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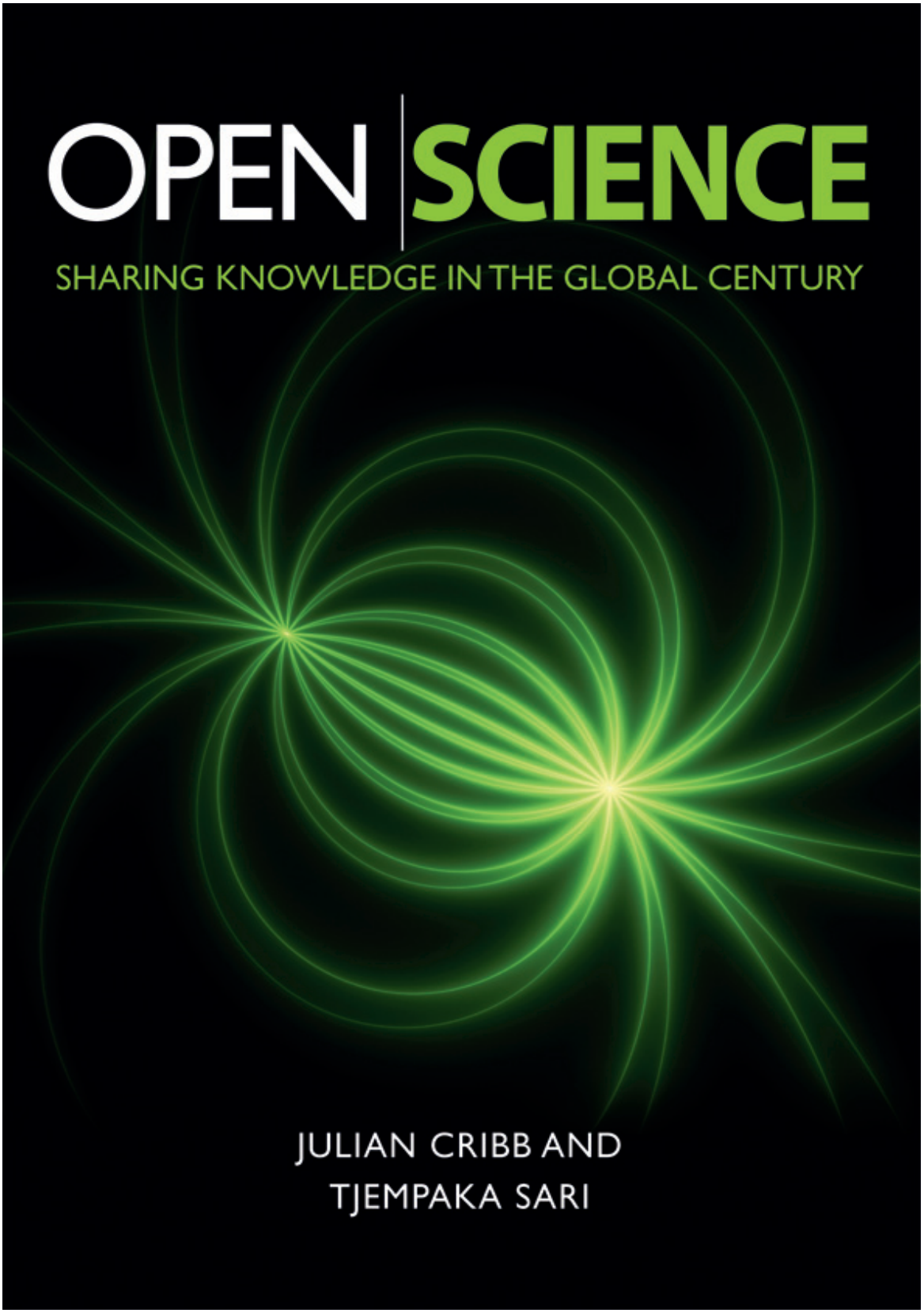

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Chapter 2

Good science writing

Science is by its nature complicated, making it all the more important that good science writing should be simple, clean and clear.

