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TO CONNECT TO CITIZENS, RESEARCHERS MUST RETHINK THEIR RESEARCH PRACTICES

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Abstract

Are science communicators a breed apart from which scientists seem to be excluded? Most scientists are seen as poor communicators and thus should be trained to acquire excellent communication skills to be key actors in the "democratic" model of science communication. Yet scientific writing manuals as well as reports on the conduct of science insist that "communicating ***is*** the doing of science" and that scientific communication is "ordinary". We explore here some of the obstacles impairing researchers' ability to communicate and defend the idea that changes are needed in researchers' practices, in the concepts scientific practice is based on; we also show that the training young researchers receive reproduces what R. Day, author of the renowned manual on "How to write a scientific paper" calls "error in perpetuity".

The author has conducted an action-research project for the past ten years within the scientific community, analysing scientists' written and oral discourse and communication practices. Papers were analysed, as well as referees' reports, Journals' recommendations and editorials. Scientists' discourse and communication practices were studied at interdisciplinary seminars on research project design and communication, working with researchers, and with researchers and their PhD students. Writing practices are in contradiction with the standards set by the scientific community and published in Journals' recommendations, leading to verbosity and ambiguity; introductions lack key elements like a clearly formulated research question, problem or strategy, and implications of the research are often absent. The same is observed in research projects and when scientists defend their research orally. The weaknesses reported are confirmed by observations from evaluators of European Projects and American funding bodies. To connect to society in the democratic process of science communication, scientists will have to become enunciators again, revisit concepts like objectivity, responsibility and neutrality, speak in the first person, accept confrontation and share their questions.

Keywords: scientific practice, writing practices, writing standards, enunciators, democratic model, science communication

1. Introduction

Researchers must leave their « ivory tower ». In the « democratic » model of science communication, they are urged to engage in dialogue with the public, to explain the implications of their work to politicians, to connect to people and accept mutual learning situations where they will both listen actively to others and defend their arguments.This may well sound as a revolution to most of them just because they are not prepared for interacting with society. "Increasingly, public dimensions explicitly enter intra- and inter-scientific communication, as, for example, in discussions on science policy, on the possible practical applications and ethical implications of certain scientific developments and on the public and political impact of releasing certain findings. The growing evidence of a crisis of confidence in the public credibility of science appears to be provoking anxiety among scientists about their public role" [1]

Science communicators and the media who complain of an ever-widening gap between themselves and scientists must be aware of the barriers existing inside the scientific community. Both the training researchers receive in the laboratory or at conferences, and their ordinary communication practices are centered on communication towards their peers, that is a very limited community of hyper-specialists who widely use a common jargon. Moreover evaluation practices mostly based on the famous "Publish or Perish" motto, and publications in disciplinary Journals reinforce the peer-directed communication. Such practices have led to what can be called "truncated communication" both orally and in writing – for example abstracts lacking both the issue and objective sections as well as the perspective and implications ones.

We explore here some of the obstacles impairing researchers' ability to communicate and defend the idea that changes are needed in researchers' practices, in the concepts scientific practice is based on; we also show that the training young researchers receive reproduces what R. Day, calls "error in perpetuity" [2]. The author has conducted an action-research project for the past ten years within the scientific community, analysing scientists' written and oral discourse and

communication practices. Papers were analysed, as well as referees' reports, Journals' recommendations and editorials. Scientists' discourse and communication practices were studied at interdisciplinary seminars on research project design and communication, working with researchers, and with researchers and their PhD students.

2. What Journals' recommendations to authors say: scientific communication is "ordinary" communication

2.1 Uniform recommendations:

When we analyze the recommendations on « how to write a scientific paper » to be found in journals or scientific writing manuals, they're all similar in nature, mainly because recommendations share the same origin, when a small group of editors of general medical journals met informally in Vancouver, British Columbia, in 1978 to establish guidelines for the format of manuscripts submitted to their journals. The Vancouver Group's requirements for manuscripts were first published in 1979 and are known as the Uniform Requirements for Manuscripts Submitted to Biomedical Journals. They are reproduced in National Standards as well as in many Journals' recommendations [3]. They have inspired authors of scientific writing manuals who recommend that scientific writing must follow basic communication rules, and in that sense, insist that it is similar to any piece of writing. The researcher as author must be kind to his reader! "Writing is an instrument for conveying ideas from one mind to another; the writer's job is to make the readers apprehend the meaning readily and precisely."

