Discourse analysis of English research articles*

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บทคัดย่อ

บทความนี้มุ่งรายงานผลการวิเคราะห์สัมพันธสาร (discourse analysis) ของคลังข้อมูลบทความวิจัย (research article corpus) กล่าวคือ เป็นการวิเคราะห์ 4 ส่วนสำคัญของบทความวิจัยภาษาอังกฤษ (บทนำหรือ Introduction, วิธีการวิจัยหรือ Methods, ผลการวิจัยหรือ Results, และอภิปรายผลการวิจัยหรือ Discussion) ในสาขาชีวเคมีจำนวน 60 บทความจากวารสารวิชาการชั้นนำของโลก โดยใช้แนววิเคราะห์ move analysis ของ Swales (1981, 1990) เพื่อกำหนดต้นแบบ (model) ในการเขียนบทความวิจัยสาขานี้ การวิเคราะห์คลังข้อมูลพบว่าบทความวิจัยสาขาชีวเคมีประกอบด้วย 15 moves (3 moves ในบทนำ, 4 moves ในส่วนวิธีการวิจัย, 4 moves ในส่วนผลการวิจัย, และ 4 moves ในส่วนอภิปรายผลการวิจัย) ผลของงาน

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**รองศาสตราจารย์ ดร. ประจำภาควิชาภาษาอังกฤษ คณะอักษรศาสตร์ มหาวิทยาลัยศิลปากร

วิจัยนี้แสดงถึงการเรียงตัวของ move อย่างเป็นแบบแผนในบทความวิจัยภาษาอังกฤษสาขาชีวเคมี ลักษณะต่าง ๆ ที่สามารถปรากฏในแต่ละ move และความถี่ของ move ที่พบ อันแสดงถึงสถานภาพของ move ในคลังข้อมูล งานวิจัยนี้เป็นการบูรณาการระหว่างวิชาภาษาศาสตร์และชีวเคมี ชี้ให้เห็นถึงคุณค่าของการวิเคราะห์ทางภาษาศาสตร์ที่สามารถให้ความกระจ่างในด้านโครงสร้างแบบแผนของบทความวิจัยทางวิทยาศาสตร์โดยเฉพาะอย่างยิ่ง การวิเคราะห์สัมพันธสารตามแนว move analysis จะช่วยให้นักวิทยาศาสตร์สามารถติดตามงานวิจัยที่ตีพิมพ์ในวางสารได้อย่างมีประสิทธิภาพ อีกทั้งยังช่วยให้นักวิทยาศาสตร์ที่สนใจจะผลิตบทความวิจัยสามารถเผยแพร่ผลงานของตนตามแบบแผนและเป็นที่ยอมรับมากขึ้นจากวารสารวิชาการชั้นนำของโลก

1. Introduction

It is known that English has acquired the status of an international language (e.g., Johns and Dudley-Evans 1991; Grabe and Kaplan 1996). As a result, research articles in English have become one of the main channels for distributing and advancing knowledge among scholars world-wide. Therefore, the ability to read and to write research articles in English is, thus, crucial for academic and professional success.

To be able to understand and/or produce academic research articles, both native and non-native speakers of English need to be aware of, but not limited to, the rhetorical organization in their field of interest. In this regard, Swales' (1981, 1990) move analysis has provided valuable insights into the rhetorical organization of individual sections of research articles. However, certain criticism of this line of research has been raised. First, many move-based studies involved an insubstantial number of texts (e.g., Peng 1987; Williams

1999; Wood 1982), limiting the generalizability of the results. In addition, many studies focused on individual sections of research articles (e.g., Brett 1994; Hopkins and Dudley-Evans 1988; Samraj 2002; Swales and Najjar 1987), making the rhetorical description incomplete.

This study addresses the criticism mentioned by focusing on the sizable corpus of 60 biochemistry research articles. Following Swales' analytical framework originally proposed for only the Introduction section, the corpus was analyzed to determine the rhetorical pattern for the four conventional sections of Introduction, Methods, Results, and Discussion. A total of 15 rhetorical moves were identified and individual moves were described with regard to their frequency of occurrence, the sequence of moves in each section, and the possible variations of each move as shown by the corpus. Finally, the basic template for structuring academic research articles was proposed. The findings of the study provide insights that will help scientists or particularly biochemists who are not native speakers of English better understand how research articles are constructed to be able to better meet the international academic community's expectations and demands.

2. Methodology

2.1. Compilation of the corpus

Previous move studies have shown that disciplinary variations have influences on rhetorical structure (e.g., Nwogu 1997; Posteguillo 1999; Swales 1990; Thompson 1993). To control possible variation among disciplines, the academic discipline of biochemistry was selected because it is of interest to scholars from many disciplines, including those in the basic hard sciences (biology and chemistry), the health sciences (medicine and pharmaceutical science), the natural sciences (environmental science and ecology), and the applied sciences (biotechnology and food science). Therefore, this study could potentially benefit learners/practitioners from multiple disciplines.

Sixty biochemistry research articles were collected from the five specialized journals published in the United States in the year 2000. These journals are: *Cell (C), Molecular Cell (MC), Molecular and Cellular Biology (MCB), Journal of Biological Chemistry (JBC), and Molecular Biology of the Cell (MBC).* Twelve articles were randomly selected from each journal, yielding a corpus of 60 biochemistry research articles with approximately 320,000 words.