Alas, achieving clarity is something that escapes many scientific writers, whether they are addressing their peers, a knowledgeable but non-scientific audience, or society at large. Indeed, the reader often receives the impression that the writer has not thought much about their audience at all, as they struggled to give birth to long, tortuous and impenetrable prose, with clause piled upon clause, adjective upon adjective, idea upon idea. A good deal of science writing more closely resembles a train wreck than an act of communion with the reader: with words scattered like carriages all over the line.

Good writing begins with the need to pause and reflect on the audience. Who are they? What do they want from your science? How much time do they have for what you are about to tell them? What is their level of literacy or technical understanding? How do they speak and write themselves? What are the issues they are most concerned about or interested in? What will win their hearts or engage their intellects?

Finding out these things requires a skill at which scientists excel, but rarely, in this particular case, undertake: research.

In some situations the answers are easy to come by. Science journalists, for example, usually have a fairly clear idea of their audience, both from surveys carried out by their publisher and from first-hand contact with readers/viewers or receipt of their letters and emails. Technical writers for an industry or professional magazine often have a very clear idea who they are writing for. The communicator for a scientific institution,

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however, has the challenge of a wide diversity of possible audiences – government, industry, scientists, peers, non-government organisations (NGOs) and special interest groups, the general public and other 'stakeholders' – and has to tune the writing for each audience according to their needs. This often requires research. The same goes for scientists, who are passionate about their work and anxious to share its gems with a wider public: understanding this audience and its needs is an important first step in writing well. For the freelance writer, whose work may end up anywhere from full-length books to short news items, understanding the audience is even more critical, because making a living depends upon it. The advice in this chapter is generic. It is intended for all who write about science, in particular those mentioned above. It refers chiefly to writing for non-scientific audiences – the public, politicians, farmers, industry, and so on – but many of the principles apply equally to good writing in science journals, scientific and institutional reports, and on the internet.

SIMPLICITY IS STRENGTH

Complex ideas do not need to be conveyed through complex writing. Indeed, they are most easily understood by the reader if the language used is simple and clear. This may seem self-evident, but how often this rule is ignored! There are many reasons for this:

(a) The writer fears that simple language will not do justice to a complicated idea (or will 'dumb it down').
(b) Scientific terminology and expression is preferred for reasons of scientific precision, even if it is opaque to the reader.
(c) Writers fail to understand clearly the needs of their audience.
(d) The writer is unaware of how inaccessible professional language is to others.
(e) The writer does not in fact want people to understand what they are talking about because 'knowledge is power'.

The last is a salient and all too common feature of bureaucratic writing, but is also unpleasantly pervasive in the social sciences, education and other specialised research fields, which conceal their meaning behind a vocabulary designed to exclude uninitiated readers. For centuries, lawyers and priests used Latin to invest themselves with artificial mystique and power in the eyes of the public – and some of today's specialists are not much better. However, most of today's science is funded by the public via

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their taxes – and they deserve an explanation they can understand and, hopefully, make use of.

The true value of science to society depends upon it being explained in a simple, clear way that people can use in their lives, their work or their behaviour. Conversely, science that is explained in an over-complicated or obscure fashion stands a very good chance of never being used, or not being adopted as widely as it deserves.

In short, bad writing wastes good science.

What is bad writing? Well, most people know it when they see it. It is anything that puts a wall of words between you and the meaning. To illustrate the condition, here are two prize-winning examples from *Philosophy and Literature Magazine*'s Awards for Bad Writing:[1]

