ECM stiffness and subsequent changes in downstream cell proliferation and differentiation.*
Identified	Process: relational	Identifier [rankshifted clause]	circumstance

On the other hand, the last sentence from Extract 1 can be analyzed as:

(6)

Our findings	*reveal*
Sayer	Process: verbal
dominant clause	

that, in an evolving developmental context,	*HAVDI/N-cadherin interactions*	*can alter*	*stem cell perception of the stiffening extracellular microenvironment.*
Circumstance	Actor	Process	Goal
dependent clause (Projection)			

In (5), the process *reveals* shows the relation between the two participants, Identified and Identifier (Identifier is a sign of Identified). On the other hand, *reveal* in (6) function as saying and projects the dependent clause. In addition, as we saw in 3.2, the Process *revealed* in (5) is a metaphorical realization of logical relations; (5) implies a logical relation (cause: reason), whereas (6) does not.

Verbs such as *imply*, *indicate*, *show*, *demonstrate*, *signify*, *suggest* may function either as verbal or being (a sign of) (Halliday, 1994: 142), and the borderline between the two are not necessarily sharp. However, in order to identify 'vailed' relations, this analysis is worth conducting.

4. Conclusion

The five lexicogrammatical characteristics, lexical density, syntactic ambiguity, grammatical metaphor (nominalization and obscure logical relations), peculiar usage and two types of 'A shows B' have been analyzed and discussed. The results of the text analysis have brought us the following question: what can English teachers share with their students? It does not seem reasonable that they try to be English teachers of their students' specialty: teaching technical terms and reading technical papers together are not the main job for teachers conducting English courses in liberal arts. It also does not necessary to teach terms and theory of SFL; it is just an unnecessary burden to both students and teachers. However, it might be useful for English teachers to be familiar with SFL (this does not mean that they have to be SFL researchers.). It seems reasonable for English teachers to share with students the lexicogrammatical features that may cause problems in reading academic texts and skills to overcome the difficulty. Items that English teachers can share with

their students, in terms of the discussion in this paper, are listed as:

1. the skill to unpack nominalization
2. the skill to identify logical relations
3. the skill to recognize ambiguity in text
4. the skill to identify peculiar usage as technical terms
5. the skill to recognize two types of 'A shows B'

Students have difficulty in reading scientific academic papers not just because they are not good at English or they do not understand 'special' English, but because they are not familiar with the lexicogrammatical resources of English that scientific academic papers tend to exploit. To provide students with practical assistance, identifying causes of problems and taking efficient and possible measure are the two wheels of a cart: analyzing texts in order to identify the characteristics of the language in a given field is an important mission of linguists and developing teaching methods to share skills in order to overcome difficulties that arise from the characteristics is an important mission of English teachers.

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Notes

1 Note that rank shift is not always metaphorical. For example, in *But whether these ECM actions drive the spatial organization of β cells, as they do in epithelial cells, is unknown.* (from Extract 2), the clause *whether these ECM actions drive the spatial organization of β cells* serves as a participant although it is still a

clause. Also see 3.1.

2 According to Halliday (1994: 191), a nominal group is interpreted as:

those	two	splendid	old	electric	trains	with pantographs
Deictic	Numerative	Epithet		Classifier	Thing	Qualifier
		Attitude	Quality			

3 A clause consists of a process, participant that takes part in the process and optional circumstances. Each element has more specific types. For example, English has six types of Process: material, relational, mental verbal, behavioural and existential. Each process includes accompanying participants. For example, process of material includes Actor and may include Goal. There are nine types of circumstantial element: Extent, Location, Manner, Cause, Contingency, Accompaniment, Role, Manner and Angle.

4 Oxford Dictionary of English (ODE), Second Edition revised (2005).

5 *Life: the science of biology* p. 393

6 Furuno, Tadahide (e-mail communication, September 28, 2020)

7 Furuno, Tadahide (e-mail communication, September 28, 2020)

8 *Life: the science of biology* p. 393

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