Introductions in Biomedical Research Articles

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This paper reports on a detailed study of introductions in biomedical research articles, using Swales' (1990) Create-A-Research-Space (CARS) model. Ten biomedical research articles selected from three different academic journals have been analysed. The results show that these introductions in large part follow the 'move' structure given in the CARS model, but some distinctive patterns with respect to the use of individual steps, cyclicity between different moves and the relative length of various moves and steps in the introductions have also been found. The results also indicate the need for re-considering some steps in the CARS model to accommodate the potentially distinctive features of biomedical introductions.

Introduction

In the present-day academic community, research articles are frequently used as a major indicator of a researcher's academic standing and it is only natural that a great deal of a researcher's time and effort is spent on the writing of research articles itself. It should not be surprising, therefore, that this genre of writing has been subjected to extensive rhetoric and linguistic studies in the past twenty years. These studies have covered various aspects of this genre, including the introduction (Fakhri, 2004; Gledhill, 2000; Gupta, 1995; Samraj, 2002, 2005; Swales, 1981, 1990; Swales & Najjar, 1987), the results section (Brett, 1994; Thompson, 1993; Williams, 1999), discussions (Holmes, 1997; Hopkins & Dudley-Evens, 1988), the abstracts (Lorés, 2004; Martín, 2003; Melander, Swales & Fredrickson, 1997; Salager-Meyer, 1990, 1992), and the rhetorical structure of the whole research article (e.g. Kanoksilapatham, 2005). In addition to the studies of the rhetoric structure of the whole research article or its various parts, other studies have examined the specific linguistic features of this genre, such as textual metadiscourse (Dahl, 2004; Peterlin, 2005; Valero-Garcés, 1996) and the use of the passive and active voice (e.g., Tarone et al., 1998).

The most studied aspect of the research article genre is perhaps the introduction (Samraj, 2002). One of the best known studies in this respect is probably conducted by Swales (1981, 1990). Based on the study of 48 articles in 14 disciplines, Swales (1981) proposed a model to account for the structure of research article introductions, which he later modified by incorporating the findings of other researchers (Swales, 1990). This later model is known as the CARS model (an acronym for *Create A Research Space*). Since the publication of this and its earlier model, many others have tried to test its applicability across both different languages and cultures (Ahmad, 1997; Fakhri, 2004; Fredrickson and Swales, 1994; Taylor and Chen, 1991). At the same time, some researchers have also tried to use the CARS model in the analysis of research articles in various academic disciplines, such as Computer Science (Posteguillo, 1999), Medical Science (Nwogu, 1997) and Biochemistry (Kanoksilapatham, 2005). However, relatively little research has been done specifically on research article introductions alone. Two recent exceptions are Anthony's (1999) study of Software Engineering and Samraj's (2002) studies of Conservation Biology and Wildlife Behaviour. Both these studies have revealed disciplinary variation in the structure of introductions in these disciplines. This finding points to the need for more in-depth study of this genre in specific disciplines.

The present study will examine if a generalised model like the CARS is applicable to introductions of English language research articles in a newly emerged discipline, Biomedical Science, and if so, how well it can account for the features of writing in a corpus of ten research articles in this field. The study should be beneficial to aspiring researchers, especially novice researchers in biomedicine, in understanding the rhetoric structure of biomedical introductions and the various linguistic strategies in realising the structural elements of the introductions. Its findings can also be useful for the design and the teaching of courses in English for Specific or Academic Purposes.

Methodology

Swales' CARS model

Swales' (1990) current CARS model is actually a refinement of his earlier work on research article

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 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 3: Occupying the niche
- Step 1A Outlining purposes **or**
- Step 1B Announcing present research
- Step 2 Announcing principal findings
- Step 3 Indicating RA structure

Figure 1 **Swales' (1990) CARS model**

introductions in 1981. The original four move model was revised into three moves and is represented in Figure 1.