> *The move from a structuralist account in which capital is understood to structure social relations in relatively homologous ways to a view of hegemony in which power relations are subject to repetition, convergence, and rearticulation brought the question of temporality into the thinking of structure, and marked a shift from a form of Althusserian theory that takes structural totalities as theoretical objects to one in which the insights into the contingent possibility of structure inaugurate a renewed conception of hegemony as bound up with the contingent sites and strategies of the rearticulation of power.*

and

> *Indeed dialectical critical realism may be seen under the aspect of Foucauldian strategic reversal – of the unholy trinity of Parmenidean/Platonic/Aristotelean provenance; of the Cartesian-Lockean-Humean-Kantian paradigm, of foundationalisms (in practice, fideistic foundationalisms) and irrationalisms (in practice, capricious exercises of the will-to-power or some other ideologically and/or psycho-somatically buried source) new and old alike; of the primordial failing of Western philosophy, ontological monovalence, and its close ally, the epistemic fallacy with its ontic dual; of the analytic problematic laid down by Plato, which Hegel served only to replicate in his actualist monovalent analytic reinstatement in transfigurative reconciling dialectical connection, while in his hubristic claims for absolute idealism he inaugurated the Comtean, Kierkegaardian and Nietzschean eclipses of reason, replicating the fundaments of positivism through its transmutation route to the superidealism of a Baudrillard.*

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Deliberately, neither of these examples is taken from the scientific literature – to demonstrate to the scientific reader just how impenetrable and exclusive specialised language can appear to the uninitiated. However, there is plenty of science writing that is just as hard for the ordinary person to understand. The flaws are plain: long, tortuous sentences, specialised use of terms and concepts that obscure rather than clarify the meaning, piles of adjectives, pomposity, bombast and a general implied sneer at the intellect of the reader who cannot follow them. This reveals that bad writing can often be offensive as well as annoying. Bad writing is the opposite of communication – which is the sharing of meaning.

In all forms of writing – from poetry to journalism, novels and plays, to speeches and science writing – simplicity is strength. It is the foundation of good communication. Elaboration can come later. A good way to approach science writing is to write the first draft as one would speak to a person very like the audience you are writing for, using their common, everyday language. If this is the general public, write as you would address your aunt or uncle – a person of average intelligence, education and interests, but no scientific background. If the audience comprises politicians or busy senior executives, then write very concisely and with a high degree of impact. These people do not have time to read long, densely argued documents, but generally want only the headline messages. If the audience is farmers, fishermen, miners or foresters, then write as they speak, colloquially and using plain, practical language explaining how the science applies to their activities. Reading aloud what one has just written is a good way of 'hearing' whether it is readily understandable or not. Reading it to a non-scientist or member of the intended audience is better still.

One of the sins of science writing is verbosity – the use of too many words. Because so much science is written in a verbose style, especially in textbooks and journal articles, many scientists find it hard to break the habit. It is, after all, the language to which they are most accustomed; they have had to penetrate its thickets ever since they were undergraduates. Not so the ordinary person who simply finds it incomprehensible and soon loses interest, or is distracted by the effort required to extract the intended meaning from the writing. Scientists sometimes complain that when they explain their work to lay people, they see their audiences' attention wander. The phenomenon is known as EGO (eyes glaze over). It does not mean that the science is intrinsically uninteresting – just that it is being explained in a way that does not engage the audience. This applies to writing, too, but without the warning signs.

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The first building block in simple writing is to use short sentences. The full stop is one of the most useful devices in science communication because it allows the reader pause to digest a complex or important idea. This is essential, if science is to achieve full value. Also, it avoids the 'train wreck' of subordinate clauses created by long, turgid sentences, packed with too many ideas and qualifications. It enables the reader to absorb the ideas in bite-size chunks and order them in their mind. It can be used more or less where one would draw breath if speaking the words aloud. It can also be used to create a staccato effect, which is important to high-impact writing, though less desirable in longer articles or documents. The short sentence works well in science journalism, in writing for the internet (where the eye may be tired by sentences that last for several lines), in writing for politicians and executives, and in writing speeches for general audiences. A short sentence usually consists of a subject, a verb and an object. It can have an elegance and an impact all of its own, without having to plunder the thesaurus.

