

「論文」

The Behavior of Adverbs in the Results Sections of Experimental Medical Research Articles: A Corpus-Based Move Analysis

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Abstract

Move analysis has clarified the functions of moves and steps, which the writers in a discourse community share, and corpus linguistics has developed the concept of phraseology as a new unit of analysis. These two types of studies can be integrated in investigations using corpora based on move analysis. Creating corpora based on move analysis can lead to the description of lexical phrases strongly associated with the functions of steps. Previous studies on this topic have been conducted mainly in the clinical medicine field within the framework of the Introduction, Methods, Results, and Discussion (IMRD or IMRAD) structure by calculating n-grams or using keyword analysis. However, the behavior of 4-grams with adverbs has not yet been investigated. Furthermore, keyword analysis has almost exclusively focused on the behavior of a limited range of grammatical words, neglecting the analysis of other types of words such as adverbs. Thus, in this study, we created a corpus based on the move analysis of experimental medical research articles, which included a total of approximately 1.6 million words. The Results sections of the studied articles included three moves: (RM1) Introducing experiments, (RM2) Announcing results, and (RM3) Commenting results. Identifying 4-grams with adverbs revealed the overall word combinations, although some low-frequency adverbs were not extracted in 4-grams. To describe the behavior of low-frequency adverbs and place the word combinations into lexical phrases, we observed the concordance lines of adverbs in each move while referring to the Life Science Dictionary. In conclusion, we found 26 lexical phrases strongly associated with the functions of three steps in RM1, three steps in RM2, and two steps in RM3. The current study opens the possibility of using a corpus based on move analysis to establish lexical phrases strongly relevant to the functions of steps for use in teaching English for specific purposes.

1. Introduction

1.1 Move Analysis and Phraseological Studies

Swales (1990: 140) proposed the “Create a Research Space (CARS) model,” advocating the functions of “moves” and “steps” and providing a brief list of expressions, especially for the Introduction sections. Dudley-Evans and St John (1998: 89) defined a “move” as “a unit that relates both to the writer’s purpose and to the content that s/he wishes to communicate” and a “step” as “a lower level text unit than move that provides a detailed perspective on the options open to the writers.” According to Coffin (2001) and Hyland (2002), move analysis has uncovered the functions of moves and steps shared by the writers in a “discourse community”—a group of people that “has a broadly agreed set of common public goals” (Swales, 1990: 24). Move analysis of research articles (RAs) in a particular discourse community reveals the functions of moves and steps in the traditional Introduction, Methods, Results, and Discussion (IMRD or IMRAD) structure, wherein these are included as article sections. As Thompson (1993) and Williams (1999) pointed out, move analysis mainly focuses on the Introduction and Discussion sections rather than the Results sections. However, Swales (1990: 175–176) stated that “the major differences do not lie so much in Introductions and Discussions (where I believe most people expect it) but rather in the Method and Results sections.” Thus, this study focuses on the functions of moves and steps in the Results sections of RAs.

Regarding the move analysis of medical RAs, Nwogu (1997) investigated 15 clinical medical RAs and identified 11 moves, including two moves in the Results sections. Clinical medical RAs “apply an initial hypothesis to a largely heterogeneous population; data collection is followed by definition, analysis and conclusions,” while “experimental research is based on hypothesis, a largely controlled method and observation, followed by deduction and further hypothesizing, perhaps leading to more experimentation” (Williams, 1996: 185). In fact, Williams (1996) found different and common uses of verbs in two clinical and experimental medical RAs. In addition, Thompson (1993) and Williams (1999) reported the rhetorical patterns of experimental medical RAs and biomedical RAs, respectively. Similarly, Kanoksilapatham (2005, 2007) identified the flow of discourse in experimental biochemical journals. Although these previous studies on move analysis illustrated moves or steps different from those

of clinical medical RAs, they did not exhibit the list of expressions involved. Thus, the current study attempts to reveal the linguistic features associated with the functions of moves and steps in the Results sections of experimental medical RAs.

In contrast with move analysis, corpus linguistics provides novel insights for analyzing language from the viewpoints of lexis and grammar as continua while developing the concept of phraseology as a new unit of analysis (Sinclair, 2004). Previous phraseological studies calculated n-grams or conducted keyword analysis to reveal the “recurrent patterns of associated words” (Cheng, 2012: 101) in a variety of labels and definitions, such as “lexical phrases,” “formulas,” “routines,” “fixed expressions,” “prefabricated patterns” (or “prefabs”), “n-grams,” and “lexical bundles” (Gray & Biber, 2015: 125). In this study, “n-grams” are defined as word combinations calculated by special software, CasualConc (Imao, 2019), while “lexical phrases” are “the general construct of phraseological patterns of three or more words,” (Gray & Biber, 2015: 127) generalized by investigating the concordance lines.

As a pioneering study combining move analysis and phraseological studies, Mizumoto et al. (2016) built a corpus based on move analysis. They collected and conducted move analysis on around 1,000 RAs in the area of applied linguistics published during 2000–2015 for a total of approximately 85 million words. They created a web-based system for supporting academic writing by exhibiting typical 3-gram to 5-gram units for each move and their concordance lines in the area of applied linguistics as well as of computer science, materials science, and medicine.¹ Regarding the field of clinical medical RAs, Saber (2012) created a clinical medial corpus based on IMRD as four subcorpora, collecting 375 articles published during 2006–2009 that included approximately 1.2 million words. Because “keywords can be lexical items which reflect the topic of a particular text” (Hunston, 2002: 68), he established keyword lists for each subcorpus by comparison with the whole corpus. Moreover, he reported 3-grams to 5-grams with nouns or verbs in the keywords and identified the functions of steps. However, little is known about the functions of n-grams with adverbs in RAs. Thus, as a first step of this study, using a corpus based on move analysis, we examined 4-grams with adverbs in keywords in the Results sections of experimental medical RAs. As Hyland (2008a: 8) advocated, 4-grams are “far more common than 5-word strings and offer a clearer range of structures and functions than 3-word bundles.”

