

PART I

ADDRESSING PEERS

GUIDELINES

ABSTRACT

An abstract is like the face of a person. It can tell one what to expect. It should give the gist of the paper in a short paragraph. Besides being a summary, it has another purpose. A showpiece, it beckons the reader into the paper. You do not want to compose an abstract so well devised the prospective reader after glancing at it will decide to skip the paper. But even worse, you want to avoid writing an abstract so discouraging as to turn the reader away from both the abstract and the paper itself.

Don't compose an unreadable abstract. This would seem to go without saying. An opening sentence such as »*Fragments of polyketide synthase (PKS) genes were amplified from complementary DNA (cDNA) of the fusarin C producing filamentous fungi *Fusarium moniliforme* and *Fusarium venenatum* by using degenerate oligonucleotides designed to select for fungal PKS C-methyltransferase (CmeT) domains*« is impossible: Too technical, too dense, too complicated a syntax, heavy with **acronyms**.

Let's start with translating and breaking down this sentence. How about, instead, »*Two species of filamentous fungi produce fusarin. Their complementary DNA serve to amplify fragments of polyketide synthase genes. We use for this purpose degenerate oligonucleotides, designed to select for the desired methyltransferase domains.*« Moreover, since the **title** of the paper starts with »Fusarin C Biosynthesis«, don't repeat it. The desired meaning of the above sentence is »*We have prepared oligonucleotide PCR primers selective for fungal polyketide synthase genes.*« Why not start the abstract thus?

Think of an abstract as a shop window. It requires elegance and attractiveness. The latter ought to be a reflection of the quality of the work, of the novelty of its approach, of the importance of its results. The former is exclusively a matter of word-craft, of style. It is not enough to whip out an abstract in five minutes, either before writing the paper or after having done so. A good abstract might be hours in the making. To invest time assembling such a jewel is not out of whack.

How can it be done? Write as if you were penning a postcard to a friend: use simple sentences, don't get technical and utter a clean message in a maximum of 50 to 100 words.

Incapable of such a feat? In that case, take a printout of your completed paper and underline a dozen sentences you feel epitomize the work. Paste them together and tie them together with transitions. Now, edit this paragraph. Be merciless. Try to reduce it by a third. You should now have the

first draft of your abstract. It only remains to turn it from decent into artful English. Do not hesitate to resort to a dictionary of synonyms and to use other tools such as a style manual. Read your abstract aloud, a crucial test. It will make you jettison multisyllabic unpronounceable words. It will make you focus on the genuine achievements of the paper. It will make you grab your reader by the sleeve: »*come inside, Mister, I have something truly marvellous I'd like to show you*«. This is the message from a well-designed abstract.

REFERENCE: K. K. Landes (1951) *Scrutiny of the abstract*.1. AAPG Bulletin, 35(7):1660; (1966) *Scrutiny of the abstract*.2. AAPG Bulletin 50:1992.

Whom to thank? 

ACKNOWLEDGEMENTS

This appears an almost perfunctory and ancillary part of a publication. Such a perception is misleading.

This segment is worthy of your full attention. Failing to thank someone for assistance does not speak highly of your accuracy and care – two essential qualities in a scientist.

Which brings up the question: whom to thank? The answer could not be simpler: anyone who is not listed among the authors and who nevertheless has somehow helped or contributed. The criterion for authors, covered elsewhere in this book, is very simply that any of the co-authors ought to be able to present and defend the paper, as a whole or in part.

How then should this segment be presented and written? There is no prescribed format. Nevertheless, I shall suggest one. Why not take model on the Acknowledgement section of nonfiction books? It is often prepared and written with great care. The author uses this opportunity to recapitulate the history of the book and to set it on the record. By doing likewise with your text, you will be able not only to thank all the relevant parties, but also to put together a piece of writing which, in the future, historians may turn to as a source of valuable information.

REFERENCE: R. A. Day (1994) *How to write and publish a scientific paper*. 4th edn, Oryx Press, Phoenix AZ.

They are eyesores. 

ACRONYMS

The TA is BI. This assertion, which could be construed as stating the sexual preferences of a teaching assistant (TA), is meant here as »the topic of acronyms is a bothersome issue«. One of the many problems with acronyms is the multiple meanings many of them have. Of course, within the confines of a single publication, addressed primarily to a group of specialists, such ambiguities vanish.

Acronyms are necessary due to the need for brevity. Long names of chemicals beg to be shortened. Thus monopyrrolotetrathiafulvalene (29 letters, far from a record) is shortened into MPTTF, with only five. Some such chemical acronyms have entered common language. Examples include DNA, RNA, TNT, DDT, ... Names of commonly-used laboratory tools and techniques are also turned into acronyms. Fourier-transform infrared spectrometry becomes FTIR (four instead of 37 letters), atomic-force microscopy is AFM and a superconducting quantum-interference device is a SQUID.

This last example illustrates a consequence of acronyms entering the scientific lingua franca. A naïve student using the SQUID and who continually hears it referred to as such may never learn what the acronym stands for. To him, the acronym is an opaque screen. He does not know the real composite name hiding behind, hence he may never find out how the contraption works. Is it such a hot idea for a user not to understand how an instrument works?

But acronyms have some redeeming value, too. Their very existence points to the pressure for efficient communication within the scientific community. Indeed, acronyms help to network research scientists worldwide. Often, an in-house abbreviation within a single research group transfers into common scientific language.

Another nice aspect of acronyms is their testifying to the playfulness of scientists. Play is an essential component of science. To make-up an acronym, a wordplay, belongs to such an attitude.

Do's and don't's? My first rule is to try and stick to a maximum of three letters in a non-punning acronym, such as DNA or TNT. One of the reasons is that, in a language such as English, it is difficult to pronounce more than three consecutive consonants. If you need more letters, then you should make sure that you have enough of a balance between vowels and consonants for easy pronunciation. A common trick is to tailor the acronym to an already existing word, as exemplified by SQUID. Quite a

few scientists have had a field day turning loaded words into acronyms, such as PENIS standing for an algorithm used in nuclear magnetic resonance (NMR for short). Make sure that, whenever an acronym first appears in a publication, it is flanked with its translation. But make as little use of acronyms as possible. They clutter a text, they hinder the flow of reading, they are eyesores and tongue-twisters, they are a necessary evil.

REFERENCE: K. T. Hanson (1995) *The art of writing for publication*, Allyn & Bacon, Needham, MA.

switch from the passive to the active 

ACTIVE OR PASSIVE VOICE?

This question is a dilemma only because the conventional way of writing scientific papers heavily favors the latter. But first, let's give a look at a few samples of such writing.

»*The characteristics of ... have been suggested so far to be the result of cooperative phenomena.*« The timidity in this sentence reflects a very real and respectable uncertainty, in attribution of a cause to scientific results. It stems from the difficulty of interpretation, which can never be certain and which, therefore, has to be muted. But there is a fine line between such prudence and downright obfuscation. One wishes the author of this paper had stuck his neck out and written for instance »*Cooperative phenomena account for the characteristics of ...*«. If this were too strong an assertion, it could be qualified: »*Cooperative phenomena account, at least in our view, for the characteristics of ...*«.

Another example: »*This work was motivated by previous demonstrations that ...*«. This opening statement aims at identifying a historical continuity, the study we are about to read did not arise in a void, it followed upon earlier work. Why not write instead »*We base this work on previous demonstrations that ...*«, which requires only a rephrasing from the passive to the active voice? Notice that, not only did I turn the sentence from passive to active, but I also moved it from the past tense to the present.

The habit of using the past tense is another feature in writings by scientists. When colleagues pen this sentence: »*Support effects have been attributed to co-reactant activation sites ...*«, thus referring to an opinion

which they might wish to challenge, why don't they write instead »*Do co-reactant activation sites truly produce support effects?*«

Sometimes, the combination of a switch from the passive to the active, together with dispensing with unnecessary words, works quite nicely: »It was demonstrated that this surface provides the best efficiency for ...« thus easily becomes »This surface is most efficient at ...«.

Turning to the passive voice is second nature to scientists. This is their way of playing possum. It is a diversion tactic against possible criticism of their work by referees and peers. They qualify their statements making them innocuous in the hope of deflecting any challenge. In so doing, assertions lose their edge, the writing becomes moot and the reader's attention wanders.

REFERENCE: M. Young (1989) *The technical writer's handbook*, University Science Books, Mill Valley, CA.

your paper has three constituencies 

BIBLIOGRAPHY

Why is a good bibliography essential? It demonstrates your seriousness as a scientist. What is a good bibliography? It displays honestly and conscientiously the foundations of your work. The phrase »scholarly apparatus« is synonymous with a bibliography: the end part of your paper is a testimony to your **scholarship**. Your results may be trusted, you are also a scholar to be respected. You know what you are writing about, you know your place in the science world, you read what others have published in the field.

The goal of a list of references is not one-upmanship. Avoid being vain, because it will invite ridicule and scorn, as if you were wearing a flashy suit with a gaudy tie and outrageous multicolored shoes. Refer only to those of your earlier publications truly critical to the understanding of the present work. Nor is the sole purpose of a bibliography to ingratiate yourself with the most influential among your peers, those most likely to be called upon to serve as reviewers or referees.

Your paper has three constituencies among its readership. Your peers make up only one. No less important are the young scientists, those start-

ing in the profession, the graduate students. Make your paper helpful to them. Select for their didactic value three papers, or book titles, for inclusion at the very beginning of your list of references. The third constituency you ought to keep in mind is that of present and future science historians. They need to configure the network of scientists active in a field. Inclusion of not only your friends but your enemies, is a must. You want your paper to have lasting value? Then, rather than omitting any but the most recent references, those published during the last couple of years, provide a decent time line.

At the risk of stating the obvious, the first requirement for a bibliography is total reliability. Check and recheck against the original publication in the journal, the spelling of the names, the volume and page numbers. You will be surprised by the number of errors which can and do occur in transcription.

If you have simply lifted your bibliography from another paper, such errors will also broadcast to the world the cardinal sin of a copy-and-paste job – this is plagiarism. It is actionable. If you do not have access to a library and thus are unable to read publications in your field, ask for the cooperation of a colleague elsewhere, operating under wealthier circumstances. He or she will be happy to give such help to a fellow-scientist.

A way to check whether you have provided a fine bibliography is to be prepared to give, at the drop of a hat, a summary of each cited paper.

REFERENCE: J.S. Dodd (ed) (1997) *The ACS style guide*. American Chemical Society, Washington DC.

It suggests availability. 

BODY LANGUAGE

We scientists may be polyglots, able to read and write, and even speak several languages. We have some mastery of the language of mathematical equations. We are fluent in the language of the scientific discipline we have specialized in. But there is one particular language at which, as a rule, we are poor. That is body language.

The stereotypes are aired on movies, on television and in cartoons. While they exaggerate, they carry some truth. The bespectacled scien-

tist is seen as an unattractive middle-age male who looks rigid, boring and uncompromising. He is visibly not at ease. His body lacks grace and charm. He cannot dance.

Counter those stereotypes. You love your science. Show it, express your enthusiasm bodily. Be dynamic whenever you are engaged in any form of science communication. Instead of standing stiffly behind a lectern or while pointing at an image on a screen, move about the room. Get close to the listeners, make eye contact with them individually. Meet people with an engaging smile. To smile is to grant a welcome. It suggests availability. It tells people without words that you are open and more than willing to share your knowledge and worldview.

The way you dress sends, not a single signal, a whole alphabet. This is too obvious to elaborate upon. Look at yourself in the mirror, ask a family member to help you in selecting your attire (attire as in »attraction, to be attractive«). The way you hold yourself, your involuntary gestures – a leg moving rhythmically, a tic with your hand, your furrowing your eyebrows, etc. – all assume significance and can be detrimental to your message.


You can improve in those sectors by regular physical exercise such as walking, swimming, tennis or gymnastics. An instructor or personal trainer in physical exercise surely would help. Likewise, consulting a physical therapist. Better yet, you could hire a coach who specializes in preparing public speakers. This person can also help you greatly by monitoring your voice, controlling its pitch and volume, and directing it at specific parts of your audience, making it carry drive and feeling. What your voice will express, your body will also start to follow. The voice can lead the rest of the body in expressiveness.

Starting with your hands. They are your most precious auxiliary. You can learn to make better use of them, in the following way. Stand in front of a mirror and read aloud, for instance a **paragraph** from a newspaper. Now repeat the performance and make sure to use your hands, in order to highlight points and create emphasis. Do this for a couple of minutes twice a day for a week. You should notice an improvement, your hands now accompany your speech. The second week, replace the newspaper with one of your own texts.