> "The secret of producing an outstanding piece of writing is to always keep the reader in mind. Authors who keep readers in mind convey their information more lucidly than authors who write only for themselves. The scientist who has the attitude, "Why should I worry about how this is presented; everybody *knows* what I mean," is incorrect; everybody does not know. The person whose native language is not English may not know; the student who is only beginning to approach the author's level of expertise in the subject area may not know ; and other scientists in similar but separate fields may not know. The thoughtful scientist-writer keeps these people in mind." [4]

Editors and authors of manuals unanimously recommend clarity, simplicity and concision.

> "What is scientific clarity? I believe that the key to scientific writing is clarity. Successful scientific experimentation is the result of a clear mind attacking a clearly stated problem and producing clearly stated conclusions. Ideally clarity should be a characteristic of any type of communication; however, when something is being said *for the first time*, clarity is essential. Most scientific papers, those published in our primary research journals, are accepted for publication precisely because they do contribute new knowledge. Hence we should demand absolute clarity in science writing." [5]

> "Be concise, don't ramble. Short, concise papers are more likely to be accepted than long rambling papers (and will cost less to publish). (...) The readers of the journal are more likely to read and understand a well-written paper than they will a murky and poorly presented one." [6]

When researchers complain that their papers have been rejected, or when they miss an opportunity to see their results published – because they have wasted time and somebody else has published the same results in the meantime! – Journals'editors reply: Write simply and clearly!

> "They (the papers) are written with little or no regard for style and clarity. Occasionally, I hear of an important paper that has been ignored because no one could understand it, until the work was rediscovered independently by someone else. (….) I think therefore that it is preferable to err on the side of simplicity and to try to explain as much and as clearly as possible. " [7]

Most Journals'editors go to great lengths to guide researchers and help them get their results published. I will just take one example, that of the *Journal of Epidemiology* [6] which published an editorial entitled "Be kind to your reader" to convince their readers to adopt a style both simple and concise. The editorial's author has selected extracts from verbose and lengthy papers and turned them into readable -and short !- pieces :

> *Original:* The association of risk of Type I diabetes with the consumption of any milk was similar to that with consumption of whole milk only. Similarly, Type II diabetes risk was associated in the same way with the consumption of any milk and of whole milk. To assess whether the results are explicable by cream, it would have been desirable to consider separately those who drank only skim milk ; where heavy consumption of skim milk was not associated with a reduced risk of Type I diabetes, for example, it would be reasonable to suggest that cream was responsible for the observed inverse association of milk with Type I diabetes risk. Because the number of individuals who drank skim milk exclusively was small, however, it was not possible to consider this group separately.
>
> *Shortened:* The association of both Type I and Type II diabetes with the consumption of any milk was

> similar to that with consumption of whole milk only. There were too few subjects who drank only skim milk to assess reliably whether the results are explicable by cream.

It is interesting to note that in order to achieve clarity, scientists are advised to adopt a style close to that of “ordinary speech”. Tha author of a writing manual writes: “I am advocating that writers should write naturally and economically, without affectation of a special "scientific" style. They should come as close as possible to the natural mixture of constructions and the natural balance and rhythms of comfortable everyday speech.”

Verbosity in scientific communication comes from many sources:

- a tendency to use nouns instead of verbs. Very often, verbs found in scientific writing are almost devoid of meaning: they are very poor in content like « perform », « carry out » etc.

> “Verbs should be substituted for abstract nouns wherever possible; expressions such as "separation of the compounds was accomplished," "examination of the patients was carried out," and "transformation of the equations was achieved" should be eliminated. Constructions such as "the compounds were separated," "the patients were examined," and "the equations were transformed" are more concise, exact, direct, and readable. Even better, in some instances, might be "we separated the compounds," "I examined the patients," and "Equations, transformed by use of ..., were substituted.”[8]

- use of the passive. Combined with abuse of nouns (see example above), it leads to ambiguity: the reader doesn’t know who has done/said what is being reported.