Although n-grams are produced automatically by using special software such as Antconc (Anthony, 2019), the “frequency-driven approach” (Biber, Conrad, & Cortes, 2004: 1) has been criticized from the perspective of the method of identification. When words such as adverbs and adjectives are inserted, the word sequences are regarded as indicating different phraseological patterns (Durrant, 2009); Namely, some phraseological patterns might be ignored (Cheng, 2012). To reduce the possibility of this issue, keyword analysis has mainly been carried out by observing the concordance lines carefully (Hunston, 2002). For instance, in the area of medical RAs, Kawamoto and Ishii (2018a, 2018b) investigated a corpus of approximately 1.4 million words consisting of 12 moves, modified by Nwogu (1997), from 395 clinical medical RAs published during 2013–2014. The keywords in each move were determined according to the value of the log-likelihood ratio (LLR) with comparison to the whole corpus. Moreover, Kawamoto and Ishii (2018a), following Gledhill (2000a, 2000b), observed the concordance lines of grammatical words such as *has*, *that*, and *our* in the Introduction and Discussion sections. However, little is known about how adverbs in keywords behave in RAs. Moreover, reading concordance lines of adverbs leads to the identification of lexical phrases with adverbs that are not evident due to their low frequency. Here, as a second step of this study, we identified lexical phrases with adverbs associated with the functions of steps in the Results sections of experimental medical RAs.

1.2 Functions of Moves and Steps in the Results Sections of Experimental Medical RAs

To build a corpus based on move analysis of experimental medical RAs, the moves need to be identified for comparison with those in previous studies. Although Thompson (1993) analyzed 36 Results sections of experimental medical RAs and found six rhetorical moves, the steps were not noted at all. On the other hand, based on Brett (1994), Williams (1999: 347) investigated eight Results sections of biomedical RAs and identified “three broad classes,” which can be regarded as moves, although the term *categories* was used. Moreover, the functions of *categories*, which can be identified as steps, were reported as in Table 1.

Table 1: Functions of the Classes (Moves) and Categories (Steps) in Results Sections Identified by Williams (1999: 363–364)

Classes	Categories
Metatextual Categories	0.1 Pointer 0.2 Structure of Section
Presentational Categories	0.3 Procedural 1.1 Statement of Findings 2.1 Substantiation of Finding 2.2 Non-validation of Finding
Comment Categories	3.0 Explanation of Finding 3.1 Comparison of Finding with Literature 3.2 Evaluation of Finding or Hypothesis 3.4 Implications of Finding

In addition, Kanoksilapatham (2005: 290–291) collected 60 biochemical RAs comprising 0.32 million words to identify 15 distinct moves, including four moves in the Results sections: “Stating procedures,” “Justifying procedures or methodology,” “Stating results,” and “Stating comments on the results.” Although the same corpus data were analyzed, Kanoksilapatham (2007) renamed the four moves in Results sections as Move 8 to Move 11 and described the functions of their steps, as presented in Table 2.

Table 2: Functions of the Moves and Steps in Results Sections Identified by Kanoksilapatham (2007: 76)

Move 8: Restating methodological issues	Step 1: Describing aims and purposes Step 2: Stating research questions Step 3: Making hypotheses Step 4: Listing procedures or methodological techniques
Move 9: Justifying methodological issues	
Move 10: Announcing results	Step 1: Reporting results Step 2: Substantiating results Step 3: Invalidating results
Move 11: Commenting results	Step 1: Explaining results Step 2: Generalizing/interpreting results Step 3: Evaluating results Step 4: Stating limitations Step 5: Summarizing

Tables 1 and 2 include some common functions with different names or definitions. For instance, Kanoksilapatham (2007) did not identify “Metatextual Categories” as shown in Table 1, while “0.3 Procedural” in Table 1 seems equivalent to “Move 8: Restating methodological issues” and “Move 9: Justifying methodological issues” in Table 2. Thus, in this study, “Move 8: Restating methodological issues” and “Move 9: Justifying methodological issues” in Table 2 were combined as the first move called (RM1) Introducing experiments. Following Kanoksilapatham (2007), the second move was labeled as (RM2) Announcing results, and the third move was designated as (RM3) Commenting results. As for RM2, “1.1 Statement of Findings” in Table 1 can be regarded as “Step 1: Reporting results” as part of “Move 10: Announcing results” in Table 2, while “2.1 Substantiation of Finding” and “2.2 Non-validation of Finding” in Table 1 can be considered as “Step 2: Substantiating results” and “Step 3: Invalidating results” as part of “Move 10: Announcing results.” Regarding RM3, “Comment Categories” in Table 1 functioned as “Move 11: Commenting results” in Table 2.

In sum, given the functions of moves and steps in Tables 1 and 2, in this study, the texts were segmented into three moves: (RM1) Introducing experiments, (RM2) Announcing results, and (RM3) Commenting results (see Table 3), and tagged RM1, RM2, and, RM3, respectively.

