The Construction of Knowledge in Medical Research Articles

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Keywords: medical research articles, knowledge construction, knowledge claims, rhetorical strategies.

Abstract. This article presents a theoretical analysis of the various aspects involved in the construction of knowledge in the medical research article, currently a highly demanding but also rewarding genre in the international academic environment. The analysis takes into consideration the most prevalent features of present-day written academic discourse, with focus on the writing conventions and rhetorical strategies primarily used for successful scientific communication in medicine. The paper offers a multidisciplinary approach by adopting a pragmatic view of linguistics applied to written medical discourse in order to create a comprehensive picture of the current requirements of medical research reporting.

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As a member of the teaching staff of a Romanian medical university, I have gradually become aware of the requirements of the highly competitive national and international academic environment of our times. In this context, universities place tremendous focus on the activities most likely to increase the visibility of the institution and thus generate larger numbers of students and extensive funding. These activities primarily include the publication of English-written scientific articles or books in influential international journals or publishing houses, participation in medical international events where English is usually the official language, but also winning research projects in national and international competitions following the submission of application proposals in Romanian and/or English that are evaluated by national and international specialists. Out of these, English-language publications in international journals and fund-generating research projects seem to be the most highly valued and rewarded activities that can be conducted within higher education institutions worldwide, Romania included. Therefore, it has become common knowledge that, at least in the academic world, "we are what we write,"[1] and that publishing scientific research articles is crucial not only for the advancement of science, but also for personal and institutional recognition and prestige.

This reality also indicates that the undeniable expansion of English in academic circles, which has practically turned it into a basic academic skill that scholars around the world must possess for adequate academic performance and

[1] Ken Hyland, "Writing in the University: Education, Knowledge and Reputation", *Language Teaching* 1 (2011): 53–70, 53.

desired results, has also been registered in the Romanian environment, especially in the fast moving world of medical sciences, where the latest breakthroughs are exclusively presented in English-language publications. This current context of academic globalization blurs the boundaries between national and international communication for scientific and academic purposes,[2] at the same time requiring native and non-native speakers of English to produce similarly outstanding results despite inherent differences between these two categories of language users. Thus, besides solid research skills and English-language proficiency, knowledge of rhetorical strategies and writing conventions in a second language has become essential prerequisites for successful international publication and recognition.

In view of these facts, the current paper aims to provide an accurate account of how knowledge is constructed in medical research articles by taking into account the realities of the present-day international academic environment, as well as the particularities of medical research reporting. Such an analysis could enable academics worldwide, especially non-native speakers of English, to gain an understanding of the requirements needed for functioning successfully in their specialty fields. To this end, the specific manner in which knowledge is constructed in medical research articles, the factors involved in this process as well as its consequences shall be discussed in connection with the most important features of present-day written academic discourse. These features can be summarized as follows: an inability to exist in the absence of genuine scientific research activities, a stringent need to present research results in English, a clear distinction between facts and interpretation, an 'institutional-individual' duality reflecting two types of goals that academics must achieve simultaneously, disciplinary differences between the hard and soft sciences leading to different rhetorical strategies, writing styles and author identities, as well as a persuasive and interactive dimension which allows authors to negotiate their claims, and readers to be active participants in the creation of scientific knowledge through the acceptance or denial of claims, in this way also establishing academic hierarchies.

The first characteristic of written academic discourse is the fact that it cannot exist in the absence of genuine scientific research, regardless of the field of activity. Once scientific findings are obtained as a result of researchers' skilful use of appropriate tools and resources, these must be communicated via appropriate linguistic and rhetorical devices in order to become acknowledged as such by the relevant discourse community and thus turn into new scientific knowledge.

This communication process mainly takes place in English, which has unquestionably become the international language of written and oral scientific communication and therefore the language of medicine. As a result, the 20th century witnessed an unprecedented increase in the number of English language publications over other languages in order to spread newly produced information and knowledge. Thus, according to a study published in 2008, "in the last 130 years, the percentage of English language journals in the American journal catalogue Index Medicus (now called Medline – Medical Literature Analysis and Retrieval System Online) has increased from 35% to 89%" while that of German-language journals dropped from

[2] Rainer Enrique Hamel, "The Dominance of English in the International Scientific Periodical Literature and the Future of Language Use in Science", *AILA Review* 1 (2007): 53–71.