> “Scientific writing contains far too much use of the passive voice; let's start moving away from it, as we tried to do in this piece. *Regardless of what anybody tells you*, it's okay to use first person in scientific literature. You don't have to say "the research was conducted," you may say "we conducted the research.” [9]

> “Authors should minimize the use of verbs in the third person, passive voice. When a verb concerns the interaction of inanimate objects ("the membrane is acted upon by the drug"), the active voice is usually preferable ("the drug acts on the membrane") because it is more direct and concise. When a verb concems an author's belief or conjecture, use of the interpersonal passive ("it is thought" or "it is suggested") is highly inappropriate. When a verb concerns action by the author, the first person should be used, especially in matters of experimental design ("to eliminate this possibility, I did the following experiment"). Constant use of the first person is not advisable, however, since it may distract the reader from the subject of the paper.” [8]

Use and abuse of the passive voice leads to "dullness", "ambiguity and confusion", "vagueness and approximations of meaning", “verbosity”; it is "dishonest for writers", and it "distorts their intended meaning":

> “Excessive use of the passive constructions seems artificial and uncomfortable to readers. On top of this, ambiguity and confusion are often added because passive constructions often do not specify clearly who was the actor or agent in an event. (...) It is therefore at least confusing and at worst dishonest for writers to use 'it ….that' constructions when they mean I/we think. (...) Writers must not be required artificially to force all their thoughts into an impersonal mould: there is real danger that they will distort their intended meaning.” [10]

Use and abuse of the passive voice has other consequences: clichés, stereotypes and phraseology can be found everywhere: scientific discourse becomes dull, lacks originality and vigour, harnessing creativity and thinking: “ They strait-jacket their ideas into stereotyped patterns of expression. ”. Dangling constructions will make most readers laugh, yet they are so common in papers! R.A Day provides two humorous examples: [2]

> “Lying on top of the intestine, you will perhaps make out a small transparent thread.”
> “How many people do you employ broken down by sex?”

- researchers do not make sufficient efforts to choose the right word : very often they will use « synonyms », find some vague expression or just repeat or reformulate. This is particularly true of French researchers who have been trained in their native language to abhor repetition. This cultural feature of writing - instilled in French people from early age- is nevertheless a trademark of scientific writing. “Use the right word for a concept”, “use the same word for the same concept” is again common advice to researchers. Hyperspecialization have led authors to make unlimited use of compound nouns, “clusters” of words which very often are intelligible to only a few and certainly not to the lay reader. And yet, recommendations are again very clear: use of compounds should be limited to two or three words, not more.

> “In general, nouns should be modified by no more than two other nouns and preferably by no more than one. The total number of modifiers (nouns, adjectives, qualifiers of adjectives, verb forms) for a noun should rarely exceed three; use prepositional phrases instead. Expressions such as "heavy beef heart mitochrondria protein" or "the constant pressure heat capacity temperature maxima" impede comprehension and frequently contribute to ambiguity.” [8]

All these recommendations are further supported by surveys made by John Kirkman [10] entitled “Which style do technical readers prefer?” Kirkman submitted to volunteers six different versions of a scientific (3 surveys) and technical (one survey) text. In each survey the subject was the same, only the style was different. Volunteers were asked to read the texts, in the order they wished, and then they had to say which text was the easiest and most

pleasant to read, the easiest to understand and the easiest to assimilate. They were also allowed to make comments and justify their choices. In each of the three surveys on scientific texts (1535, 526 and 741 answers), a large majority chose the text using direct, active, first-person style and with simple sentences. Why not use this style when writing? asked Kirkman. The volunteers provided only vague answers, blaming their superiors or Journals' editors who, they said insisted for papers to be written in the passive, impersonal style. Kirkman was thus able to identify a mysterious group whom he calls "a spectral reactionary group 'they' ".

2.2. What referees say:

I analysed referee's reports and passages rewritten by referees when reviewing articles [11]. Their remarks and the corrections they entered in papers all point to the same criteria for quality as those defined by the Vancouver Group and Journals' recommendations.

Scientific papers are evaluated on their form and content before being published. The evaluation process is part of the system of control of science. [12]. In quality Journals, referees are asked to assess the scientific merit and presentation of the paper, and they must fill in reports emphasizing major criteria acknowledged by most Journals: a typical checklist is presented below, from *Journal of Applied Statistics*.

1. Are the facts, arguments and conclusions in the paper technically valid and accurate?
2. Is the previous work adequately referenced and integrated with the new results?

Structure

3. Is the title brief yet clear enough to identify the paper?
4. Does the list of keywords index all the features of interest in the paper?
5. Does the summary indicate the main topics and results?
6. Does the introduction outline the purpose, scope and approach of the paper?
7. Are the main results and conclusions given early in the paper?
8. Are there details which could be reduced, put in an Appendix, or omitted?