2. Methods

2.1 Overview

To describe the behavior of adverbs, we followed the “top-down corpus-based analysis” advocated by Biber, Connor, and Upton (2007: 13). To apply a top-down approach, we collected 304 articles from 30 leading journals (identified in the Appendix) utilizing the IMRD structure and created a corpus according to the move analysis.² When conducting move analysis manually, we consulted the text independently with reference to the criteria presented in Section 1.2 and identified the boundaries between the moves (see Section 2.2). First, to follow a corpus-based approach, using Antconc (Anthony, 2019), we identified keywords according to the value of LLR with comparison to the whole corpus (approximately 1.6 million words) as a reference corpus. TagAnt (Anthony, 2015) was used to check parts of speech in context and count the frequencies of words that were used as adverbs in RM1, RM2,

and RM3. When the keywords behaved as more than one part of speech, we focused on the behavior of the keywords as adverbs. For instance, the words *next*, *first*, and *further* in RM1 and *overall* in RM2 and RM3 worked as not only adverbs but also adjectives. Similarly, when the adverbs functioned in an adverbial phrase, we investigated the behavior of keywords as adverbs and excluded the analysis of the adverbial phrases. For example, in RM3, although the adverbial phrases *taken together* and *all together* occurred 174 times and six times, respectively, we described the behavior of the adverb *together*. Next, to reveal frequent word combinations, based on CasualConc (Imao, 2019), 4-grams with adverbs in keywords in each move were extracted according to the frequency criteria of 20 times per million words (Hyland, 2008b). The minimal frequencies for 4-grams in RM1 and RM2 were determined to be five and eight, respectively. Although the frequency in RM3 should be two according to the calculation, the corpus size of RM3 was so small that it was considered to be at least four. In calculating 4-grams, the adverb *not* was not considered in RM2 and RM3. Although the meanings of phrases with and without the adverb *not* are opposite, both such phrases were identified. For example, the phrase *was significantly reduced in* and the phrase *was not significantly reduced in* can be considered equivalent.

To observe the behavior of some adverbs that were not extracted in 4-grams and to describe lexical phrases with adverbs, reading the concordance lines of adverbs in keywords was conducted, with reference to their raw frequency and LLR. To check the word combinations and place them into lexical phrases, we consulted the Life Science Dictionary (LSD) available on the web.³ The LSD is a monitor corpus that consists of about 100 million words from abstracts published in about 150 leading journals during 1998–2015 and freely available from PubMed.⁴ Because “it seems to be the case that most abstracts reflect the IMRD pattern of the RA itself” (Swales, 1990: 181), using the LSD corpus was an effective method for checking the word combinations and the behavior of adverbs. Lastly, we categorized the lexical phrases with adverbs according to their functions and simultaneously labeled the names of the steps based on Kanoksilapatham (2007), as shown in Table 2.

2.2 Criteria for the Boundaries Between Moves

Although Kanoksilapatham (2005, 2007) reported move structure and example sentences, she did not present clear criteria for boundaries between moves. To maintain

replicability, our corpus data were created according to the concept that tense and reporting verbs function as signals of move segments (Waard & Henk, 2012). Tense denotes authors' rhetorical purposes: The past tense refers to specific experiments, while the present tense generalizes the findings (Malcolm, 1987). Thus, the past tense indicates the signals of RM1 and RM2, whereas the present tense functions as the signal of RM3 (see Table 3). The choice of the reporting verbs relates to the rhetorical function. The reporting verbs included "Procedural Verbs" (*examined*, *used*, and *evaluated*), which served as the signal of RM1, "Objective Verbs" (*found* and *observed*), which functioned as the signal of RM2, and "Post-Experimental Verbs" (*suggest* and *indicate*), which indicated RM3 (Thomas & Thomas, 1994: 134–139). Using verb-based analysis, we segmented all texts manually. For example, when two signal verbs appeared in one sentence, we separated the sentence into two different moves. Accordingly, we identified the signals of RM1 and RM2 in the following sentence.

- (1) We **examined** expression of [.....] **and found** that astrocytes at [.....].
(Tasdemir-Yilmaz & Freeman, 2014: 22 [emphases added])

Furthermore, a participial construction such as *suggesting* led us to divide a sentence into RM2 and RM3, as in the following sentence.

- (2) Notably, these ratios **did not change** between [.....], **suggesting** that the [.....].
(Case et al., 2014: 868 [emphases added])

2.3 Corpus Data of the Results Sections

In creating a corpus, one difficulty is in how to treat balance and representativeness (Biber, 1990, 1993). In this study, corpus data were obtained from the compiled articles with the IMRD structure based on the three criteria advocated by Nwogu (1997: 121): "representativity, reputation, and accessibility." First, to guarantee the representativeness of the corpus data, the span of journals was limited, as Saber (2012) mentioned. Second, regarding the reputation, leading journals in the field of experimental medicine, including the four journals analyzed by Kanoksilapatham (2005, 2007), were selected using the Journal Impact Factor (Journal Citation Reports) and the number of citations. Lastly, regarding accessibility, all articles were extracted

from e-journals (available from the Hiroshima University Library) that could be transferred easily from HTML pages to Notepad on a personal computer. The figure legends, tables, headings, and section titles were excluded. The corpus consisted of 304 articles from 30 leading experimental medical journals published in 2014 (approximately 1.6 million words). Table 3 presents the overall information and the functions of moves in the Results sections.