2.2. Swales' analytical framework of move analysis

Swales' move analysis represents academic research articles in terms of an organized text made up of distinct sections; each of which is in turn subdivided into moves, which are in turn subdivided into steps. According to Swales, **a move** refers to a text segment that performs a particular communicative function. For instance, in Swales' (1990) model, the Introduction section includes three basic moves. The beginning move of *Move 1: Establishing a territory* establishes the topic. *Move 2: Establishing a niche*, following Move 1, justifies the present study. Then, Introductions are concluded by *Move 3: Occupying a niche* that describes the present study. Each move is in turn comprised of a series of **steps**. For example, *Move 1* is accomplished by *Step 1: Claiming interest or importance of the topic*, *Step 2: Making topic generalization*, and *Step 3: Reviewing items of previous literature*.

Swales' framework originally proposed for Introductions has been extended to other sections of research articles in various disciplines (e.g., Brett 1994 on sociology; Peng 1987 on chemical engineering; Thompson 1993 on biochemistry; Wood 1982 on chemistry; Ruiying and Allison 2003 on applied linguistics). In this study, based on Swales' (1990) framework and previous research, moves were identified in each conventional section of the corpus. Based on the cut-off of a 60 % occurrence rate, each move was identified as conventional or optional. That is, to be recognized as a conventional move, a move must occur in 60 % of the section in the corpus. Otherwise, it is considered optional. Next, all possible variations characterizing each move and the sequence of moves in each section were identified. Finally, a rhetorical structure for each section was proposed.

3. Results

The analysis of the corpus reveals a 15-move model recognized in biochemistry research articles (see Appendix). The following sections describe each of the 15 moves identified, together with its characteristic features, its possible variations, as well as its status as either conventional or optional.

3.1. The Introduction section

It is known that Introductions generally contextualize a research study being presented. Move analysis of the Introduction corpus reveals a three–move structure.

Move 1: Acknowledging the importance of the field

Move 1 asserts the importance of the topic of study and is invariably present in this corpus. Congruent with Swales' framework, Move 1 in this corpus is characterized by three steps. *Step 1: Claiming the centrality of the topic* assures that the article developed on the topic is worth investigating and the field is well established. *Step 2: Making topic generalizations* makes generalizations about the topic of the study and *Step 3: Reviewing previous research* presents background information of previous research deemed to be relevant to the topic being discussed. Examples illustrating Steps 1-3 of Move 1 are represented as shown in the corpus with the only one exception that attributions to previous studies in the corpus were replaced by **R** (reference).

Step 1: Claiming the centrality of the topic

MCB6] *Iron-sulfur (Fe-S) cluster prosthetic groups play a key role in a wide range of enzymatic reactions, as well as serving as regulatory switches.*

Step 2: Making topic generalizations

[C2] *Mitotically proliferating cells generally coordinates rates of cell cycle progression with rates of cellular growth (i.e., mass communication).*

Step 3: Reviewing previous research

[MC11] *Double-stranded RNA (dsRNA) induces potent cellular responses in diverse biological systems (R).*

Move 1 Step 1 is consistently recognized through the use of citations interspersed several times throughout the Introductions, resulting in the "cyclical" or "recursive" occurrence of this move. The recursiveness of Move 1 Step 3 thus reflects the complexity of the study presented and demonstrates the richness of current literature in biochemistry.

Move 2: Preparing for the present study

Move 2 draws attention to weakness in the literature and/or asserts that a particular research question requires an answer. Move 2 was recognized in 40 Introductions or 66.66 % of the corpus. Two strategies of this move in the biochemistry corpus include *Step 1: Indicating gaps* and *Step 2: Raising questions*. The examples to illustrate two steps of Move 2 are:

Step 1: Indicating gaps

[C6] *The mechanism of processing the nature, 184nt 6S RNA from its precursor has not been characterized.*

Step 2: Raising questions

[MC11] *The key (as yet unresolved) questions in analysis of dsRNA-associated PTGS are (1) Why are both strands required in the trigger RNA? and (2) How can dsRNA exert an effect at concentrations that are substantially lower than those of the endogenous target RNA?*

Step 1: Indicating gaps is pervasive in this biochemistry corpus. In 40 biochemistry Introductions that have Move 2, 38 Introductions employ Step 1 to point out a research study's limitations. *Step 2: Raising questions* is not as frequently used as Step 1 in this corpus; indeed, it was found in only six of the 40 Introductions. Similar to Move 1, cyclical patterning of Move 2 is common, showing that the study being presented is complex, and various aspects of a single study have a gap to be accounted for.

Move 3: Introducing the present study

According to Swales' model, the move of introducing the present study can be characterized by explicitly outlining purposes or stating main features or procedures of the present research, by announcing principle findings, and by indicating the organization of the article in which the study is being reported. In this corpus, Move 3 was recognized to have three possible variations or steps; namely, *Step 1: Stating purposes*, *Step 2: Describing main features of the present study*, and *Step 3: Announcing principal findings.*

Step 1: Stating purposes

[JBC4] *The present study was designed to evaluate whether the efficiency and carrier ligand specificity of replicative by pass past Pt-DNA abducts by Po? could be determined by the mode of translesion synthesis and whether...*

Step 2: Describing main features of the study

[MCB6] *In the study presented herein, we investigated proteins from S. cerevisiae that exhibit strong homology to the bacterial IscA product of the isc gene cluster. Two proteins, designated Isa1p and Isa2p, contain a C-terminal region exhibiting at least 50% similarity to bacterial proteins encoded by orf6 in the nif operaon and by iscA in the isc operon, respectively.*

Step 3: Announcing principal findings

[MC5] *Our results show that U2snRNP is functionally associated with the E complex and is also required for its assembly.*

In congruence with Swales and Najjar's (1987) study of physics articles, Move 3 Step 3 is frequent in biochemistry Introductions, suggesting that announcing the important results of the experiments is not withheld until the Results and Discussion sections. As noted by Swales (1990) and shown in the above examples, even though the principal finding is announced, the information concerning the finding is kept to a minimum, consisting of only a brief and specific statement of principal findings. Similar to Moves 1 and 2 in Introductions, Move 3 is also cyclical and invariably present.