According to Swales' (1990) model, the introduction section includes three basic moves: Establishing a Territory, Establishing a Niche, and Occupying a Niche. In order to establish a territory, one needs to indicate the importance of the research topic of the article. To establish a niche, the author has to justify the present study. To occupy a niche means that the author needs to describe what the present study is about. Each of these moves can be realised by a series of three or four steps or sub-steps. For example, Move 1: Establishing a Territory can be achieved by claiming interest or importance of the topic (Step 1), making a topic generalization (Step 2), and/or reviewing items of previous literature (Step 3). Move 2: Establishing a Niche, on the other hand, requires the author to show some limitations or incompleteness in the previous research by making a counter-claim, identifying a gap in this research or raising questions. The final move—Occupying the Niche—can be achieved by indicating the specific purpose of the research conducted, announcing the main findings or indicating the structure of the research article. This hierarchical relationship between moves and steps shows a strong Birmingham tradition of discourse analysis, where a higher order structure such as a move is made up of one or more lower order structures such as steps or acts (see e.g., Sinclair & Coulthard, 1975, for the analysis of classroom discourse) and the lowest structure is realised by a range of linguistic strategies.

Data

A total of ten recent research articles were randomly selected from three leading journals in the biomedical field. Four articles were taken from *The New England Journal of Medicine* and three articles each were taken from *Nature Medicine* and *The Journal of Clinical Investigation*. These journals were selected after consultation with faculty members of the medical faculty of the National University of Singapore. Only original research articles with clearly demarcated introductions were used in this study. This meant the exclusion of the two of the most prominent journals in the field, *Science* and *Nature*, from this study as their articles did not provide clear demarcations for the introduction. Review articles were also excluded from this study.

All the articles were written in English and published either in the September or October 2004 issues. A complete list of the selected articles can be found in the Appendix. The introductions of these articles were then analysed and coded according to Swales' CARS model with minor modifications. These modifications will be elaborated in the next section.

It was not possible to determine if the writers were native or non-native English language speakers, but this distinction is not important in this study as all these articles would have been redacted by the editors before publication. Furthermore, this study is not concerned with the variation between the research article introductions of native or non-native English language speakers, but is instead concerned with how research article introductions are written in the biomedical field.

■ Results and Discussion

Overview of results

Table 1 offers an overview of how well the CARS model can account for the rhetorical structure of the ten biomedical introductions in the corpus. Some general observations can be made here. First, it seems clear that the CARS model has been quite well adhered to. Except for Move 2, which is present in only nine introductions, the other two moves are invariably present in all the ten introductions. Second, some steps seem to be redundant in that they are either too rare (e.g., Step 1A of Move 3) or completely absent (e.g., Steps 1A and 1C of Move2, and Step 3 of Move 3) in the introductions. Finally, it seems necessary to collapse some steps (e.g., Steps 1 and 2 of Move 1) of the original CARS model into one single step as they seem to overlap with one another in both forms and functions. We elaborate our analysis in detail in the following sections.

Table 1 **Summary of CARS moves and constituent steps in the corpus**

		Number of articles
Move 1: Establishing a territory		**10**
Step 1	Claiming centrality or Making topic generalisation(s)	10
Step 2	Reviewing items of previous research	10
Move 2: Establishing a Niche		**9**
Step 1A	Counter-claiming	0
Step 1B	Indicating a gap	7
Step 1C	Question-raising	0
Step 1D	Continuing a tradition	4
Move 3: Occupying The Niche		**10**
Step 1A	Outlining purpose	1
Step 1B	Announcing present research	10
Step 2	Announcing principal findings	6
Step 3	Indicating RA structure	0

Identification of moves and steps

- **Move 1**

As we have summarised in the methodology section, Move 1 is concerned about establishing the importance of the research topic. Three steps may be used to achieve this: centrality claims, topic generalisations and/or literature review. The first step is mainly concerned with making assertions about the importance of the topic being discussed. According to Swales (1990: 144), these claims are "appeals to the discourse community whereby members are asked to accept that the research about to be reported is part of a lively, significant or well-established research area." Several ways can be used to make such claims, including a) claiming interest or importance of the research topic; b) referring to the classic, favourite or central character of the issue; or c) making assertions of active research activity in the area concerned (Samraj, 2002; Swales, 1990). Some linguistic cues in recognising such claims include the following: 'increasingly interested in', 'a classic problem', 'favourite topics', 'important', and 'central' (see Swales, 1990, for more examples). Examples from the articles included in this analysis are[1]:

1. *Identifying the pathways that allow asthma to be expressed is **fundamental** to improving preventive strategies, developing diagnostic tools, and designing therapies (ref). (RA3)*
2. *Hypercholesterolemia and inflammation are thought to represent **distinct** elements that converge on a common pathogenic pathway in atherosclerosis (ref). Recognition of the **hallmarks** of inflammatory pathology in atherosclerosis has opened up therapeutic opportunities (refs). (RA5)*
3. *Thus through the opposing effects of α-MSH and AGRP, MC4R serves as a **central** integrator of peripheral signals that modulate food intake (ref). (RA9)*
4. *The RAA system plays an **important** role in the maintenance of vascular tone, circulating blood volume, and electrolyte balance in the body. (RA10)*

All the above examples contain explicit linguistic cues to show the importance of the research area or phenomenon. However, the process of identifying this first step in this small corpus of biomedical research articles is not as straightforward as it seems. The first problem with this analysis is that none of these examples is introduction initial (i.e. they do not appear as the first sentence of an introduction), in contrast with what Swales (1990) claims. They occur either as the second sentence (Examples 1 & 2) or as the last sentence(s) of a paragraph (Example 3) or the beginning sentence(s) of a new paragraph (Example 4). Thus, the next question is: What are the initial sentences in the ten research article introductions? What steps or moves can they be classified into? The following is a whole list of all the first sentences in the introductions investigated for this study.

5. *Croup (acute laryngotracheobronchitis) is **common**, occurring yearly in 3 percent of children under six years of age (ref). (RA1)*
6. *Tuberculous meningitis is the **severest** form of infection with Mycobacterium tuberculosis, causing death or severe neurologic deficits in more than half of those affected in spite of antituberculosis chemotherapy (refs). (RA2)*
7. *Asthma may affect **as many as one in four** urban children (ref) … (RA3)*
8. *Chronic hepatitis b is a **serious** problem worldwide (ref). (RA4)*
9. *Atherosclerosis, a **chronic** inflammatory disorder of the vascular wall, is **characterized** by the progressive formation of fatty streak lesions, stable plaques and unstable or ruptured plaques, which trigger clinical complications (ref). (RA5)*
10. *Obesity has emerged as a **public health concern** during the last decade (ref). (RA6)*
11. *Rheumatoid arthritis, a **chronic and debilitating** systemic inflammatory disease, is **characterized** by synovial hyperplasia and inflammatory cell recruitment, intra-articular fibrin deposition and, eventually, cartilage and bone destruction (ref). (RA7)*
12. *Deregulation of apoptosis is thought to **invariably occur** in human cancer, and to facilitate the acquisition of **deleterious** cancer traits (ref), including loss of tumor suppressor genes, angiogenic changes, and immortalization (ref). (RA8)*
13. *Prevention of obesity in mammals is **dependent** on a number of systems, including the activity of an anorexigenic pathway **made up of** the adipocyte-secreted hormone leptin, its neuropeptide effector pro-opiomelanocortin (POMC), and the melanocortin-4 receptor (MC4R). (RA9)*
14. *In renovascular hypertension, the reduction of renal blood flow due to renal artery stenosis originating from obstructive vascular diseases, such as atherosclerosis or fibromuscular dysplasia, induces **excessive** activation of the renin-angiotensin-aldosterone (RAA) system and **leads to hypertension** (ref). (RA10)*

These introduction initial statements do not seem to contain explicit linguistic cues for centrality claims such as 'important' and 'crucial', but they are all statements about the commonness or severity of a disease or its characterisations, as quite clearly shown by the words and phrases we highlighted in bold. Can these statements be classified as centrality claims as they at least imply the importance of the research topic or are they Step 2 of Move 1: Making Topic Generalisations? According to

[1] The number in front of each statement(s) reflects the example number. Ref = one reference; refs = more than one references; and RA = Research Article (see Appendix for the list of the research articles studied)

Swales (1990: 146), topic generalisations can be either "statements about knowledge or practice, or statements about phenomena." Statements about knowledge or practice "express in general terms the current state of the art-of knowledge, of technique" and "of current requirements for further progress" whereas statements about phenomena emphasize the "frequency and complexity" of the data. To put it more simply, these statements give overviews of the research topic. A few linguistic cues used by Swales (1990) to illustrate this step include 'well-known', 'much evidence', 'a common finding', and 'many situations'. From this description, it would seem that the introduction initial sentences in the corpus can be either centrality claims about the importance or generalised statements about phenomena, though explicit linguistic cues provided by Swales (1990) may not be so evident in either case. In other words, we find it difficult to distinguish between the two steps: there do not seem to be sufficient linguistic or functional grounds to separate them. Hence, in this paper, we decide to merge the two steps into one.