Short sentences impose discipline on the writer. They compel you to ask 'What am I really trying to say here? What is the most important statement to make first, which can then be qualified or explained in subsequent sentences?' Short sentences encourage clarity of thought and expression. In science this is very important because, just as people tend to form judgements about other people if they wear ragged clothes, speak badly or have poor personal hygiene, people also form judgements about science based on how well it is communicated. This is human nature, and there isn't much one can do about it. Clear, concise writing suggests that the scientist has thought clearly about the issue concerned. Turgid, abstruse and laboured language, on the other hand, conveys an impression of muddled thinking and not caring much about the reader: it does the science itself a disservice, which in turn may limit its value (as well as the prospects of its researchers).

The art of writing a short sentence lies in reducing the number of subordinate clauses. This means keeping to a minimum the number of clauses beginning with 'which', 'that', 'who', 'when' and other qualifying words. For example, we could easily have written the previous two sentences as a single sentence of 35 words, with the word 'which' joining them. We chose instead to break it in two, without harming the meaning but slightly improving the clarity. Short sentences do not devalue science. They enhance it. Using short sentences also obliges the writer to decide which is the most important fact and present it first, instead of running everything together in a single sentence and making the reader guess.

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As with roses, the secret of concise writing lies in hard pruning. After producing a first draft, it is essential to go back over it and strip out every needless word or phrase. You may be surprised how often three, four or five words can be replaced by a single word. Believe it or not, there are few pieces of scientific writing that cannot be improved by removing half of the words initially used. Try it! When writing about science, prune, prune and prune again. Eliminate all extraneous expressions, clumsy phrases, non-essential adjectives and adverbs, and obscure or bureaucratic terminology. Rephrase more economically. Then, having stripped the writing to its bones, you can return to it to elaborate, as required. This is how to write well: building the edifice on a plain but strong foundation.

The gardener often enjoys the act of pruning, knowing it will result in a good crop of flowers. Likewise, the act of pruning one's writing can be enjoyable: seeking to convey the absolute essence of what one is describing. Many people, including many scientists, find writing an unpleasant chore, rather than the fulfilment of their research. Pruning can make the labour pleasurable, as well as enhancing the meaning and significance of the science itself in the minds of those who read about it.

CURING OLD VICES

Common vices in science writing include the use of the passive voice instead of the active, the use of the subjunctive mood instead of the present or future tense, the over-use of adjectives to describe a single noun, and the use of professional terminology or 'jargon'. It is quite easy to purge oneself of these bad habits without having to go back to school to study grammar and syntax.[2]

A great deal of science is written in the passive voice, rather than the active. The active expresses the action directly: 'We pursued the research'. The passive focuses on the object being acted on: 'The research was pursued by us'. The reason for overusing the passive voice probably lies in the desire of scientists to appear objective and impersonal when describing experiments and their results. However, science uses the passive to gruesome excess; this makes the writing ponderous and less easily digested than it should be. It adds unnecessary words – in the above example, 50 per cent more words are used by the passive. Writing for the public should avoid the passive voice as far as possible (e.g. instead of saying 'The passive voice should be avoided in writing for the public …'.). Even scientific editors no longer favour the passive. Search for it in your writing and convert it ruthlessly to the active voice. Your prose will sparkle with new vigour and directness.

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For example: 'In this study the chemodynamics of heavy metals in soils were investigated.' Why not simply 'In this study we investigated the chemodynamics of heavy metals in soils'? Or instead of 'A new treatment for diabetes has been developed by Australian scientists', just write 'Australian scientists have developed a new treatment for diabetes.'

The use of the subjunctive mood is a common feature of science writing, which makes it more turgid and its meaning more vague and uncertain to the reader. Without getting into technicalities, the subjunctive is characterised by the use of words like 'would', 'could', 'should', 'may' and 'might'. These are often preferred by scientists to the use of the present tense (is, are) or the future tense (will, shall). However, they increase uncertainty in the reader as to what is meant – and removing them often does little damage to the sense. For example, in the sentence 'Heavy metals could pollute soil or groundwater … ' the word 'could' can be omitted: 'Heavy metals pollute soil or groundwater … ' This is simply a cleaner, more direct way of writing, which avoids the subjunctive but does not significantly alter the intended meaning. It expresses the meaning more directly and with less uncertainty.