Based on the cut-off of a 60 % occurrence rate, all moves identified in Introductions of biochemistry are conventional, although Move 2 occurs less frequently than Moves 1 and 3. Cyclical organization of the three moves of Introductions is also discernible. The linear order of Moves 1-2-3 postulated by Swales (1990) and confirmed by others in various academic disciplines (e.g., Berkenkotter and Huckin 1995; Crookes 1986; Swales and Najjar 1987) was observed in this biochemistry corpus.

3.2. The Methods section

The Methods section typically describes procedures used in the study being reported. Four moves are found in the Methods section of this biochemistry corpus.

Move 4: Describing substances investigated

The physical substances investigated by biochemists cover a wide range of materials from natural substances, human/animal organs or tissues, to chemicals (e.g., antibodies, enzymes, microsomes, serum, proteins, medium, genes, DNAs). Move 4, which identifies the physical substances under investigation, is invariably present and can be characterized by three steps. *Step 1: Listing substances investigated* explicitly itemizes substances required by the study. *Step 2: Specifying sources of the substances* provides the information regarding how the substances are obtained, such as, by purchase, as a gift, etc. It is also common in biochemistry to find *Step 3: Providing background information of the substances* that gives additional information regarding substances investigated such as the description, the properties, or the characteristics of the substances. The three steps of Move 4 are illustrated as follows:

Step 1: Listing substances investigated

[C8] *Bacterial strains used in this study and their origin are listed in Table 3.*

Step 2: Specifying sources of the substances

[MCB4] *COS-7 cells were obtained from S.Brandt (Vanderbilt University, Nashville, Tenn).*

[JBC4] *Peptomycin B was a gift of M. Yoshida (Tokyo, Japan) and used at a final concentration of 10 ng/ml.*

Step 3: Providing background information of the substances

[C10] *Antisense riboprobe for RNase protection assay contains the murine mdm2 cDNA fragment spanning from nt+264 to nt +3 (R).*

[MC10] *The fun 12 strains J130 and J133 were described previously (R).*

The prevalence of this move, particularly Move 4 Step 2, in biochemistry research articles indicates the collaboration and solidarity among scientific institutions that are involved in scientific experiments. In addition, Move 4 Step 3 shows that due to the common background knowledge of substances in biochemistry, the description of the substances investigated was minimally captivated by a phrasal expression like "*described previously*" in MC10.

Move 5: Describing experimental procedures

Biochemistry as a discipline is well established; its procedures, methods, and techniques are usually protocolized. Move 5, which identifies the experimental procedures, is invariably present. The move as found in this corpus has three possible steps. *Step 1: Referring to established experimental procedures* recounts an experimental process that is already established by previous researchers under a specific method or technique or protocol. *Step 2: Describing details of the methods* features detailed description of the methods that are unique and unorthodox. *Step 3: Providing background information of the procedures* justifies the choice of the method(s) selected or certain procedures such as the exclusion of certain data or the approval of use of human tissues.

Step 1: Referring to established experimental procedures

[MCB6] *Detection employed the ECL kit (American Pharmacia Biotech) according to the manufacturer's specification.*

[MC4] *Chromatin binding assays were performed as previously described (R).*

Step 2: Describing details of the methods

[JBC12] *For comparison to P. carinii gsc-1, membranes were rehybridized with a P. carinii actin probe (R).*

[MBC7] *Proteins in both fractions were precipitated by the addition of 4 volumes of cold acetone, collected by centrifugation, and resuspended in electrophoresis sample buffer.*

Step 3: Providing background information of the procedures

[JBC10] *Complete details of all constructions will be provided upon request.*

[C1] *They were referred to as Cre-Mate mice, since the nature of the gene targeted for conditional ablation in the epidermis was irrelevant for that study.*

Moves 4 and 5 in biochemistry are highly interwoven and recursive, as shown in the following example of MBC1:

DNA Construction

[MBC1] **(S1)** *The following murine expressed sequence tag (EST) clones were obtained from the American Type Culture Collection (Manassas, VA): GenBank accession numbers AA000682, W09622, AA119182, AA017916, and W09622.* **(S2)** *The plasmid DNA was isolated and sequenced.* **(S3)** *These EST clones and the full length cDNA of SH3P7/mAbpl in pExkix were used to generate the different constructs used in this study.* **(S4)** *The serine 235 colon for which we found a poplymorphism was included in all generated plasmids containing this region.* **(S5)** *To construct glutathione S-transferase (GST)-mAbp1 fusion plasmids for expression in bacteria, DNA sequences encoding either the full-length protein (aa-433) or truncations were amplified by PCR using primers that generate BamHI and HindIII sites at the 5' and 3' ends, respectively. ...*

In the above example, the source of the substances investigated is identified (Move 4 Step 2) in S1. After providing information concerning material preparation in S2 (Move 5 Step 1), the section moves on to mention materials that are readily available (Move 4 Step 1) in S3. Then, the section describes procedures in detail (Move 5 Step 2) in S4 and S5. The example depicting the interplay between Moves 4 and 5 raises the possibility that imposing the fixed order of these two moves might not be appropriate in biochemistry research articles.