Table 3: Corpus Data on the Results Sections

	Tokens	Number of files	Moves	Applied Signals
RM1	243,711	4,398	Introducing experiments	Procedural Verbs past tense (examined / used / evaluated)
RM2	404,428	5,379	Announcing results	Objective Verbs past tense (found / observed)
RM3	84,281	3,137	Commenting results	Post-Experimental Verbs present tense / participial construction (suggest / indicate suggesting / indicating)
Total	732,420	12,914		

3. Results

3.1 Overview of Adverbs and 4-grams with Adverbs in the Results Sections

Table 4 shows the adverbs identified as keywords and their raw frequencies in the three moves in the Results sections. For RM1, RM2, and RM3, the numbers of keywords identified were 94, 249, and 108, while the numbers of adverbs in the keywords were 5, 27, and 12, respectively.

Table 4: Adverbs as Keywords of the Results Sections

RM1	next (533), further (289), therefore (274), first (244), stably (48)
RM2	not (2,198), also (1,353), significantly (1,026), only (721), however (649), interestingly (252), furthermore (233), moreover (222), notably (219), similarly (216), indeed (206), alone (195), importantly (178), strongly (141), approximately (134), completely (118), almost (115), slightly (98), markedly (93), consistently (91), nearly (81), substantially (80), dramatically (76), remarkably (67), strikingly (66), conversely (66), surprisingly (62)
RM3	not (483), thus (404), together (216), therefore (153), collectively (97), rather (66), directly (66), strongly (57), hence (38), overall (33), functionally (23), altogether (16)

To investigate the frequent word combinations shown in Table 4, 4-grams with adverbs were produced. Table 5 shows 4-grams and their frequencies with adverbs. These 4-grams occurred at least five times. Hereafter, the adverbs listed in Table 4 are written in italics.

Table 5: 4-Grams with Adverbs and Their Frequencies in RM1

<i>we next</i> sought to (40)	<i>we next</i> examined whether (8)
<i>we next</i> examined the (27)	<i>we next</i> assessed whether (8)
<i>we next</i> asked whether (21)	<i>next</i> we examined the (8)
<i>we next</i> investigated whether (20)	<i>next</i> we asked whether (8)
<i>we next</i> investigated the (17)	<i>we therefore</i> hypothesized that (7)
to <i>further</i> investigate the (17)	<i>we therefore</i> examined the (7)
<i>we next</i> tested whether (16)	<i>we next</i> analyzed the (7)
<i>we next</i> tested the (15)	to <i>further</i> examine the (7)
<i>we next</i> determined whether (15)	to <i>further</i> test the (7)
<i>we first</i> examined the (12)	<i>we therefore</i> tested whether (6)
<i>next</i> sought to identify (11)	<i>further</i> investigate the role (6)
<i>we next</i> assessed the (9)	to <i>further</i> examine whether (5)
<i>we first</i> tested the (9)	<i>next</i> we tested whether (5)
to <i>further</i> explore the (9)	<i>therefore</i> we examined the (5)
to <i>further</i> confirm the (9)	<i>we next</i> compared the (5)
to <i>further</i> characterize the (9)	<i>we next</i> explored the (5)
<i>next</i> sought to determine (9)	<i>we next</i> used the (5)

These 4-grams with adverbs in Table 5 are strongly associated with the function of (RM1) Introducing experiments. The frequent word combinations were the pronoun *we* with the adverbs and the adverb *further* between *to*-infinitive and some verb stems. However, other word combinations could be made but may not have been extracted.

Table 6 shows the 4-grams with adverbs in RM2 that were found at least eight times.

Table 6: 4-Grams with Adverbs and Their Frequencies in RM2

we <i>also</i> found that (16)	we <i>also</i> observed that (10)
was <i>also</i> observed in (15)	found to be <i>significantly</i> (9)
was <i>significantly</i> higher in (15)	<i>notably</i> we found that (9)
were <i>significantly</i> enriched in (14)	<i>interestingly</i> we found that (8)
<i>however</i> we found that (13)	<i>however</i> in contrast to (8)
was <i>significantly</i> reduced in (12)	were <i>also</i> observed in (8)
we <i>also</i> observed a (11)	<i>significantly</i> more likely to (8)
was <i>significantly</i> lower in (11)	was <i>significantly</i> higher than (8)
were <i>significantly</i> reduced in (11)	<i>alone</i> or in combination (8)
<i>also</i> observed in the (10)	

In Table 6, the 4-grams with the adverbs shown above were used to realize the function of (RM2) Announcing results. For example, the adverbs *notably* and *interestingly* appeared with the pronoun *we* and were used to emphasize important results. On the other hand, the adverb *significantly* was used with the passive voice to indicate an increase or decrease. Although 7 of 27 adverbs related to RM2, which were listed in Table 4, were identified by calculating 4-grams, there was a need to investigate the behavior of the other 20 adverbs by observing the concordance lines carefully. Table 6 shows 4-grams with adverbs in RM3. The listed 4-grams appeared at least four times.

Table 7: 4-Grams with Adverbs and Their Frequencies in RM3

<i>together</i> these results indicate (15)	<i>together</i> these findings indicate (5)
<i>together</i> these data suggest (14)	<i>together</i> these results suggest (5)
<i>together</i> these data indicate (12)	<i>collectively</i> these results indicate (5)
<i>collectively</i> these data suggest (10)	<i>altogether</i> these results demonstrate (4)
<i>collectively</i> these results suggest (8)	<i>collectively</i> these data indicate (4)
<i>thus</i> we conclude that (7)	<i>collectively</i> these results demonstrate (4)
<i>we therefore</i> conclude that (7)	results <i>strongly</i> suggest that (4)
<i>together</i> these data demonstrate (7)	<i>thus</i> indicating that these (4)
<i>together</i> these data suggested (6)	<i>together</i> these data indicated (4)
<i>together</i> these results demonstrate (6)	<i>we thus</i> conclude that (4)

In Table 7, these 4-grams with adverbs were strongly relevant to the function of (RM3) Commenting results. The frequent word combinations were the nouns *results*, *data*, and *findings* with the adverbs *together*, *collectively*, and *altogether*. Moreover, the pronoun *we* appeared with the adverbs *thus* and *therefore*, and the verb *conclude*. However, some adverbs in RM3 of Table 4 had not yet been investigated due to their low frequency.