Of course, science often wants to convey a degree of uncertainty, and this is the reason for the ubiquitous 'could' and 'would'. However, this is often faulty reasoning on the part of the writer. Uncertainty can be conveyed directly by stating that the conclusion is not certain, or open to different interpretations, and explaining why. This is more direct and honest than using syntax to obscure the meaning, and the reader will appreciate it. Where it is unavoidable, the word 'may' is often preferable: 'The universe may end, not in a bang but a whimper … '

STRUCTURING THE ARTICLE

The traditional scientific journal article begins with a few general statements about things that are usually well-known or accepted. It then outlines the background to the research, provides a description of the experiments carried out and their methods, reports and discusses the results, then finally draws a conclusion from them and discusses its wider implications. The reader must work their way through each of these steps in order to be rewarded with the finding.

A science article written for the media or a lay audience, on the other hand, adopts almost exactly the opposite structure. It reports the main finding and its impact on society in the very first sentence, then explains who did the research and why, adds further detail and finally, if there is room, goes on to discuss what most scientists would see as the main game

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– the research itself. This is because audiences are usually more concerned about how the science affects them directly than they are with the method by which it was achieved. They are users of science, not its practitioners.

In journalism, the conclusion is nearly always presented first and the rest of the article then expands on this, providing the reader with the supporting evidence for the initial claim and the background to it. This structure has since become common in many forms of reporting: corporate and government reports, for example, present their findings in an executive summary – often a series of terse bullet points – so the busy reader can seize the essence without having to wade through the detail. In journalism, most readers read the first few paragraphs, but few make their way to the end of the article. If important information is placed here it will be lost (or even cut out completely by the editor).[3]

This 'upside down pyramid' article structure, with the most important fact first, achieves a much higher impact on the reader and is likely to stick in their mind longer. Where there are several important findings from the research, the article will present them one at a time in the first few paragraphs, rather than risk obscuring or losing some key points by running them all together.

Scientists often assume the reason they are doing their work is self-evident, but this is often not the case. A good science article therefore makes clear, in its opening paragraphs, *why* the research is being carried out – to save lives, prevent environmental damage, improve industrial productivity, and so on. Indeed, it is on this simple fact that the importance of the article and its chances of publication depend. If it is omitted, the relevance of the science to the reader may well be lost. The editor may regard the story as unimportant and 'put it on the spike' (discard it).

The credibility of science with the public often depends on who performed it, so the science article identifies the researchers and institutions involved early on. This is a sign to the reader – who may be unfamiliar with journals and peer review – how trustworthy the information is. However, a good article or media story does not waste space on long wordy names, titles or teams.

A good science article often goes directly to the meaning of the science to society, rather than to the science itself. This is especially the case with a new technology or piece of applied science. The exception would be a 'blue sky' discovery, or findings from fields such as astronomy or palaeontology without immediate practical application. In these cases, the article will dwell on the sheer wonder or novelty of what has been found and seek to engage the reader through their curiosity about the natural world.

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To engage the reader at the outset it is vital to choose a strong heading. Unlike a scientific paper, where the heading often describes the research, a heading in the media, a press release, a book or a report is intended to catch the eye and capture the attention of the reader – not to inform them. It is usually concerned with the impact of the science, not with the science itself. It is an advertisement for what follows, not a synopsis of it. For this reason, a strong heading is usually short – three to five words work best. An attractive heading may also use mystery, humour or an unusual word to attract the reader. All it needs to do is entice them into reading the first paragraph, which then delivers the main message of interest and lures them to read on.

An effective piece of science writing often has only one idea per sentence. As mentioned above, this gives the reader time to digest important facts.

Where high impact is required, occasionally use only a single sentence per paragraph.