A final point: talking with your hands, more generally using body language will help you to act out the invisible. Your work involves characters and forces, perhaps at the microscopic level, perhaps in the astronomical range, in any case outside normal perception. It will help your listeners if you convey your mental image of such actors in your work with a little

gesturing. A little: remain somewhat restrained and discreet, and you will be all the more convincing.

REFERENCE: D.B. Givens (2005) *The nonverbal dictionary of gestures, signs & body language cues*. Center for Nonverbal Studies Press, Spokane WA.

Wrapping-up your story 

CONCLUSION

When a letter is written, it goes into an envelope. When the mail arrives, we can usually tell from the mere aspect of the envelope, whether it contains a bill to be paid or a letter from a dear friend. The conclusion to an article published in a scientific periodical has this same feature, it qualifies the paper as to its type, its merits and its lasting value. Keep it in mind when drafting a conclusion, do not treat it as perfunctory. Do not make it a study in conformity, nor a repeat of the **abstract** of your paper. Wrapping-up your story is a significant component of your publication.

A good conclusion should be eloquent and it should remain modest. Eloquent, because you want to leave your readers on an upbeat, so that they hold a good impression. And yet modest, do not regale yourself with what you have just accomplished: how pioneering, how outstanding an achievement! Blowing your own horn is a turn-off.

The optimal length of a conclusion is a couple of paragraphs, no more than a page overall, i.e., about 1,500 characters at most. And what are, or should be its ingredients? The Discussion part of the paper will have already critically examined the foundations of the work, the key assumptions made, the quality of the experiments, the statistical significance of the measurements, ..., so there is no need to reiterate this in the Conclusion. Towards the end of it, readers should find a one-sentence summary of the work, couched in a neutral, objective manner – remember to avoid one-upmanship, it stinks. Readers need such a sentence to reassure and perhaps convince themselves they have grasped the essence of what you had been telling them.

Bringing a scientific publication to its conclusion need not resemble the closing of a door, for two reasons: any scientific contribution is open-ended, moreover it is open to criticism and controversy too. You wish to

craft your conclusive sentences accordingly. Why not devote them, instead of burning incense to your own immortal glory, to a forward, prospective look?

Thus I recommend that your conclusion consist predominantly of statements about possible or probable extensions of the study which has just been reported upon. It will help you, in any case, to clarify in your mind what this future task consists of, whether you intend to do it or not. It will give your readers the sentiment that you are behaving responsibly, that you have an authorial attitude towards your work, worthy of respect. The clarity with which you will set your results in context, within the evolution of the discipline, more than within the narrower framework of your own evolving research, is a marker of a fine, thoughtful conclusion.

REFERENCE: M. Alley (1996) *The craft of scientific writing*. 3rd edn, Springer, New York.

favor nonprofit organizations ↘

ELECTRONIC PUBLISHING

*A*re we witnessing the demise of printed journals, with the transition to electronic publishing? Broadcasting science on the World Wide Web has many advantages. It is less costly, at least in principle. It spares considerable numbers of trees from being turned into paper pulp. Each page appears exactly as it was formatted, from use of software such as the Acrobat pdf. Bypassing printers accelerates publication. Moreover, closeness to e-mailing amounts to a return to the origins: in historical terms, science journals originated with private correspondences between natural philosophers, during the seventeenth century.

Those are all assets. But there are issues too, which need addressing. Free access has been a universal rule for the **Internet**. While consistent with the scientific ethic, which encourages the widest discussion and criticism, it runs somewhat counter to the need of the publishers, including professional societies. These want to make a profit, enough of it in any case to support electronic publishing. One can only hope that the Internet phenomenon will favor nonprofit organizations with respect to commercial publishers. This may well turn out to be a vain hope. Indeed, one should recognize a pivotal consideration. The editorial process bears

the major portion of the cost of publication – an invariant in going from traditional to electronic publishing.

One might argue indeed that the main issue of electronic publishing is editorial control. Academic publishing has thrived, over several centuries, by certifying a paper's validity in a number of ways, not only peer review but also prestige of the journal, and the whole scholarly process, from recording an observation in a laboratory notebook to having one's paper see the light of publication.

In the Age of the Internet, peer-review is made somewhat easier and faster by technology. It is essential that the quality control it ensures retains its excellence and be not debased. Scholarly values are inherently conservative, which may hinder at times the spread of revolutionary new ideas. Adherence to them may also stifle participation from developing countries to the advancement of knowledge. Editorial control is necessary at all stages of scientific communication, in order to ensure maximum discussion of the contents of each paper, while protecting its authors from *ad hominem* attacks and from gratuitous controversy, merely for the sake of being contentious.

The Web brings with it a facility, the electronic library. In the near future, each scientific paper will carry a bibliography of so many links, each of which will offer a virtual entry into a subset of the literature. I deem most promising this new dimension of publishing. With the appropriate technology, it ought to vastly decrease the amount of unnecessary duplication of effort and results.

The Web also carries with it a patchwork organization. It is segmented into discussion groups, centers of interest, ..., i.e., into a collection of highly specialized niches. This is worrisome. Science needs interdisciplinarity, it also needs for its sociology to include cores of people who are generalists, not specialists. Thus, I encourage you to publish in hyperspace in the less rather than in the more specialized journals. Otherwise, self-selecting of the readership into groups of narrow specialists may give the kiss of death to science. Even a cursory look at science history shows that real progress has always been both unpredictable and on the margins, rather than occurring in the mainstream.

I shall merely mention the issue of copyright, since fighting unauthorized copying and piracy conceivably will make effective use of technological tools. A more worrisome issue, I believe, is the archival: no worldwide agency is presently empowered and funded to preserve all the material which appears on the Net, electronic publications in particular. Yet,

scholarly work demands being preserved, and even the more so in the absence of current interest.

Moreover, rapid technological change ensures that supports for the data have an effective lifetime measured in just a few years. The example of floppy disks, Zip disks, CDs and DVDs, comes to mind. Fortunately, for the last 30 years or so, migration of digital documents from a machine, an operating system or an application program has been the preservation method of choice. It may well be so ingrained by now into our mental habits as to become a universal rule for archival safeguarding.

REFERENCE: G. P. Schneider, J. Evans and K. T. Pinard (2005) *The Internet illustrated introductory*. 4th edn, Course Technology, Boston MA.

harbinger of scientific collaborations ↘

E-MAILING

E-mail is easy, too easy. To e-mail indiscriminately, in mass, is to abuse the recipients, thus also drowning information in noise. The ability to dash off a note to a correspondent from anywhere, by typing on a keyboard, is a dream come true.

The greatest asset of e-mail is arguably its informality. In the office, e-mail has become the choice mode of communication among coworkers, using an intranet web. It has supplemented, to some extent has replaced conversations at the bench, in the instruments room, in the halls or next to the coffee machine.

To turn from local use to the global, e-mail allows one to reach out across the oceans, with no hindrance from the differing time zone – a superiority over phone or fax. This asset has been turned into habit, one wakes up in the morning to a detailed answer. It is such a nice and easy way to exchange information that it is a harbinger of scientific collaborations. I wrote a whole book in collaboration this way, trading chapters (or rather scenes in a play) by e-mail. The two of us did not need to get together at all. Nevertheless, we went through a baker's dozen of revisions.

Beware of the disadvantages of the informality. Those include the shapelessness of quite a few messages, the misspellings, the abuse of abbreviations and of cyberspeak. They blemish the appearance. The contents of a message suffer also from flippancy, if not from downright vulgarity.

E-mail can stoop to the level of a graffito scribbled on lavatory tiles. This need not be, but is too often the case.

E-mail suffers also, not so much in principle but in practice, from the lack of a permanent record. We exchange a large amount of correspondence and it vanishes into thin air. Usually, after a few weeks, months or years, instead of being archived, it is deleted from a personal computer. The loss is definitive. It is grievous, at least to librarians and to historians.

Which serves to emphasize that any message has to be significant, in order to rise from the noise, let alone endure. At the time of writing (autumn 2004), the signal-to-noise ratio for e-mail is of the order of one in ten. For one significant message, we receive on the average about ten pieces of garbage – known as spam in cyberspace. Avoid like the plague spamming your colleagues, or giving them impression of being deluged (by you!) with information they can do without. In that category: militant political propaganda, commercial advertising, newspaper clippings passed on, cartoons and jokes, ... This is my recommendation, resist proselytism, i.e., curb the impulse to widely circulate unsolicited files to people on an e-mail list, who belong to the circle of your professional acquaintances.

A positive recommendation now, as forceful as the warning just uttered. A good use of e-mail will hone your personal expression. Make it a genuine voice-mail: it is ideal for transmission of your own voice, with its idiosyncrasies, its mannerisms, its most endearing features. E-mail is or can be a written transcription of speech. In-between text and speech, it can become a close approximation to speech, this is up to you.

Truly, e-mail is speech: all the more reason to keep it articulate, direct and clean.

REFERENCE: J.v.Emden (2001) *Effective communication for science and technology*. Palgrave Macmillan, London.

a keen awareness 

ERUDITION

Some people may be surprised to find this word and notion discussed here. To them, erudition evokes old dusty volumes molding on library shelves, an arcane or disused knowledge absolutely antinomic to living, throbbing science. The two main reasons for their myopia are the

cults of novelty and of facts. People interested only in facts pay no attention to their progenitors, nor to the process through which such facts were garnered. And yet we know (indeed for a fact) that any scientific fact is theory-laden. In other words, it stands and it means something only within the framework of a theory.

But what is erudition? The function of science is to acquire new knowledge. Another process is the accretion, accumulation and archiving of the existing knowledge. This storage function is performed by libraries, data banks and, most important, in human brains. Erudition is the retrieval of crucial information from such vaults. It is responsible for attribution of intellectual work to its sources. Erudition is the routine, normal activity of the scholarly mind when it delineates the historical roots of things and concepts.

Thus it becomes very obvious why erudition pertains to science and its communication. Science is cumulative. It is a layered manifold. Any understanding, whatever the phenomenon studied, requires leafing through these layers and pages.

Any piece of work builds on earlier knowledge. The authors of a scientific paper need a keen awareness of the earlier work which their own study has built on. Not only do they need to assemble such a **bibliography** in the course of their work, they also need to acknowledge in print their indebtedness to the earlier authors. It is part of the evidence which they have to provide for their readers. In other words, erudition is the means by which they will make their own contribution stand out. Only the historical dimension supplies such a background, puts a piece of work in perspective and shows it as either epochal or trivial.

The **Introduction** to your paper should carry this information. Supply the needed historical continuity between your work and that of your predecessors. The following image is not too far-fetched: only erudition will enable you to build a stand upon which to set your results. Not only is this the only way in which they will make sense, it may well provide them with a pedestal for public admiration.

Reference to the past and even to the distant past anchors your publication in history. Instead of belonging with the flotsam of debris which the next wave, the next scientific fashion will sweep away and disperse, you will inject your contribution with lasting value.

With a little luck, erudition may enrich your work with much more, with something essential. You may uncover a missing link which everyone until now had overlooked. It will put paid to the notion (feeble) that

anything more than a few years-old (three years? five years?) can safely be discounted and is best ignored.

REFERENCE: M. Turner (1998) *The literary mind*. Oxford University Press, New York.

an understanding at a single glance 

FIGURES AND CAPTIONS

Make sure that each figure be essential to your paper: essential to the paper, not to your pride. As soon as you realize that you are inserting a figure to advertise the talents in your research group, instead of illustrating a point in the argument, remove it. It is extraneous. It is dead wood. Ultimately, it detracts from your article because it impedes the flow.

What makes a figure indispensable? First, it is a shorthand, a shortcut as well. As the Chinese proverb puts it, a figure may be worth a thousand words. Second, it needs to be attractive. The graphics need to be clean and demonstrative. Find a good depiction of the data points so that their plot makes a nice, interesting curve. Thirdly, a figure may convey information in a unique manner. It may be a need to depict schematically a piece of apparatus, or a model for the data, a mechanism, part of your argument, what have you. In such cases, a figure is indeed the only option.

Whenever your figure is a graph of the data, do not plot out the whole set of data points. Restrict yourself to the main pieces of data. Easy readability of the figure is the reason for such a rule. It is easy to remember in terms of Edward Tufte's Least Ink Principle: any table or figure in a paper ought to be at its most economical of the printer's ink, if it is to be grasped easily, by the eyes and by the brain. Such a cleanup amongst the plotted data is a form of respect for your readership.