Exposition

9. Does the paper say in words what it is about, what the findings and implications are, and why they matter?
10. Are all of the mathematical details necessary?
11. Is any symbol or abbreviated technical term used unnecessarily?
12. Are text tables limited to what is needed for exposition and illustration? Are all numbers sufficiently rounded? Is there a verbal summary for each table? Are the captions clear?
13. Does every graph have a clear message? If not what is its point?
14. Are any passages unclear or verbose?

Detailed criticism and constructive comments should be given separately.

Our study shows that most referees agree on the following points: the abstracts produced very often do not follow the recommendations to authors – i.e do not contain the five points , rationale, objectives, material and methods, results, conclusions and perspectives - and thus cannot meet the expectations of a reader who hasn't read the article

> "You should consider (a) whether the content is of sufficient scientific interest for the space required, (b) whether the title and abstract are adequate: the abstract should not only indicate the general scope of the article but also state the main results obtained and conclusions drawn ; it should be complete in itself and suitable for direct inclusion in abstracting journals, (…)"Guidelines for referees, *Journal of European Optical Society*

Referees find it hard to read the article because of the grammatical structures, the language and style they find "verbose, repetitious, lacking rigour, misleading or confusing". They therefore do not feel confident that they understood what the researchers did and doubt the scientific quality of the work presented. They complain the rationale for the work is not explained and that objectives and hypotheses are missing or not stated clearly: introductions to papers are rated as "weak" and referees cannot see the originality of the work. Finally they find a lot of papers to be just descriptions of work that was done without much analysis and complain that discussions are just "rambling", i.e leading the reader nowhere.. To conclude this brief analysis, let us listen to the angry conclusion of one editor in a letter he sent to a researcher: « This is a fundamental problem with this kind of writing. It is not really a question of writing style or even of good English: it is a question of clear thinking or perhaps just of thinking at all ».

3. Researchers' writing practices and more generally communication practices, are in complete contradiction with the standards the scientific community has set and is expecting researchers to follow:

No wonder then their papers or presentations cannot meet the requirements of a reader or listener who expects to know "why, what, how" and finally "what do you think?" These observations led me to take interest in other communication practices and I started an action-research project which so far has involved more than a thousand

researchers participating in seminars for building projects and writing papers, projects and reports. Reading hundreds of papers I found a lot of them to be murky indeed and missing the essential information – why was the research done? What are the hypotheses? And what is the interest of the research, what is worth discussing? Which led me to point to "truncated information" as examplified by truncated abstracts which, contrary to what Journals are aking for, very often start with the Material and Method section, ignoring altogether the Rationale and Objective sections. Working specifically on the relation between supervisor and PhD student, on how the subject proposed by the former evolves (or should evolve) into a research project conducted by the latter (his or her thesis), we found out that very often there is little re-formulation of the research question or of the hypotheses. A lot of students who complain that they are used as "extra pairs of hands" or just "data providers" in the lab have never had their attention drawn to the core element of a research project, the research question. Which may cast doubts about the nature of research, about the quality of the training and send one to reflect on the responsibility of supervisors. Working with individual researchers or with a consortium on building a research project, we know we have to look for their research questions in order to achieve more effective communication and a stronger project. Moreover, because the vital part of the research project (or paper) is missing, very often the relations between arguments or elements of the research are loose: we observed that, in oral exercises as well as in their written papers, researchers happen to be confused about the relation they established or want to establish between elements. When questioned, they will often hesitate or change their minds, unsure of the "sense of direction". There again we identified one reason for poor human relations and loose argumentation of the research. Our findings are in agreement with observations made by evaluators of projects, both in the United States and at the European level.

We argue here that researchers have lost the taste for confrontation: very little place is devoted to debate and controversy, introductions to papers are lengthy catalogues of references, and discussions are rambling, leading nowhere. In the early 1980's, George Pérec, the renowned French writer , at the time a librarian in a research organization, had noted the worst effects of scientific writing in his pastiche of a scientific article he pompously entitled "Experimental Demonstration of the tomatotopic organization in the soprano (Cantatrix Sopranica L.) [13] Two recent pieces of information are worth mentioning here: first the results of a study [14] which amazingly concludes that in research, "Communication implies dialogue; (its aim) is to reach mutual understanding of the arguments that lie behind the different judgements" and that some questions which are not addressed by researchers ought to be: Why is the research done? What are its benefits? Whose interests are involved? How reliable are the results? Are there controls for scientific research and do they work? Second, the attempt made in May 2005 by the UK Council for Science and Technology to propose a universal ethical code for researchers [15]. Two key articles in the code refer, one to skill acquisition "Act with skill and care in all scientific work. Maintain up to date skills and assist their development in others"; two, to communication "Responsible communication: listening and informing. Seek to discuss the issues that science raises for society. Listen to the aspirations and concerns of others".