3.2 Behavior of Adverbs in RM1

3.2.1 Relationship Between Adverbs and Steps in RM1

As mentioned in Section 2.1, to observe the behavior of some adverbs that were not be extracted in 4-grams due to their low frequency and to describe lexical phrases with adverbs, the concordance lines of adverbs in keywords were carefully observed. Moreover, the LSD was consulted to check the word combinations and place them into lexical phrases. The lexical phrases were categorized according to their functions, and the names of steps were labeled. In (RM1) Introducing experiments, three steps were identified: Step (1) “Describing aims and purposes,” Step (2) “Making hypotheses,” and Step (3) “Listing procedures or methodological techniques,” based on Kanoksilapatham (2007: 76). As presented in Table 8, five adverbs in keywords were extracted using the value of LLR, nominalized frequency (NF) calculated per 1,000 words, and raw frequency. The rank was determined according to the value of LLR.

Table 8: Adverbs in RM1

Rank	Keyword	LLR	NF	Frequency	Step
1	next	695.87	2.19	533	Steps (1) and (3)
2	first	84.90	1.00	244	Steps (1) and (3)
3	therefore	80.24	1.12	274	Steps (1), (2), and (3)
4	further	70.08	1.19	289	Steps (1) and Step (3)
5	stably	27.29	0.20	48	Step (3)

Note: LLR = log-likelihood ratio; NF = normalized frequency.

As shown in Section 3.1, the adverbs *next*, *first*, *therefore*, and *further* tended to co-occur with the pronoun *we*. For instance, for the adverb *next*, the phrase *we next* occurred 391 times while the phrase *Next, we* appeared 124 times.

3.2.2 RM1-Step (1): Describing Aims and Purposes

To indicate Step (1) Describing aims and purposes, the pronoun *we* appeared with verbs related to what was planned in the study, such as *asked* and *determined*, followed by, as an option, either the conjunction *whether* or *if* or the noun phrase *the role* or *the effect(s)* (Table 9). Hereafter, vocabulary items in the same column are interchangeable, while those separated by a horizontal line are not. The word combinations were checked by referring to the LSD.

Table 9: Lexical Phrase (1) in RM1-Step (1)

We	<i>next</i> <i>first</i> <i>therefore</i> <i>further</i>	asked	whether if
		addressed analyzed assessed determined evaluated examined explored investigated tested	whether if the role of the effect(s) of
<i>Next,</i> <i>First,</i> <i>Therefore,</i>	we	characterized	the role of the effect(s) of
		compared	the effect(s) of

As an alternative choice for describing aims and purposes, the pronoun *we* emerged with the verbs followed by *to*-infinitive (Table 10).

Table 10: Lexical Phrase (2) in RM1-Step (1)

We	<i>next</i> <i>first</i> <i>therefore</i>	attempted sought set out wanted	to
<i>Next,</i> <i>First,</i> <i>Therefore,</i>	we		

As shown in Section 3.1, the adverb *further* appeared with *to*-infinitive in the phrase *To further* 176 times. The phrase *To further* with several typical verbs was related to consolidating the given findings (Table 11).

Table 11: Lexical Phrase (3) in RM1-Step (1)

<i>To further</i>	confirm establish validate verify
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On the other hand, the phrase *To further* with several typical verbs was also used to indicate a further exploration, as shown in Table 12.

Table 12: Lexical Phrase (4) in RM1-Step (1)

<i>To further</i>	address assess characterize define delineate demonstrate determine dissect elucidate evaluate examine explore investigate narrow down probe quantify test understand
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3.2.3 RM1-Step (2): Making Hypotheses

As the second step in RM1, the adverb *therefore* leads to an account of developing the hypotheses. The verb *hypothesized* with the adverb *therefore* was observed by producing 4-grams with the keyword. Furthermore, observing the concordance lines of the adverb *therefore* revealed similar word combinations with the verb *reasoned*, as shown in Table 13.

Table 13: Lexical Phrase in RM1-Step (2)

we	<i>therefore</i>	hypothesized reasoned	that
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3.2.4 RM1-Step (3): Listing Procedures or Methodological Techniques

As the last step in RM1, the pronoun *we* served to list procedures or methodological techniques with several particular verbs, as shown in Table 14.

Table 14: Lexical Phrase (1) in RM1-Step (3)

We	<i>next</i> <i>first</i> <i>therefore</i> <i>further</i>	calculated generated injected mapped measured performed quantified selected transfected treated used
<i>Next,</i> <i>First,</i> <i>Therefore,</i>	we	

In addition, the lexical phrase including the adverb *stably* was used to show technical experimental procedures (Table 15).