Insert a particular figure both within the appropriate **paragraph** – this is not necessarily self-evident, your first decision may not be the best, hence this choice of location deserves careful consideration and even debate within your research group – and as a milestone along the road travelled, i.e., the whole sequence of figures; some readers may well look over the figures before they start reading the paper. The graphics in your paper are an integral part of it.

Yet, at the same time they need to be semi-autonomous from the text.

They tell their own story. Think of their collection as equivalent to the **abstract** of the paper, or to the summary in case you end the paper with a summing-up. Nowadays, many journals advertise their wares with a graphical table of contents. Think of the set of figures in like manner, as a kind of advertisement, informative with respect to what's in the paper and giving the gist of it.

Yes, our colleagues are submerged with information of every kind. Make it easy for them – however humbling to your self-regard as an outstanding prose writer. Offer them an understanding at a single glance (well, at a few really) of the main points of your work.

What constitutes then a successful caption to a figure or scheme? Concision: two sentences maximum. Utter clarity and precision. 100% redundancy with the figure, bringing in any extraneous element is a no-no. 0% redundancy with the text of the paragraph the figure is embedded in.

REFERENCE: Council of Biology Editors (1994) *Scientific style and format: the CBE manual for authors, editors, and publishers*. 6th edn, Cambridge University Press, New York.

claiming priority 

FREE ACCESS

Should electronic publishing be kept unrestrained to individual scientists? This current question may soon be answered. In the meanwhile, it is worthwhile to ponder it, so as to anticipate some of the changes about to occur in science publishing.

Given that the **Internet** is synonymous with a free, unimpeded flow of information, free access is a logical demand. One may draw upon the precedent of blogs: anyone may post on the Net a combination of news and editorials.

Is it however realistic to expect free access to be granted so that any scientist will be free to post his/her results for the purposes of discussion, and of claiming priority and archiving?

Is there to be continued peer review of the material published electronically? Then, the process has to accommodate it as the compul-

sory first step. In the present printed journals system, peer review and preparing a manuscript for publication are not free. Such steps, with the editing involved, amount to about 50% of the publishing costs in a scientific journal, whether issued from a professional society or a commercial publisher. Transfer from hard copy to electronic publishing won't affect such fixed costs. Who is to pay? Authors are notorious for declining to foot the expense of publication. Even with a change in mentality, this factor alone puts a dent in the ideal of open access.

Moreover, free access as a concept clashes with the present realities of scientific publishing: is scientific research more an egalitarian or an elitist enterprise? Open access assumes that it can be made egalitarian. This would be a revolutionary change. Scientific publication currently obeys an elitist, not an egalitarian model.

Bibliometric data are eloquent. They follow Zipf or Pareto-like distributions, which points to a hierarchical social organization of scientific research. In any given field, the square root of the total number of active scientists is responsible for half of the total output. Assume for instance a field with 100 active participants. Only 10 of those sign half of all publications.

Why such a hierarchical structure and where does it originate? Science is inherently conservative because of its cumulative nature. Newly established knowledge piles on top of prior results.

The training of young scientists, who serve an apprenticeship with a master or mentor, is akin to belonging to a guild of craftsmen. Moreover, universities, libraries, doctoral dissertations all share transmission of the existing knowledge among their roles. This, often a primary requirement, make all such institutions inherently conservative.

To sum up: quality control and open access are mutually exclusive. This jaundiced conclusion may be made void by the practices which will develop, I may have overlooked a crucial feature in my analysis. In which case, it will be very interesting to watch the whole new course which scientific publishing finds for itself.

REFERENCE: S. Bachrach, R. S. Berry, M. Blume, T. v. Foerster, A. Fowler, P. Ginsparg, S. Heller, N. Kestner, A. Odlyzko, A. Okerson, R. Wigington, and A. Moffat (1998) *Intellectual property: who should own scientific papers?*. Science 281(5382):1459–1460.

a fundamental opposition 

IDEOGRAPHIC VS. NOMOTHETIC

This is a distinction useful to keep in mind. Any scientific work mixes the two approaches. The ideographic considers the object of study as a unique phenomenon, whereas the nomothetic attempts to formulate generalizations. The ideographic approach, generally speaking, is inductive and descriptive. It relies more on intuition. The nomothetic tends to be deductive and systematic, it edicts laws.

From the perspective of a classification of knowledge, the hard sciences are on the nomothetic side, the social sciences on the ideographic. But the duality also exists within a single discipline, whether biochemistry or astrophysics. It is a question of temperament: some people are drawn more towards an ideographic style of research, or reporting, others by the nomothetic. The duality goes a long way in explaining the difficulty of the dialog between a scientist and a journal referee. Their worldviews differ entirely. When they argue a given result in a manuscript, truly they are expressing a fundamental opposition. It may well be that the author, having a more ideographic mindset, does not wish to go beyond the piece of datum to an interpretation. The referee, whose outlook is nomothetic, finds such behavior myopic at best and takes the author to task for not attempting to rise from the observation to the underlying law of nature. The opposite scenario can also occur, when a study takes a nomothetic view and attempts sweeping generalizations; while the referee enforces a positivistic attitude, sticking to the letter of the results and avoiding any overinterpretation of their meaning.

The distinction is also useful with respect to science communication. When a practitioner of the hard sciences addresses peers, the nomothetic style is more or less to be expected and compulsory. By conforming with the format of publications in scientific journals, one willingly adopts this approach, which in any case is the most familiar. When addressing the public, the message needs reformulating and reconstructing. It begs for a switch from the objective to the subjective, and the ideographic approach reasserts itself.

Hence we should remain aware of this very basic distinction. It operates in every field of research, it colors any piece of scientific writing, whomever it is addressed to.

REFERENCE: P. T. Manicas (1998) *Social science, history of philosophy*. In: *Routledge encyclopedia of philosophy*. Routledge, London.

ILLUSTRATION

To combine image and text ought to be a winning combination. But is it truly? What are the conditions for success? Ought images and the text they illustrate be redundant, or just complementary to one another? Should they be alloyed into unity, or only allied in a form of parity? And what is it that makes an image interesting?

A lesson from history is that the answers to the above questions have changed markedly with time. As early as the thirteenth century, Western libraries carried manuscripts in which blocks of text were interspersed with technical diagrams. In the sixteenth century, printed reports from travellers were illustrated, not only with maps of the exotic lands which had been visited, but also with woodcut engravings showing the strange human types, the extraordinary plants and animals from the places visited. The Renaissance was also the time for the appearance of anatomical plates: they made possible diffusion of brand-new knowledge about the body, ushering-in a revolution in medical thought and in surgical practice. The seventeenth century witnessed an innovation of lasting value and consequences, the insertion in books of diagrams for concepts. Both Newton and Descartes, among quite a few other authors, made use of such illustrations. As for the Enlightenment, it created its own versions of diagrams as tools for thought. This was the time when the first bivariate plots and the first histograms were published (William Playfair, Jean-Henri Lambert).

From the mid-seventeenth century on, a key role of scientific illustration was to display the otherwise invisible. Robert Hooke was the pioneer, when he published in 1665 his *Micrographia*, i.e., an atlas of plates drawn from viewing a wide diversity of specimens through the microscope. John Dalton, about 1805, illustrated his atomic theory with schematic representations of atoms in molecules. Fox Talbot, one of the co-discoverers of photography, entitled *The Pencil of Nature* the portfolio of photographs which he published in 1844. The notion he advocated was that nature, through this novel means, was able to express herself and to draw her self-portrait – a remarkably naive statement. Eadward Muybridge, in 1887, with another album of photographs, collecting series of still pictures shot at short intervals, *Animal Locomotion*, was able to analyze movement and to describe accurately the strides taken by, e.g., a galloping horse. Just a few years later, Röntgen, with his famous X-ray picture of a hand, would depict in 1895 the ability of his new rays

to penetrate matter and to image, as it were, its innards. A year later, Becquerel with his picture of a key would extend it to the mysterious rays emanating from salts of some heavy metals. All such pictures, from Hooke to Becquerel, demonstrated the uncanny power of science, for depicting reality in ways never seen before. Scientific images replaced the mythical images of yesteryear, the mermaids and the unicorns of legend, with novel sources of wonder.

But what are the roles of illustrations in scientific publications, if not multiple and diverse? I see six main functions. The first is documentary, to show that something is real, that it can serve as a piece of evidence. The second function of an image is methodological, when it depicts an experimental set-up, an apparatus. The third, non-identical with the first, is persuasive: an image shows that a model matches, more or less, the data. The fourth is also a little different; it has anteriority over the one just mentioned: heuristic use of a diagram, such as an histogram or a regression line, to try and make sense of the data. The fifth is to use an image as a short-hand for a description in words: a flow-chart plays such a role. Finally, an image often serves to communicate to the viewer the quality of the work done, in a rhetoric of excellence (one-upmanship and self-promotion at work).

As is well known, and as is to some extent an exaggerated difference, the two halves of the brain process differently visual and verbal material. We see things before we become able to name them.

Moreover, the visual has greater informational content (*»a good picture is worth a thousand words«*, this Chinese proverb can be trusted). Pattern recognition allows a reader of Chinese pictograms to give meaning to one among several thousand characters. In another form of visual literacy, a sequence of discrete images makes up successive frames in a story. Not to forget the hedonistic component, more easily fulfilled for most of us with images than with text.

What are, by contrast, the assets from a textual mode? It allows the convincing presentation of a linear argument, such as a series of logical deductions or inferences. It offers narrative continuity, where images – I am talking here about still images, not about those from a movie or a video – are by necessity discrete.

We are all familiar with iconic narratives. I am about to push such means as a highly effective tool for telling a story. In the presence of an illustrated text, as a rule people look at images first. The set of images in a scientific publication has a life of its own. Semi-autonomous, it tells a sto-

ry of its own, at least its own version of the story. Respect for your readership dictates that you make this channel an effective summary of your message. If you devise it as self-contained, it won't duplicate your textual explanations, it will contribute its own, separate appeal and dimension. In science communication, the images often amount to evidence while the text amounts to rhetorical discourse, aimed at convincing its reader.

Not to forget: there is a third channel of communication, in quite a few science reports, the equation. It is a shorthand, with heuristic value. It consists, literally, of thought in action.

The text presents an argument, aims at convincing (I am repeating it for emphasis), and sums up at the end. Conversely, the image, akin to an exhibit in court, also pleases the eye.

The right brain hemisphere is predominantly non-verbal. It excels in the visual, it seeks to determine relationships between objects perceived or imagined in space.

The left hemisphere processes information sequentially, it has been described as the analytical half. It is more adept at processing verbal information. Verbally presented material, textual material equivalently, is encoded only in the verbal mental apparatus. Visually presented material is encoded in both the verbal and the iconic systems. This explains why, generally speaking, it ought to be easier to remember pictures.

Now to some recommendations. For a standard length paper, pick a dozen images. Make sure they are interesting, keeping in mind that each is, or ought to be, a story frame. Work on the captions, to make them concise and clear. If you provide your readership with a memorable set of images, you will have told the iconic part of your story.

What is an interesting image? In addition to the Chinese proverb, let me mention the rule of thirds in photography. Divide both sides of a picture, vertically and horizontally, into three segments. Thus, the image consists of nine juxtaposed rectangles. Place the center of interest at one of the four intersections, not at the center of the image.

It is useful to distinguish between literal representations that are intended to resemble the object they portray, and symbolic or schematic representations. Charts, graphs and diagrams occupy a middle ground. There is a continuum between realistic pictures, which resemble what they portray, and words, whose meaning is conventional.

Diagrams are subject to three rules, of specificity, selectivity and simplicity. They are specific. Any diagram carries a single concept. Overload it, and it sinks. Diagrams are selective. Any diagram selects from an infi-

nite set of possibilities a single type. It is selective also with respect to the data chosen for depiction. And diagrams follow a principle of simplicity, or rather of simplification: a diagram operates like a special pair of glasses which, when trained upon a complex system, simplify into such an understanding, that a mere single glance suffices.

The main function of diagrams is heuristic, as a tool for thought. Charts such as maps, diagrams and graphs are effective in instruction, because they allow students to use alternative systems of logic. Learners can bring to bear their specific skills. Some people are able to recognize quickly geometric patterns. Others are less conversant with right-brain processing.

Devote great care and quite a bit of time to devising good captions. Ideally, the viewer is intrigued by an image and turns to the caption to better understand what is shown. A didactic mode is thus usually expected, one that is somewhat redundant with the image. Nevertheless, it has to remain brief. With choice words, describe this key scene in the iconic story.