The white space between the paragraphs emphasises the point being made in a delicate way, without using exclamation marks, underlining, **bold type** or *italics*. In fact, the last three can offend the reader, as they are the typological equivalent of shouting at them (like using CAPS in an email).

Good science writing is usually very economical in its use of language. It compensates for complexity by elegance and simplicity of expression and choice of words. It avoids pomposity or talking down to the reader. It goes directly to the wider significance of the research and why it was done. It explains its relevance to the general reader, rather than to science. It seeks to convey a sense of wonder, where appropriate, but does not exaggerate or overstate. It is checked with the scientist, to ensure accuracy. If there is room, it refers to doubts, criticisms and alternative interpretations of the science.

JARGON AND BUREAUCRATESE

Scientists use language in very particular ways in order to convey specialised meanings. This works fine among the peer group but it can lead to confusion, ambiguity and misinterpretation externally. Because science itself is concerned with being as precise as possible, it is a great shame if it loses precision because its audience misunderstands what they are told. In science, new words are often coined to describe new phenomena, or else old words are given new meanings to which the public is not privy. Scientists sometimes forget this.

For example, a soil scientist may refer unthinkingly to a soil layer as a 'horizon', whereas his lay audience may wonder what that line the sun goes

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behind is doing at the bottom of a hole. This is a case of one word having two (or more) meanings: technical and general. Classically, scientists often refer to their 'models', blithely unaware that many people in society think a model is an elegant person sporting stylish clothes, or alternatively, a small plastic aeroplane. In the sentence 'We are using a new model to predict rabbit populations…' the average person may be puzzled why the scientist would employ a mannequin to forecast rabbit plagues – and probably wonder how the scientist came by such a generous budget!

Scientific terms slip off the tongue, or the keyboard, very easily, and great care must be taken to avoid them or at least to translate them for the audience. Is a base an electron pair, a headquarters or the bottom of something? Is a phase part of a waveform cycle or a period in your life? Is a port the plughole in a computer, a place for ships to dock or a fortified wine? Is a bond a chemical link, a financial instrument or a manacle? Context will usually supply the answer, but one can never be sure what all readers will make of it and science writing must always be scanned carefully for such ambiguities.

A good test for whether a word is jargon is to imagine oneself standing at the supermarket checkout and saying the word to each person as they come past the cash register. How many would be able to provide even a rough explanation of the meaning? If the answer is 'not many', then the term should be avoided and a more common term used.

Avoiding scientific jargon is not as hard as it seems, as articles written for the public, for government and even industry usually focus on the application of the science, not on the science itself. It is nearly always possible to describe the application of science in plain language. Nevertheless, scientists sometimes complain that the translation of science into plain language 'devalues' it or 'dumbs it down'. However, if the use of scientific terminology will only cause the audience to misunderstand – or, worse, completely misinterpret what is being said – then it makes no sense to use it, as the result will only be confusion. Scientists should never expect people outside their discipline to understand the exact meaning they ascribe to a specialised term – even an apparently simple one like 'model'. Every effort should be made to re-phrase the language so that it has meaning for the audience. This sometimes takes more time and effort than some researchers can spare, and is the reason for the growing value of the skilled communicator as a messenger and interpreter between science and society.

Another challenge for the science writer turning scientific reports or articles into stuff the public can understand is 'bureaucratese': the leaden language of the public servant. Nowadays science is often twice as difficult

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to understand because it mingles scientific jargon with bureaucratese. This language is supposed to be dispassionate, but in fact it is usually clumsy, verbose and hard to read. It too favours the passive and the subjunctive, as well as a whole lexicon of specialist terms intended to exclude the uninitiated. Indeed, bureaucratese is often deliberately designed not to be understood, or else to be ambiguous, in order to withhold knowledge (and power) rather than share it. Because a great deal of science happens in bureaucracies – in universities, research agencies or government departments – the two languages often become horribly intermingled, resulting in a disaster for clarity and for the communication of science. In writing about science, it is very important to purge bureaucratic language as well as technical terms.[4]

A nasty bureaucratic habit is to refer to everything by its initials or its acronym. This is fine if you know what it means – but is simply gobbledegook to the general public. Acronyms are bad in several ways: first, because they are meaningless by themselves and cannot even be looked up in a dictionary; second, because the phrase from which the initials are drawn is usually badly chosen and not easy to guess; third, because acronyms break the flow of meaning by forcing the reader to pause and puzzle over them; and fourth, because they sneer at the person who has not been initiated into the secret of their meaning.

