

Functions of Moves/Steps and Patterns Containing the First Keyword in the Introduction Sections

— A corpus study of experimental medical research articles based on move analysis —

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Abstract: The aim of this study is to describe prototypical three-grams to five-grams and their patterns that include the first keyword in the Introduction sections of experimental medical research articles. A move analysis was conducted for 300 experimental medical research articles from 30 journals published in 2014, which consisted of approximately 1.5 million words in total. In the Introduction sections, three moves were defined. To identify the keyword in the three moves, the score of Log-Likelihood Ratio was calculated by comparing each move with the whole corpus data. Moreover, three-grams to five-grams with the first keyword in each move were produced with the use of CasualConc. Finally, they were categorized into the patterns strongly associated with the functions of the steps in each move. In Move 1, five patterns were defined as Step 1, while two patterns were identified as Step 2. In Move 2, six patterns were described as Step 1, while one pattern was regarded as Step 2. In Move 3, three patterns were reported as Step 1, while two patterns were labeled as Step 2 and 3, respectively. In conclusion, these three-grams to five-grams and their patterns could be of help to teach the art of writing academic English.

Key words: Move analysis, N-gram, Medical English, English for Academic Writing

1. Introduction

1.1 Move Analysis and the N-grams Approach in Corpus Studies

Since Swales (1990) advocated the discourse structure in the Introduction sections of research articles (RAs), known as “Create a Research Space (CARS) model” (p.140), the genre approach, based on qualitative research in the branch of English for specific purposes, has developed into a move analysis of the Introduction, Methods, Results, and Discussion (IMRD) sections (Tessuto, 2015). The discourse structure is realized by moves and steps. Dudley-Evans and St John (1998) 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” (p.89). Corpus studies have provided a novel insight into language description with a

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qualitative approach that views lexis and grammar as a continuum rather than an opposition, while developing the notion of phraseology, “recurrent patterns of associated words” (Cheng, 2012, p.101). To identify the phraseology, calculating n-grams, where “n” represents the two or more, is the most frequently used method, along with special software such as Antconc (Anthony, 2019) and CasualConc (Imao, 2019). As Cheng (2012) noted, n-grams have been defined with various terms such as “bundles,” “clusters,” “chunks,” and “formulaic language” (p.102).

As a pioneering study for combining the move analysis of RAs and the n-grams approach in the field of medical RAs, Saber (2012) collected 375 clinical medical RAs, published during 2006–2009, which included approximately 1.2 million words in total and built a corpus based on IMRD as subcorpora. Defining “keywords” as “lexical items which reflect the topic of a particular text” (Hunston, 2002, p.68), Saber produced keyword lists in each subcorpora with comparisons to the whole corpus. Moreover, he described three-grams to five-grams with nouns and verbs in the keywords and identified the functions of steps. For example, the keyword “studies” in the Introduction sections led to three-grams “studies have shown” or four-grams “studies have examined the” ; these n-grams were used to “describe references” (Saber, 2012, p. 53). However, it can be assumed that generating a suitable corpus based on move analysis leads to the description of n-grams strongly relevant to the functions of steps. Therefore, investigating a corpus based on a move analysis, this study aims to report prototypical three-grams to five-grams and their patterns with the first keyword in the Introduction sections of experimental medical RAs and to identify the functions of steps.

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

Swales (1991) defined the functions of moves and steps in RAs as shown in Table 1. Nwogu (1997) identified three moves with two steps in each move not of experimental medical RAs, but of clinical medical RAs as shown below. However, Swales (1990) stated, “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” (pp.175-176). Therefore, in this study, the Introduction sections were divided into three moves and the steps were labeled with reference to Table 1.

Table 1. Moves and Steps in the Introduction Sections Adapted from Swales (1990) and Nwogu (1997)

Swales (1990, p.141)	Nwogu (1997, p.135)
Move 1 Establishing a territory Step 1 Claiming centrality and/or Step 2 Making topic generalization(s) and/or Step 3 Reviewing items of previous research	Move 1: Presenting Background Information: Step 1 Reference to established knowledge in the field. Step 2 Reference to main research problems.
Move 2 Establishing a niche Step 1A Counter -claiming or Step 1B Indicating a gap or Step 1C Question-raising or Step 1D Continuing a tradition	Move 2: Reviewing Related Research: Step 1 Reference to previous research. Step 2 Reference to limitations of previous research.
Move 3 Occupying the niche Step 1A Outlining purposes or Step 1B Announcing present research Step 2 Announcing principal findings Step 3 Indicating RA structure	Move 3: Presenting New Research: Step 1 Reference to research purpose. Step 2 Reference to main research procedure.