And what happens if, conversely, one uncouples an image from the accompanying text? Turning them into entirely disjointed stimuli is often a nice trick. It gives the viewer a feeling of freedom: free to take pleasures from the images, free to gather information from the text. Entertainment and learning are separate but equal, they coexist on the page. The now defunct monthly magazine *The Sciences*, which was published by the New York Academy of Sciences, under the editorship of Peter Brown, made this its policy and, as it were, trademarks: articles on scientific topics were illustrated with reproductions of contemporary art pieces, which had little to do – quite a few were nonrepresentational – with the subject matter in the text. This was wonderful! I'll come back to this issue at the end of this segment.

Photographs, as illustrations, provide the documentary illusion: the reader can project into the laboratory, looks at the oscilloscope or through the eyepiece. Reproduction of the document with a picture is unavoidable with such evidence as an MRI scan of the brain, or images of atoms on a surface, as captured for instance by atomic force microscopy. Historical or archeological artifacts need likewise photographic documentation. The apparent objectivity of the medium gives the image the appearance, nay the illusion of reality.

However, several studies in the field of perception have concluded that subjects can recognize three-dimensional objects at least as well, if not better, when the edge lines (or contours) are drawn, by contrast with

shaded or textured images. Thus, line drawings have to be privileged over photographs as an effective means for identification: we do not see photos of our politicians on the front page of newspapers, but caricatures which both simplify and exaggerate their characteristic facial features. The preference to be given to line drawings over photographs is consistent with Tufte's Principle of least Ink for effective graphic design.

Plotting two variables (x, y) against one another is, arguably, one of the main graphic tools for scientists. Whenever displayed in the ensuing paper, as a rule it is beset with obesity: too many data points. Use the smallest number which will support your argument. You will anyway state the total number of points in the text, when you provide a correlation coefficient for the regression (if linear). Such an image, known technically as a bivariate plot, is a great way to focus attention on the discrepancies. Truant data points may well be the most interesting to the investigator.

Scientists tend to pride themselves on linear regressions. What is good about this attitude is that it partakes of a quest for simplicity. However, data reduction does not stop with the finding of a correlation (remember: it does not imply causation). It entails building a model which will, not only explain the reason for the correlation, but also account for it qualitatively and quantitatively.

Pie charts display qualitative data. Histograms are a great tool to display and interpret accurate quantitative data: even minute differences in height jump to the eye.

Visual and verbal elements are in pronounced contrast. The former reveal, at a glance. The latter have a cumulative effect. The former are illuminating, the latter are argumentative. The former have the potential for being misleading, the latter can also be hijacked and this is the tall tale.

You have to exercise control, so that they do not conflict. Both kinds of evidence differ as to their strong points, as they differ in their capacity for delusion.

Such control is applied through the *offset* you choose to give an image with respect to the text it illustrates. If minimal, then the image has maximum documentary content, minimum symbolic content. Its chief role is didactic. At the other end of the scale, at maximal offset, the image has negligible documentary content and dominant symbolic content. Its chief role is oniric and subliminal, to massage the unconscious. In-between, going from weak offset to strong offset, the documentary content of an image goes from great to significant to minimal, while the symbolic

content goes from light to attractive and to captivating. The corresponding intended roles of the image are, respectively, persuasive, the anecdotal, and enigmatic.

REFERENCE: E. R. Tufte (1983) *The visual display of quantitative information*. Graphics Press, Cheshire CT.

an organizing scheme 

INDEX

Which books don't need one? Perhaps a 35-page-long lyrical description of sunsets – St-Exupéry's *Little Prince* did not carry one. A romance, such as *The Bridges of Madison County*. A play.

Most other books are improved by having an index. Its name is transparent. Like the finger with the same name, this device points to something, the location of a particular item in a book. It does so by coupling the name of the item with the relevant page number. Experienced readers know how to use it, to look up the various appearances of a given name or topic. An index is a tool for information retrieval. It allows one to access the desired piece of information without having to browse or read the book. Or one may remember having read something in which case consulting the index is a shortcut to finding it again.

Since it is of such service to your readers, an index is an absolute *must* in a good book. The presence of an index is near-compulsory in any work of non-fiction. Furthermore, a good book deserves to close with a comprehensive, detailed index.

What do I mean by the phrase »a good book?« In science communication, books cover a wide range, from the journalistic to the scholarly. Only in the former is an index dispensable. It is a *must* in the latter.

There are specialists, within the publishing industry, whose job it is to compose indices. A professional indexer brings special skills and a kind of genius to the task. As an author, to interact with such a wizard is a most rewarding learning experience.

Often and in the less ambitious books, the author may be the most qualified person for compiling an index. My recommendation is to try and compose it yourself. Putting together the listing of names and topics in your book is no longer the ordeal it used to be when one had to write

file cards and organize them alphabetically in a shoe box prior to typing a long list.

The personal computer has put an end to that. Software now allows you to highlight all the words that you designate for the index as you go along. After your very last editing, read the manuscript one last time for this sole purpose.

I have so far emphasized only the aspect of service to the readership. However, the index is also a tool for you, the author. It is a detailed analytical table of contents, magnified to the utmost detail. Hence, you can use it as an organizing scheme. It is not unknown for a conscientious author to compose the index for a book before writing a single line of the manuscript. By doing so, you will ensure that all the topics you wish to include will be covered, and all the authorities cited.

REFERENCE: T. M. Bernstein (1984) *The careful writer: a modern guide to English usage*. Atheneum, New York.

being distinctive 

INTRODUCTION

An overspecialized organism may face extinction. It lacks the flexibility to adapt to changing conditions. While overspecialization may not make science disappear, given social needs, it does it great harm. Nowhere is this more obvious than when perusing titles of papers or reading through their introduction.

Thus this will be my first recommendation. Write for the generalist, not for the specialized reader. This will compel you to take a bird's-eye view of your work: what did you achieve exactly? What were the bases for launching this study? Which will stand as your most robust conclusion? What are others in the field likely to pursue in direct filiation?

You need also to be reminded that you are competing for the attention of the readership in a flood of other printed material. Your prospective reader is leafing through the pages of a periodical on a computer screen, or negligently turning the pages of an actual journal, while giving full attention to information from the Web. Accordingly, your introduction needs to be much better than catchy. It has to be compelling.

How can you achieve it? By being distinctive. Identify what is unique,

not so much with your research but with yourself, your personality, your voice. Colleagues are interested as much in your approach to science as they are in what your paper establishes.

Having expressed these essentials, delve into the more obvious parts. Writing an introduction is equivalent to throwing open your room, turning your private space into public space. A lab notebook becomes a blog. Your study becomes a cubicle in a crowded place, with onlookers behind your shoulder, watching your every sentence. Those are apt metaphors. They translate into these rules: (i) Spell out and make explicit what is given to you. It is one of the functions of an introduction to tell why you did this particular study and what you hoped to achieve. (ii) Anchor your contribution into the scientific flow, i.e., refer to earlier work by others and to contemporary work by your competitors. You won't lose any credit by giving due recognition. You will gain in respect and you will only reduce future animosity.

I am not telling you to shy from waving your flag. Advertising is definitely involved in the writing of an introduction, but the softest of touches is needed. One-upmanship can be very destructive.

Don't omit telling the readers what they are about to find in the rest of your paper, if they keep at it. Your introduction provides an advance summary.

Now that you have heeded these instructions, you may have drafted three manuscript pages. You need to edit them. Condense your introduction into no more than two or three **paragraphs**, one page maximum *in toto*. In making it short and crisp, make sure that the writing is fluid and clear. Brevity is golden.

REFERENCE: J. Zobel (2004) *Writing for computer science*, 2nd edn, Springer, New York N.Y.

element of hypocrisy 

I OR WE?

For a paper with a single author should a scientist use the first person singular (I) or plural (we)? The latter, the more formal way of addressing one's readership, is also the more traditional. In support of this

convention, one of the many lessons from the history and philosophy of science is to see the advancement of knowledge as collective and cumulative, not as an individual endeavor. Thus, in that view the role of any individual scientist should be played down.

Conversely, there is an obvious element of hypocrisy in the use of that style. It partakes of a whole set of other conventions, which when taken together make for a way of writing that is rather leaden and for the resulting poor readability. I shall only mention here the systematic use of the passive voice, the one-upmanship manifested in statements of »we are pleased to report« type, and an overall legalistic style in which any assertion is accompanied by its qualifications.

Why not write in the first person? It has the double asset of being more genuine and more direct. It forces the author of the paper to present his or her argument in the form of a narrative – which is good since it is likely to induce greater interest from any readership.

Indeed, if the history of science can guide us in deciding between these two options, we ought to remember that scientific publications originated with private correspondence. Letters by philosophers-scientists reported their findings, and they were gradually disseminated to a whole network of acquaintances. Indeed, if we want to follow tradition, then we ought to go back to such a conversational style as was used in the seventeenth and eighteenth centuries before the advent of scientific societies and the first professional journals.

If we do so, this may be perceived in the community as a sign of arrogance. »Who does this upstart think he is?«, a few of our colleagues may grumble. And they may be in the right. It takes high quality indeed for any work of science to be presented with pride, with the pride attached to its lasting value. Is such a self-confidence justified?

Thus, the choice between »I« or »we« boils down to a question of whether self-assurance is warranted on your part. There is a pro, but there is also a con. Con: you know very well that any conclusions are tentative, that once published they will undergo critical scrutiny from the scientific community and that, in the long run, they are more than likely to become superseded. Pro: you deem your results important, you have checked them with the utmost care, and you stand by them.

REFERENCE: R. Barrass (2002) *Scientists must write*. 2nd edn, Routledge, New York.

IRONY

To write a piece in an ironical mode or to sprinkle bits of irony over a paper is not reprehensible. To the contrary, it gives a lilt to your prose, it makes it more buoyant. Moreover, if you are writing a review of any kind – be it of a research proposal, a **referee report**, a **review article**, a summary of a study from another research group, ... – then an ironic tone becomes near-compulsory.

Irony belongs to the same family as wit and sarcasm. It is a subdued form of humor. Without your being outright funny, which almost always is unacceptable to editors of scientific journals, a touch of irony, a few self-deflating comments will pull in readers, and put them on your side, while lightening your piece.

After all, playfulness is essential to science. It colors everyday life in the laboratory. It can find its way into publications through the private language of the laboratory turning into an accepted shorthand expression in the literature.

For instance, certain DNA-protein conjugates are devised with the help of chimeric molecules comprised of a protein head covalently attached to an oligonucleotide tail. Their nickname, »tadpoles«, has now migrated from the Molecular Sciences Institute in Berkeley, California where it was coined, to the open literature, such as the magazine *Nature*. In echoing it there, Garry P. Nolan writes (ironically):

»Brent and colleagues applied (...) molecular gymnastics to create a novel detection reagent, which they quixotically term »tadpoles« for their apparent shape and the series of metamorphosis steps they must endure until their final maturation and application.«¹

The words »gymnastics« and »quixotically« in this sentence bear the color of irony.

If irony needs to be distinguished from wit which it closely resembles, it also needs to be carefully distanced from sarcasm. Sarcasm in print is an unacceptable form of aggressivity, even though competition between research groups sharing similar goals fosters it. Such expletives should stay within the walls of your laboratory. You can project your competitiveness in other ways, by spicing-up your research reports with the salt of irony. Thus, you will mute your criticisms of what you may consider

– whether rightfully so or not is immaterial – shoddy work, overinterpretation of the data and intolerable self-aggrandizement.

No one will take real issue with small, ironical jabs, especially if some are turned against yourself in a wry, self-deprecatory manner. Any scientific communication needs to be tinged with doubt, if anything as a portent of the critical reception the scientific community will greet it with.

Irony will make your voice stand out. This is also a necessity. You want to appear as an original and a creative scientist, rather than just yet another anonymous contributor to the public discourse. Your approach should be distinctive: mark it with irony.

Irony is defined by dictionaries as a contrarian trait. Even though this is true, it is nevertheless too strong. I prefer to consider irony as a verbal tease. It is a way of neither taking oneself nor one's antagonists with utter seriousness.

Life is a comedy, at least for part of the time. Scientific life is no exception. To write ironically is to heed that fact.

REFERENCES: G. P. Nolan (2005) *Tadpoles by the tail*. Nature Methods 2:11–12; the primary publication which Nolan comments upon is: I. Burbulis, K. Yamaguchi, A. Gordon, R. Carlson, and R. Brent (2005) *Using protein-DNA chimeras to detect and count small numbers of molecules*. Nature Methods 2:31–37.

riding the wave 

NEOLOGISMS AND EPONYMY

Why do some scientists come up with new words, which they impose on their readers and listeners? Do they enrich or pollute the language? The good reason, which applies to perhaps a tenth such additions to the lexicon, is new concepts that need new words. The real reason is advertising of one's work, one-upmanship. The habit thrives on the need for novelty.