Table 15: Lexical Phrase (2) in RM1-Step (3)

We	<i>stably</i>	overexpressed knocked down
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3.3 Behavior of Adverbs in RM2

3.3.1 Relationship Between Adverbs and Steps in RM2

RM2 served to announce the results. Observing the concordance lines of 27 adverbs in Table 3 revealed that these adverbs can be divided into two types: 12 adverbs that tended to appear in a sentence-initial position and 15 adverbs that were likely to appear in the middle of sentences. Three steps were identified, which were different from those in Kanoksilapatham (2007). Seven out of 12 adverbs that appeared in a sentence-initial position signaled Step (1) Highlighting important results, while the remaining five adverbs that appeared in a sentence-initial position and the adverb *also* that occurred in a sentence-medial position functioned as Step (2) Showing additional or adversative results. On the other hand, when the 14 adverbs appeared sentence-medially, except for the adverb *also*, they worked as Step (3) Describing quantitative data.

3.3.2 RM2-Step (1): Highlighting Important Results

Table 16 shows seven adverbs, of 12 sentence-initial adverbs, that play an important role in lexical phrases for highlighting important results, and it identifies the number of adverbs that appeared at the initial and middle positions of the sentences in RM2.

Table 16: Adverbs in RM2-Step (1)

Rank	Keyword	LLR	NF	Frequency	Initial position of the sentences (Initial position of RM2)	Middle position of the sentences
1	notably	100.59	1.31	219	199 (49)	20
2	interestingly	100.19	0.60	252	245 (84)	7
3	importantly	62.15	0.67	178	162 (21)	16
4	remarkably	38.76	0.71	67	49 (21)	18
5	strikingly	37.93	0.11	66	58 (27)	8
6	indeed	31.69	1.31	206	157 (93)	49
7	surprisingly	31.12	0.60	62	47 (20)	15

Note: LLR = log-likelihood ratio; NF = normalized frequency.

Although behavior of the adverbs *notably* and *interestingly* were identified with the pronoun *we*, as shown earlier, reading the concordance lines of the other adverbs in Table 16 revealed the same lexical phrase as that presented in Table 17.

Table 17: Lexical Phrase in RM2-Step (1)

<i>Notably,</i> <i>Interestingly,</i> <i>Importantly,</i> <i>Remarkably,</i> <i>Strikingly,</i> <i>Indeed,</i> <i>Surprisingly,</i>	we	found observed	that
	[phenomenon]	was were	found observed

It is worth noting that the lexical phrase navigates readers to what was found in the study, even though the Results sections of medical RAs are considered to be written in an objective way, as Thompson (1993) stated. In addition, when these adverbs sometimes appeared at the initial position of RM2, as shown in Table 16, they functioned not only as signals of highlighting results but also as connectors between RM1 and RM2.

3.3.3 RM2-Step (2): Showing Additional or Adversative Results

Table 18 shows five adverbs of 12 sentence-initial adverbs and the adverb *also* that occurred sentence-medially, which led to lexical phrases for showing additional or adversative results.

Table 18: Adverbs in RM2-Step (2)

Rank	Keyword	LLR	NF	Frequency	Initial position of the sentences (Initial position of RM2)	Middle position of the sentences
1	also	128.86	3.34	1353	19 (2)	1334
2	similarly	71.42	0.53	216	142 (17)	74
3	however	64.14	1.60	649	497 (82)	152
4	furthermore	46.19	0.57	233	228 (28)	5
5	moreover	39.68	0.57	222	217 (23)	5
6	conversely	29.48	0.16	66	53 (10)	13

Note: LLR = log-likelihood ratio; NF = normalized frequency.

The adverbs *similarly*, *moreover*, and *furthermore* were used to form the lexical phrase for adding what was observed (Table 19).

Table 19: Lexical Phrase (1) in RM2-Step (2)

<i>Similarly,</i> <i>Moreover,</i> <i>Furthermore,</i>	we	found observed	that
	[phenomenon]	was were	observed found

Although the adverb *also* appeared in the middle of sentences, as shown in Table 20, it served to form the lexical phrase for adding to the results. Moreover, the adverb *also* with the subject *we* emerged with objective verbs (Table 20).

Table 20: Lexical Phrase (2) in RM2-Step (2)

We	<i>also</i>	detected identified	[substance]		
		noticed	that		
		found	that		
		observed noted	a significant	increase decrease	in

Furthermore, the adverb *also* co-occurred with the nouns *data* and *analysis* and the verb *reveal* (Table 21).

Table 21: Lexical Phrase (3) in RM2-Step (2)

our The This	data analysis	<i>also</i>	revealed	that
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Lastly, the adverb *also* was used mainly with the passive voice (Table 22).

Table 22: Lexical Phrase (4) in RM2-Step (2)

was were	<i>also</i>	<i>(significantly)</i>	detected evident found induced observed present seen enriched increased decreased reduced	in by
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The lexical phrase in Table 23 shows the relationship between events.

Table 23: Lexical Phrase (5) in RM2-Step (2)

was were	<i>also</i>	associated	with
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The function of the lexical phrase shown in Table 24 is to connect the results by contrasting what was observed.

Table 24: Lexical Phrase (6) in RM2-Step (2)

<i>However, Conversely,</i>	we	found observed	that
	[phenomenon]	was were	found observed

3.3.4 RM2-Step (3): Describing Quantitative Data

In contrast with the adverbs shown in Tables 16 and 18, except for the adverb *also*, the 14 adverbs in Table 25 tended to appear in the middle of sentences.