2. Methods

In order to produce three-grams to five-grams with the first keyword in each move, as Biber, Connor, and Upton (2007) advocated, the “top-down corpus-based analysis” (p.13) was conducted. To apply a top-down approach, move analysis was manually conducted while collecting 300 articles from

30 leading journals (identified in the Appendix) published in 2014 that consisted of the IMRD structure. These included approximately 1.5 million words in total, excluding the figure legends, tables, heading, and section titles. CasualConc (Imao, 2019) was used to follow a corpus-based approach, and keywords in the Introduction sections of each move were determined according to the score of Log-likelihood Ratio (LLR) with comparison to the whole corpus as a reference corpus. As Biber, Conrad, and Cortes (2004) demonstrated, three-grams to five-grams with the first keywords in each move were selected according to the criteria of 40 times per million words. Although the minimal frequencies in each move were considered to be two to four times according to the calculation, their frequencies were determined to be three times at least in more than one article. Three-grams to five-grams with the first keyword were categorized into patterns based on their functions and were labeled the names of the steps with reference to Table 1. Table 2 presents the corpus data of the Introduction sections.

Table 2. Three Moves in the Introduction Sections

	Functions of Moves	Tokens	Frequency of occurrence (%)
Move 1	Presenting Background Information	40,412	100.00 %
Move 2	Reviewing Related Research	80,875	100.00 %
Move 3	Presenting New Research	32,025	98.67 %
Total		153,312	

3. Results

3.1 Overview of Keywords in the Introduction Sections

The following table shows 10 keywords in the Introduction sections. The numbers of keywords obtained in three moves were 153, 145, and 49, respectively. The rank was sorted according to the score of LLR.

Table 3. 10 Keywords in the Introduction Sections

	Move 1			Move 2			Move 3		
	keyword	LLR	NF	keyword	LLR	NF	keyword	LLR	NF
1	is	287.65	147.77	been	531.72	56.88	we	446.49	210.77
2	are	193.75	92.30	have	505.05	65.66	here	442.17	46.21
3	disease	181.84	30.68	has	346.37	44.27	study	154.65	36.85
4	have	159.08	53.70	is	341.21	128.10	show	135.18	27.79
5	cancer	130.48	35.88	are	242.61	80.87	that	125.82	194.85
6	been	118.63	39.84	studies	177.91	29.55	report	111.86	12.80
7	including	107.50	25.24	can	123.25	30.17	demonstrate	100.42	16.86
8	has	107.00	35.88	recently	122.20	11.13	provide	68.41	14.05
9	immune	89.82	15.34	however	120.53	27.32	our	63.93	14.36
10	such	86.13	28.70	such	109.63	24.73	identify	63.50	44.34

Note. LLR=log-likelihood ratio; NF=nominalized frequency (per 10,000 words)

The keywords are strongly associated with the function of the moves. For example, in Move 1, the present tense is used in the verb “is” or “are” to generalize the topic, while, in Move 2, the present perfect with the passive voice, “have been” or “has been,” serves to refer to previous studies. Furthermore, the combination of keywords in Move 3 could form phrases, such as “here we study,” “here we demonstrate that,” and “here we report that.” They are used to present new research.

Having established that the keywords play an important role in strongly relating to the functions

of moves, this study reveals three-grams to five-grams including the first keyword in each move, and their functions of steps.

3.2 Three-Grams to Four-Grams with the Verb “is” in Move 1

When the function of presenting background information is accomplished, the verb “is,” the first keyword, played an important role in comprehending the two steps established by Nwogu (1997) as in Table 1. Since five-grams with the verb “is” were not extracted with more than two occurrences, three-grams and four-grams were sorted according to the patterns of word combinations with shared connotations (Table 4 and 5). First, Table 4 illustrates three-grams to four-grams related to Step 1, stating what is widely accepted as a fact in the research area. Hereafter, labelling in square bracket is referred to by Williams (1996).

Table 4. Three-Grams to Four-Grams with the Verb “is” in Step 1 of Move 1 and Their Frequency

Step 1: Reference to established knowledge in the field
i) is + (one of) + the <i>is</i> the most (9), <i>is</i> one of the (4), <i>is</i> the most commonly (3), <i>is</i> the second most (3)
ii) is + a/an <i>is</i> a complex (7), <i>is</i> an important (6), <i>is</i> a critical (5), <i>is</i> a hallmark of (4), <i>is</i> a fundamental (4), <i>is</i> a major (4), <i>is</i> a key (3)
iii) is + <i>Adjective [Significance]</i> + for/to <i>is</i> essential for (11), <i>is</i> critical for (8), <i>is</i> essential to (5), <i>is</i> required for (6), <i>is</i> responsible for (6), <i>is</i> crucial for (3)
iv) is + <i>Past Participle [Relations/Defining]</i> + with/to/by <i>is</i> associated with (14), <i>is</i> thought to (8), <i>is</i> characterized by (6), <i>is</i> initiated by (3), <i>is</i> mediated by (3)
v) is + <i>Past Participle [Epistemology]</i> + <i>to-infinitive</i> <i>is</i> thought to (8)

Note. The number in parentheses shows the raw frequency.