Another problem with the identification of centrality claims is that they are not easily distinguishable from Step 1D of Move 2 (Continuing a tradition). For example, the following two sentences also contain similar linguistic cues to those of centrality claims such as 'essential' and 'priority' and can arguably be regarded as serving to claim interest or importance of the research topic.

15. *Since the majority of children with croup have mild symptoms and a transient, uncomplicated course, we thought it* ***essential*** *to have clearer evidence of benefit before advocating corticosteroid treatment for this large subgroup of children. (RA1)*

16. *Validating a cytoprotective mechanism of surviving has become a* ***priority*** *because of the dramatic exploitation of this pathway in human tumors (ref), its frequent association with unfavorable disease outcome (refs) and the recent identification of molecular antagonists of survivin that are approaching clinical testing in cancer patients (ref). (RA8)*

However, these sentences appear after other steps in Move 2 and before Move 3. This placement makes them a better candidate for niche establishment by continuing a tradition. The need to use the position of a statement in a text as a determinant of its function has long been pointed out by Sinclair & Coulthard's (1975) analysis of spoken discourse and is also echoed by Anthony (1999) in his analysis of research article introductions in Software Engineering.

Taking these problems into consideration, all the introductions of the corpus can be said to use centrality claims to establish a territory (Step 1 of Move 1) (see Table 1). This is in contrast with an average use of Step 1 of slightly less than 50% in Swales' (1990) report. One immediate reason, of course, is that we have re-defined this step so that it also encompasses topic generalisations.

As the second step of Move 1 in Swales' CARS model is now merged with the first step, we come to the third step of Move 1 in the model: reviewing previous research. Step 3 in Establishing a Territory, according to Swales (1990: 148), "is the review of one or more items deemed by the authors to be relevant to that establishment." This step can be readily recognised in all the biomedical introductions in this corpus, reflecting the rich research culture in biomedicine. This finding is in contrast with that found in computer science, which very often does not have this step probably due to its relatively short history and heavy commercial involvement (Posteguillo, 1999).

One typical function of Step 3: Reviewing Previous Research is to support centrality claims or topic generalisations. In the following paragraph, the first sentence (italicised) is the centrality claim, which seems similar to the topic sentence in traditional essay writing terms. All the remaining sentences are, in a way, supporting sentences used to exemplify the centrality claim.

17. ***Croup (acute laryngotracheobronchitis) is common, occurring yearly in 3 percent of children under six years of age (ref).*** *Less than 5 percent of such children are hospitalized, and of these, 1 to 2 percent receive endotracheal intubation (ref). Corticosteroids are effective in moderate-to-severe croup, resulting in reductions in the frequency and duration of intubation (refs) and hospitalization (refs) and the frequency of administration of nebulized epinephrine (refs), a treatment reserved primarily for severe respiratory distress. (RA1)*

In addition to providing support for centrality claims or topic generalisations, literature review can also be used to perform some other functions, such as justifying the gap created, as Samraj (2002) has observed. Most of the justifications of this kind seem to be embedded with rather than separated from other steps or moves. When this happens, this review of literature will not be considered Step 3 of Move 1 (cf. Samraj, 2002). Instead, it will be regarded as part of a separate step or move (such as Move 2-1B). In the example below, a number of references are used to signal the review of relevant literature, but this review seems to be an integral part of indicating the gap that the authors intend to fill in. Therefore, these statements are not taken to be Step 3 of Move 1, but rather Step 1B (Indicating a Gap) of Move 2 (Establishing a Niche).