Table 25: Adverbs in RM2-Step (3)

Rank	Keyword	LLR	NF	Frequency	Initial position of the sentences (Initial position of RM2)	Middle position of the sentences
1	significantly	664.8	2.53	1026	8 (2)	1018
2	not	382.44	5.43	2198	11 (4)	2187
3	only	125.84	1.78	721	52 (12)	661
4	completely	63.13	0.29	118	1 (1)	117
5	slightly	62.95	0.24	98	0 (0)	98
6	almost	55.65	0.28	115	4 (3)	111
7	markedly	51.03	0.23	93	1 (1)	92
8	alone	48.30	0.48	195	0 (0)	154
9	dramatically	40.12	0.18	76	0 (0)	76
10	nearly	33.03	0.20	81	6 (1)	75
11	consistently	31.85	0.22	91	34 (11)	57
12	substantially	31.36	0.19	80	0 (0)	80
13	approximately	29.90	0.33	134	16 (7)	118
14	strongly	22.65	0.34	141	0 (0)	141

Note: LLR = log-likelihood ratio; NF = normalized frequency.

These sentence-medial adverbs play a critical role in indicating how the event or data quantitatively changed (Table 26). It is worth mentioning that, in terms of the “semantic prosody,” defined by Louw (1993: 157) as “a consistent aura of meaning with which a form is imbued by its collocates,” the adverb *completely* connoted the meaning of “negative” and was associated with the past participle *abolished* or *abrogated*.

Table 26: Lexical Phrase (1) in RM2-Step (3)

was were	<i>(almost)</i> <i>(not)</i>	<i>completely</i>	abolished abrogated blocked depleted eliminated inefficient inhibited lost suppressed		
		<i>significantly</i>			
	<i>(not)</i>	<i>significantly</i>	associated correlated	with	
			related	to	
		<i>significantly</i> <i>strongly</i> <i>(only) slightly</i> <i>markedly</i> <i>consistently</i> <i>substantially</i> <i>dramatically</i>	higher lower smaller	than in	
			decreased increased reduced	in	
	more	than			

Furthermore, the adverb *approximately* led to the description of data (Table 27).

Table 27: Lexical Phrase (2) in RM2-Step (3)

was were	<i>approximately</i>	two three	times	higher larger smaller	than in
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The adverb *only* showed limited conditions, such as the location and object (Table 28).

Table 28: Lexical Phrase (3) in RM2-Step (3)

[phenomenon]	was were	significant	<i>only</i>	for
		detected found identified observed increased reduced		in when
	occurred showed			
We		detected found		

The adverbs *almost* and *nearly* were used to show the results in an indirect way (Tables 29 and 30).

Table 29: Lexical Phrase (4) in RM2-Step (3)

was were	<i>almost</i> <i>nearly</i>		identical	
	detected found	<i>almost</i>	exclusively	in

Table 30: Lexical Phrase (5) in RM2-Step (3)

<i>almost</i> <i>nearly</i>	complete	absence	of
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Lastly, although Table 6 shows the phrase *alone or in combination*, the phrase usually appeared with the preposition *with* to describe a condition (Table 31).

Table 31: Lexical Phrase (6) in RM2-Step (3)

<i>alone</i>	or	in	combination	with
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3.4 Behavior of Adverbs in RM3

3.4.1 Relationship Between Adverbs and Steps in RM3

RM3 is used for commenting results. As with RM2, reading concordance lines of 12 adverbs revealed that these adverbs can be divided into two types. Seven adverbs that tended to appear in the initial position of sentences and one adverb that occurred sentence-initially signaled Step (1) “Generalizing/interpreting results,” as stated in Kanoksilapatham (2007: 76). On the other hand, four adverbs that were likely to be found in the middle of sentences worked as Step (2) Emphasizing relationships, which was not mentioned in Kanoksilapatham (2007).

3.4.2 RM3-Step (1): Generalizing/Interpreting Results

Table 32 shows seven adverbs that occurred in the initial positions of sentence and one adverb that appeared in the middle of sentences. These adverbs were strongly related to generalizing the findings.

Table 32: Adverbs in RM3-Step (1)

Rank	Keywords	LLR	NF	Frequency	Initial position of the sentences (Initial position of RM3)	Middle position of the sentences
1	together	960.62	4.69	216	183 (161)	32
2	thus	622.52	4.79	404	324 (287)	80
3	collectively	258.19	1.15	97	83 (78)	14
4	therefore	129.07	1.81	153	108 (90)	45
5	strongly	49.66	0.67	57	0 (0)	57
6	hence	46.25	0.45	38	31 (23)	7
7	overall	39.81	0.66	33	29 (25)	4
8	altogether	38.96	0.18	16	15 (15)	1

Note: LLR = log-likelihood ratio; NF = normalized frequency.

Although the adverbs *together*, *collectively*, and *altogether* with the pronouns *these*, which mark the interpretation, were observed in Table 7, reading the concordance lines revealed similar behavior with the other word combinations, as shown in Table 33. The adverbs shown in Table 32, except for the adverb *strongly*, appeared at the

initial position in RM3. Hence, it can be concluded that not only the verbs *suggest* and *indicate* but also the adverbs shown above were used as connectors between RM2 and RM3. Although the adverb *strongly* appeared only in the middle of sentences, as shown in Table 32, the lexical phrase was sometimes used to emphasize the function of Step (1) with the adverb *strongly* occurring between nouns such as *data* and *results* and verbs such as *suggest* and *indicate* (Table 33).

Table 33: Lexical Phrase (1) in RM3-Step (1)

<i>Together,</i> <i>Collectively,</i> <i>Altogether,</i> <i>Thus,</i> <i>Overall,</i>	these our	data experiments findings observations results	(strongly)	demonstrate indicate show suggest	that
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Furthermore, to interpret the data obtained, the adverb *thus* appeared with a participial construction such as *suggesting* and *indicating* (Table 34).

Table 34: Lexical Phrase (2) in RM3-Step (1)

, <i>thus</i>	indicating suggesting	that
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In addition, the lexical phrase including the pronoun *we* appeared with the verb *conclude* as shown in Table 35.