The following examples include three-grams or four-grams, which are used to present the theme of the article and the general idea of the topic according to Step 1. Below are some examples from RAs in which the importance of the topic is clarified by the phrases underlined.

- 1) Marijuana is the most commonly used illicit drug in the United States.
(J. Neurosci. 2014, 34, p.5529, [underline added])
- 2) The SRF transcription factor is an important regulator of cytoskeletal and muscle - specific gene expression.
(Genes & Dev. 28, p.943, [underline added])
- 3) The microtubule cytoskeleton is essential for intracellular organization, transport, and division of eukaryotic cells.
(Curr. Biol. 2014, 24, p.384, [underline added])
- 4) The latter is associated with particularly aggressive behavior and poor prognosis.
(Nat. Genet. 2014, 46(6), p.573, [underline added])
- 5) Alternative "cassette" exon splicing is thought to represent the most frequent type of AS in animals and has been implicated in the control of diverse aspects of normal and disease biology.
(Genome Res. 2014, 24, p.1774, [underline added])

Moreover, three-grams to four-gram were used to accomplish the function of Step 2, which states the main research problems, as shown in Table 5 below.

Table 5. Three-Grams to Four-Grams with the Verb “is” in Step 2 of Move 1 and Their Frequency

Step 2: Reference to main research problems
i) <i>Noun [Negative]</i> + is + known + about less <i>is</i> known about (3), little <i>is</i> known about (3)
ii) is + needed + to-infinitive <i>is</i> needed to (3)

Note. The number in parentheses shows the raw frequency.

In the following examples, the authors of RAs highlight the main research problems according to Step 2.

- 6) Less is known about the relationship between cannabis use and brain structure in humans.
(J. Neurosci. 2014, 34 (16), p.5529, [underline added])
- 7) Moreover, minimally invasive monitoring of patients with SCLC is needed to optimize therapy selection.
(Nat. Med. 2014, 20, p.897, [underline added])

3.3 Three-Grams to Five-Grams with the Past Participle “been” in Move 2

To review related research, the keyword “been” in Move 2 is strongly related to Step 1 and Step 2 consistent with Nwogu (1997). First, as Step 1, Table 6 presents three-grams to five-grams with the past participle “been” categorized based on semantics of verbs and the following words such as prepositions, that-clause, and to-infinitive. The past participle “been” was used in the passive voice, followed by the modality “have” or “has.” Extracting three-grams to five-grams with the past participle “been” appearing as the first word generalized the patterns clearly, except for the case when the dummy subject “it” occurred.

Table 6. Three-Grams to Five-Grams with the Past Participle “been” in Step 1 of Move 2 and Their Frequency

Step 1: Reference to previous research
i) been + <i>Past Participle [Observation/Reporting]</i> + in <i>been</i> observed in (9), <i>been</i> found in (9), <i>been</i> identified in (7), <i>been</i> described in (4), <i>been</i> detected in (4), <i>been</i> demonstrated in (3)
ii) been + <i>Past Participle [Observation/Reporting]</i> + as <i>been</i> described as (4), <i>been</i> implicated as (3)
iii) been + <i>Past Participle [Reporting/Relations]</i> + in/with/to <i>been</i> implicated in (21), <i>been</i> associated with (11), <i>been</i> linked to (10), <i>been</i> implicated in the (6), <i>been</i> attributed to (4), <i>been</i> linked to the (4), <i>been</i> correlated with (3), <i>been</i> associated with the (3)
iv) it + has + been + <i>Past Participle [Observation/Reporting]</i> + <i>that-clause</i> it has <i>been</i> (22), it has <i>been</i> suggested that (4), it has <i>been</i> shown that (3)
v) been + <i>Past Participle [Reporting/Observation]</i> + <i>to-infinitive</i> <i>been</i> shown to (63), <i>been</i> proposed to (17), <i>been</i> shown to be (16), <i>been</i> suggested to (10), <i>been</i> found to (9), <i>been</i> reported to (8), <i>been</i> shown to be important (5), <i>been</i> demonstrated to (3), <i>been</i> proposed to regulate (3), <i>been</i> shown to bind (3), <i>been</i> shown to have (3), <i>been</i> shown to induce (3), <i>been</i> shown to regulate (3)
vi) been + used + <i>to-infinitive</i> <i>been</i> used to (12), <i>been</i> used to identify (4)

Note. The number in parentheses shows the raw frequency.