18. ***Only*** *two published trials have focused on corticosteroid treatment of mild croup (refs). One* ***did not*** *use clinical criteria to define mild croup clearly (ref), and the other included children with audible stridor at rest and indrawing of the chest wall (ref), symptoms that most health care professionals consider to represent more severe disease. The first study was* ***small*** *(100 patients) and assessed* ***only one*** *outcome: return to medical care for croup (ref).* ***Though*** *the*

second study showed that corticosteroid treatment was beneficial (ref), the inclusion of a substantial proportion of patients with more severe croup leaves the applicability to children with milder symptoms ***uncertain****. (RA1)*

- **Move 2**

According to the CARS model, four main steps may be used to realise Move 2: Establishing a Niche: 1A) Counter-claiming, 1B) Indicating a Gap, 1C) Question-raising or 1D) Continuing a Tradition. By counter-claiming, the author tries to show that "the previous work is hopelessly misguided" (Swales, 1990: 154). This step does not appear at all in the present small corpus of 10 biomedical introductions. One possible reason is that counter-claiming may be considered to be too face-threatening.

The most popular step to use for establishing a niche in the biomedical introductions investigated is Step 1B, Indicating a Gap in earlier research. This step is signalled through the use of a number of linguistic means, including the use of negative or quasi-negative quantifiers (e.g., *no, little, few*), lexical negation (e.g., *fail, lack, inconclusive, elusive, limitation*), and negation in the verb phrase (e.g., *not, rarely, ill*) (see Swales, 1990, for more examples). Example 18 above provides a good illustration of this step. Two more examples (Examples 19 & 20) are also given below. Indicating a gap in previous research is used in seven out of our ten biomedical introductions (see Table 1). This shows that biomedical researchers typically like to build upon previous research by overcoming its limitations and filling in a gap that it has left.

19. *The roles of prostanoids in renovascular hypertension, however,* ***has not been fully defined****. (RA10)*

20. *Although NMU and the leptin receptor are both expressed in the ARC (refs), the interaction between the leptin and NMU systems in the regulation of food intake and body weight* ***has not been clarified****. (RA6)*

Step 1C in Move 2: Question-raising is absent in the biomedical introductions in our analysed corpus. Step 1D in Move 2 in the CARS model—Continuing a Tradition includes expressed needs, desires or interests and logical conclusions, and is considered to be "a weaker challenge to the previous research" (Swales, 1990: 156). Step 1D typically follows either Indicating a Gap (Move 2, Step 1B) (see Examples 15 and 16) or Reviewing Previous Research (Move 1, Step 3) (see Example 21 below) in our corpus. Altogether, five instances of continuing a tradition can be found in the ten biomedical introductions (see Table 1).

21. *Data from mice that are null with respect to apolipoprotein E (Apoe$^{-/-}$) and low-density lipoprotein receptor (Ldlr$^{-/-}$) indicate that LTB4 contributes to lesion formation (refs), and it has been suggested that 5-LO participates in the atherogenesis of Ldlr$^{-/-}$ mice (ref). A defined locus on mouse chromosome 6, where the 5-LO gene (Alox5) is located (ref), has been identified to confer strong resistance to atherogenesis in the resistant strain CAST/Ei (ref).* ***Thus, both human and mouse studies raise the possibility that 5-LO may have a proatherogenic role****. (RA5)*

- **Move 3**

In the CARS model, Move 3: Occupying the Niche consists of three steps. Step 1 can be either Outlining Purposes (Step 1A) or Announcing Present Research (Step 1B). Steps 2 and 3 are Announcing Principal Findings of the research and Indicating the Structure of the Research Article, respectively.

Step 1 in Move 3 is present in all the introductions of the corpus (see Table 1). This is consistent with Swales' (1990) observation that Step 1 is the obligatory element of Move 3. Specifically, Step 1B: Announcing Present Research is consistently present in our corpus whereas only one Step 1A: Outlining Purposes can be located. The following excerpt is the sole example in our corpus of an introduction which contains both Step 1B (the first sentence) and Step 1A (the second sentence).

22. ***Therefore, we conducted*** *a multicenter, randomized, double-blind, placebo-controlled clinical trial of corticosteroid treatment for mild croup, defined by strict clinical criteria.* ***The objectives*** *of the study were to determine whether dexamethasone treatment of mild croup would reduce the incidence of a return to a medical care provider for croup and the associated economic costs. (RA1)*

In a few instances, where outlining research purposes occurs as a part of Step 1B in the same sentence, we count it as one step, that is, Step 1B (Announcing Present Research). For example, the first half of the following sentence shows the objective of the research (Outlining Purposes) and the second half shows the picture of what the research is about (i.e., Announcing Present Research). Instead of counting this case as consisting of both Step 1A and Step 1B, it is considered a single step—Step 1B. This decision was made on two main accounts: 1) the analysis of steps seems to be based on a sentential level rather than on a clausal or phrasal level in Swales'(1990) model; 2) the function of a sentence is better determined by that of its main clause rather than that of a subordinate clause (cf Halliday, 1994).

