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Commentary

Change in Format, Register and Narration Style in the Biomedical Literature: A 1948 Example

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Abstract: Scientific communication has evolved over time and the formats of scientific writing, including its stylistic modules, have changed accordingly. Research articles from the past fit a research world that had not been taken over by the internet, electronic searches, the new media and even the science mass production of today and reflect a reality where scientific publications were designed to be read and appreciated by actual readers. It is therefore useful to have a look back to what science looked like in the past and examine the biomedical literature from older archives because several features of those publications may actually harbor vital insights for today's communication. Maintaining a vivid awareness of the evolution of science language and modalities of communication may ensure a better and steadfast progression and ameliorate academic writing in the years to come. With this goal in mind, the present commentary set out to review a 1948 scientific report by I.L. Bennett Jr, entitled "A study on the relationship between the fevers caused by bacterial pyrogens and by the intravenous injection of the sterile exudates of acute inflammation", which appeared in the *Journal of Experimental Medicine* in September 1948.

Keywords: scientific writing; academic writing; diachronic change; rhetorical practices

1. Introduction

More than 3 million scientific manuscripts are published each year in over 30,000 peer reviewed journals and these figures are growing [1]. The biomedical literature is estimated to make up a large portion of these published studies [2] and the introduction of internet has opened up the possibility to share and exchange information across research groups to a point that was unthinkable even in the recent past [3]. The web has opened the possibility of easier ways to exchange ideas through social media [4–8] and crowd science [9,10], to retrieve information via open access publications [11], to easily search for information, thanks to databases and repositories [12–15]. Digital publications have also abated publishing costs, triggering an increase of editorial initiatives, i.e., publications, especially in the natural sciences [16]. The high rate of publications and the gargantuan amount of scientific literature have led the scientific community to question what optimal ways to communicate are. The efforts to optimize publications in the biomedical field have also led to several format consensuses for different types of publications, such as the Consort statement for RCTs [17] or PRISMA statement for reviews [18]. We are, in short, facing an era of globalized research, collaborations and literature [19,20]. It may, therefore, come as no surprise that the whole literature, including life science and medicine, is trending toward an increase in formal homogeneity regarding both the structure and the way content is presented.

This need for standardized formats is motivated by the need to streamline knowledge extraction and maximize its transferability to applied uses. Arguably, the standardization of reporting optimizes

the whole process of condensing data into a meta-analysis, which then can serve as a basis for guidelines and to create better health policies [21]. Data extraction is therefore at the very core of the debate about the usability of the biomedical literature [22] and methods are being developed to optimize text mining in the biomedical field [23–25] to automate the process of data retrieval and facilitate discovery [26] and even clinical decisions [27]. However, this extreme mechanization of science is not flawless. On the one hand, mass production of science, as it is made possible by the exponential growth of publishing opportunities in the digital world, may also mean that scientific reports are making less of a dent, are not being heard in the midst of the deafening roar of the information overload that is plaguing current research, a 'mountain' of information that was already becoming apparent in the 1980s [28]: while the number of published items is increasing, academic reading may have plateaued, which means that more data may be lost [29]. On the other hand, if biomedical reports are trending toward being conceived and composed as data repositories to be accessed and even mined for big data retrieval projects, it may be reasonable to wonder whether communication in academic and biomedical writing is still optimal, as reading time is progressively becoming shorter [29], yet content is more and more complex [30]. Information may be getting lost because its alienation from preferred human communication modalities may result in reduced communication with researchers, who are, after all, still human.

In this scenario of progressively more standardized formats for scientific publishing and reports of biomedical research [31], we believe that reconsidering the structure, language and content of older studies, with all their limitations, far from being a useless academic exercise, may be extremely fruitful to re-evaluate current trends in the scientific literature and re-assess their validity.

2. Materials and Methods

To this purpose, we decided to examine one manuscript, published by the *Journal of Experimental Medicine* (JEM) in 1948. It may be objected, not without reason, that one study alone is insufficient data to draw broad conclusions on the characteristics of science reporting in a given time period. We wholeheartedly subscribe to this argument, but we would like to point out that while such an article would hardly be accepted by a contemporary low tier journal, let alone such a prestigious one as JEM, the mere fact that it was actually published must reflect the fact that its features must not have stood out as odd at the time, and may have well resonated with common attitudes toward science, though we concede that no claims can be made on the broader general biomedical literature of the 1940s by relying on this manuscript alone.