A related phenomenon, even where the acronym is explained, is 'alphabet soup' – the excessive use of initials, as in the following example:

> *The FAIMMS sensor network will utilise leading edge technology to provide real-time 3D profiles of reef systems at seven sites along the Great Barrier Reef (GBR). AIMS is the national operator of FAIMMS, which is one of the components of the Great Barrier Reef Ocean Observing System (GBROOS), for which AIMS is also responsible. GBROOS is part of a nation-wide collaborative program, the Integrated Marine Observing System (IMOS), designed to observe the oceans around Australia.*

It is possible for the general reader to fathom what is meant here, but the over-reliance on obscure abbreviations creates constant hiccups in the flow of meaning and should be avoided.

Another common vice of scientific (and bureaucratic) writing is to attach too many adjectives to a single noun. Sometimes as many as five, and even seven, adjectives may be piled onto one poor, struggling, inoffensive little noun. The words 'one', 'poor', 'struggling', 'inoffensive' and 'little' are the adjectives that describe the word 'noun'. The use of such strings can

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perplex the reader, who has to decide which adjective is the most important in the context, and how each adjective affects all the others. The use of too many adjectives to over-describe an object is bad writing and unnecessary. If the adjectives are essential they can be distributed over several sentences. In reality, however, most of them can be left out without losing meaning. This improves both clarity and ease of reading. When pruning one's work, it is good practice to remove all adjectives. Then go back and see which ones are truly vital and allow these alone to stand.

WHO? WHAT? WHEN? WHERE? HOW? WHY?

A good science article answers all these questions. Especially it answers the question 'why?', explaining to the reader the reason the research was carried out, and why it is important to humanity. The reason why is often taken for granted in scientific writing, which is a big mistake when writing for a wider audience.

Each question helps to establish the meaning of the science to the reader. 'Who', for example, explains who is affected by the science, and who performed it. This conveys both its relevance to society or industry, and its trustworthiness, embodied in the name of the research institute or corporation. 'What' explains what was actually done. 'When' conveys to the reader whether this is new knowledge, or 'news'. 'Where' is important because people habitually think of their own locality first, and science performed locally by local researchers addressing local problems is of much greater interest than science performed in some other country by and for people they have never heard of. 'How' explains how the science was actually performed and how it affects the community.

LIVELY WRITING

Good science writing contains passion. In this respect it is quite unlike scientific writing, where the goal is to be objective and engage the reader's mind through fact alone. Science writing seeks to engage both intellect and feelings, making it one of the higher literary forms. It should intrigue and inspire, and provoke surprise, wonderment, fear or excitement. It can be clean, elegant, even beautiful. It can have rhythm and music.

Passion can be displayed in many ways – in the choice of words, the vigour of the prose, the cadence of the sentences, the use of metaphor and analogy, and the colour and pace of the language. Just as we are engaged by

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a lively speaker more than by a dull one, science can hold greater significance for the reader if the writer allows their feelings to show. This is why it is often a challenge for the trained scientist to make the conversion from the cold, dispassionate prose in which findings are habitually reported to the livelier style required to convey it to a wide audience. However, many accomplish it with triumphant success – Jared Diamond, Richard Dawkins, Stephen Hawking, Stephen Jay Gould, Paul Davies and Tim Flannery, to name but a few.