23. ***To investigate*** *the essential role of endogenous NMU in energy metabolism and the relationship between the leptin and NMU systems,* ***we*** *generated mice lacking the gene encoding NMU (Nmu$^{-/-}$ mice). (RA6)*

Step 2, Announcing principal findings, can be found in six of the ten biomedical introductions (see Table 1). This result is quite close to the 45% found by Swales and Najjar (1987) on physics introductions, but it is different from the 7% found in the same study on the

introductions of educational psychology. It would thus seem that biomedicine may be more similar to hard sciences like physics than to soft sciences like educational psychology. Another observation about Step 2 in this corpus is that most of Step 2 is restricted to one or two sentences, as we can see from Examples 24 & 25. This is in congruence with the result of Kanoksilapatham's (2005) study on biochemistry introductions, where the information about the findings is kept to a minimum in the introduction.

24. ***Our data indicate*** *that 5-LO has a role in promoting the formulation of aneurysms induced by an atherosclerotic diet through potential MIP-1α and MIP-2 chemokine-dependent inflammatory circuits involving myeloid and endothelial cells. (RA5)*
25. ***We identified*** *a novel pool of survivin that localizes to mitochondria and is rapidly released in the cytosol in response to apoptotic stimuli. (RA8)*

In the ten biomedical introductions, no instance of Step 3 can be found. This is in stark contrast with Cooper's study of IEEE[2] introductions (1985, cited in Swales, 1990), where she found a Step 3 in about 67% of her introductions. Swales suggested that the high incidence in Cooper's study might be connected to the absence of an established schema for research reporting in a new and rapidly evolving discipline like IEEE in the 1980s. The reverse may also be true for the present study on biomedicine. Although biomedicine may be relatively new and still developing, we suspect that it may have inherited rhetoric practices from its mother discipline—medicine, which has a long history.

Cyclicity and length of moves and steps

While the CARS model is presented as a linear one with the first move followed by the second which is in turn followed by the third, Swales (1990) acknowledges the possibility of cycling between different moves, commenting that 'brevity and linearity' may be more characteristic of the natural and life sciences and of engineering. His observation is generally confirmed with biomedical introductions in our corpus, as biomedicine can be considered part of life sciences. The ten biomedical introductions investigated are in general quite short, varying from 185 words to 572 words in length, with an average of 3.4 paragraphs per introduction and 26.8 words per sentence (see Table 2 below). This is in sharp contrast with software engineering introductions, which range from 591 words to 1479 words in length (Anthony, 1990).

Only two introductions (RA2 & RA10) exhibit cycling between different moves, as can be seen from Table 2. Eight other introductions closely follow the linear order as prescribed in the CARS model. In the case of RA10, which is longest in terms of the number of words and sentences used, there are four cycles of Move 1 and 2 steps before the present research is finally announced. This is again in contrast with software engineering introductions, where cyclicity between different moves is invariably present (Anthony, 1999). One plausible reason would be the length of the introduction: the longer the introduction, the greater the likelihood of move recycling (Anthony, 1999; Crookes, 1986; Swales, 1990).

With respect to the length of individual steps and moves (see Table 3), it is obvious that Move 1 is the lengthiest move among the three, taking up about 2/3 (or 64.7%) of the total number of words in the introductions. Moves 2 and 3 are about the same in length, occupying 18% and 17% of the total length respectively. Within Move 1, Step 3 (Reviewing Previous Research) is the longer of the two steps, taking up more than 2/3 (or 69.6%) of the whole move length. This result shows clearly that biomedical researchers seem to be obliged to do much rhetorical work to establish their research territory. In particular, they need to be familiar with what other researchers have done before and be able to find a gap that they can fill in or continue what others have tried to do. This is in contrast with Anthony's (1999) study of software engineering introductions. He found that while software engineers also pay a lot of attention to territorial establishment (36% of the total length), they seem to put more emphasis on the writing of their own