The *Journal of Experimental Medicine* was chosen because of its extensive archives, which have been completely digitalized and allow for access to their whole collection, starting from the very first issue, which was published in 1896. The article was chosen in the archive of publications that appeared in the late 1940s at a time when the internal structure of research articles in JEM started to closely resemble our contemporary models. Our purpose was to observe how a common model of scientific article in biomedicine could be interpreted differently from the contemporary literature and thus, for this purpose, we refrained from searching older studies, which could be considerably different from our current standards, but also more difficult to compare and relate to them [32]. The present article, in particular, was selected as it presents some representative features of a specific format and language, which set it apart from today's comparable scientific literature.

In the present brief commentary, we focus our attention on a study of the "Observations on the fever caused by Bacterial pyrogens "series and, more specifically, on the second manuscript of the series, titled "A study on the relationship between the fevers caused by bacterial pyrogens and by the intravenous injection of the sterile exudates of acute inflammation", published in JEM, volume 88, issue 3. This manuscript is quite short and since it represents a sort of follow-up to part I [33], which was published back-to-back in the same issue of the Journal, it is also more concise.

This study was composed by Ivan L. Bennett Jr. [33,34]. Dr. Bennett was a talented internal medicine specialist whose brilliant career spanned from the US Navy to the Yale School of Medicine

and the John Hopkins University. He published at least 39 PubMed-indexed papers on fever and pyrogens and was a recognized expert in the field. As frequently happened at the time, these articles were published as installments or episodes and basically reported on associated experiments, possibly a single broader study or research line, which was split into separate accounts for the sake of clarity and to better underline its continuity. Table 1 exemplifies some such reports selected from Bennett's production, which were published in the "Studies on the pathogenesis of fever" series across a 10-year time span in different journals, as an example.

Table 1. Selected studies by JL Bennett in the "Studies on the pathogenesis of fever" series.

Authors	Study Title	Journal	Date
Petersdorf RG, Keene WR, Bennett IL Jr.	IX. Characteristics of endogenous serum pyrogen and mechanisms governing its release.	J Exp Med.	1957 Dec 1;106(6):787–809.
Petersdorf RG, Bennett IL Jr.	VII. Comparative observations on the production of fever by inflammatory exudates in rabbits and dogs.	Bull Johns Hopkins Hosp.	1957 Jun;100(6):277–86.
Petersdorf RG, Bennett IL Jr.	VI. The effect of heat on endogenous and exogenous pyrogen in the serum of dogs.	Bull Johns Hopkins Hosp.	1957 May;100(5):197–208.
Bennett IL Jr., Beeson PB	II. Characterization of fever-producing substances from polymorphonuclear leukocytes and from the fluid of sterile exudates.	J Exp Med.	1953 Nov;98(5):493–508.
Bennett IL Jr., Beeson PB	I. The effect of injection of extracts and suspensions of uninfected rabbit tissues upon the body temperature of normal rabbits.	J Exp Med.	1953 Nov;98(5):477–92.

This solution would actually be quite impractical today, as efforts are being made to condense studies while avoiding publishing reports on incremental new data [35] and it has been shown that the Average Publishable Unit, i.e., the amount of content that constitutes an independent article, has steadily increased [30]. This habit of multiplying publications beyond what is reasonable is ironically labeled "salami science" [36,37] and it is often mostly fueled by the need to increase the number of publications on one's resume for career purposes, as the number of publications is a commonly used metric for scientific proficiency [38]. It must be noted, however, that this publishing modality, as it appears here, far from being used to maximize the number of publications, may have solely served the purpose of highlighting the common thread that ran across several studies, presumably making it easier for the readers to follow through in the absence of more sophisticated literature search tools.

