

## A BRIEF HISTORY OF THE EVOLUTION OF THE MEDICAL RESEARCH ARTICLE

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### *Abstract*

*Given the current importance of publishing medical research articles in high-impact international journals, this article briefly presents key moments in the evolution of this reporting genre for a better understanding of the diachronic changes that have shaped it into a highly useful tool for creating and spreading knowledge, as well as for establishing academic hierarchies at both individual and institutional level. Therefore, focus will be placed not only on the evolution of its structure and purpose, but also on issues such as knowledge construction, knowledge claims, writer-reader interaction and the appropriate writing conventions and rhetorical strategies required for successful scientific communication.*

**Keywords:** medical research articles, knowledge construction, knowledge claims, writing conventions, rhetorical strategies

The history of the scientific research article is closely connected with the activities of the Royal Society of London, which in 1660 became the first public institution dedicated to experimental scientific research and learning. Its initial full name was “The Royal Society of London for Improving Natural Knowledge”, and some of its founding members included Robert Boyle, Robert Hooke, John Wilkins, Christopher Wren, and John Evelyn [1]. In 1665, the Society began publishing its *Philosophical Transactions*, the first scientific periodical and one of the most important European scientific journals until the 19<sup>th</sup> century, when its leading position was weakened by the appearance of specialized publications. Henry Oldenburg was the first appointed secretary in charge of managing the correspondence between the Society and the rest of the scientific world. In this capacity, Oldenburg “English’d” German, French and Italian letters although communications in Latin still prevailed, and generally encouraged the exchange of scientific ideas to such an extent that he was regarded as the inventor of the present

day scientific article [1,2].

The *Philosophical Transactions* initially published news, letters and descriptions of experimental reports without a standardized format or style. As Hyland pointed out, “essentially, scientific papers evolved as a way of offering a vivid account of experimental performances to distant readers” [3]. In the absence of conventional means of turning speculations and claims into commonly accepted scientific knowledge, the contributors would mainly rely on virtual witnessing, replication of the results for verification purposes and mutual trust [4,5]. Therefore, the experiments were presented in great detail in order to allow readers to virtually reconstruct them in their minds as well as in their own laboratories, and thus verify the accuracy of the reported results. In time, as the genre evolved, these detailed descriptions were replaced by today’s usually concise *Materials and Methods* section of research articles.

As far as the style of writing was concerned, besides great attention to realistic details, which also included accounts of failed experiments, and the avoidance of philosophical speculations and personal disputes, modesty was displayed through the caution expression of opinions. In this respect, Robert Boyle admitted to often using

words such as *perhaps*, *it seems*, *it is not improbable* to convey lack of confidence in the truth of propositions and opinions, thus recording the first use in scientific writing of what is now acknowledged as hedges [1,4]. Hedges are linguistic devices such as *relatively*, *approximately*, *may*, *it is assumed*, *it is believed*, *to our knowledge*, *from our point of view*, which are often 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 [6]. In scientific writing, such strategies have been used in order to separate facts, founded on observations, methods and results from cautiously expressed opinions. The reports published in the early issues of the *Philosophical Transactions* were also written using active-voice verbs and first-person pronouns for increased credibility. Experimental reports adopted an adorned style of writing in the attempt to impress readers and establish writer authority [1,7].

This early record of the use of hedges and other rhetorical devices suggests that besides the bare facts, scientists have always relied on linguistic and rhetorical resources for convincing the scientific community of the accuracy of their claims, for establishing and consolidating individual positions within their respective discourse communities and for ultimately creating scientific knowledge. Since hedges generally decrease author commitment and promote writer-reader interaction, they are currently regarded as safe rhetorical means of cautiously introducing new knowledge claims, especially in *Discussion* sections where they occur extensively, until such claims are approved by the international medical discourse community. Hedges have polypragmatic and often overlapping functions [6,8,9], and can 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 [6].

A detailed analysis of the *Philosophical Transactions* between 1665 and 1800 carried out by Bazerman revealed a great deal about the development of the experimental report into today's research article [2]. A first striking remark is that observations and reports of natural events such as earthquakes or unusual fetuses prevailed in the first 80 volumes of the *Transactions* in favor of experimental reports, which only accounted for 5 to 20% of each volume. Bazerman also noted the increasing involvement of scientists who switched from mere observers to conscious investigators as "the definition of experiment moves from any made or done thing, to an intentional investigation, to a test of a theory, to finally a proof of, or evidence for, a claim" [2]. This increased the attention given to describing the experiments, especially the methods used, the results

obtained and their relevance.