25% to 1.9%.[3] Also, according to the same source, while in 1879, there were 284 journals in English and 201 in German in Index Medicus, in 2007, Medline, the online journal database derived from Index Medicus listed 4609 journals in English and only 98 in German, which means that nine out of ten new Medline-indexed journals are in English.[4]

As far as the most recent publication trends are concerned, a brief internet search conducted in October 2013 revealed that only one out of ten medical journals that feature the word "international" in their title accepts manuscripts written in languages other than English. Thus, articles in French, German, Italian, Spanish or Portuguese can be submitted for publication in the *International Journal of Psychoanalysis*, provided that they are accompanied by an abstract in English. Conversely, according to the submission requirements of journals such as the *International Journal of Clinical and Experimental Medicine*, the *International Journal of Medical Sciences*, the *International Journal of Obesity*, or the *International Journal of Surgery* all manuscripts must be written in English. Therefore, although medicine was one of the fields that massively opened its Anglophone journals to international contributors whose first language was not English,[5] the internationalization of journals has come to refer to the scientists' nationality and country of origin rather than to the language of publication.

However, being accepted for publication in a medical journal is not the only aim researchers must focus on. The impact factor of the journal as well as the number of citations of a given paper or author have become increasingly important especially in recent years, following the development of widely accessible online publications and internet-based databases. English-language publications also seem to be cited more often as "English makes up over 95 per cent of all publications in the Science Citation Index".[6]

Nowadays English is not only used extensively throughout the world in an unprecedented growth, with a quarter of the world's population speaking it at the end of the 20th century,[7] but it also seems to become a language of second-language speakers, dropping to the fourth position in the world as far as the number of native speakers are concerned, while the number of non-native speakers is on a continuous increase.[8] Therefore, even if English has become a *lingua franca* in the scientific and medical environment, specialized knowledge does not solely originate in English-speaking countries since non-native speakers of English are also solid contributors to specialized journals. Non-native scientists who wish to be published in prestigious

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[3] Christopher Baethge, "The Languages of Medicine", *Deutsches Arzteblatt International* 105, no. 3 (2008): 37–40, 37.
[4] Ibid.
[5] John M Swales, *Research Genres. Explorations and Applications* (Cambridge: Cambridge University Press, 2004), 42.
[6] Ken Hyland, *English for Academic Purposes. An advanced resource book* (London: Routledge, 2006), 26.
[7] David Crystal, *English as a Global Language* (Cambridge: Cambridge University Press, 2003).
[8] Humphrey Tonkin, "Language and the Ingenuity Gap in Science", *Critical Inquiry in Language Studies* 8, no.1 (2011): 105–116.

international medical journals must not only be proficient English language users but also possess familiarity with the layout, formatting and rhetorical standards demanded by editors and reviewers. Failure to meet international publication criteria may result in article rejection, subsequent resubmissions or the need to resort to costly proofreading services prior to article acceptance.

Another characteristic of academic writing is the clear distinction between facts, which can be presented with straightforward confidence, and interpretation, which must be introduced cautiously, as it is only inferred or assumed.[9] The reporting function has always been a major feature of research articles ever since their first publication in the *Philosophical Transactions of the Royal Society of London*. By distributing the results of increasingly complex and specialized experiments, articles have contributed to the creation and spread of knowledge alongside books, at times even surpassing their importance as science development tools. For instance, during the late 17th century major scientific discoveries such as the microscopic investigations conducted by Anton Leeuwenhoek's and Robert Boyle's vacuum experiments appeared in the *Philosophical Transactions* and not in books, although the latter continued to be considered major research contributions throughout the 19th and 20th centuries.[10]