For our description, we intentionally refrained from analyzing the science content of this article, as this aspect would be mostly affected by the scientific acquisitions of the time and the methods and the experimental models chosen for the study are just a reflection of the tools that were available in the 1940s to investigate pathological events. Furthermore, by choosing to focus on a manuscript from 1948, we de facto opted to consider an article with an internal organization that closely resembles contemporary manuscripts, as the current organization of scientific manuscripts was being established in most biomedical journals right in that period (see below). Once we removed the actual science and the internal organization of the paper from the scope of the present commentary, we decided to examine the 'presentation' of the paper [32] and proceeded then to analyze it from its linguistic surface features into a discourse analysis of its move structure [39] in search of the differences in attitude toward the reporting of biomedical experimentation that could set it apart from contemporary science. The purpose of the linguistic analysis was to investigate whether differences in lexicon or register

existed between the current literature and Bennett's work. We then broadened our analysis to the organization of the discourse, an area that has been actively researched [40] and that has proved very useful to better understand the attitudes, stances and values of the author [41].

3. Results and Discussion

The manuscript is brief—only 5 pages—and it appears to have been cited 18 times, according to Google Scholar. This hardly makes it the most cited study by Bennett, although its influence may be underestimated because its cultural parable had presumably already vanished long before citations started to be accurately tracked. The manuscript is structured into the familiar sections of Introduction, Materials and Methods, Results, Discussion, Summary and Conclusions, and Bibliography. This does not come as a surprise, as this format of Introduction, Methods, Results and Discussion (IMRD) had already been consolidated in the *Journal of Experimental Medicine* by the mid- 40s, consistently with other biomedical journals [42]. It is written in a single column, according to a format that the *Journal of Experimental Medicine* upheld well into the 1990s [43].

3.1. The Introduction

The Introduction Section has the purpose of providing the readers with the background information that is necessary to fully understand the study at hand [44]. In this paper, Bennett devotes little room to the Introduction before diving right into the methodological explanation of his investigation. This may also be due to the fact this is a follow-up paper to a back-to-back part I manuscript, whose introduction is actually significantly longer [33]. Yet, his opening remarks may display some peculiar features, when compared to contemporary literature. The first statement opens up with a personal name:

'Menkin (1) has isolated from . . . '

This sentence has the purpose of illustrating his colleague's propositions and readily highlight their limits, thus both setting the stage for his own research and at the same time, defining the boundaries of the knowledge gap that the present study will strive to fill. Valy Menkin was a Russian-born researcher and a professor at Harvard Medical School who had devoted a great deal of effort in investigating inflammation since the 1930s [45–49]. A quick look at the biomedical publications of the time reveal that the habit of referring to individual researchers when citing their work was a common practice [50–57] and a recent corpus analysis of publications from different research fields has actually shown that the use of citation referring directly to the researcher's name, also known as integral citations, constituted almost half of the total citations in the 1960s in biology. Furthermore, the same study also showed that, when citing a scholar's work in the hard sciences, the preferred verbs ascribed to the cited researchers were mostly verbs associated to activities, e.g., *observe* or *analyze* [58], or, in this case, *isolate*. This personification of research, this identification of science with the figure of the 'expert' in the field may sound quite distant to us, who are accustomed or—grown used—to consider science as a collaborative effort carried out by research teams, countless individuals worldwide [59], whose efforts sum up to a significant force capable of gathering the staggering amount of data that make up current research in all its refined nuances, but whose contribution is also necessarily diluted in such a vast sea [60]. And this simple statement, the opening statement of this research paper, which begins with a single personal noun, may certainly sound odd, like an echo from a distant era [61]. It could be objected that the relatively less complex research methods available at the time required smaller teams, hence, smaller authorships and a more direct identification of research with individual scholars. A quick glance at the—dismally short, to our modern eyes—reference list of this paper seems to support this assumption: four out of a total of six references were signed by a single author. This seldom happens in today's academic world, where the number of authors is actually steadily increasing [62] and some scholars indeed agree that this trend may be accounted for by the increasing complexity of methods in science [63]. It is, however, difficult to think that science was so simple in the past that publications usually required only one contributor, without actually suspecting that the attitude

toward authorship was likely to be different as well and this may, at least in part, justify this plethora of single-authored manuscripts at the time. The idea that the simplicity and strength of this incipit, where a whole hypothesis is reified into a character may actually be concealing a whole different stance on authorship is supported by the observation that the number of non-integral citations (i.e., citations where the author is not explicitly mentioned in the citing sentence) has steadily increased over the years in several fields, including biology, and this trend can be associated to a reduced prominence of the role of individuals and authors in science [58].