Such a need, respectable in itself, has become as unconscionable, as rude as scratching one's crotch in public. So many of the **opening paragraphs** in a publication carry phrases which overuse has made meaningless such as »for the first time«, »we have recently disclosed«, »the use of X has emerged as a new and important field«, »we have recently reported«,

etc. Jaded as we have become, such wordings get under our skin like some of the most blatant attempts at manipulation in TV commercials, which are not even funny.

Let us look at an actual example. It explains the constant need of language to incorporate new terminology. It also shows scientists riding the wave of these additions. The word »surfactant« has entered common language. A surfactant molecule reduces surface tension, generally in an aqueous medium. A sub-class is known as »gemini surfactants«. A surfactant molecule comprises a head group and a tail, made of a hydrocarbon chain. Gemini surfactants have two head groups and two tails. The two moieties are bridged by a spacer, which connects either the head groups or the tails. The term, gemini surfactant, was coined in 1991 by Fredric M. Menger, who in 2000 also published a review article on these compounds.

The new term is a shorthand, which explains its entering general use. It might have been different. Perhaps, Dr. Menger also considered other names such as, to quote only a few, binary surfactant, tandem surfactant, joined surfactants, twin surfactants, dual surfactant, duplicate surfactant or even catamaran surfactant, which is exactly what it looks like, schematically.

»Gemini« was an inspired epithet, everyone knows this sign of the zodiac. It has a strong symbolical meaning, drawing from astrology, it is a source of amusement upon transfer to the scientific sphere. Moreover, when Dr. Menger introduced the new term, everyone in the field knew him as the progenitor. Accordingly, to refer in a publication to gemini surfactants was an implicit homage to Dr. Menger, which cannot have displeased him.

However, any metaphor is loaded and the excess baggage can become a nuisance. If the Gemini sign is well-known, most graphical representations show a head-to-tail disposition of the twins. Gemini surfactants, conversely, show a head-to-head arrangement of their two moieties. Which is why I referred above to »catamaran surfactants«.

30 Dr. Menger was no stranger to introducing new terminology in the literature, he was familiar with this form of advertising. Some of his publications in the nineties refer to »chemical collectivism«, or to »chemically-induced birthing and foraging in vesicle systems«.

The take-home lesson? Better to refrain from coining a new term. It will make you look brash and condescending. Do it only if your work warrants it and is truly superior.

REFERENCE: I. Verdaguer (1996) *Making sense of neologisms*. Forum 34(3):98.

for critical asides and irony ↘

NOTES

Information is characterized as either essential or not, as central or peripheral – to an argument for instance. Information that is both essential and peripheral belongs in the notes, not in the body of a text. What about segments of writing which are uninformative but somehow essential? They may be part of the logic or of the rhetoric. How does one tell, for instance, if a statement belongs in the text or in a note? Anything that gets in the way of the main argument, anything of interest, be it of marginal interest, any hindrance to fluidity of a read, has to be tucked away in the notes.

Notes are important, in the same way witnesses are important in a trial. They testify to your not having made up your story. Whereas a text displays a polished prose, the notes manifold gathers all the beams, struts and buttresses which the text needs as supports. They serve as a counterpoint, for critical asides and irony, to qualify an assertion, to provide bibliographical information about the source of a statement. Notes are not meant for the general reader, for someone who has picked up the book at random or having browsed through it and been hooked. Notes are addressed to the scholar, to the expert.

How should you write them, then? In a note, information is at its highest density, concise in expression and compressed. Footnote or endnote? This depends on the house style for that publisher, for this journal. I prefer personally footnotes, which a quick glance at the bottom of the page reveals. To go back and forth between the page one is reading and the back of the book, or the end of the article, is more work. It is too much work, again speaking personally.

The British share with the German a lovely tradition, the bibliographic essay. It serves as an alternative to footnotes or endnotes. The British put it at the end of the book, the German put it in front. The characteristic feature is a narrative of its own. A bibliographic essay makes for separate reading, no less enjoyable than with the text proper, just different. In such a piece, the author shares with interested readers a critical review of the

literature. Each reference is evaluated, not only for its pertinence, but for its quality too.

REFERENCE: A. Grafton (1997) *The footnote*. Harvard University Press, Cambridge MA.

a bait 

OPENING PARAGRAPH

To quite a few of us, composing the opening paragraph is an ordeal. We find ourselves tongue-tied. If we put something down, it stinks. We feel humiliated. We can't write. A double-espresso later, we are at the same point. We feel disappointed and highly frustrated.

What should we do? How to go? Are they guidelines or recipes? What are the rules?

Here is a suggestion for starters. Identify three elements in your work. These might be the method of study, the material observed and your main conclusion. Associate a word or a phrase to each such element. Now compose a full sentence which will include each of the three words or phrases. This provides you with three sentences. Set these in the most logical order. Now, you need some sort of a transition between sentences 1 and 2, 2 and 3. After you have thus glued them together, you are looking at the first draft of your opening paragraph. But you can improve on it markedly. Shorten it. Make it more informal, more natural and congenial.

Now, to another way of attacking your task. The opening paragraph is your hook, as they call it in journalism schools. It is the device with which to hook the interest, the attention too of the readership. Can you think of a fun manner to start your paper, something that will be unexpected, something which you will have fun presenting to the readers?


A third way, rather standard, is to devote the first paragraph to an announcement. You tell readers what is to follow. The opening paragraph will give away the gist of the paper. It tells people: »Here is what I am about to tell you. My story will have the following parts. First, I shall cover the background to this investigation. Second, I will be telling you of our methodology. Third, you will be shown our results. Fourth, will come the

interpretation we submit for our results, whose meaning as you will see is XYZ«.

Let us look at actual cases. A recent paper (autumn 2004) starts with the sentence »*Speculating about the future of science seems to be genetically encoded in scientists.*« Excellent! It intrigues. Whether the assertion is true or not is irrelevant, the conjecture is witty. One is impelled to read on. Another opening sentence from the same journal reads »*The drive to shrink electronic devices to the nano-level, has, in recent years, led to the design and investigation of molecular-scale components endowed with sensing, switching, logic, and information storage functions.*« Too long. Breaking it into separate sentences improves it: »Electronic components have sensing, switching, logic and information storage functions. In recent years, one witnesses a drive for their miniaturization down to the nano-level, the molecular scale.«

I cannot overstate the importance of your opening lines. To invest a couple of hours just in writing your opening paragraph is well justified. The hook has to be made attractive. Find a bait, so that you make a big catch!

REFERENCES QUOTED: G. M. Whitesides (2004) *Angew chem int edn engl* 43:3632–3641; M. Ruben et al (2004) *Angew chem int edn engl* 43:3644–3662.

articulate your viewpoint 

ORGANIZING YOUR MATERIAL

The two obvious steps are the organization of the documentation and of the story you tell. Your documentary material should consist of some research report or results, evidence in favor or against its conclusions, some kind of a logical argument, graphs of the data, and opinions from a number of people who may have been approached in person, on the phone or just from reading the literature. After going through the whole material, make a list of points – typically no fewer than a dozen and no more than two dozen, the numbers give you an idea of how coarse-grained your organizational structure can remain.

Number these various points in sequence. The order you pick does not matter, as long as you are consistent. It can be the logical order, that of

steps in a demonstration or in a persuasive argument. It can be the chronological. It can be any old order. Be aware though that your organizing principle will affect the narrative you compose.

Your first need is indeed to plan ahead and to choose how to segment your text or presentation. You will be ordering your documentation as a function of such a plan. For instance, Richard Dawkins in his little book *The View From Mount Improbable*,² in which he considers the eye as an organ optimized through Darwinian evolution, first introduces cup eyes from the animal kingdom; he then goes on to pinhole eyes; thirdly, he presents lenses-endowed eyes. His obvious organizing scheme is from the simplest to the more involved and complex, a move generally to be recommended.

In organizing any intellectual piece of work, I personally find most helpful the compiling of a list. Anglo-Saxon culture has an admirable trait, reasoning by points: first listing the various points – i.e., aspects, angles, topics, ...in a subject – and setting them in sequence only when a sufficient number has been collected.

But what kind of a sequence? For lack of a better organizing scheme, one well-suited to your material, you may want to opt either for the *logical* or for the *chronological* order. These almost always work fine.

It will often help to write out the opening paragraph of your article, chapter, ..., at the same time as you draft a list of the topics to be covered. These initial sentences will haul behind them those which are to follow. They will thus order gradually, one by one, the whole gamut of items on your list.

Early planning is indeed a necessity. It will make you aware of the gaps which remain to be filled in the documentation to be gathered, prior to any write-up.

Let us assume this first step has been satisfactorily fulfilled. You now need to organize the argument, so that it be logical and proceeds in nice steps. As soon as you articulate your viewpoint, try to think of other takes on your material. Do not utter the *pros* without considering also the *cons*, all the more so that you have refutations at the ready.

As an example of a nicely-flowing narrative stemming from a transparent logical organization of its material, Atul Gawande's »The Bell Curve« essay in *The New Yorker* has these parts: 1. a case history of a debilitating illness, cystic fibrosis; 2. statement of the problem, hospitals in the United States differ markedly in their performance towards such patients; 3. a description of the performance-based grading of hospitals, a rapidly devel-

oping practice at present (at long last?); 4. a portrait of a militant for such grading; 5. a description of a standard program of cystic fibrosis care, as performed in a specialized ward in Cincinnati; 6. by contrast, description of the more aggressive, and much more successful approach taken in a Minneapolis hospital; 7. portrait of the Minneapolis innovator; 8. in conclusion, besides being graded on their results, doctors need to constantly strive for excellence.

My recommendation then is to compile an analytical table of contents prior to putting pen to paper. You only need to flesh it out afterwards, when you tell the story. An analytical table of contents is what can still be found in a number of books, of nonfiction especially. It is what we enjoyed (or infuriated us) in those old-fashioned British novels of the eighteenth and the nineteenth century, with very detailed chapter headings, such as (I am making them up): »23. In which the General does not go to war but nevertheless finds his match.« or »17. Our hero goes to college, becomes sick, quickly recovers and is elected to the debating team.«

An important case is the Discussion part in a primary publication. Needless to say, you will be presenting your interpretation of the results. Remain aware there are other viewpoints too. Thus, you need to play the Devil's Advocate. List the objections to your interpretation. List them from a to Z, trying to be as objective as possible, i.e., having steeped yourself in the firmest of doubts, wearing the robes of St. Thomas. Then proceed to review those counterarguments one by one, settling each on its merits. Your having done so will immunize your paper against the harshest among possible criticisms. You will be able, then, to close your paper by pointing to directions for future study.

Once your text is in working order, turn to the illustrations and do the same. They need to tell their own version of the same story. Order them in sequence so that each image frames an episode in your story. Make sure that the train of illustrations tells the same tale as the text does, although in its independent way.

Such preparatory work, the detailed overall planning of an entire paper or even of a whole book, requires a great deal of thought. But it is worthwhile, a good investment.

There is a yet better option. I have tried it myself a few times. It applies only to the writing of a book, though. As your very first task, put together the **index**. After you are done listing all the entries which you think ought to be part of the index, work backwards. From the list of topics thus defined, cluster them into sections and chapters. Finally, do

the writing. The chief merit of this admittedly unusual procedure is to prevent omissions. Thus, consider the index as both programmatic and recapitulative.

Now and only now you should start writing your story. You know how to organize it, from having heard or read so many stories: 1. set the stage; 2. present the characters, both the »good« guys and the »bad« guys; 3. present the task in front of the good guys; 4. go through the obstacles they face, including the resistance from the bad guys; 5. if need be, have a shoot-out scene; 6. tell how ultimately the good guys prevailed; 7. if you are writing an essay of moderate length, neither a short newspaper piece nor a book, you may want to end, in short story manner, with an unexpected twist to the story.

Last but not least, *where* should such ordering take place? So that it be not disperse, and that you won't have to look in too many places for this roadmap, I suggest that you write it down in a commonplace book, or in the equivalent within your computer.