Move 6: Describing apparatus and its setting

Move 6 provides detailed information regarding the setting of the apparatus used for a particular task in an experiment. This kind of information is crucial for future research replication. Commonly used apparatuses in biochemistry include microscopes, cameras, spectrophotometers, etc. However, only six of 60 research articles or 10% of the corpus contained this move.

[JBC6] *Ultraviolet and visible absorbance measurements were made with a Cary 3 double beam spectrophotometer equipped with a Cary temperature controller from Varian (Sugar Land, Texas).*

[MBC8] *Images were recorded through a Hamamatsu C-2400 New vicon camera using a 10 x objective and brightfield optics. Video images were digitized at a rate of 6 frames/ min as described above.*

Move 7: Describing statistical analysis

Move 7 is found in only eight of 60 research articles or 13.33% of the corpus. The following are representative examples of Move 7:

[MC1] *The t-test was used to statistically compare the individual ratios from two given strains.*

[JBC7] *The data were fitted to the Michaelis-Menten Equation 1 by using a non-linear least squares approach and the kinetic constants+- S.E.*

Although an explanation to the low use of Moves 6 and 7 remains to be determined, the low occurrences of Moves 6 and 7 of the Methods section in biochemistry research articles raise further questions whether these two moves are a new phenomenon or emerging trend in biochemistry. Or, are the moves used specifically to accommodate the uniqueness of the study being reported?

In summary, the four rhetorical moves identified in the Methods section vary widely in terms of their occurrence. Moves 4 and 5 are the two central moves in biochemistry research articles. In sharp contrast to these moves, Moves 6 and 7 are rarely found. The Methods section is not as uniform as the Introduction section in terms of rhetorical organization. While a 1-2-3 order is consistently maintained in Introductions, no distinct pattern is apparent in the Methods section of the biochemistry corpus. Moves 6 and 7, if present, are likely to end the Methods section. However, the exact relationship between Moves 5 and 6 cannot be established due to their low occurrence in the corpus.

The analysis of the corpus also reveals the unique characteristic of experimental procedures in biochemistry research articles; standard practices and established methods are familiar to most scientists. As a result of the standardization of experimental procedure, simple reference to the specific name of the method or procedure used to conduct research is adequate. Established scientific procedures mentioned in this step in this corpus also include referring to certain protocols or following manufacturers' suggestions with some modifications on the substances investigated in the procedures.

3.3. The Results section

The Results section generally describes the findings in an ostensibly objective manner. However, as will be shown later, the Results section of biochemistry research articles does not seem to conform to such typical nomenclature.

Move 8: Recounting methodological procedures

In contrast to the general function of the Results section to focus on presentation of findings, Move 8 in stead explains *why* and *how* the data have been produced. A number of steps were recognized in the corpus, including *Step 1: Restating purposes of the study*, *Step 2: Restating research questions*, *Step 3: Restating hypotheses,* and *Step 4: Restating experimental procedures.* A combination of steps of Move 8 in this biochemistry corpus is common as shown in the following examples.

Steps 1 and 4: Restating purposes of the study and experimental procedures

[JBC1] *To determine whether these GTPases participate in the phagocytosis of P. aeruginosa, we expressed guanine nucleotide binding-deficient alleles of Rac1 or Cdc42, or a GAP for both proteins, in RAW LR?FMLPR.2 cells, and performed association and phagocytosis assays.*

Steps 3, 1, and 4: Restating hypotheses, purposes of the study, and experimental procedures

[MCB12] *Mondo A and Mlx heterodimerize are predicted, based on primary amino acid sequences, to bind CACGTG E-box sequences. To determine whether p19 cells contained E-box binding activity associated with MondoA-*

Mlx heterodimers, P19 cytoplasmic extracts were incubated with double-stranded CACGTG oligonucleotides immobilized on beads and following extensive washing, retention of MondoA Mlx heterodimers on the DNA beads was determined by Western blotting

In JBC1, Move 8 is expressed as a statement of aim (Step 1), followed by procedures used in the study (Step 4). As found in MCB12, Move 8 includes Step 3 of a hypothetical statement (*Mondo A and Mlx heterodimerize are predicted...)*, Step 1 of a research aim (*To determine...*), and Step 4 of a procedure (*P19 cytoplasmic extracts were incubated...*). Move 8 (Procedural statement) occurs frequently in 95% of the corpus.

Move 8 does not provide novel information about the study being reported. In fact, this move highlights some crucial information of the preceding Methods section to prepare the readers for the presentation of the findings in Move 10: Presenting results, to be discussed.

Move 9: Justifying methodology of the study

Move 9 provides the rationale for the authors' decision to opt for certain experimental methods, procedures, or techniques. This move can be expressed by *Step 1: Referring to established knowledge of the topic* and *Step 2: Referring to previous studies*. Examples of Steps 1 and 2 of Move 9 are italicized in the following examples:

Step 1: Referring to the established knowledge of the topic

[MC12] (We chose the more precisely defined LSTer region over the RSTer region for analysis.) *LSTer region contains two approximately equivalent arrest sites, LSTer 2, separated by about 27 kbp ....*

Step 2: Referring to previous studies

[MBC7] ....*However, both identified murine GBPs had C20-type Cax motifs, and the mGBP1 protein appeared to be successfully C20 modified (R).* (Therefore, mGBP1 was examined to determine if it would also be C20 modified or might instead be farnesylated.)