The whole introduction is a mere two-paragraph passage. The former contains the discussion of Menkin's research and the second one prepares the reader for the present study by laying out its working hypothesis and its purpose. The first two sentences are also skillfully crafted and noticeable for their deliberate use of an elaborate syntax.

> *'Menkin (1) has isolated from sterile exudates in dogs a material closely associated with the euglobulin fraction which causes a . . . '*

Where displacing the direct object ('a material') after the prepositional phrases allows for seamless connection to the following relative clause, thus creating a more complex, rich sentence.

It would probably be safe to say that the author is deliberately using a high register, which is also marked by the use of a topicalized object in the second sentence:

> *'This substance he described as a product . . . '.*

Topicalization [64] is a mechanism that requires the object of a sentence to be dislocated from its usual position—after the verb—to the beginning of the sentence, so that it can more easily connect to what has just been said in the preceding sentence, i.e., the comment of the preceding sentence can become the topic of the new sentence and occupy the position in the sentence that best suits topics, the beginning, while avoiding the need for a passive construction [65]. Apparently, this structure must have been Bennett's favorite, because he similarly states, in his part I manuscript,

> *'This material he terms pyrexin and describes as a product of cell injury.'*

While still correct in standard English, this usage appears to be unusual in the current scientific literature. A search in the archives of the *Journal of Experimental Medicine* retrieved only 23 occurrences of the collocation

> *'This he . . . '* (believed/considers/etc.)

Which is a generalized form for the topicalization of the demonstrative pronoun. Interestingly, the most recent occurrence dated back to 1940 [66].

The reasons for this may be numerous. Topicalizations and left dislocations have become more unusual in contemporary English [67] so it is unsurprising to observe it seldom in the biomedical literature as well. Furthermore, a growing number of authors in international journals are L2 English speakers who may have a reduced language competence and therefore, may be less comfortable at using these expressive devices. It must also be remembered that a renewed sensitivity to the need of avoiding that language itself may pose a barrier to communication was brought about by the debate carried forward by campaigns such as the Plain English Movement [68] since the 70s. This may have affected the biomedical community, which has been making a broader cultural effort to promote the use of simple syntactical structures and avoid obscure jargon with the purpose of improving reciprocal understanding within the community and finding a common language basis for researchers of different origins and cultural backgrounds [69].

3.2. The Materials and Methods Section

It is interesting to note that the Materials and Methods section is written in a smaller font than the rest of the manuscript, a habit that the *Journal of Experimental* Medicine has maintained over the years. Smaller fonts imply that the content of these paragraphs is somewhat less relevant [70], abiding by the principle of iconicity [71]. This is hardly surprising. It is a common opinion that this section represents the most technical part of a scientific report [72] and a person who is familiar with the standard methods of a given field will often skip it [73] or have a quick glance to better clarify possible doubts or concerns about the results. Numerous current journals actually segregate the Materials and methods section to the end of the manuscript (as the *Journal of Experimental Medicine* started to do since January 2005) and it is not unheard-of to see this section confined to Supplementary information. The use of two different fonts creates an interesting background/foreground effect by pushing back a part of the text while highlighting another one and confers the text a three-dimensionality that would be otherwise difficult to achieve with the same effectiveness. This contrast has been somewhat lost when the Materials and Methods section was moved to the end of the manuscript, as per the current format. Though the Material and Methods section of part I manuscript is slightly more schematic and similar to current standards, an outstanding difference between the present paper and the contemporary biomedical literature is its highly narrative nature. The authors avoid reporting experimental details that would be considered necessary to ensure reproducibility by today's standards [74] while opting for a very readable storytelling that recounts the whole setup of the model, in the Materials and Methods section, and then the main findings of the study, in the Results section. More details about this can be found in Section 3.5, which is entirely dedicated to storytelling.