REFERENCE: A. Gawande (2004) *The bell curve*. The New Yorker, December 6: 82–91.

informative words 

PARAGRAPH

»After all these somewhat abstract mathematical generalities I am now going to show you a few pictures of surface ornaments with double infinite rapport. You find them on wall papers, carpets, tiled floors, parquets, all sorts of dress material, especially prints, and so forth. Once one's eyes are opened, one will be surprised by the numerous symmetric patterns which surround us in our daily lives. The greatest masters of the geometric art of ornament were the Arabs. The wealth of stucco ornaments decorating the walls of such buildings as the Alhambra in Granada is simply overwhelming.«

(from Hermann Weyl (1952) *Symmetry*.
Princeton University Press, Princeton, NJ, p. 109)

A close read of this excerpt from a classic of twentieth-century science makes us aware of the ingredients in a successful paragraph. It is both rich and easy to read, because Weyl chooses highly informative words. »Stucco« is one such word. The phrase, surface ornaments, is meant to contrast with »mathematical generalities«. It does so subtly. Instead of pitting the adjective »concrete« against »abstract«, Weyl chose the word »ornaments«. This noun refers unambiguously to crafted objects, i.e., to actual objects as opposed to mathematical idealizations. Moreover, this noun announces the sentence which follows and gives examples of such ornaments.

Weyl is a master of the subtle contrast. Another example, from the same paragraph, is »prints« versus »dress material«. These are not only apt words, they are evocative too. The second term, prints, indeed conveys an image of surface ornaments, often repetitive in design, consisting of multiple adjacent copies of a pattern. The key word here is the adverb »especially«. It draws attention to the first term, »dress material«, reminding us that woven fabrics in general indeed show repeating patterns.

The next phrase, »Once our eyes are opened«, is quite effective. It is truly the pivot of this paragraph. Having made us attentive, which was the purpose of the preceding words, the writer reinforces such heightened perception by making us be aware of it. What he is really doing is encouraging us to take stock of the wide diversity of symmetric patterns to be encountered in daily life.

The last two sentences serve to substantiate the claim, to exemplify it historically (the heyday of Arabic culture) and geographically (Andalusia), and to draw our attention, again with the gentlest of nudges, to such decoration occasionally rising to the level of high art.

This paragraph shows that science communication can forego mathematical equations, it can dispense with technical jargon. The paragraph is devoted to a single idea: we see symmetric patterns all the time. We ought to take better notice of them.

Furthermore, the paragraph has a point of departure (math) and a point of arrival (art history). In between, it flows very nicely. The »overwhelming wealth« in the last **sentence** neatly pulls together all the elements the paragraph has launched. The phrase is even generous: the writer anticipates and forgives our having been inattentive to the wealth of symmetric patterns around us.

REFERENCE: J.M. Williams (1994) *Style: ten lessons in clarity and grace*. HarperCollins, New York.

this elusive quality ↘

SCHOLARSHIP

A scholar is someone who knows a specific field in depth. Such a definition clearly is not sufficient. We have to elaborate upon it. Scholarship is what prevents the phrase »narrow specialization« from redundancy. Scholarship identifies with broad specialization. Yes, this is something of an oxymoron. There seems to be a contradiction between being specialized, i.e., positioning oneself at the extreme point of knowledge in a given area, and for this sharp point to somehow have diffused into a whole arc. Which explains why few scientists are able to endow themselves with this elusive quality of scholarship. We shall see what makes it desirable.

But we need first to gain a better understanding of what scholarship consists of. One might also term it an old-fashioned quality. The word »scholar« is a relative of »scholasticism«, the school of thought which the New Science of Galileo, Descartes and Newton had to upset, in order to usher in modern, experimental science.

Scholasticism was dogmatic, steeped in the writings of Aristotle and the teachings of the Church. Such a connexion had left scholarship with a somewhat negative connotation: a scholar, in such a jaundiced view, is a person holding on to past knowledge, timorous in the face of novelty, someone who is steeped in, even brainwashed by, the old paradigms.

Accordingly, present-day scientists, new to the pursuit, perhaps unimaginative or not knowing any better, deem scholarship useless and irrelevant to the practice of science. But let us return to the definition of scholarship as »knowledge in-depth«. This equates with **erudition** in the attendant literature. A scholar is someone who is not only familiar with the literature of the field, but who somehow transcends such familiarity. A scholar's brain can immediately give an accurate reference for X, to connect Y and Z and, in so doing, makes one despair of ever emulating that ability.

The counterargument here is: is it not the case that the **Internet** now allows one to dispense with scholarship, since it offers, on any topic, at

the instigation of a search engine such as Google, the whole world of scholarship? Indeed, there is even a subset of this leading search engine known as Google Scholar. To answer the charge is easy: in order to look for something, one has to know in advance what one is looking for.


How then to acquire scholarship? This ability goes with disinterestedness. It is the product of intellectual curiosity. If you do not have the inclination to poke around, to acquire seemingly useless knowledge, to put your work into a wider frame, such myopia will leave you blind with respect to scholarship. The only way in which to gain it is to be adventuresome in your scientific pursuits. For instance, browsing the pages of a journal, while looking up some precise information from a paper in that journal, is one of the efficient ways in which to build up one's scholarship. If this is the way toward acquiring it, how then does one teach scholarship? By the virtue of example, first and foremost.

Scholarship, however, is neither necessary nor sufficient for the advancement of knowledge. It is not necessary: there are discoveries made in a flash such as, for instance, that of the PCR procedure for copying strands of DNA. Cary Mullis did not need to be a scholar in order to invent it. That his breakthrough qualifies more as an invention than as a discovery is a valid point.

Neither is scholarship sufficient to ensure that a contribution be of value. There is the case, all too frequent, of the fine scientist who applies skillfully to the problem at hand all the relevant procedures, who furthermore is well-versed in the literature of the field, and who nevertheless fails to make a deep impact – for lack of vision.

Enough said. To discuss scholarship is to uncover paradoxes and apparent contradictions, one after the other. I shall leave you with the central paradox of scholarship in science: innovation thrives on knowledge of things past.

REFERENCE: C.E. Glassick, M. Taylor Huber, G.I. Maeroff (2000) *Scholarship assessed: an evaluation of the professoriate*. Jossey-Bass Publishers-Wiley, Hoboken NJ.

felicitous choice 

SENTENCES

A sentence is the fundamental unit in any piece of writing. As such, it has to work well. You will need to revise your first draft. You will need to keep working at each sentence to perfect it until it fulfills its role.

To become an invisible and efficient piece of textual machinery, a sentence has to be logical, precise, well-built. It should sound nice, read aloud. It ought to be concise. This provides us with five criteria, logic, precision, simplicity of structure, euphony and brevity.

But let us consider a couple of examples. Here is exhibit A. This actual published sentence reads:

»Modern culture trains us to expect instant answers to every question, but reading encourages slow-fuse inquiry.«

Let us apply the above criteria, starting with the need for statements to be logical. Do we expect answers, in the plural, to every question, or just a single answer to every question? The latter. Do we expect an instant answer to every question? Unlikely. This is an exaggeration. Reading, if considered in a questions-answers mode, does not encourage *inquiry*. Rather, it may provide *answers* to one's questions. »Slow-fuse inquiry« is a non-starter. What is clearly meant is »slow-fuse answers«, which makes sense, not »slow-fuse questions«, which is what »slow-fuse inquiry« amounts to. Is not reading also an integral part of modern culture? A culture does not »train«. A culture molds, induces, incites, encourages, breeds conformity or dissent, ...

Application of criterion number one thus shows Exhibit A to be marred by logical flaws, even absurdities. To remedy them is the first task. A first revised version thus might read:

*»We may expect instant answers to questions.
Yet, reading only yields slow-fuse understanding.«*

I have broken the original sentence into two, simplified the structure, and removed the logical inconsistencies. In addition, a slow-fuse is a delaying device. Hence, we should strengthen the sentence by replacing a noun – a nominal phrase actually – with a verb, thus:

»We may expect instant answers to questions.
But reading delays the fulfilment.«

This second revised version suffers from the second sentence lacking a strong coupling with the first. A better, third revision is accordingly:

»We may expect instant answers to questions.
But reading delays them.«

I won't belabor this example further. I shall only note that the very first criterion, the need for a sentence to be logical, has proven its worth. Moreover, in so doing, we have also satisfied the fifth criterion, that for concision. We have reduced Exhibit A from its original 96 characters to 58 characters, a gain by 40%. Our editorial work has produced something clearer than the original prose, something now readily understood (if rather mundane).

Exhibit B is a sentence from the pen of Richard Dawkins, of *Selfish Gene* fame. This biologist is taking-up the question of organisms evolving eyes, using images of objects the right way up, rather than upside down. Two successive sentences of his read:

»But the physical difficulties of turning the rays round are formidable. Amazingly, not only has the problem been solved in evolution, it has been solved in at least three independent ways: using fancy lenses, using fancy mirrors, and using fancy neural circuitry.«

The first sentence is graced by felicitous choices: (i) »turning the rays around« is likely to have been the first draft. The correction to »round« instead of »around« is good, euphonically, it brings in the alliteration rays-round; (ii) it is written in problem-solving approach, from stating that the »difficulties are formidable«; (iii) it uses only plain language, skirting the technical term (inversion) with the paraphrase »turning the rays round.«

The second sentence flows directly from the first: notice how »amazingly« answers »formidable«. Notice how »amazingly« is echoed in the triple use of the adjective »fancy«. The mood in these two sentences, their color (yes, sentences can be endowed with color), is wonderment at the

beauties of nature, evolution in this case. Furthermore, this second sentence in Exhibit B makes us want to read on. It sketches what will follow. Obviously, Dawkins will next tell us what the three solutions consist of, using lenses, using mirrors or using neural circuitry.

With these two examples, I meant to emphasize how a sentence has to be crafted with care, if it is to carry meaning effectively.

REFERENCE: W. Zissner (1990) *On writing well: an informal guide to writing non-fiction*. 4th edn, HarperCollins, New York.

the invisible, global stockmarket 

SIGNERS

Why does authorship of scientific papers carry such a massive weight? A reason is moral responsibility for one's offspring. Another is the quasi-heroic feat inherent in almost any piece of scientific research. On the average, we are told, a scientist publishes *a single* paper over his lifetime, printing the gist in his Ph.D. dissertation. If this is the norm, then ownership of a whole list of publications becomes all the more respectable.

But is it really? In the idealistic enthusiasm which accompanied the student revolution of 1968, there were proposals to entirely abolish such signs of private property. Some came out in the open literature. Several papers originated anonymously with »Groupe des cristaux liquides d'Orsay.«

To publish is comparable to issuing stock. Your name henceforth becomes valuable in the invisible, global stockmarket in which reputations, good or bad, are made. The stockbrokers are your entire community of peers. Is your name a blue-chip stock, a sound investment, or is it rather a junk-bond, not worth the paper it is printed on? There are many shades in-between these polar opposites. The analogy, moreover, extends to speculative bubbles. For instance, the names of Stanley Pons and Martin Fleischmann, associated with the cold fusion debacle do not ride very high in present public trading.

A related question is, who should be included amongst the authors of a scientific publication? As a rule it results from teamwork. But who qualifies as a member of the team? Obviously not the commercial supplier of chemicals, even though those were needed for the work. But where to

draw the line? Be very restrictive in this matter. The criterion I submit, and deem excellent, is for every single person whose name appears on a paper to be able to both present and defend the entire piece of work. If this exclusionary principle were to apply, about 30% of the current authors would see their names deleted.

The final question is that of the ordering of the names of the authors, if there is more than one. A common usage is to set the name of the group leader first, followed by the lieutenant, and so on, down to the simple soldiers. Such a military ranking, even though frequent in current practice, reflects a single reality, seniority, rather than the actual commitment various people made to the work. When the scientist who has carried out the brunt of the work is put last, it legitimately rankles.

Another custom is to set your name last, preceded by the list of those of your coworkers in decreasing order of importance to the work. This improves upon the preceding habit. Nevertheless, anyone in the know – ultimately, everyone along the grapevine – will refer to this publication by attributing it to the senior author, anyway (which is helped by the asterisk denoting the person one should write to, for reprints, additional information, or anything else). Thus, such a listing may create confusion, to no one's advantage.

Personally, I prefer the alphabetical order of names. This is a British tradition and it has much to commend itself. It is currently in disuse, which is unfortunate. Returning to it would solve many problems.

REFERENCE: S. Bachrach, R. S. Berry, M. Blume, T. v. Foerster, A. Fowler, P. Ginsparg, S. Heller, N. Kestner, A. Odlyzko, A. Okerson, R. Wigington, A. Moffat (1998) *Intellectual property: who should own scientific papers?* *Science* 281(5382):1459–1460.

do not forget to breathe 

SPEECH DELIVERY

Practice makes perfect. Nowhere is this more true than in the intricate art of public speech. Experience makes people good at it. To mention professions for which the vocal dimension is foremost, actors and teachers usually excel at it.

Rehearse often your presentation, not only isolated segments but also at least one nonstop run-through.

There is a great deal you can do to improve your own performance.