The gradual changes to the concept of the experimental report were also reflected in the organization of the articles published in the *Philosophical Transactions of the Royal Society of London*. First, articles became longer due to the growing amount of details generated by the need to perform series of experiments rather than single events for testing research hypotheses. Authored articles replaced the voice of the editor that had initially introduced the reports, a rationale would precede the trials, results of early trials would be later tested in other experiments and, where contention was an issue, the report would begin with a statement about the topic of the dispute and a discussion of the opponent's position or work. This was followed by the author's own position, methods and results, so that in time, the hypothesis would be stated before the experiment even in the absence of contention [1,2]. These gradual changes show how the acceptance or denial of somebody else's work, opinions and claims has always represented a central element responsible for shaping the development of the research article since its early days.

In time, as more complex issues were treated, the organization of articles also changed. They would begin with an introduction and accounts of failed experiments, followed by series of experiments and their conclusions based on the author's reasoning, which would culminate in the final conclusions. Then, towards 1800, philosophic statements were used to introduce the problem, which was presented via a surprising result or by pointing to a research gap, much like the present day 'Create a Research Space' (CARS) model for *Introduction* sections identified by Swales [4]. Accounts of the experiments would then be followed by conclusions, which also discussed the consequences of the stated claims. Bazerman [2] summarized the development of the experimental reports published in the *Philosophical Transactions* by identifying four distinct stages: simple reports of events (1665-1700), arguments over the results (1700-1760), discovery accounts for explaining unusual events (1760-1780) and reports containing claims and experimental proofs (1790-1800).

In the first half of the 18<sup>th</sup> century, communications on medical topics were also published in the *Philosophical Transactions*, some still in Latin, although the relevance of the clinical contributions was not very high. Following a decline in scientific activity by mid 18<sup>th</sup> century, an attempt to improve the quality of the articles published led to the creation of a committee for the review of all papers prior to publication, at the suggestion of the Earl of Macclesfield, future president of the *Royal Society*. The committee also included a medical member in the person of William Heberden, which led to quality improvement in medical and biological papers [10].

Two major changes influenced the evolution of the *Philosophical Transactions* in the 19<sup>th</sup> century: the division of the journal in 1887 into two distinct sections, one dealing

with mathematical and physical topics and the other with biological papers, and the introduction in 1896 of sectional committees for review purposes, which two year later became an anonymous process [1]. Other 19<sup>th</sup> century developments included the gradual inclusion of not only amateur scientists and gentlemen in the Royal Society but of what would be currently referred to as trained and certified scientists, as well as the infusion of government funds into an initially autonomous and free-thinking organization [1]. The development of the experimental report was also linked with the increased professionalism, critical attitude and research interest of both contributors and target readers, which encouraged a shift from “scientific reports characterized by narrative structure, personal involvement and author-centered norms of courteous conduct, towards a reporting format with greater emphasis on methodology and experimental description” [3].

Besides the *Philosophical Transactions*, the history of medical journals is connected with the Edinburgh Medical School and their *Medical Essays and Observations* published beginning with 1731, which then became the *Edinburgh Medical Journal*, peer-reviewed since 1733 [1,10]. A detailed analysis of the evolution of medical research writing as reflected in *Edinburgh Medical Journal* articles published between 1735 and 1985 was conducted by Atkinson [1]. According to this study, the initial interest in case studies based on the observation of single patients changed so that by the end of the 18<sup>th</sup> century the disease became the centre of attention and the main criterion for grouping and describing patients. In addition, a change towards impersonal, non-narrative texts was noticed in conjunction with the beginnings of public medicine.

Other important events in the evolution of the English-language medical research article are connected with the emergence of two journals with remarkable tradition and influence in the international medical community. Thus, the *Lancet* first appeared in 1823 with the purpose of publishing the lectures of medical men working in London medical schools and of promoting case reports written by the medical and surgical intelligence of the time, while later, in 1857, the *British Medical Journal* was founded following the creation of the British Medical Association and the fusion in 1853 of the *Provincial Medical and Surgical Journal* with the *London Journal of Medicine* to form the *Association Medical Journal*. The remaining part of the 19<sup>th</sup> century and beginning of the 20<sup>th</sup> century witnessed the appearance of specialist British journals that reflected developments in fields such as physiology, pathology, bacteriology, tropical medicine, hygiene, or surgery [10].