3.3. The Results Section

The Results section is actually structured into distinct paragraphs, each of them with a title in italics that sums up what the paragraph is focusing on, but these paragraphs can be read together without any gap in the narration and if closely scrutinized, it becomes readily apparent that they contain both method elements

> *'Three groups of rabbits received daily injections of 2.0 ml. of whole exudate for from 10 to 21 days.'*

and findings:

> *. . . the fever index following injection of this amount of exudate approximated that resulting from 0.1 ml. of this vaccine . . . '*

The exposition of the results is quite defective when compared to modern reports, for a lack of adequate methods to handle data and produce high-quality informative graphics. All graphs were plotted by hand and though they may report the mean data, they systematically fail to additionally report measures of variation, e.g., standard deviations. Such measures of variations are actually lacking in the whole manuscript and the absence of inferential statistics is equally noticeable, as expected [75]. Furthermore, some observations appear vague by our standards. We can, for instance, consider the following sentence, which is taken from a figure legend and which comments on the plot:

> *'The sudden drop in leucocytes . . . . . is characteristic.'*

Although it is quite easy to intuitively understand what is meant here by "characteristic", in the absence of a clear measure of the inter-sample variability, its vagueness would be unacceptable in today's publishing and any conclusion based on this observation would probably be debatable.

3.4. The Discussion and Conclusion Sections

The Results section is then followed by a Discussion, which has two main purposes: interpreting the findings,

'The fact that the exudate itself is not pyrogenic until the dog's temperature has returned to normal makes it difficult to attribute the dog's fever to absorption of this substance . . . '

and acknowledging ongoing knowledge gaps, to set the stage for further future publications,

'Further studies of this apparent inconsistency are under way.'

The Discussion section is a sharply written short paragraph with a high degree of coherence and cohesion. The former concept refers to the semantic unity of the text, i.e., the presence of common sense that allows readers to move from one sentence to the other while perceiving the continuity of the meaning of the text. Cohesion refers, instead, to the presence of syntactical and lexical links between the sentences [76]. It could be described as the manifestations of coherence on the linguistics surface of a text. To better appreciate its structure, we reported the whole Discussion below:

*/// ' **These findings** confirm Menkin's observation that there is present in the chest fluid of dogs[1] given an intrapleural injection[2] of turpentine a substance which causes definite febrile[3] response in rabbits[4]. ///*U1 *The failure of rabbits[4] to develop tolerance to repeated injections[2] of sterile exudates[5], the failure of animals[4] tolerant to bacterial pyrogens[6] to show tolerance to the fever[3]-promoting effect of these exudates[5], and the failure of repeated injections[2] of exudate[5] to maintain tolerance for bacterial pyrogen[6], indicate that the production of fever[3] by these exudates[5] is not due to contamination with bacterial pyrogen[6]. The shorter duration of the febrile[3] response following the injection[2] of exudate[5] as compared with that following administration of bacterial pyrogens[6] furnishes additional evidence that the substance in the exudate[5] which causes fever[3] is not a bacterial product. The fact that the exudate[5] itself is not pyrogenic until the dog's[1] temperature has returned to normal makes it difficult to attribute the dog's[1] fever[3] to absorption of this substance. Further studies of **this apparent inconsistency** are under way. ///* U2

The significance of the sudden drop in circulating leucocyte count shortly before the appearance of the fever[3]-promoting factor in the chest fluid is also under investigation.' /// U3

The Discussion can be divided into three main units (U1-U3) whose boundaries are here marked with "///". U1 sums up the main conclusion that can be drawn from the data presented in the Result section. Interestingly, the connection to the preceding section of the manuscript is established by the use of an anaphoric encapsulator (AE) [77], here marked by bold fonts, which is a linguistic device to summarize the content of a previous sentence or sentences ("These findings") while establishing a new discourse referent that then becomes the topic of a new sentence. The comment of this topic (what is confirmed by these findings, i.e., the presence of a substance that causes fever in rabbits) is then examined, broken down into its constitutive elements in U2, where the author discusses what the different observations of the study suggest regarding the nature of the exudate. This is an example of linear progression of the topic, i.e., a situation in which the comment of a sentence becomes the topic of the following sentence, thus ensuring the seamless continuity of meaning and thus its coherence, while at the same time allowing for the development of the theme and thus avoiding that the paragraph just repeats the same topic over and over again, without adding any new piece of information [78]. The systematic approach of Bennet's examination is underlined by his use of a parallel structure of repetitions ("The failure . . . , the failure . . . , the failure . . . "), which almost approximates a list of arguments. At the same time the use of a similar wording reflects the fact that these are all aspects of the same initial observations; they all are different characteristics of the same data, like light refracted into multiple colors by a prism. U3 then opens up the end of the Discussion to future developments by suggesting that further obscure elements will be clarified by ongoing studies.