Table 2 **Move structure in the ten biomedical introductions studied**

RA	Move structure	Words	Sentences	Paragraphs	Words/Sentence
1	1 2 3	354	13	4	27.2
2	1 2 1 2 3	286	8	2	35.8
3	1 3	185	8	3	23.1
4	1 2 3	427	16	4	26.7
5	1 2 3	308	12	4	25.7
6	1 2 3	347	14	3	24.8
7	1 2 3	392	17	4	23.1
8	1 2 3	272	9	3	30.2
9	1 2 3	451	19	3	23.7
10	1 2 1 2 1 2 1 2 3	572	21	4	27.2
Average		**359.4**	**13.7**	**3.4**	**26.8**

[2] IEEE = The Institute of Electrical and Electronics Engineers

Table 3 **Length of moves and steps in the ten biomedical introductions studied**

RA	Length of moves and steps as number of words										
	M1	1.1/1.2	1.3	**M2**	2.1B	2.1D	**M3**	3.1A	3.1B	3.2	**Total**
1	**134**	17	117	**135**	100	35	**85**	21	33	31	**354**
2	**75**	51	24	**179**	131	48	**32**	0	32	0	**286**
3	**135**	55	80	**0**	0	0	**50**	0	50	0	**185**
4	**334**	8	326	**21**	21	0	**72**	0	72	0	**427**
5	**227**	95	132	**16**	0	16	**65**	0	32	33	**308**
6	**239**	98	141	**33**	33	0	**75**	0	30	45	**347**
7	**321**	55	266	**15**	0	15	**56**	0	40	16	**392**
8	**97**	30	67	**112**	67	45	**63**	0	27	36	**272**
9	**334**	89	245	**46**	46	0	**71**	0	27	44	**451**
10	**431**	209	222	**89**	89	0	**52**	0	52	0	**572**
Average	**232.7**	70.7	162	**64.6**	48.7	15.9	**62.1**	2.1	39.5	20.5	**359.4**
% of move	**100.0**	30.4	69.6	**100.0**	75.4	24.6	**100.0**	3.4	63.6	33.0	**3.4**
% of total	**64.7**	19.7	45.1	**18.0**	13.6	4.4	**17.3**	0.6	11.0	5.7	**100.0**

research (46% of the total length), announcing their main findings, indicating the structure of their reports and evaluating their research. This contrast gives support once again to the disciplinary variation in the writing conventions of the same genre.

■ Conclusion

Introductions are prevalent in most research articles. These introductions serve both to orientate the reader and to generate the reader's interest in the topic. This paper has analysed ten biomedical introductions in great depth using Swales' (1990) CARS model. Several findings are worth noting here. Firstly, while biomedical introductions in the analysed corpus seem for the most part to include all the moves in the CARS model, many steps in Moves 2 and 3 are never or rarely used, namely, Steps 2-1A (Counter-claiming), 2-1C (Question-raising), 3-1A (Outlining Purposes), and 3-3 (Indicating Research Article Structure). Secondly, cyclicity between different moves does occur, but not very frequently. In most cases, biomedical introductions investigated for this study exhibit linearity in that there is a fixed order of steps and moves, as prescribed in the CARS model. In addition, they can be considered to be relatively short. Finally, among the three moves, it is apparent that Move 1 (Establishing a Territory) occupies the bulk of biomedical introductions in the corpus, showing that researchers in this field are under rhetorical pressure to provide sufficient background information with respect to previous research and to establish a sound rationale before describing their own research.

In addition to findings related to biomedical introductions in the sample of data analysed, several outcomes may also be worth noting with reference to the CARS model itself. First, matching functional terms like individual steps and moves to certain language forms is not always a straightforward process. Identifying and classifying the steps and moves in the CARS model can be very tedious and requires many rounds of analysis and reanalysis before a final decision can be made as to which step or move a certain sentence belongs to. This process can often be problematic as well, as a single sentence or statement can often serve multiple functions in a given context (Bhatia, 1993; Samraj, 2002). Thus, new rules may sometimes be needed to account for hard-to-resolve cases. In this paper, we have combined Step 1-1 and Step 1-2 as we find that they overlap with each other in language forms as well as in language functions. We have also used the concept of textual location to determine whether one statement belongs to one step or to the other (as in the case of Step 1-1 and Step 2-1D). Finally, we have also tried to resolve the problem of one step (in the case of Step 3-1A) embedded with another step (Step 3-1B) by merging them into a single step. While many of these problems may sound trivial, they may hamper the applicability and reliability of the model in general. Hence, further specifications and clarifications of the individual steps and moves in the CARS model may be needed when applying it to research article introductions in specific disciplines.