4. Looking for explanations:

"The writing is very formal, rarely uses proper names and almost never uses the pronouns I, you or we (...) One of the reasons for this kind of formality is the prohibition against using I or we. I do not know where this prohibition came from; it originated in this century and often exists only in the mind of the writer. The American Institute of Physics Style Manual which prescribes the style for more than a dozen technical journals, specificaIly advises contributors to AIP Journals to use the first person. Even so, most of the authors of papers submitted to these journals strenuously avoid writing we."

Authors of manuals wonder where the writing and communication habits decribed above come from. None of the answers provided – bad habit, false idea of what scientific style is -, can satisfy the trainer who must explain that there is something wrong in attitudes passed from generation to generation of scientists!

But looking beyond just writing style, we must be concerned by the absence of clearly formulated questions, supported by strong arguments and referring to an equally clearly formulated research or societal problem. Following are some explanatory hypotheses we can propose after studying communication practices both oral and written. They all point to practices which have drifted away from "good practice". (i) Communication has become restricted in most cases to a very limited circle of hyper-specialists who share the same jargon and the same concerns. Yet one thing is really disturbing: do they all share the same question and address the same problem – which could be a reason why they don't feel the need to formulate them when trying to get published in a Journal? Would then fitting "within the scope of the Journal" mean that the questions are very well known by all readers so that they don't need to be written down? (ii) Research has become technical: this is a serious hypothesis since it has long been noted that researchers connect through their tools and methods rather than through their questions. With the almost unlimited possibilities offered by new techniques and new software for example, it is easy for researchers to lose sight of why they are doing what they are doing. (iii) The concepts of neutrality and objectivity certainly need to be revisited: most researchers will argue that they are using the passive and over-using the modal "may" just because "a researcher must be objective and neutral". But when engaged in a discussion about why they write, and what it means to be an author, they are likely to very quickly run short of arguments: like the mysterious reactionary group identified by Kirkman (see above), the neutral

and objective researcher is a mythical embodiment of concepts that have not been discussed for a long time! (iv) Quality in research is another very sensitive subject. Researchers have accepted –very recently, for example it started in France in the late 1990's- to engage in a "quality approach", i.e regularly checking their material and the lab environment for example. But quality is not only concerned with material and methods. It is also concerned with well formulated problems, strongly supported questions and hypotheses, and of course by reliable results presented in ethically written papers. We assume that researchers have lost sight of what exactly quality in scientific research is, when they omit to formulate their questions or hypotheses and staunchly refuse in some cases to share their questions or hypotheses. (v) Responsibility and ethics are at stake in researchers' attitudes: taking responsibility for one's own writing seems very difficult for the researcher who will try and find some kind of excuse in the need to be "objective" or "neutral". And the training they receive in the lab will reinforce this retreating posture: most students –and a lot of senior researchers too- told us that "it is forbidden to use the first person" but they are of course unable to explain why! Most of the above mentioned elements are linked of course to the conformism and mimetic behaviour as well as plagiarism which plague the scientific community. Training has become a system of "error in perpetuity" as Robert Day puts it. The Publish or Perish system and the power relations inside the scientific community are certainly to blame.

5. Conclusions: the missing links

Considering the observations and findings listed above, which emerge from years of patient work with researchers from all disciplines and many countries, it seems essential not to take for granted, in training scientists, that they will readily know what they can say: giving them a few minutes to prepare a message they will have to deliver in about 30 seconds (some trainers will propose the exercise) may well lead to masquerade! No wonder either that scientists should so often complain of being manipulated by the media or misunderstood by a public who is "ignorant". In the training sessions we conduct, it may take a researcher hours to discover what the research he has been doing for months really means, how it precisely connects to a scientific or societal problem, what its implications are. It is an illusion thus to assume that the communication problem experienced both by the media and by politicians for instance is only technical and should be treated using only techniques. As we have shown, obstacles to communication are embedded in the way researchers do research, in their practices, in the training they receive and in the concepts in which the production of knowledge is grounded.

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