[C10] DKO4 cells were used, *in which mutant Ras had been detected homologous recombination (R) and a conditionally active Raf allele (EGFP-?Raf-1:ER) was stably expressed in these cells (R).*

In contrast to the prevalent use of Move 9 in biochemistry research articles, this move was not recognized in other disciplines (e.g., Posteguillo 1999 on computer science; Brett 1994 on social science). In fact, this move was first identified by Thompson (1993) in biochemistry research articles (15 out of 16 research articles analyzed). In this biochemistry corpus, Move 9 occurs in 71 % of the articles, verifying the trend of this procedural justification move in biochemistry. As Thompson claimed, the use of Move 9 implies that scientists do not feel research results can persuasively speak for themselves. Therefore, to gain acceptance from the larger scientific community, the results have to be carefully situated, assuring the reader that the results have been obtained from a sound and justified methodology.

Move 10: Presenting results

Having prepared the readers by providing crucial information about the procedures (Move 8) and convincing the readers that the choice of technique(s) was justified (Move 9), biochemists use Move 10: Presenting results to highlight the results obtained from the study.

Typically, this move is accompanied by a pointer (e.g., *Figure 1*, *data not shown*, or *our unpublished results*). The following texts represent Move 10 examples found in the corpus:

[MBC5] *Cultures shifted to glucose are blocked in [^{3}H]inositol incorporation into protein, whereas the control culture in galactose remains capable of incorporating this precursor (Figure 3).*

[JBC10] *One round of PCR (consisting of 30 cycles) detected GABA $_{(2)}$ mRNA in all the CNS tissues, as well as the salivary gland and thyroid (data not shown).*

The above examples illustrate that the results can be reported by direct and brief statements. However, consistent with the findings of Nwogu (1997) and Williams (1999), who analyzed medical research articles, the statements of results in this biochemistry corpus are usually more complicated than the above examples, consisting of two elements; namely, *Step 1: Substantiating results* and *Step 2: Highlighting incompatibility of the results*. Step 1 indicates the validity of the finding; the authors are making an appeal to the scientific community that their results should be a part of consensual knowledge. Step 2 highlights a difference between the result of the current study and that of previous studies, suggesting to the scientific community that the authors are contributing something novel that might be worth further investigation. The following examples illustrate the integration of the two steps of Move 10:

[C6] *We were not able to target the endogenous E. coli 6S RNA with antisense loigonucleotides. Secondary structure predictions and the observation that 6S RNA in extracts is relatively resistant to nuclease digestion.*

However, there is a 6S-like RNA in the genomic sequence of Haemophilus influenzae that has an insertion of 13 nt at the end of the predicted stem of the E. coli6SRNA.

[JBC6] *The C65A/C72A/G88R and C40A/G88R/C95A variants are approximately 90 and 60 % folded at 37 C, respectively (data not shown). Compared with G88R Rnase A, the T_m values for the C65A/C72A/G88R and C40A/G88R/C95A variants are decreased by 18.1 and 13.6 C, respectively. In contrast to these variants, wild type RNase A and the G88R, A4C/G88R/V118C, and A4C/C65A/C72A/G88R/V118C variants are folded at 37 C.*

Move 10: Presenting results is a central move of the Results section, occurring in 100% of the corpus. Like other moves in the Introduction and Methods sections, Move 10 is cyclical, reflecting the complexity of the study that entails different results.

Move 11: Commenting upon results

The Results section in biochemistry research articles not only reports data but also comments on them. As shown by the corpus, Move 10: Presenting results is usually accompanied by Move 11: Commenting upon results, the move that presents the author's subjective comments on the results obtained. Move 11 occurs in 91% of the articles. Move 11 in this biochemistry corpus include various steps; namely, *Step 1: Explaining results, Step 2: Interpreting results, Step 3: Comparing/Evaluating results, Step 4: Stating limitations,* and *Step 5: Summarizing results*. As the labels of these steps imply, Move 11 tends to co-occur with Move 10: Presenting results. The following examples show the co-occurrence of Move 10 and one step or a series of steps of Move 11.

Move 10 and Step 2 of Move 11: Interpreting results

[MCB4]

Move 10 *...an inhibitor of lysosomal cysteine proteases (R), had a significant effect on c-Myc degradation (Fig. 1B).*

Interpretation *These results suggest that proteolysis of c-Myc is proteasome dependent.*

Move 10 and Step 1 of Move 11: Explaining results

[MBC3]

Move 10 *..........................Our results determine localization of these mutants in vivo using GFP-tagged Ste18p.*

Explanation *We presume that the localization of GFP-tagged Ste18p is representative of native Ste18p because the wild-type fusion protein rescues mating in a ste18 strain.*

Move 10 and Steps 3 and 2 of Move 11: Comparing/Evaluating and Interpreting results

[C1]

Move 10 *..........................Within 3 hrs after the switch to high calcium, anti E-cadherin labeled two distinct and highly organized rows of puncta at sites of intercellular contact. This contrasted with disorganized puncta noted in established kidney epithelial lines. Each dot of anti E-cadherin staining was aligned with an identifically positioned dot in the opposing row.*