On the one hand, it is generally agreed that information included in books and textbooks has already gained the approval of the target discourse community and now constitutes proven scientific knowledge. On the other hand, "freshly" obtained results are usually firstly reported in journal articles, which have become "the major vehicle for knowledge in academic cultures, central to the legitimation of a discipline and the reputation of its practitioners".[11] In this context, instead of pursuing the scientific truth only, research has become a search for collective agreement through the rhetorical strategies adopted by research article writers in order to convince the audience of the validity and relevance of their results. This is how the scientific knowledge claim has become "the heart of academic argument"[12] while the construction of academic texts relies on a model centred on claims and denials of claims.[13]

Historically speaking, a clear distinction between observed facts and interpretation was recommended by Boyle since the beginning of scientific writing, alongside a modest attitude reflected in the cautious expression of opinions. To this end, linguistic devices aimed at reducing the author's commitment to the truth of propositions and opinions, such as *perhaps*, *it seems*, *it is not improbable*, which are currently acknowledged as hedges and used extensively in scientific reporting in order

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[9] Ken Hyland, "English for Professional Academic Purposes: Writing for Scholarly Publication", in *Teaching Language Purposefully: English for Specific Purposes in Theory and Practice*, ed. Diane D. Belcher (Ann Arbor: University of Michigan Press, 2007), 83–105.

[10] Charles Bazerman, *Shaping Written Knowledge, The Genre and Activity of the Experimental Article in Science* (Wisconsin: The University of Wisconsin Press, 1988).

[11] Ken Hyland, "Talking to the Academy: Forms of Hedging in Science Research Articles", *Written Communication* 13 no.2 (1996): 251–281, 252.

[12] Ken Hyland, "Scientific Claims and Community Values: Articulating an Academic Culture", *Language and Communication* 17 no. 1 (1997): 19–32, 21.

[13] Greg Myers, "The Pragmatics of Politeness in Scientific Articles", *Applied Linguistics* 10 no. 1 (1989): 1–35.

to show deference, decrease writer commitment or encourage reader participation were recorded as early as Boyle's time.[14] This fact suggests that, despite different historical contexts of occurrence, some rhetorical strategies employed by scientific writers have maintained their usefulness throughout the evolution of scientific reporting.

According to the available literature, academic writing also seems to be characterized by the following duality. First of all, writing cannot take place outside research institutes or higher education establishments, which possess the necessary resources for carrying out scientific research. The research activities and the writing process associated with them must therefore conform to the norms and conventions of the institution in which they take place. Generally, the main goal of this resulting academic output is to increase national and international value and prestige, which is usually reflected in positive evaluations and high academic rankings.

However, academic institutions, although often regarded as sole entities, function through the endeavour and cooperation of individual members. Universities for instance can only reach top rankings if their staff members obtain internationally acknowledged research results. Consequently, a professional has to juggle several identities simultaneously in the same piece of discourse: a professional identity within the respective discourse community, an organizational identity within an institution or organization, a social identity as part of one or several social groups, plus an individual identity that reflects his or her self-expression.[15] The goal of successful academics is to effortlessly negotiate all these aspects and thus achieve multiple goals.

This 'institutional-individual' duality renders academic writing an essential link within the academic cycle of publication, credibility, recognition and reward put forward by Latour and Woolgar.[16] Valuable academic writing published in prestigious journals or publishing houses brings credibility, recognition and reward, but also further funding and support to both individual scholars and the institutions they are affiliated to. Powerful institutions will then attract new and valuable professionals who can contribute to the achievement of institutionalized goals, at the same time gaining personal credit and reward.

However, authorial intentions and the means employed to express them in writing vary according to discipline, the expectations of the disciplinary community, disciplinary culture and possibly national culture or mentality. As far as the disciplinary field is concerned, writing in the soft or hard sciences involves not only the use of subject-specific terminology but also diverse rhetorical devices. The differences between writing in the humanities field and writing in the sciences field are related to the ways in which knowledge is created and presented in these two distinct environments. Unlike science data, which are able to speak for themselves in a text, careful interpretation and arguing are required in the humanities, where language itself,

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[14] Dwight Atkinson, *Scientific Discourse in Sociohistorical Context: the Philosophical Transactions of the Royal Society of London, 1675-1975* (Mahwah, New Jersey: Lawrence Erlbaum Associates, 1999).

[15] Vijay K. Bhatia, *Worlds of Written Discourse: A genre-based view* (London: Continuum, 2004).