The constant efforts to improve the structure and content of research papers continued throughout the 20<sup>th</sup> century, which proves the dynamic nature of the research article in response to scientific and disciplinary changes. The main developments were generated by the

standardization of experimental procedures, which led to a less-detailed, shorter *Methods* section and greater emphasis on contextualizing and discussing results in order to demonstrate their relevance [1,2,3]. The way methods are presented in research articles has changed to such an extent that the concept of replicability turned into a myth due to the insufficient amount of information provided in this section, which thus prevents the independent replication of the experiments [11]. However, some journals still require that enough information be revealed for replication purposes. For instance, inadequate presentation of the methods used in research articles was listed among the top ten reasons why manuscripts are not accepted for publication in *Respiratory Care*, as stated by the journal’s editors and reviewers [12].

The need to situate results in a wider context also encouraged frequent references to other publications and citations, thus increasing the space allotted to *Discussion* sections and creating intertextuality among the articles published [2]. *Discussion* sections of medical research articles are meant to highlight the importance and relevance of a study in connection with the most up-to-date research in the respective field, at the same time mentioning the limitations of the reported research and the further studies required in order to provide adequate solutions to unanswered or controversial issues. However, given the current abundance of references to research reported in other publications, present-day *Discussion* sections seem to mainly rely on the presentation of data rather than on the use of rhetorical strategies aimed at convincing the target audience of the validity and usefulness of the findings. Besides decreasing author responsibility, this practice heavily narrows down the target audience and restricts it to fellow colleagues from the same specialty or sub-specialty, who would have to be familiar with all the latest studies listed as references in order to correctly assess all the knowledge claims introduced by their peers.

Other 20<sup>th</sup> century developments included the growing use of visuals as means of supplementing and supporting the written text, an increase in multiple authorship, the use of simpler syntax, and the clear division of papers into sections signaled by headings and sub-headings in order to facilitate modular reading [3]. As far as the format is concerned, until 1945 articles rather resembled book chapters with headings connected with the main topic [13]. The Introduction, Methods, Results and Discussion (IMRAD) structure of research articles recommended by many journal editors after World War II for the purpose of standardization spread quickly and became a uniform technical requirement in 1978, following the meeting of several biomedical journal editors who formed the Vancouver Group, which later transformed into the International Committee of Medical Journal Editors (ICMJE). Since then, the requirements underwent several revisions, including the adoption of abstracts structured according to seven sub-headings in papers that

report clinical investigations [14]. The IMRAD structure and its slight variations, such as additional subheadings for *Discussion* sections or alternative names for *Methods* (*Materials and Methods*, *Patients and Methods*) continues to be required by most scientific and medical journals. The creation and consistent use of this structure was attributed to journal editors who insisted on clear formatting for a more uniform and standardized peer review process [13].

Although by facilitating modular reading this format is regarded as beneficial, especially for today's extremely busy scientists, it was also seriously criticized by Peter Brian Medawar [15], winner of the Nobel Prize in Physiology or Medicine for turning the research article into a fraud by "providing a totally misleading narrative of the processes of thought that go into the making of scientific discoveries". Medawar blamed this already traditional inductive format for heavily relying on the formulation of hypotheses, which are largely generated by guesswork and inspiration and which must then undergo rigorous testing. Consequently, he suggested that *Discussion* sections should open articles and be followed by the presentation of scientific acts and facts. A similar view was expressed by Knorr-Cetina [16], who drew attention to the fact that although the purpose of scientific papers is that of reporting research, authors intentionally omit "much of what happened in the laboratory", do not respect the actual sequence of events and resort to literary strategies for convincing readers of claim reliability and importance.

The developments that led to the current format, structure and main features of the research article, which is currently regarded as "the standard product of the knowledge-manufacturing industries" [16] have reflected the demands of target audiences, editors and peer-reviewers, especially given the growing number of articles submitted for publication, and the strong competition among researchers in pursuit of international recognition and reward.

The main role of medical research articles has always been, at least theoretically, to contribute to the progress of science. However, within the current academic environment, articles are also published so that authors can gain individual benefits (higher positions in the medical and academic hierarchy, subsequent funding through research programs, etc.) which in turn bring benefits to

the institutions in which the respective authors function (higher international rankings, improved visibility, better funding, larger numbers of tuition-fee paying students, etc). Therefore, research papers remain the most influential means of not only spreading but of primarily creating knowledge, as well as of establishing academic hierarchies at both individual and institutional level.

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