Evaluation *As expected, puncta also stained with anti-alpha cetenin and anti-beta catenin, but not desmosome-specific markers. Double rows of puncta were observed irrespective of whether keratinocytes were switched from low to high*

calcium or placed in high calcium from the start,
Interpretation *suggesting that the structure represented an intermediate step in adhesion, rather than a reaction to calcium.*

Move 10 and Steps 1 and 4 of Move 11: Explaining results and Stating limitations

[JBC2]

Explanation ....*weak correlations may have resulted from the unknown quality of the commercially obtained kidney microsomes employed here, since extensive denaturation of CYP4F2 and/or CYP4A11 to the P420 state during preparation would markedly decrease their immunochemical detection.*
Limitation *Unfortunately, the limited availability of these kidney samples obviated more detailed characterization, particularly the spectroscopic measurement of P450 concentrations.*

The above examples show that the Results section of biochemistry research articles displays the disciplinary variation that deviates from the style stated in a manual or guideline for writing for publications. For instance, as stipulated by the *Publication Manual of the American Psychological Association* (1996), the Results section should focus exclusively on the results of the study, leaving all subjective evaluation and comments to the Discussion section. However, such a rigid boundary does not seem to exist in biochemistry research articles. The integration of comments in the Results section thus suggests that scientific findings are of relatively limited value unless they are situated in a wider context.

All of the four moves identified in the Results section are conventional, with Move 10 (statement of finding) occurring in 100% of the articles. As mentioned earlier, the sequence of these moves is not rigidly fixed, allowing for a number of possible variations. For instance, the justification move (Move 9) precedes the procedural move (Move 8) in some articles. The moves in the Results section also show cyclical patterning, particularly with Moves 8 and 9, and Moves 10 and 11. Move 10 is the core of a cycle and is repeated until discussion of the data is exhausted.

3.4. The Discussion section

The Discussion section contextualizes the present research and relates it to previous work in the field, reflecting a sense of membership in the larger scientific community. Four moves were recognized in the Discussion corpus.

Move 12: Contextualizing the study

Move 12: Contextualizing the study provides a detailed description of the study. This move is central to the Discussion section, occurring in 90% of the corpus. Move 12 is characterized by *Step 1: Establishing the reported study* in order to situate the study being reported in the interest of the discourse community. The other variation found with Move 12 is *Step 2: Making generalizations, claims, or deductions*. Steps 2 allows the scientists to go beyond the results and place their work under the discourse community scrutiny. The examples illustrating Steps 1 and 2 of Move 12 are as follows:

Step 1: Establishing the reported study

[C7] *Type III secretion systems translocate proteins out of cells and often require chaperones specific for each of* *the secreted substrates. Chaperones were thought to prevent internal degradation of the secretion substrate and to deliver that protein to the secretion apparatus.*

Step 2: Making generalizations, claims, deductions

[JBC7] *(S1) A detailed understanding of the catalytic mechanisms and substrate selectivity of HAT enzymes is an important component of defining the molecular basis of their biological functions. (S2) Furthermore, such understanding is likely to enhance the design of potent and selective HAT inhibitors. (S3) Prior to this investigation, a preliminary mechanistic analysis on the HAT enzyme GCN-5 was reported. (S4) In this study, mixed histone substrates were used as the acetyl-CoA acceptor (R). (S5) Whereas this study revealed an intersecting line pattern for GCN-5 suggestive of a ternary complex mechanism, more detailed studies investigating order of substrate binding were not described. (S6)The complexity of the mixed histone substrate may have made detailed mechanistic studies difficult.*

The example taken from [JBC7] is a representative example illustrating how extensive Move 12 is. It begins with a generalization (Step 2) covering the first two sentences of the section (S1-S2). Then, a previous study related to the study being presented (Step 1) is reported to support any generalizations made at the beginning of the section (S3-S4). A generalization regarding a research gap that refers to the absence of detailed studies (Step 2) is identified (S5), followed by an account that explains the reason for the difficulty of conducting mechanistic studies (S6). Thus, this example displays how two strategies of Move 12 are integrated. In particular, the authors claim the centrality of the topic, being reinforced by citing a previous investigation. Then, a limitation of the investigation is pointed out. In short, this move prepares the readers for the study being reported in the article by justifying the need for further research.

Move 13: Consolidating results

Move 13 is used in every article to highlight the strengths of the study and/or to defend their research successes. This move is characterized by *Step 1: Restating methodological issues*—including related aspects such as the aim and the procedures of the research, *Step 2: Restating results, Step 3: Referring to literature for comparison/ contrast, Step 4: Explaining results, Step 5: Making claims,* and *Step 6: Exemplifying results.*

Step 1: Restating methodological issues

[MBC12] *Here we describe three additional human retromer proteins, hVps35, hVps29, and hVps26, and define the protein-protein interactions that allow them to assemble into a multimeric complex.*

[MC9] *By using temperature-conditional mutant alleles, VAM3 was found to genetically interact with VPS16, VPS18, and VPS33 (Figure 1B).*

Step 2: Restating results

[MC12] *Our results indicate that during replication in B. subtilis, DNA moves through a stationary replisome located at or near midcell...*

[MBC5] *We show that the essential Gpi11 and Gpi13 proteins are involved in late stages in the formation of the yeast GPIs, and we identify and characterize three new candi-*

dates GPI precursors.