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APPENDIX: Biomedical research articles studied

RA1 Bjornson, C.L., Klassen, T.P., Williamson, J., Brant, R., Mitton, C., Plint, A., Bulloch, B., Evered, L., & Johnson, D.W. (2004). A randomized trial of a single dose of oral dexamethasone for mild croup. *New England Journal of Medicine, 351*(13), 1306-1313.

RA2 Thwaites, G.E., Nguyen, D.B., Nguyen, H.D., Hoang, T.Q., Do, T.T., Nguyen, T.C., Nguyen, Q.H., Nguyen, T.T., Nguyen, N.H., Nguyen, T.N., Nguyen, N.L., Nguyen, H.D., Vu, N.T., Cao, H.H., Tran, T.H., Pham, P.M., Nguyen, T.D., Stepniewska, K., White, N.J., Tran, T.H., & Farrar, J.J. (2004). Dexamethasone for the treatment of tuberculosis meningitis in adolescents and adults. *New England Journal of Medicine, 351*(17), 1741-1751.

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RA4 Liaw, Y.F., Sung, J.J., Chow, W.C., Farrell, G., Lee, C.Z., Yuen, H., Tanwandee, T., Tao, Q.M., Shue, K., Keene, O.N., Dixon, J.S., Gray, D.F., & Sabbat, J. Cirrhosis Asian Lamivudine Multicentre Study Group. (2004). Lamivudine for patients with chronic hepatitis B and advanced liver disease. *New England Journal of Medicine, 351*(15), 1521-1531.

RA5 Zhao, L., Moos, M.P., Grabner, R., Pedrono, F., Fan, J., Kaiser, B., John, N., Schmidt, S., Spanbroek, R., Lotzer, K., Huang, L., Cui, J., Rader, D.J., Evans, J.F., Habenicht, A.J., & Funk, C.D. (2004). The 5-lipoxygenase pathway promotes pathogenesis of hyperlipidemia-dependent aortic aneurysm. *Nature Medicine, 10*(9), 966-973.

RA6 Hanada, R., Teranishi, H., Pearson, J.T., Kurokawa, M., Hosoda, H., Fukushima, N., Fukue, Y., Serino, R., Fujihara, H., Ueta, Y., Ikawa, M., Okabe, M., Murakami, N., Shirai, M., Yoshimatsu, H., Kangawa, K., & Kojima, M. (2004). Neuromedin U has a novel anorexigenic effect independent of the leptin signaling pathway. *Nature Medicine, 10*(10), 1067-1073.

RA7 Seo, S.K., Choi, J.H., Kim, Y.H., Kang, W.J., Park, H.Y., Suh, J.H., Choi, B.K., Vinay, D.S., & Kwon, B.S. (2004). 4-1BB-mediated immunotherapy of rheumatoid arthritis. *Nature Medicine, 10*(10), 1088-1094.

RA8 Dohi, T., Beltrami, E., Wall, N.R., Plescia, J., & Altieri, D.C. (2004). Mitochondrial survivin inhibits apoptosis and promotes tumorigenesis. *The Journal of Clinical Investigation, 114*(8), 1117-1127.

RA9 Srinivasan, S., Lubrano-Berthelier, C., Govaerts, C., Picard, F., Santiago, P., Conklin, B.R., & Vaisse, C. (2004). Constitutive activity of the melanocortin-4 receptor is maintained by its N-terminal domain and plays a role in energy homeostasis in humans. *The Journal of Clinical Investigation, 114*(8), 1158-1164.

RA10 Fujino, T., Nakagawa, N., Yuhki, K., Hara, A., Yamada, T., Takayama, K., Kuriyama, S., Hosoki, Y., Takahata, O., Taniguchi, T., Fukuzawa, J., Hasebe, N., Kikuchi, K., Narumiya, S., & Ushikubi, F. (2004). Decreased susceptibility to renovascular hypertension in mice lacking the prostaglandin I2 receptor IP. *The Journal of Clinical Investigation, 114*(6), 805-812.