The text is enriched by a series of coreferential expressions, i.e., terms indicating the same referent, which are scattered in the paragraph and are here indicated using apex numbers. Even a brief

glance reveals the dense fabric of these insistently recurring coreferential anaphors, which confer the paragraph a tightly united, i.e., cohesive nature. The overall effect of this paragraph is a tight sequence of observations, closely weaved to one another into a unity.

The following section is the familiar Conclusions paragraph, which is mostly schematic despite the absence of a bulleting notation, which is common in contemporary literature. Even so, this paragraph is composed by a sequence of unconnected statements that summarize the main findings and conclusions of the paper. Interestingly, this paragraph is titled "Summary and conclusions". A closer look at previous studies published in JEM reveals that this Summary section is one of the most consistent paragraphs in this reporting format and it can be found as early as the first issue of JEM [79], although a "Conclusion" section was the most common final paragraph for JEM articles at least in the first two decades of the 20th century and these two could be often seen alternating in JEM. The similitude in function and characteristics of Summary and Conclusions was so high that they could also appear fused, as with Bennet's manuscript. The Summary is arguably the predecessor of our modern Abstracts, whose importance in science communication and data retrieval cannot be overstated [80]. Significantly then, the Summary remained at the end of the manuscript, just like the Conclusions, right before the Bibliography section, until the change in formatting that JEM underwent in July 1990 [43]. There, the Summary could not fulfill most of the functions that are commonly associated with abstracts, e.g., allowing users to identify relevant studies and thus saving time and acting as a frame or short introduction to the universe of the article, both for content and terminology. A Summary, as it was intended at that time, was possibly just meant to serve, as the name implies, as a way to summarize key concepts of a study into a few take-home messages and was to be read after the article itself. It could also be argued that this, in turn, implies a different attitude toward journal reading and even journal role in continuing education and scholarly activity. Abstracts are currently placed at the beginning of a study because readers—in the biomedical science as obviously in other fields as well—are supposed to skim through a great amount of literature using databases such as MEDLINE, where abstracts are provided freely to all users regardless of individual or institutional subscriptions and researchers only read the full texts that are pertinent to their research or professional interest. But with an article structure such as the one in the manuscript we examined, the reader was supposed to go through the whole study and use the Summary to reinforce the learning of the concepts that had just been presented. The Journal itself could therefore act as the trusted portal to access new knowledge and the reader may have been supposed to just browse the latest issue, solely relying on titles to discriminate the content of the study.

3.5. Storytelling

The potential role of storytelling in science and scientific communication is the subject of a lively debate [81,82]. It has been shown that storytelling fits our cognitive schemata [83], making it very easy for readers to follow through the sequence of events typical of narration. Our memory encodes events in a narrative way [84] and it is widely agreed that using a story is the best way to send a message through in a text or in oral presentations [85]. It is therefore interesting to note that science, and more specifically, the biomedical field, are no strangers to storytelling. Although storytelling may be mistakenly associated with recounting products of fiction or imagination and be thus perceived as inadequate to report 'real science', it is actually only a peculiar way of structuring the events of a story—regardless of their nature—along a narrative arc, with a beginning, a middle and an end, passing through a plot where difficulties are overcome and solutions found. It is a voyage that starts from an A point and arrives at a B point, i.e., the resolution. It is not a simple layout of facts, but rather a chronological and causal sequence of events that follow up one another in a plot, given a setting [86]. This form of reporting has rather been abandoned in recent times, and storytelling has been delegitimized as an unscientific and unnecessary device [87], though it is now experiencing a renaissance [88].