[16] Bruno Latour and Steve Woolgar, *Laboratory Life. The construction of Scientific Facts* (Princeton: Princeton University Press, 1986).

the rhetorical choices of the authors and their position in relation with the audience represent domain-specific writing tools and can thus be regarded as data.[17]

Also, new information is not typically discovered in the humanities, but rather deduced, interpreted, evaluated or re-evaluated, which makes it less quantifiable or palpable. At the same time, the lower risk of replicating research results and refuting findings in subsequent studies allows writers in the soft sciences to increase their degree of commitment through the use of the first person pronoun *we*, while the possessive adjective *our* (*our data*, *our results*, *our findings*) is preferred in the hard sciences for its reduced degree of commitment.[18] The fundamentally different ways of creating knowledge in the hard and soft sciences also influence the style and tone of academic discourse as writers in the hard sciences usually assume a less personal style by downplaying their role in the research in favour of the issue or phenomenon studied, thus leading to the impression of objectivity.[19] Conversely, writers in the humanities and social sciences seem to be more explicitly involved and to assume more personal positions signalled by the use of interactional markers and overhedging compared to those in the science and engineering fields, who prefer fewer hedges, weaker claims and directives as the most frequently occurring interactive features.[20]

Such rhetorical choices may also be connected with the individual character of soft science research, which is usually carried out by individual scholars who assume sole responsibility for their written statements. They also use more self-references and self-citations than hard science authors, which represents another disciplinary difference.[21] On the other hand, medical research projects frequently involve teamwork, multiple authors and thus a possibly lesser degree of commitment to the truth of a proposition or to newly introduced information. However, by assuming an appropriate degree of authorial presence, successful academic writers signal their membership to the target discourse community thus gaining identity, credibility and authority in their field.[22] Therefore, although academic writing has been regarded as impersonal and objective, recent research shows that several rhetorical strategies such as the use of personal pronouns, citations, self-references, boosters (*definitely*, *it is clear that*) or hedges (*might*, *perhaps*, *possible*) are employed by writers in order to successfully support their claims and convince readers of the validity, relevance and usefulness of their findings, especially within the current academic, social and

[17] Claus Gnutzmann and Frank Rabe, "'Theoretical Subtleties' or 'Text Modules'? German Researchers' Language Demands and Attitude Across Disciplinary Cultures", *Journal of English for Academic Purposes* 13 (2014): 31–40.

[18] Enrique Lafuente Millán, "'Extending this claim, we propose...' The Writer's Presence in Research Articles from Different Disciplines", *Ibérica* 20 (2010): 35–56.

[19] Ken Hyland, "Options of Identity in Academic Writing", *ELT Journal* 56 no. 4 (2002): 351–358.

[20] Ken Hyland, "Stance and Engagement: A Model of Interaction in Academic Discourse", *Discourse Studies* 2 (2005): 173–192.

[21] Ken Hyland, "Self-Citation and Self-Reference: Credibility and Promotion in Academic Publication", *Journal of the American Society for Information Science and Technology* 3 (2003): 251–259.

[22] Millán, "'Extending this claim, we propose...' The Writer's Presence in Research Articles from Different Disciplines", 35–56.

economical context which stresses the importance of publishing in high-ranking international journals. Thus, the format and structure of academic texts such as research articles suggest that knowledge and facts are presented objectively for the sake of the advancement of knowledge and the pursuit of truth, while pragmatic text analyses usually reveal different purposes and a possible "guided objectivity" when linguistic and rhetorical resources are skilfully exploited by experienced professionals.