Interestingly, it was found that the patterns of the behavior of the past participle “been” were strongly associated with the function of Step 1. For example, in the first pattern, following the preposition “in,” the authors would precede to describe where the object of research has been reported in previous studies. The second pattern, following the preposition “as,” defined the object of research.

The third pattern, with the use of the dummy subject “it” and that-clause, summarized the previous studies. Finally, the fourth and fifth patterns, following to-infinitive, summarized some previous studies relevant to the research. The following examples consisted of three-grams to five-grams with the function of summarizing what was found in the area.

- 1) Other Plasmodium species have also been observed in the microvessels of various organs during infection, including those infecting lower primates, rodents, and more recently *P.vivax* in humans. (Cell. Microbiol. 2014, 16(5), p.687 [underline added])
- 2) PI₃K has been described as activating mTOR complex 2 by promoting its association with ribosomes. (Nat. Immunol. 2014, 15(1), p.89 [underline added])
- 3) Recently, SIRT2 has also been implicated in *Listeria monocytogenes* - mediated reprogramming of host cell gene expression. (EMBO J. 2014, 33(13), p.1439, [underline added])
- 4) It has been suggested that CSCs cluster in hypoxic niches, rely on fermentative glycolysis, and have decreased mitochondrial respiration similar to progenitor cells during normal development. (Cell Metab. 2014, 19, p.795, [underline added])
- 5) Third, GATA3 has been shown to be important for the occurrence of liver but not BM NK cells, suggesting that liver and BM NK cells derive from different developmental pathways. (J. Exp. Med. 2014, 211(3), p.565, [underline added])
- 6) Gene expression profiling has been used to identify molecular heterogeneity in other human cancers. (Cancer Cell. 2014, 25, p.154, [underline added])

Next, Table 7 shows three-grams to five-grams with the past participle “been” following the adverb “not.” They refer to the limitations of previous studies according to Step 2.

Table 7. Three-Grams to Four-Grams with the Past Participle “been” in Step 2 of Move 2 and Their Frequency

Step 2: Reference to limitations of previous studies

i) not + (yet) + been + *Past Participle [Observation/Reporting]*

has not *been* (23), have not *been* (8), not yet *been* (5), not *been* described (3), not *been* identified (3),
 has not yet *been* (3)

Note. The number in parentheses shows the raw frequency.

As the following example shows, the pattern above mainly co-occurred with the conjunction “however” as a signal for what has not been revealed.

- 7) However, the direct involvement of R-loops on endogenous expanded alleles in the pathology of FRDA has not yet been investigated in vivo. (PLoS Genet. 2014, 10(5), p.1, [underline added])

3.4 Three-Grams to Five-Grams with the Noun “we” in Move 3

In realizing the function of presenting new research, the keyword “we” was linked to three steps, which were added as Step 3 to the two steps advocated by Nwogu (1997) in Table 1. The prototypical word combinations with the noun “we” were strongly related to the functions of the steps. Table 8 shows three-grams to five-grams with the noun “we,” which were divided into three patterns. To generalize the patterns clearly, though the noun “we” was used with the adverb “here” or adverbial phrases such as “in this study,” “in this work” and “in the present study,” three-grams to five-grams with the noun “we” appearing as the first word were included.

Table 8. Three-Grams to Five-Grams with the Noun “we” in Step 1 of Move 3 and Their Frequency

Step 1: Reference to research purpose
i) we + verb [<i>Purpose</i>] + to-infinitive / we + focus/focused + on we sought to (13), we set out to (9), we aimed to (5), we focus on (4), we focused on (3), we sought to determine (3), we set out to determine (3), we set out to investigate (3)
ii) we + verb [<i>Theory</i>] + that-clause/this we hypothesized that (12), we address this (3), we reasoned that (3), we tested the hypothesis that (3)
iii) we + verb [<i>Experiment</i>] + whether we investigated whether (6)

Note. The number in parentheses shows the raw frequency.

The first pattern applies to the following examples, in which the noun “we” follows the adverb “here” or the adverbial phrase “in this work.”