To give a better sense of how narration was used in Bennett's manuscript, we provide below a little paragraph from the Materials and Methods section:

> *'By the time the fever-promoting factor could be demonstrated in the chest fluid, the dog's temperature had returned to normal. The circulating leucocytes increased in number after administration of turpentine and this increase persisted for 3 or 4 days, after which there was a sudden sharp drop about 24 hours before the exudate became pyrogenic. This sudden fall in leucocyte count almost invariably preceded the appearance of the fever-promoting factor in the chest fluid and came to be recognized as a reliable sign of its presence . . . .*
>
> *. . . Over periods as long as 2 months, no diminution was observed in the fever-promoting property of fluids so stored.'*

There are some remarkable differences from a contemporary manuscript, and even more so if we remember that this passage is taken from the Materials and Methods section. The first clear difference is that this paragraph is apparently reporting the results of an experiment, not the description of the methods. In the absence of further details, a contemporary reader would likely be inclined to assign it to the Results section. The reason why this description can be found in the Materials and methods section is because here, the author is describing the setup of the model, which is then going to be employed to address the experimental hypothesis later on in the manuscript.

Importantly, the author relies on a fine thread of time expressions, which appear here underlined. These recreate a defined time dimension within the description, with differences in the sequence of events and in the aspects of the events that are reported. The sentences are constructed in such a way as to render the different planes on which the action was taking place ('By the time . . . the temperature had retuned'). Adverbs and adjectives (' . . . almost invariably . . . ', ' . . . a sudden drop . . . ') are used to represent gradual and lengthy processes or to recreate the unexpected rapidity of the event sequence, to hint at repeated experiments or to suggest, without explicitly stating so, a rich repertoire of observations. The use of inchoative expressions (' . . . came to be recognized . . . ') are further devices that contribute to rendering the sense of an unfolding process. The choice of verbs used in the passage reinforces the temporal perspective of the narration by mean of morphology (' . . . had returned') or semantics (' . . . preceded . . . ', ' . . . persisted . . . '). The events are not simply listed in an achronic sequence, there is no use of the present tense, which is commonly utilized in academic writing to abstract and generalize experimental observations [89]; the facts are encased in a temporal edifice which allows us to immerse into the narration plot. The use of narrative strategies in the description of experimental methods and results is not limited to Bennett's work. An earlier study from Valy Menkin [90] reveals an elaborate textual organization by alternating narrative passages written in smaller fonts, which presented similar features to those analyzed above:

> *'On the following day the incubated solution of serum and enzyme appeared distinctly turbid; all the others were clear. About 0.4 cc. of each sample was injected intracutaneously into the dermis of the abdomen of a white rabbit. This was followed by the intravenous injection of 15 cc. of 1 per cent trypan blue in saline. The rapidity and intensity of local staining served as a rough measure of the rate of filtration through the endothelial wall.*

with passages in bigger font,

> *'The results of these observations indicate that the intracutaneous inoculation of the tryptic digest of blood serum induces a rapid increase in capillary permeability subsequently followed by active leukocytic migration. The crystalline substance, leukotaxine, recovered from inflammatory exudates, manifests precisely similar biological properties.'*

which report on the general considerations that can be drawn from the experimental observations, and noticeably, consistently rely on the use of the present tense. It must be noted that as this study was

published in 1938, its internal structure still considerably differed from Bennett's and contained only an Experimental section, roughly corresponding to both the Material methods and Results section. This may have prompted the author to further organize the text by introducing these differences in format and style to better support his arguments.

This study may be a powerful reminder of how science can be explained in an engaging way. Readability may be a very important factor, even for science reporting, if we consider that getting the message through should be a requirement for every scientific article, at least any scientific report that is striving to leave a mark in science, even in the limited scientific niche where it is positioned [91].

However, it must also be duly acknowledged that the narrative description of the experiment, as is found in this 1948 paper, has significant limits. Although this paper flows smoothly when read, it would not be easy to replicate its experiments because of the lack of those minute details that mercilessly break down narration and make the modern Materials and Method sections so typically dry and unpleasant to read and yet so essential, when those details are needed. Furthermore, it must be admitted that is not easy to compare data and it is not easy to extract data for metanalysis purposes [92], when expressed narratively. Considering the staggering abundance of available scientific literature for any field of science and any specialty in the biomedical area, these limits cannot be overlooked. Every literature search retrieves so many results that comparison and synthesis are always required from the scholar, and if these operations are made easier, then it can be argued that the whole research process is benefited [93].