Furthermore, knowledge claims are usually accepted by a certain discourse community following appropriate interaction between academic writers and their target audience, as members of the respective community. Myers pointed out that "it is important for discourse analysis and for the teaching of writing to show that, while writing does not involve face to face contact, it is a form of interaction".[23] This observation was made within an analysis of hedging as a politeness strategy in scientific articles and was based on the assumption that "the form of the statement reflects a relation between the writer and the readers, not the degree of probability of the statement".[24]

Although the very definition of scientific papers as laboratory reports accounts for their persuasive credibility, the constant interaction between writers, editors, and target readers, which is often negotiated via appropriate rhetorical strategies renders the published paper "a multilayered hybrid co-produced by the authors and by members of the audience to which it is directed".[25] This social constructivist view according to which knowledge is constructed through the interaction of networks and communities (also shared by Latour and Woolgar[26]) regards the scientific article as an interactive product and highlights the importance of publishing-related activities such as peer-review, pre-publication negotiations with editors and reviewers, and paper acceptance or rejection, which enable scientists to become renowned members of their discourse communities.[27]

Especially in the hard sciences, medicine included, teams of writers, each with clearly assigned research responsibilities, first go through the process of drafting and redrafting their work into the final version to be submitted to a journal for publication. Next, editors and peer-reviewers evaluate it and recommend alterations, improvements or clarifications, which lead to further editing and writing. The review and revision process, which often involves the reworking of the main rhetorical goals, has turned peer-reviewing into a "control mechanism for transforming beliefs into knowledge".[28] The interactive process continues after the moment of publication. Now, upon reading the paper and considering the arguments presented, fellow scientists accept newly introduced claims by further citing them in their own papers, thus introducing the

[23] Greg Myers, "The Pragmatics of Politeness in Scientific Articles", 30.
[24] Ibid., 15
[25] Karin Knorr-Cetina, *The Manufacture of Knowledge* (Oxford: Pergamon Press, 1981), 106.
[26] Bruno Latour and Steve Woolgar, *Laboratory Life. The construction of Scientific Facts*.
[27] John Flowerdew, "English for Research Publication Purposes" in *The Handbook of English for Specific Purposes*, ed. Brian Paltridge and Sue Starfield (Oxford: Wiley-Blackwell, 2013), 301–321.
[28] Ken Hyland, *Academic Discourse: English in a Global Context* (London: Continuum, 2009), 68.

respective claims in the circle of scientific facts, or reject them by expressing negative comments in their own work or by simply ignoring them.

This interactive process has become even more important in today's highly competitive academic context in which publication equals recognition and reward. The now heavily spread practice of self-citation, which is rather the opposite of modesty and deference traditionally characteristic of academic discourse is regarded as a rhetorical consequence of this increased competitiveness.[29] On the other hand, the immense number of papers published in journals throughout the world has led scientists to doubt that scientific papers are in fact written for the sole purpose of disseminating information. On the contrary, publication mainly for achieving personal reward and recognition was often regarded as the main goal of scientific papers by members of the international medical community such as Michael O'Donnell.[30] He mentioned a failed experimental proposal submitted to the *Lancet* in 1976 through which Dr. J B Healy suggested that authors' name and affiliation be removed upon publication in order to prove that the dissemination of information is the only purpose of research articles. O'Donnell also quoted Richard Smith, former editor of the *British Medical Journal*, who stated that only 5% of the journal material met minimum scientific standards and had clinical relevance.

However, regardless of any quality-related issues, knowledge claims expressed in scientific articles remain central tools in scientific discourse as the acceptance of claims opens the gates towards individual and institutional recognition and validation. The main features of appropriate knowledge claims were summarized as statements that: meet the expectation of the target discourse community and present positions likely to be accepted by the respective community, contribute to scientific development, present accurate results obtained using correct methods, recognize previous work in the field, demonstrate an objective attitude, show modesty and willingness to negotiate with fellow researchers.[31]

Claims are one step away from turning into scientific knowledge. However, since they are still regarded as opinions before gaining the ratification of the discourse community, caution instead of a direct approach is needed when introducing them. Hedging (the use of hedges) represents one valuable rhetorical strategy that allows authors to cautiously introduce knowledge claims without imposing on the readers. In brief, hedges are linguistic devices such as *relatively*, *approximately*, *may*, *it is assumed*, *it is believed*, *to our knowledge*, *from our point of view*. They may occur under numerous linguistic forms including epistemic lexical verbs, adverbs, adjectives, modal verbs and nouns, but also phrases or sentences referring to limited knowledge, limitations of model, theory or method, or to experimental limitations.[32]

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[29] Ken Hyland, "Self-Citation and Self-Reference: Credibility and Promotion in Academic Publication".