- 1) Here, we set out to investigate the mechanisms underlying the variants ARv567 and ARv7 nuclear translocation and constitutive activity, and whether their presence would affect taxane sensitivity. (Cancer Res. 2014, 74(8), p.2271, [underline added])
- 2) In this work we hypothesized that this member of the oral commensal bacterial flora exacerbates oropharyngeal candidiasis in vivo and examined inflammatory mechanisms of inter-Kingdom pathogenic synergy. (Cell. Microbiol. 2014, 16, p.215 [underline added])
- 3) Here we investigated whether interaction of CD4 and Env modulates some of the ADCC-mediating antibody recognition. (J. Virol. 2014, 88 (5), p.2634 [underline added])

As Step 2, two patterns were identified as follows.

Table 9. Three-Grams to Four-Grams with the Noun “we” in Step 2 of Move 3 and Their Frequency

Step 2: Reference to main research procedure
i) we + verb [<i>Analysis</i>] + the we investigated the (5), we analyzed the (4), we investigate the (4), we demonstrate the (3), we studied the (3)
ii) we + verb [<i>Method</i>] + a we used a (5), we generated a (4), we performed a (4), we have performed (3), we have used (3), we performed whole genome (3), we took advantage of (3)

Note. The number in parentheses shows the raw frequency.

Although the verb plays a key role in defining a sentence’s meaning, the word combinations play an important part in determining the functions of steps. While the phrase “we investigate” followed by whether-clause refers to the research purpose as in Step 1, the phrase “we investigate” followed by the article “the” refers to the procedure of research as in Step 2. The following examples include the two patterns shown above.

- 4) Here we investigated the circadian rhythms in the protein levels of NRF2 and activity of the NRF2/GSH pathway in lung tissues from light/dark cycle-entrained mice. (Genes Dev. 2014, 28, p.549, [underline added])
- 5) Here we used a combination of immunophenotyping, lineage tracing and parabiosis to explore the origin of the intestinal macrophage compartment from birth until adulthood in mice. (Nat. Immunol. 2014, 15(10), p.929, [underline added])

Finally, as Step 3, the pronoun “we” was used to state the main outcomes, linking to particular verbs as shown below. The first pattern uses a that-clause while the second pattern includes the article

“a” or “the.”

Table 10. Three-Grams to Four-Grams with the Noun “we” in Step 3 of Move 3 and Their Frequency

Step 3: Reference to principal outcomes

i) we + verb [*Observation/Reporting*] + that-clause
we show that (51), we found that (44), we demonstrate that (17), we find that (14), we report that (7),
we propose that (6), we showed that (6), we found that the (6), we provide evidence that (6),
we conclude that (3), we demonstrate that the (3), we report here that (3), we show that a (3)

ii) we + verb [*Observation/Reporting*] + a/the
we report the (15), we describe the (6), we describe a (5), we demonstrate the (3), we identify a (3),
we identify the (3), we present a (3)

Note. The number in parentheses shows the raw frequency.

- 6) Here we show that progenitors with lymphoid potential isolated from the major arteries of mouse embryos have a robust innate immune/inflammatory molecular signature.
(Genes Dev. 2014, 28, p.2598, [underline added])
- 7) In the present study, we report the identification of an alternative pathway, whereby ERG expression can be upregulated by epidermal growth factor and Src via miRNA modulation.
(Oncogene. 2014, 33, p.2496, [underline added])

4. Discussion and Conclusion

The aim of this study was to report prototypical three-grams to five-grams including the first keyword in three moves of the Introduction sections, using a corpus based on a move analysis of 300 experimental medical RAs. N-grams were also categorized into the patterns according to the word combinations. These patterns proved to be strongly associated with the functions of the steps. For instance, in Move 1, five patterns were defined as Step 1, while two patterns were identified as Step 2. In Move 2, six patterns were described as Step 1, while one pattern was regarded as Step 2. In Move 3, three patterns were reported as Step 1, while two patterns were labeled as Step 2 and 3, respectively.

Chen and Baker (2010) conducted a comparative study of how n-grams in published academic texts and L1 and L2 student writing were produced. They discovered a “gap between native expert academic prose and immature student academic writing” (p.34). To overcome the gap, L2 newcomers to a particular discourse community should acquire the knowledge of n-grams related to specific moves or steps (Le & Harrington, 2015). Although the results obtained here could offer a novel insight into teaching the art of academic writing, further data and research will be needed to compare the patterns with those in the other areas such as applied linguistics, in order to generalize the patterns.

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Appendix

Following is a list of the 30 selected journals with the number of articles taken from them 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 (10), 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 (11), Molecular Cell (9), Nature Cell Biology (10), Nature Genetics (9), Nature Immunology (10), Nature Medicine (10), Nature Neuroscience (9), Nature Structural & Molecular Biology (10), Neuron (10), Oncogene (10), PLOS Biology (7), PLOS Genetics (8)