4. A Change for the Better?

This brief description of I.L. Bennett's 1948 publication 'A study on the relationship between the fevers caused by bacterial pyrogens and by the intravenous injection of the sterile exudates of acute inflammation' has revealed key differences in biomedical reporting when compared to the current literature. The report belongs to a study series, a publication unit that consisted of multiple studies, published on the same or different issues of one or different journals by the same author/author group and that were associated by a broad theme or scope, like installments on a periodic journal. Such a publishing habit possibly had the purpose of increasing both study continuity and traceability and also reader engagement, but it has currently fallen out of use, as it would probably be impractical when considering the number of current publications and the availability of databases and search engines. The language used in the study appears more elaborate than contemporary authors would adopt in a comparable manuscript, through the use of devices such as topicalization and dislocations, which are nowadays rarely encountered or discouraged. What is probably more relevant to the purpose of the present commentary is that the study heavily relies on a narrative approach to report the experimental results, which, on the other hand, do not indulge on what would now be perceived as relevant experimental details for reproducibility. The storytelling is skillfully managed through a careful use of time indicators and well constructed rich text units that reveal a high degree of coherence and cohesion. The use of explicit narrative devices makes the reading more engaging [94] and discloses the process of the scientific thinking behind the experimental procedures as the reader is accompanied on a journey of discovery and allowed to follow through the experiment. In this regard, a study like Bennett's is very effective and it may serve as a reminder to modern researchers of how to better engage readers. However, the lack of experimental details, together with the lack of a proper data analysis, makes quality appraisal difficult and the replication of the experiment—and thus, of the results—very challenging, exposing serious shortcomings in the scientific soundness of the study. It is possible that the scarce efforts made by the author to illustrate the methodology of his work actually reflects an underlying attitude toward science, where less attention is devoted to the collaborative aspect of research, which requires full disclosure of the experimental details.

Similarly, the reference list is kept at a minimum and limited to those studies that are directly involved in the interpretation of the present one. An explanation on the paucity of citations, as compared to modern standards [95], may rest on the difficulty of finding citations in the absence

of our currently available databases but also the real scarcity of experimental data, as the amount of available research was indeed smaller than today [58]. On the other hand, however, it can be speculated that a side effect of these few selected citations could have been the possibility for the readers to actually look into the cited works and broaden their understanding of the issue, just like the 'Further reading' section at the end of some textbook chapters. As the function of citations in modern science has actually become very complex and it ranges from the need to ground novel data into a solid background network of previous discoveries, to the necessity of giving due credit to colleagues and predecessors [58], up to increasing the visibility of novel work through citation databases, reverting to such short citation lists appears unfeasible and possibly undesirable [96]. However, it may be useful to keep in mind how fewer and more focused citations may actually help the reader identify relevant information they may want to further look into.

5. Conclusions

When taken together, all these elements outline a different approach to science communication. Broadly speaking, we may be comforted by assessing that the quality of reporting has, in so many aspects, improved over the years when it comes to methodology, thoroughness of reporting, and breadth of cited literature. The standardization of science and science reporting are enabling to retrieve solid results through systematic reviews and meta-analysis. However, we also believe that it is important to pause and reflect on the greater attention devoted to communication that underlies studies like the one we examined. The scientific literature, regardless of the field, may have many purposes and communicating worthy findings is only one of them [97]. In some—extreme, actually—cases, authors have admitted that they publish their research in predatory journals, i.e., low-standard journals offering to publish their studies in non-indexed platforms for a fee, just because this aspect is not really relevant for career purposes [98]. For most of the authors, however, disappearing into the ocean of published literature is not a viable solution.

Possibly, the greatest merit of analyzing this study by Bennett could be to remind us of the need to keep readers at the center of academic communication and to engage them because ultimately, the only way for scholars to give a useful contribution to the advancement of science and society is to generate valuable results, communicate them, and be heard.

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