First, listen to yourself. Watch a video of your speaking or even reading aloud. You will be your own best critic. Note the defects and the annoying mannerisms. Return in front of the camera for an improved delivery.

There are pre-requisites to good speech. Set your body properly. Be dressed comfortably. Leave your neck free. Your chest and your feet should likewise feel unconstrained and of course painless. Discover which resting positions work best for you. Arms closed across your chest? One hand in a pocket, or posed on the lectern? Make a repertory of at least three such stands between which to alternate. Crucial is the anchoring of your whole body onto a »support:« for instance, a pencil held in your hand or between your hands can serve as such.

You do not have to remain static, to the contrary. Watch performing artists on a stage. They keep moving, don't they? Follow suit. Find which motions come to you naturally. Obey the urge and espouse their rhythm.

You are almost ready for **taking the floor**. Breathe deeply, make several conscious inspirations and expirations. They will help oxygenate your brain adequately, and keep you alert. Start speaking. Memorize and perhaps even rehearse, to someone, or to your mirror, your first lines. They will thus come easily to you.

Try not to read your talk. It will sound much better if seemingly spontaneous. You can help with cue cards to look at from time to time. Your audience will respect your need for an occasional pause, and for taking a breath – literally. They need it too.

While speaking, do not forget to breathe. Make your **sentences** short enough that you can utter each in a breath. Pace yourself. A public speaker is like a horse running on a track: once a pace has been chosen, to change it is tricky. Make sure to talk conversationally, neither rushing through the words nor being agonizingly slow. Study your written text sentence by sentence and mark it. Your breathing needs being brought in harmony with the punctuation. Your delivery will have to convey it by itself.

Volume? You want to be heard throughout the room. Avoid being too loud. Exercises will teach you to project your voice. For instance, say in succession the same word or a sentence, such as »can you hear me?« in order to be heard at distances of one, five and twenty meters. During your talk, make sure to vary occasionally the volume of your delivery, to avoid monotony. For emphasis, you may want to say some of the things in a tone of confidence, which goes with a softer voice – a trick which every teacher uses on a rowdy room needing to be silenced and to become attentive.

Likewise, give different colors to your voice. An extremely useful exercise is to repeat a single word or sentence, such as »condensation of droplets«, in various tones, those of assertion, logic, anger, sharing a secret, being lewd, etc. Such exercises are best performed with a tutor. At times, you may want to emphasize a single word: pronounce it slowly, over-articulate and detach syllables from one another: con-den-sa-tion.


Pitch? It is important that your voice be pitched at its natural, strain-free level. Learn how by reading a text aloud. If you are a beginner, do such an exercise five minutes twice daily. Singing, if you are so gifted, will help you greatly. Being tutored by a professional works wonders. Watching your audience – your audience, not the projection screen – , scanning their faces and making eye contact, these will help you to find and maintain your pitch.

In so doing, find your own voice. This is the basic secret for seducing your audience. If you make people feel there is a genuine person talking to them and sharing knowledge with them, they will bear with you to an amazing extent.

Some people are incapable of it. They speak in an affected, unnatural voice. This unfortunate personality trait probably dates back to teenage years, or even earlier. Their assumed voice is part of their mask, of their public persona. Any audience detests such phonies. The very word »phony« says it all. If you are unfortunate enough to be such a person, you will have to undergo a major change and come out of your hiding place. It may well be that only a psychotherapy will do.

Such a pathology serves to show how fundamental a voice is, to interpersonal relationships and thereby to being an efficient communicator.

REFERENCE: S.L. Tubbs and S. Moss (1999) *Human communication*. 8th edn, McGraw-Hill, New York.

a maximum of 20 characters 

SUBTITLES

These pertain to an article for a scientific journal, for a magazine or, sometimes, in a book chapter. They serve two main functions, to fence off segments in your text and to announce the contents of each such segment.

The first function is typographic. However, you won't have a choice. You will be given the house style favored by the publishers. Traffic signs are visually clean, easy to see and to understand. The format for the subtitles is usually likewise clearcut.

The second function is communication. While it is not your prerogative as author, you will be able to discuss and negotiate with your editor the wording of the subtitles in your piece. Make your subtitles neutral – do not try at being funny or cute – , informative and concise. I recommend a maximum of 20 characters for each subtitle.

REFERENCE: J. J. Gartland (1993) *Medical writing and communicating*, University Publishing Group, Frederick MD.

to grab the attention 

TAKING THE FLOOR

Do it. The expression is to be taken literally. You have been given a chunk of space-time. Your first task is to stake a firm claim over it. Take possession of your territory, of your whole territory, left and right, behind you until the projection screen, in front of you until at least the first row of seats. Be mobile.

A silent walk back and forth, during which you appropriate your space prior to launching into your lecture, helps listeners to focus on you. They will stop conversing. Prior to taking the floor, get prepared. Make a series of deep breaths, inhaling and exhaling slowly. If possible, get it done outdoors by yourself with clean, fresh air. You need to be alert, ventilation oxygenates your brain.

You are now being introduced. It is your single opportunity for surveying your audience. Feel free to address a wink or a smile to people you know. Take register of the various attitudes here and there, you will have to respond to them: expectancy, curiosity, goodwill, or even possibly, but rarely, downright hostility.

After you have been introduced, improvise the first two or three sentences. You will feel, and sound natural. This will help you to slide into your talk proper. Because you need to grab the attention of the audience, your opening lines should be terse, well-built, elegant and distinguished. Write them down in advance and memorize them. The same holds for

your closing statement. Keep in mind the Golden Rule of public speech: start by telling people what your story consists of, then tell it, and finish by summarizing what you have said.

Try to feel at ease. Dress comfortably. Have a drink and your throat lozenges within reach on the lectern, or on a nearby table. Stand straight. Be at the same time poised and relaxed. And breathe! Do not forget to breathe at regular intervals. Believe me, it is not fun to watch someone losing voice, for having forgotten to breathe, in the excitement of **speech delivery**.

Each of your air intakes is the engine propelling half-a-dozen sentences. You need a brace, a support, an anchor for your body. You might place a finger or a hand on the lectern (beside rather than behind it). You may hold your pen, your glasses ... Your hands are being watched, too. Use them. Use them a lot, for expressiveness.

Be not afraid of silence. Underline major words, major concepts, major points by a short, silent follow-up, to let them sink in. For additional emphasis, repeat important or difficult words occasionally. Repeat a whole sentence sometimes, politicians do it all the time in their speeches with what they intend as memorable lines.

Smile whenever appropriate. Be natural: if you need to pause, to look at your notes, blow your nose, or take a drink, go ahead and just do it. Keep track of the response of the audience by monitoring their facial expressions. It helps to make eye contact with two or three persons and to talk to them, as if intimately.

The no-nos? Avoid reading your notes, you should have memorized the gist of your talk. Do not read what shows on the screen, if you are using visuals, the audience is capable of doing it for themselves. Rather than reading, paraphrase what's written, improvise small asides, humorous if possible. Flesh out in an interesting manner the text and images on your PowerPoint transparencies.

And do not forget to end with a recapitulation, underlining your main points in a well-organized and literate manner. Take leave of your audience genially, kindly and courteously. Thank them for the attention they have given you.

REFERENCE: A. Wennerstrom and A.F. Siegel (2003) *Keeping the floor in multiparty conversations: intonation, syntax, and pause*. *Discourse Processes* 36(2):77-107.

TITLE

The two main recommendations are to avoid title-drafting by committee; and for the senior author to spend time putting together a long list of tentative titles, at least a dozen. Prune them to a selected few. They will yield a final choice, whether used as is, or modified until satisfactory.

But let us consider a few examples. »Direct observation of electron dynamics in the attosecond domain« is a good title. It does not use too many words. It states clearly the object of the publication. Can we improve it?

»Attosecond domain« may sound redundant. However, its referent is evident, the authors wish to report their observations in the time domain. Were one to shorten the title to »Observation of attosecond electron dynamics«, nothing of substance would be lost. Yet, the modified title is improved. Be concise, it increases readability. Note suppression of the adjective »direct«, which does not add much to the title – except a sprinkling of hype.

Consider now »Massively parallel manipulation of single cells and microparticles using optical images«. This is a problematic title. Its core, manipulation of single cells and microparticles is fine. We understand that tiny objects, in the scale of microns, are being moved. One of the obstructions to easy understanding is the catch-all word »using«. The title would read better with »monitoring« instead of »using«: one understands the action undertaken and reported to have been watched with a powerful instrument of the microscope type.

The other difficulty comes from the technical phrase »massively parallel«. What I understand it to mean is for the miniscule objects to have been displaced, as a group and in the same direction. Instead, why not »Moving single cells and microparticles as large ensembles, monitored with optical images?«

Or, »Optical images for observing large-scale manipulation of single cells and microparticles?« In this last revision, the contrast between »large-scale« and »single cells« provides an interesting trope. It then only suffices to get rid of the redundancy and shorten the sentence to »Optical observation of large-scale manipulation of single cells and microparticles« to create what is, at least in my opinion, a better title.

My third example is »Serum retinol binding protein 4 contributes to insulin resistance in obesity and type 2 diabetes.« It is long. However, to shorten it is not obvious. This is an action **sentence**, always an outstanding choice. Its subject, serum retinol binding protein 4, cannot be short-

ened, except with recourse to an **acronym**, a move to be banned except in very few cases (such as DNA). The phrase »insulin resistance« is both standard and crystal-clear. Likewise, the two »locations« of insulin resistance, obesity and type 2 diabetes, are accurately and well characterized. The only room for improvement here is with the verb, to contribute. It is a little vague, probably deliberately. One may prefer to be more specific and to rephrase this title slightly: »Serum retinol binding protein 4 bolsters insulin resistance in obesity and type 2 diabetes.«

My last example: »EphrinB2 is the entry receptor for Nipah virus, an emergent deadly paramyxovirus«. The title is somewhat unsatisfactory, it carries two distinct ideas. Why not, then, use two separate sentences: »Nipah, an emergent deadly paramyxovirus: identification of the entry receptor?« »Deadly« is a little surprising, we are used to the adjective »lethal« instead. Choosing between the two is a matter of taste. Nevertheless, those are truly minor quibbles, the original title was very good to start with.

To sum up: clarity first and foremost, concision next.

REFERENCE: M. Alley (1996) *The craft of scientific writing*. 3rd edn, Springer, Berlin, Heidelberg, New York.

it rubs raw 

UNDERSTATEMENT

We have all had the experience. We are in a noisy place, a restaurant maybe. People start raising their voices. A deafening din ensues.

In our time, a resemblance is striking: echoes from the advertising world, whether slogans or images, also try to outdo one another. »X is good for you.« »X is the best in the world.« Moreover, they may intimate at rewards, at personal self-improvement, at a reconciliation with nature, what have you. Their favorite rhetoric is that of the hyperbole – of hype for short.

Hype is not absent from scientific papers. Primary publications resort to it especially. It is found primarily in the **introduction** and **conclusion**. Sentences such as »There has been considerable interest recently in ...« have become near-standard. Other examples include the obsequious »There are few times in a scientist's career that the opportunity arises

to describe a major portion of his own work in a journal as important as ...«, the one-upmanship of »we start with our discussion at the innermost core of the phenomenon ...«, or passing off as a visionary with »the fundamental points in the design of any architecture ...«.

The point in such an attitude is to tell the world, »see how great we are«. This is not the way to do it. It rubs raw your colleagues' skins. It meets with their natural skepticism. It may cause them to shrug inwardly. Instead, let the restricted community of your peers praise you (or damn you). Cheap sensationalism belongs in tabloid dailies with their screaming headlines, not in science journals.

Hype tends to creep in naturally under the pen. A good characterization of hype is overindulgence in adjectives. Just like overindulging in sweets leads to obesity, accumulating adjectives bloats a text, makes it bottom-heavy and turns it into failure.

Avoid hype. Go for the understated. »Small is beautiful.« You won't seduce fellow-scientists by shouting your own praise. In the words of a colleague, always, always hype acts to put a minus mark on a person ... Be modest. You will be repaid in a growing reputation.

Science is cumulative. Your contributions add to it, one small step at a time – even if it appears to be a major step, from your egocentric vantage point. As Newton himself put it (he was reiterating a metaphor dating back to Bernard de Chartres, ca. 1130), »*it I have seen further it is by standing on ye shoulders of giants*«.