Table 35: Lexical Phrase (3) in RM3-Step (1)

We	<i>therefore</i> <i>thus</i>	conclude	that
<i>Therefore,</i> <i>Thus,</i> <i>Overall,</i>	we		

Lastly, the dummy subject *it* played a critical role in adjusting the interpretation with the adverbs *therefore*, *thus*, and *hence* (Table 36).

Table 36: Lexical Phrase (4) in RM3-Step (1)

<i>Therefore,</i> <i>Thus,</i> <i>Hence,</i>	it	appears seems		that
		is	likely possible	

3.4.3 RM3-Step (2): Emphasizing Relationships

Table 37 shows the adverbs that were present in the middle of sentences as keywords of RM3, except for the adverb *strongly* (Tables 32 and 33). Although the adverb *rather* was found with the conjunction *than*, the phrase *rather than* was not defined as a lexical phrase consisting of more than two words.

Table 37: Adverbs in RM3-Step (2)

Rank	Keywords	LLR	NF	Frequency	Initial position of the sentences (Initial position of RM3)	Middle position of the sentences
1	not	122.97	5.73	483	0 (0)	483
2	rather	64.97	0.78	66	2 (2)	64
3	directly	27.21	0.78	66	0 (0)	66
4	functionally	22.99	0.27	23	0 (0)	23

Note: LLR = log-likelihood ratio; NF = normalized frequency.

The lexical phrase in Table 38 included the adverb *directly*, which indicated physical interaction or action without intervening events.

Table 38: Lexical Phrase (1) in RM3-Step (2)

bind	<i>directly</i>	to
interact		with

Furthermore, with the adverb *functionally*, the lexical phrase emphasized the characteristics of the research object as a technical term (Table 39).

Table 39: Lexical Phrase (2) in RM3-Step (2)

is are	<i>functionally</i>	essential required	for
		distinct	in

4. Discussion and Conclusion

Using a corpus based on move analysis, we investigated the behavior of adverbs in the Results sections of experimental medical RAs. We produced 4-grams with adverbs and observed the concordance lines of adverbs carefully while referring to the LSD. Accordingly, we identified 26 lexical phrases for realizing three steps in RM1, three steps in RM2, and two steps in RM3. In these lexical phrases, the adverbs occurring in the initial positions of sentences sometimes functioned as connectors between moves, for example, the adverbs *interestingly* in RM2 and *collectively* in RM3. On the other hand, adverbs in the middle of sentences such as *significantly* were used to show the quantitative data in RM2.

However, our analysis of adverbs has several limitations. For instance, we did not observe the concordance lines of the adverbial phrases *as expected* and *of note* in RM2 and the adverbial phrase *taken together* in RM3. The former behaved in a similar manner as that of the adverb *interestingly*, following the phrase *we found*, to highlight important results (Table 17). The latter phrase seemed to function similarly to the adverb *therefore*, following the phrase *we conclude*, to generalize the results (Table 35). We may be able to find other lexical phrases by exploring the behavior of adverbial phrases or other parts of speech in RAs. Moreover, future work should consider how the frequencies and example sentences of lexical phrases are shown.

Lastly, our results provide new insights into teaching the art of writing RAs. The most influential element in teaching English is creating vocabulary lists (Groom & Littlemore, 2011), such as a New Academic Word List (Coxhead, 2000), a New Academic Vocabulary List (Gardner & Davies, 2014), and a New Medical Academic Word List (Lei & Liu, 2016). In addition, Simpson-Vlach and Ellis (2010) and Martinz and Schmitt (2012) presented lists of pedagogically useful expressions for academic English as an Academic Formulas List and a Phrasal Expressions List, respectively. However, these lists do not indicate the behavior of words or the relationships between

the lexical phrases and the functions of steps. As Le and Harrington (2015) mentioned, learners need to recognize frequent word combinations in specific moves or steps in a particular discourse community. Although further studies are needed to determine whether the lexical phrases obtained are observable for other disciplines and to measure their effectiveness, the lexical phrases described here according to the functions of steps should be of use for teaching English for specific purposes.

Acknowledgements

This work was supported by JSPS KAKENHI Grant Number JP19K23095.

Notes

1. Available from <http://langtest.jp/awsum/>
2. Although four articles contained Results and Discussion sections, we identified Results moves and Discussion moves appropriately.
3. Available from <https://lsd-project.jp/cgi-bin/lsdproj/ejlookup04.pl>.
4. PubMed is a web site that contains 30 million citations of Abstracts related to biomedical literature (available from <https://www.ncbi.nlm.nih.gov/pubmed/>).

Appendix

The following is a list of the 30 selected journals with the number of articles from each in parentheses.

Brain (11), Cancer Cell (10), Cancer Research (10), Cell (12), Cell Metabolism (10), Cell Reports (10), Cell Stem Cell (10), Cellular Microbiology (11), Current Biology (11), Developmental Cell (10), EMBO Journal (11), Genes & Development (11), Genome Research (10), Journal of Biological Chemistry (8), Journal of Cell Biology (11), Journal of Experimental Medicine (10), Journal of Neuroscience (11), Journal of Virology (11), Molecular and Cellular Biology (10), Molecular Cell (11), Nature Cell Biology (10), Nature Genetics (9), Nature Immunology (10), Nature Medicine (9), Nature Neuroscience (10), Nature Structural & Molecular Biology (10), Neuron (10), Oncogene (10), PLOS Biology (8), and PLOS Genetics (9)

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