[30] Michael O'Donnell, "Why doctors don't read research papers", *BMJ* 330 (2005) http://dx.doi.org/10.1136/bmj.330.7485.256-a

[31] Ken Hyland, *Hedging in Scientific Research Articles* (Amsterdam: John Benjamins Publishing Company, 1998), 252–253.

[32] Ken Hyland, *Hedging in Scientific Research Articles*.

According to authors such as Hyland,[33] Fraser[34] and Alonso Alonso *et al,*[35] hedges have poly-pragmatic and often overlapping functions. They are mainly used by research article authors in order to present propositional content as accurately and reliably as possible, avoid taking direct personal responsibility for the content presented or express knowledge claims as personal opinions and thus avoid denial and encourage reader participation.[36] Since they generally decrease author commitment and promote writer-reader interaction, they are currently regarded as safe rhetorical means of introducing new knowledge claims, especially in *Discussion* sections where they occur extensively, until such claims are approved by the international medical discourse community.

Therefore, the initial reporting function of research articles with the purpose of creating scientific knowledge coexists now with more individual-oriented goals expressed through the writers' (often hedged) claims. This dual characteristic of claims matches the 'institutional-individual' duality that characterizes written academic discourse, as well as the double function of publication: to create scientific knowledge but also to distribute rewards and establish hierarchies within specific discourse communities.[37]

In this context, the research article is the most appropriate tool for achieving both institutional and individual goals, especially through its *Discussion* section, whose main function is to interpret the results in context and thus invest them with value and relevance. It is this very speculative and discursive aspect that generated much criticism to the point of regarding *Discussion* sections as a marketing strategy aimed at selling the paper. Excessive speculation, use of passives and hedging were often criticized in analyses of scientific discourse by authors such as Adams Smith,[38] Roland[39] and Langdon-Neuner.[40] Conversely, opposing views praise the discursive nature of this mainly rhetorical section by arguing that subjectivity is essential as the function of the *Discussion* is to actually discuss, i.e. speculate beyond the evidence in order to generate future hypotheses and reach conclusions, thus providing a context for the reader and developing science beyond mere lists of numbers.[41]

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[33] Ibid.

[34] Bruce Fraser, "Pragmatic Competence: the Case of Hedging", in *New Approaches to Hedging*, ed. Gunther Kaltenböck, Wiltrud Mihatasch and Stefan Schneider (Bingley: Emerald, 2010), 15–34.

[35] Rosa Alonso Alonso, María Alonso Alonso and Laura Torrado Mariñas, "Hedging: An Exploratory Study of Pragmatic Transfer in Non-Native English Readers' Rhetorical Preferences", *Ibérica* 23 (2012): 47–64.

[36] Ken Hyland, *Hedging in Scientific Research Articles*.

[37] Ken Hyland, "Writing in the University: Education, Knowledge and Reputation".

[38] Diana Adams Smith, "Style in Medical Journals", *British Medical Journal* 287 (1983): 1122–1124.

[39] Marie-Claude Roland, "Publish and Perish. Hedging and Fraud in Scientific Discourse", *EMBO Reports* 5 (2007): 424–428.

[40] Elise Langdon-Neuner, "Scientific' Writing", *The Write Stuff* 18 no.2 (2009): 69–72.

[41] John Skelton and Sarah Edwards, "The Function of the Discussion Section in Academic Medical Writing", *BMJ* 320 (2000): 1269–1270.

To conclude, this paper attempted to present the process of knowledge construction in medical research articles by discussing it against the most important characteristics of present-day written academic discourse in order to reveal the basic requirements of successful medical reporting. The analysis also highlighted the importance of expressing knowledge claims in medical research articles through appropriate writing conventions and rhetorical strategies for the purpose of turning research results into scientific knowledge and of thus simultaneously achieving individual and institutional goals. The following pre-publication checklist could be useful especially for non-native speakers of English: carry out innovative scientific research; present it in English, making sure claims are expressed through appropriate rhetorical strategies according to the norms and conventions of the reporting genre and of the target discourse community; adopt a persuasive style by encouraging reader involvement in order for newly introduced claims to become scientific knowledge.