REFERENCE: D. Berntsen and J.M. Kennedy (1996) *Unresolved contradictions specifying attitudes – in metaphor, irony, understatement and tautology*. *Poetics* 24:13–29.

the backbone of the sentence 

VERBS

A verb is the backbone of the sentence. It needs strength. As a rule, scientific publications almost uniformly include weak verbs. Overuse has weakened the meaning of verbs such as: confirm – control – demonstrate – describe – design – display – emerge – exploit – find – fulfill – implement – involve – consist – form – monitor – observe – obtain – occur – suggest – surround – report – represent – show. Furthermore, again

as a rule, such verbs are used in the passive voice, which further drains them of substance.

One of the solutions, anthropomorphic since we stand on two legs, is to hang the **sentence** on two rather than a single verb: »a major line of investigation ... is to understand the processes underlying the self-organization of matter and to implement them in artificial systems«. This particular sentence resembles one of those tents held on two masts. Those are the two main verbs, to understand and to implement. Their difference in meaning activates the sentence, it moves it along from the more passive act »to understand« to the more active »to implement«.

Another crutch is the adverb: »Figure 2 shows unequivocally that CH₄ re-forming reactions do not change the number of exposed Ir atoms«. A weak verb, to show, calls for an adverb strengthener, unequivocally in this case. But there were other, better options. By turning around the sentence, one rewrites it as, for instance, »CH₄ re-forming reactions do not change the number of exposed Ir atoms, that is the lesson from Figure 2«. Editing improves it further to »CH₄ re-forming reactions do not change the number of exposed Ir atoms, as Figure 2 tells us«.

The best solution by far, rather than recourse to two verbs or to adverbial-strengthening, is a strong verb. How does one recognize such a verb? By its infrequent use in scientific publications. How does one find it? By looking it up: the number one repository for vocabulary, in the English language, is *Roget's Thesaurus*. Get yourself a copy of this inexpensive little book. While a few of its idioms, nouns, adjectives, verbs, are hopelessly obsolete, it will nevertheless provide you with an enrichment of the lexicon.

For instance, paragraph 525 of the *Thesaurus* offers quite a number of alternatives to »show«: to manifest, express, indicate, point out, bring forth, bring forward, set forth, expose, produce, bring into view, set before one, hold up to view, lay open, lay bare, expose to view, set before one's eyes, show up, bring to light, display, demonstrate, unroll, unveil, unmask, disclose.

REFERENCE: R. Graves and A. Hodge (1990) *The use and abuse of the english language*. Paragon House, New York

OTHER REFERENCES: the first quoted sentence is from A. Petitjean et al (2004) *Angew chem int edn engl* 43:3695–3699; the second from J. Wei and E. Iglesia (2004) *Angew chem int edn engl* 43:3685–3688.

VISUALS (FOR A LECTURE)

To seduce through the ears and to appeal to the eyes, those are your tools for a talk using visual aids. What are those? Typically slides or transparencies, they alloy images and text. Sometimes, they consist only of images, or just text. Aim at about a slide per minute, about 60 for a one-hour talk; for transparencies, every two or three minutes, which translates to about 25 for a one-hour lecture.

Include in your presentation the recurring indication of the advancement of your talk. It is important that your listeners be given such information: how many more parts to the talk, how far from the summing up, when is it going to be over? Show a table of contents at the start, return periodically to it to indicate what remains to be covered.

My first rule is the most difficult to implement: make your visuals and your speech complementary. Their occasional redundancy is good. But avoid duplication becoming systematic. For instance, avoid reading aloud what is written on your slides. Your audience can do it much more quickly silently. Paraphrase the words on the screen. This is easy. However, to paraphrase creatively, in a witty and seemingly spontaneous way, is quite another ballgame. How to achieve it? By practice.

The second rule is subtraction. Once you have assembled a first draft of a presentation – using PowerPoint for instance – delete at least 20% of the material from individual slides/transparencies. You will find them quite a bit more effective.

For the text, select a single font for readability. However sexy they may look, sanserif fonts such as Arial or Geneva are hard to read. The serifs are the small slippers which letters bear on their feet. Their implied horizontal continuity helps the scanning eye. Personally, I favor a serif font such as Palatino or Times.

A fourth rule is to strive for continuity, built-in unobtrusively. Be attentive to the dominant color in your sequence of visuals. For instance, you might start with a light pink background and, rather than sticking to a uniform background for the entire presentation (often advisable) gradually work your way to a deep red. Speaking of such color cues, be attentive also to their psychological, i.e., cultural connotations.

My fifth rule is to maximize the iconic versus the textual content. Tables of numbers are an absolute no-no: only display your data with plots. Remember to show just a fraction of your data (Rule Two).

And what should your images be? Obviously, they need visual interest. Show images, which are a compromise between harmony and a jolt; the aesthetically pleasing and the informative; the obvious and the enigmatic. The mind enjoys having to do a little work – a little, not too much – when reading the picture. This is good. To gain understanding actively rather than as a passive viewer gives pleasure.

Include some whimsy. Don't hesitate to be a little outrageous. Back in the 1960s, before permissivity became widespread, during a conference of advertisers one of the speakers introduced a few mineralogical pictures among his slides. They just flashed through, with no comments on his part. His talk was a major success. In other words, keep your audience alert by, occasionally, showing it the unexpected. As in the above anecdote, the occasional surprise material, shown without comment, will spice up your talk.

Not only fantasy, beauty is also an essential ingredient. Ideally, each talk ought to include one piece of art capable of being exhibited separately, because it can stand on its own.

What about the twin projector mode, setting-up a counterpoint between two images projected together, next to one another and occasionally overlapping? Such an ambitious undertaking is worth the additional effort – and money, if you have the show prepared by professionals, which I recommend – only if the actual product shown to your audience is perfect. Moreover, it makes for a more passive audience: are you sure you really want it?

REFERENCE: E. R. Tufte (1997) *Envisioning information*. Graphics Press, Cheshire, CT.

gloomy and disquieting ↘

VOCABULARY

The atmosphere within your piece is determined by your wording. If you want it to be gloomy and disquieting to your readers, then just go ahead and make systematic use of complicated words. Conversely, if you would rather come up with an airy piece, one which readers will traverse self-confidently, then make sure to use short and simple words. Brevity

is golden. When in doubt, choose the shorter word. Use words that come naturally to you, words you would use in speech.

The English language has a huge vocabulary to draw from. A reason is that, following the invasion by the Normans in 1066, it became the juxtaposition of two languages. Latinate forms, imported at that time with the French language, coexist in English with Saxon words. The tradition has endured. The former, multisyllabic words abound in scholarly works; whereas the simpler, often monosyllabic Saxon words tend to be used in daily life.

A good rule is to comb your text for complicated Latinate words and replace them with their Saxon counterparts. This will lighten your prose. Examples? fast/rapid; speed/velocity; cloudy/nebulous; hint/suggestion; handbook/manual; settlers/colonists; get/receive; put together/assemble.

A second rule is sparingly use of recent **neologisms** in your discipline, if at all. Yes, I am telling you to renounce being trendy. You want your work to become a classic, right? Then, write in the classical manner. Eschew complicated words. Some of our colleagues have introduced them for their own reasons, in which one-upmanship has had a part.

Which is not to say that you ought to avoid totally using learned, seldom-used words. Any reader loves to learn a new word. Why? Young children, it is said, learn ten new words a day. In adults, the learning process slows down. But it does not come to a complete stop. Many of us keep learning, including new words. And this is enjoyable. A writer such as Stephen Jay Gould was very much aware of this urge on the part of readers. He provided them with the occasional mouthful word, one which he was astute enough either to define, when he introduced it, or one whose meaning people could readily guess simply from the context. My rule here is to put in – »put in«, rather than »insert« – such a nugget every 2,000 words or so.

REFERENCES: the switch from Latinate to Saxon is associated with Basic English, which C. K. Ogden introduced, rather successfully, in 1923 in his book with I. A. Richards (1965) *The meaning of meaning*. A good place to look-up the right word is *A dictionary of modern english usage*. 2nd edn, H. W. Fowler, E. Gower, reviser, Oxford University Press, New York.

WEBSITE

This is the contemporary calling card. Henceforth, you will be identified more and more by this presentation. Note, however, the role reversal. Yesteryear, you would present your calling card upon meeting a person. Now, you are not calling on anyone with your website. The whole world unbeknownst to you calls on you. In addition to the calling card, the website fulfills a number of other functions. For instance, it supersedes the list of publications which, of course, it partly includes.

How should you adapt to this switch in self-identification? What should and should not be posted on your site? Needed ingredients are a **capsule biography** of yourself, a selected **bibliography** of your publications, **abstracts** of selected papers and lectures, a few publications in full, chosen for their high significance or quality, a brief summary of the topics you are currently working on, the composition of the personnel in your laboratory, a guestbook (but only if you find the time to read it on a weekly basis), also perhaps a counter for the number of visitors.

The requirements are severe, which turns the creation of a website into a large investment in time and money. The main requirement is visual attractiveness. Take examples from magazines. Like them on the stand at a newsagent, you are in competition with many others. An unattractive website won't be visited. This is surely not your intent in putting one up for view and consultation. It has to be illustrated, for which you may well need a professional iconographer – at least a professional touch.

No wonder if graphic artists, made redundant by software available to everyone (such as Photoshop), did find another niche for themselves and are now designing websites. Yet, uploading a website calls also for other, complementary talents. It needs people capable of programming into various computer languages. It needs an expert in search engine optimization, for your site to be located easily, close to the top of the Google page – after your name has been typed in. It needs a person for key word research. Another specialist is required for usability studies. One of the mandatory subdivisions is links, they need to be built in. The site starts with a clear and simple index cover page, which is the responsibility of the graphic designer.

Once you have hired an outfit to design your site, be prepared for being called upon to provide information, repeatedly. The back-and-forth in the designing and building process is analogous to that with an architect and a contractor building a house.

These specialists will start by giving you a wireframe, i.e., a skeleton website indicating all the navigation, function and contents elements to be included in the final product. The wireframe lacks any graphic design elements. It serves as a blueprint for the later construction steps. Using the wireframe together with the sitemap, you and the designer will plan the textual contents. Writing them will be your biggest workload, it is time-consuming. A good designer will be attentive to your expressed needs and desires.

What is also time-consuming is the putting together of a draft version, then submitted to you. It will be improved with your feedback. And you will go through another cycle of submission, corrections and revisions and improvements.

After your site is uploaded, it needs to go through a final, testing phase by potential users, prior to being made fully functional.

REFERENCE: P. v. Dijk (2003) *Information architecture for designers*. RotoVision, Hove, East Sussex UK.

information overload 

WIT

Is not science utterly serious? Why then does it need a witty form of communication?

Because of the information overload we are facing. Our audiences privilege attractive messages. This holds true not only for the general public, but for our peers as well. Not only is a wittily presented piece lighter and thus easier to assimilate, it is also more likely to be remembered and recalled. Your aim is to combine being informative and entertaining.

How best can this be done? Can it be learned? My advice is to model yourself on speakers and writers whom you admire for their wit. They bring a playful attitude to their task. While respectful of their public, they seem to be fully at ease. Their personality shines through. They make playful use of words. Their very vocabulary is fun. It is fun because they spring little surprises. An occasional word in speech or from their pen is unexpected. It may borrow from everyday language, bringing fresh air into what would qualify otherwise only as specialized and highly techni-

cal scientific terminology. The unexpectedness may stem conversely from it being a word used relatively rarely even though readily understood.

But there are many other instances of wit apart from words. Wit is a state of mind, a mood. It has to be effortless, it has to sound natural. Cracking a couple of jokes at the start of a talk may be standard behavior for a salesperson or a politician, it is beneath the dignity of a scientist, as formulaic and definitely an unseemly kind of behavior.

The art of being witty thus entails being spontaneously bubbly, without letting it crystallize into distracting witticisms or puns. A good start is to put yourself into the shoes of the storyteller. You are presenting a narrative. Do so in a good-natured, seemingly spontaneous way. Practice doing so up to the point when you feel yourself in danger of losing it, of making yourself giggle from what you have just uttered. This is a litmus test of your wit.

A message which is not also entertaining is like one in a bottle dropped into the ocean. Only by the greatest of luck will it reach its recipients. You want to catch attention by being amusing, being careful neither to clown nor to mask your message with too pretty and too funny an envelope.

Get a handle on this talent by interspersing in your talk – this is done more easily in spoken than in written presentations – the occasional anecdote. Such inserts, almost mechanically, will infiltrate the rest of your talk with their light-hearted and genuine spirit. In so doing, you will grasp a basic notion, no effective communication without a modicum of amusement and entertainment.

REFERENCE: W. Strunk, Jr. and E. B. White (2000) *The elements of style*. 4th edn, Allyn & Bacon/Longman, New York.

rise to the challenge 