Step 3: Referring to literature for comparison/contrast

[MC5] *Here we report the characterization of purified functional spliceosomal complex E. In contrast to the current model of spliceosome assembly, which proposes that U2 snRNP first binds in the A complex, our data indicate that U2 snRNP first associates with pre-mRNA during E complex formation.*

[JBC4] *The experiments presented here confirm the previously reported data (R), showing that pol? can catalyze extensive bypass of platinum-DNA adducts in a single-stranded region of DNA.*

Step 4: Explaining results

[MBC8] *...they were not easily distinguished in centroid tracks of regA⁻ cells (Figure 4, D-F), primarily because the peak velocities of regA⁻ cells were in many cases depressed and the tracks were not as persistent and directional during period of increased velocity.*

[C8] *...The finding that little or no secretion substrate is present in the absence of many secretion substrate chaperones is consistent with results presented here. In pulse-chase experiments there is little secretion-substrate protein at the zero minute time point in the absence of the cognate chaperone because little or no protein secretion-substrate protein had been translated.*

Step 5: Making claims

[C1] *Primary keratinocytes are only a step removed from the tissue itself, and epidermal cells in skin display* *numerous filopodia-like, interdigitated extensions. A movement-based mechanism for AJ assembly is especially important where cells are naturally at a distance from each other, such as wound healing or resealing a vacancy after a cell has committed to terminally differentiate and exits the basal layer.*

[MBC7] *...Simply changing the CaaX motif of mGBP1 to a form recognized by Ftase significantly improved mGBP1 modification. This result also indicates that the CaaX motif of mGBP1 is not likely to be buried within the structure of the protein, because such masking would presumably impede interaction with either Ftase or GGTase I.*

Step 6: Exemplifying results

[JBC7] *This is not meant to imply that protein substrate recognition by PCAF would not be influenced by the non-catalytic domains of PCAF. For example, a 25-amino acid peptide derived from the known acytelation site of p53 is a very weak PCAF (full-length), ...*

In summary, Move 13 is invariably present and can be characterized by the core step of the move—*Step 2: Restating results*. This central step is in turn consolidated by one or a series of steps of Move 13, contributing to the common function of consolidating the results presented.

Move 14: Stating limitations of the study

Move 14 makes explicit the authors' views of the limitations of the study. Typically, in this move, the authors introduce one or more caveats about several aspects of the findings; namely, *Step 1: Stating* *limitations of the findings*, *Step 2: Stating limitations of the methodology*, and *Step 3: Stating limitations of the claims*. The following examples elucidate Move 14 identified in the corpus:

[MC9] *Many questions still remain as to how the C-Vps complex mediates the regulation of SNARE complex assembly.*

[MBC4] *Our data do not address the possibility that intermediate filaments and lysosomes are transported by conventional kinesin because Drosophila lack intermediate filament proteins and because lysosomes in the Drosophila tissues that we analyzed have not been characterized.*

Move 14 is present in 48 Discussions or 80% of the entire corpus and is deemed conventional in this biochemistry corpus. The prevalence of this move in the corpus indicates the scientists' carefulness and honesty in acknowledging the limitations of the applicability of the findings of the study.

Move 15: Suggesting further research

In Move 15, the authors advocate the need for future avenues for further research or offer recommendations for the course of future research. Specifically, in this corpus, this move typically makes suggestions for particular research questions that need to be addressed. The authors also suggest improvements in their research methodology.

[MC4] *In the future, it will be challenging to assess what contribution DNA unwinding makes to the distribution of replication start sites in vivo.*

[JBC5] *...further studies on the functional impact of the interaction of p38[JAB1] with the LHR precursor may also help improve our understanding of the pathophysiology of these disorders.*

[MBC2] *Further correlation among mutant analysis, binding, and ATPase activity is in progress and should help determine the contributions of each region for dynein-microtubule binding.*

[MCB2] *Clearly, further characterization of methylation-mediated repression will require that mCpG density be taken into account.*

Move 15 is identified in 31 Discussions (53.33% of the corpus) analyzed and thus deemed as an optional move. A possible reason this move does not occur more frequently is due to the fierce competition for the grants in the sciences (Berkenkotter and Huckin 1995).

In summary, four recognizable rhetorical moves are found in the Discussion corpus. Only Move 15: Suggesting further research was considered optional in this corpus. This section, as has been shown by previous researchers (e.g., Belanger 1982; McKinlay 1983; Peng 1987), displays a cyclical organization. The cycles usually involve Moves 12 and 13, particularly when several pieces of results are presented serially. The next cycle then begins with another statement of result, and the pattern repeats itself.

4. Discussion and Conclusion

The purpose of the present study was to present the rhetorical organization commonly followed in biochemistry research articles. As shown by this study, Swales' model for Introductions has been successfully extended to other sections of biochemistry research articles. The biochemistry Introduction section generally conforms to the rhetorical model in terms of the presence of the moves and to their sequence as stipulated by Swales. The primary departure from Swales' model lies in the patterns of cyclical configuration between Moves 1, 2, and 3. That is, each move can recur in Introductions a number of times depending on the complexity of the study being presented.

The extensive use of Move 1 Step 3 in biochemistry as found in this corpus indicates the discrepancies of practice in different disciplines. For example, as revealed by Hughes (1989) and Posteguillo (1999), and in contrast to this study's finding, Introductions in computer science research articles do not always have Move 1 Step 3 (Reviewing previous research). According to these scholars, the minimal or low use of Move 1 Step 3 is due to the relatively short history and heavy commercial involvement of computer science. The contrastive findings about the use of Move 1 Step 3 suggest that disciplinary variation is discernible and that scholars need to know conventional practices in their own disciplines.

Move 2, according to Bazerman (1988) and Dudley and Henderson (1990), was a relatively recent phenomenon in scientific Introductions written in English. The relatively high frequency of occurrence of this move (66% of the entire corpus or in 40 Introductions) suggests the trend that Move 2 is becoming a more established move in biochemistry research articles. This move has been of interest to many contrastive rhetoric scholars. In Ahmad's (1997) study, he found that Malaysian scholars somehow avoid using this move. If this move is used, it is to crate a need to do research by conducting their studies using local materials to satisfy local needs. This move thus shows that besides disciplinary variation, cultural variation also plays a vital role within the genre of research articles determining the rhetorical structure of Introductions.

Move 3 in biochemistry research articles generally constitutes a brief mention of the purpose of the study. Some Introductions go further by providing additional details of the procedures and announcing principal findings. No attempt is made to indicate the structure of the research article in this biochemistry corpus—another distinct departure from what the model predicts. Consequently, modifications to Swales' model of Introductions are proposed to make it appropriate for the specific discourse of biochemistry.

Given the scant attention to the Methods section and the extreme diversity of aims and methods across the disciplines included in the move-based studies, there has been no clear model for the Methods section unlike the well-developed Swales' model for Introductions. Nevertheless, the analysis of this study revealed unique characteristics of the biochemistry Methods section. For instance, many experimental procedures are well established and familiar to scientists in the field. However, in each article, these established procedures are employed with some adjustments to accommodate the particular features of a specific study.

The Results section of biochemistry articles confirms Swales' assertion (1990) that disciplinary variations occur not only in the

Introductions section, but also in the Results section. The results sections of biochemistry articles are distinguished from those of other disciplines by including Move 9: Justifying methodology of the study and Move 11: Commenting upon results. The trend of incorporating the move of methodological justification, as discovered by Thompson (1993), is confirmed by this study. This is probably due to the availability of many established experimental procedures in the field; therefore, justification for a particular procedure has to be made explicit and validated.

The final section, Discussion, is varied due to the diverse strategies that the authors choose to integrate. A unique feature of biochemistry research articles is that both Move 12: Contextualizing the study and Move 13: Consolidating results are conventional in this biochemistry corpus. These features are emphasized because of scientists' sensitivity to carefully situate their work in the interest of their discourse community.

The study expands the application of move analysis to biochemistry research articles in their entirety by adding to the ever-evolving knowledge of how writing in disciplines can be understood as having predictable and expected structures. The knowledge gained from this study contributes to an understanding of the discourse in research articles and reinforces how well move analysis gives an in-depth perspective on the formation of a distinctive section of a research article. The study also demonstrates what the discipline of linguistics could offer to other disciplines. Particularly, discourse analysis can offer insights into what elements are conventionally included in research articles written by biochemists.

Appendix

Move Structure for Biochemistry Research Articles

Move/Step		Frequency of Occurrence
Introduction		
Move 1: Acknowledging the importance of the field		*100.00%*
By	Step 1: Claiming the centrality of the topic	
	Step 2: Making topic generalizations	
	Step 3: Reviewing previous research	
Move 2: Preparing for the present study		*66.66%*
By	Step 1: Indicating gaps	
	Step 2: Raising questions	
Move 3: Introducing the present study		*100.00%*
By	Step 1: Stating purposes	
	Step 2: Describing main features of the study	
	Step 3: Announcing principal findings	
Methods		
Move 4: Describing substances investigated		*100.00%*
By	Step 1: Listing substances investigated	
	Step 2: Specifying sources of the substances	
	Step 3: Providing background information of the substances	
Move 5: Describing experimental procedures		*100.00%*
By	Step 1: Referring to established experimental procedures	
	Step 2: Describing details of the methods	
	Step 3: Providing background information of the procedures	
Move 6: Describing apparatus and its setting (optional)		*10.00%*
Move 7: Describing statistical analysis (optional)		*13.32%*
Results		
Move 8: Recounting methodological procedures		*95.07%*
By	Step 1: Restating purposes of the study	

Step 2: Restating research questions
Step 3: Restating hypotheses
Step 4: Restating experimental procedures

Move 9: Justifying methodology of the study		*71.59%*
By	Step 1: Referring to established knowledge of the topic	
	Step 2: Referring to previous studies	
Move 10: Presenting results		*100.00%*
By	Step 1: Substantiating results	
	Step 2: Highlighting incompatibility of the results	
Move 11: Commenting upon results		*91.01%*
By	Step 1: Explaining results	
	Step 2: Interpreting results	
	Step 3: Comparing/Evaluating results	
	Step 4: Stating limitations	
	Step 5: Summarizing results	

Discussion

Move 12: Contextualizing the study		*89.94%*
By	Step 1: Establishing the reported study	
	Step 2: Making generalizations, claims, or deductions	
Move 13: Consolidating results		*100.00%*
By	Step 1: Restating methodological issues	
	Step 2: Restating results	
	Step 3: Referring to literature for comparison/contrast	
	Step 4: Explaining results	
	Step 5: Making claims	
	Step 6: Exemplifying results	
Move 14: Stating limitations of the study		*80.00%*
By	Step 1: Stating limitations of the findings	
	Step 2: Stating limitations of the methodology	
	Step 3: Stating limitations of the claims	
Move 15: Suggesting further research (optional)		*53.33%*

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