Books, magazines, newspapers, the internet, TV and radio are nowadays chiefly designed to entertain – and when science appears in them, it too must entertain as well as inform. It should court controversy rather than avoid it, as debate is the fuel of democracy. It should present itself in lively ways, with plenty of direct quotations (as distinct from indirect quotes or citations), because the spoken voice lends vividness and immediacy to the subject. It should employ familiar imagery from sport, the arts or daily life to help make the unfamiliar familiar.

Good science writing uses punctuation thoughtfully, to aid the reader's understanding by pausing in the right places and avoiding long, complex sentences. Commas and full stops both achieve this and can be used plentifully (though not before conjunctions such as 'and' and 'but', which are supposed to join sentences together). There is a lot of confusion over the use of colons and semicolons. As a rule, a semicolon can be used to divide a sentence more strongly; this avoids breaking it in two; all parts of the sentence should have a verb. A colon can be used to highlight what follows: as illustrated in this sentence. It can also be used at the start of a list of facts or statements.

Exclamation marks rarely have a place in science writing as they give it an exaggerated, rather shocking quality, which is not always in keeping with the serious nature of science and responsible writing. Used sparingly, however, they can arrest the reader! They can also convey humour, irony or strong emotion.

Do rhetorical questions have a place in science writing? We would say that, on the whole, they do not, for the simple reason that they look as if the science writer is asking the non-scientific reader a scientific question. This is both silly and irritating. Rhetorical questions are fine in rhetoric, where the speaker may use them to keep the audience awake. In prose they are a distraction. They are more a feature of the undergraduate essay than the well-constructed science article or news report. Science is all about asking questions and seeking answers to them, but these questions do not have to

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TIPS FOR GOOD SCIENCE WRITING:

- In science writing, meaning is more important than style.
- Choose language your audience uses habitually. Relate the science to their interests, not yours.
- Simplify first, ornament later.
- Prune up to half the words you first wrote. Strip out adjectives and adverbs. Replace only those most essential to the meaning.
- Rewriting is as important as writing. Work through the first draft quickly and then come back to tighten and improve it.
- If you are struggling with a sentence that has become too long, kill it and start again. Waste no time on a sentence that has gone wrong.
- Write several short sentences in preference to one long, cumbersome one.
- Don't start important writing late at night or when tired. Sleep on it and allow your subconscious to order and structure it.
- The hardest paragraph is the first one, as it has to catch the reader's attention. Don't let it put you off. Write whatever seems good, then press on with the rest of the article and return to rewrite the first paragraph. Rewrite it four or five times until it says exactly what will capture the reader's attention.
- Avoid the passive. Avoid the subjunctive. Avoid too many adjectives and adverbs.
- Use short sentences and short paragraphs. Punctuate to give time for thought.

be rhetorical – that is, addressed directly to the reader. They can simply be framed as the question that the scientist is trying to answer.

Another common error in science writing is the use of 'statements of the bleedin' obvious'. Poorly written science articles often begin with one of these (perhaps because scientific papers usually do, as they proceed from what is well known to what has just been discovered). In science writing there is no such need. In fact, the use of such statements interferes with the telling of the story as they force the reader over dull and familiar ground, rather than telling them at once what is new and fresh. In a world awash with new information, concealing the main point of a science story behind obvious or well-known facts only reduces the number of people who will read it and use the knowledge. Most do not want to waste time reading about things they already know, so they rapidly browse on to something more stimulating. Statements of the bleedin' obvious are the enemy of good science writing and should be avoided, especially in journalism and media releases.

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WRITING FOR THE INTERNET

Writing for the internet is not so different to writing for the print media. Prose that is short, crisp and clear works best on a computer screen. Concise paragraphs, plenty of headings and white space avoid tiring the reader's eyes and hold their attention far better than slabs of type.

Internet users are quite often young and impatient, rather than old and persistent. They scan, rather than read. This means that the writing should be seeded with words that will catch their attention and invite a closer look. Today's internet user is like a grasshopper with a short attention span, skipping from item to item or site to site, often in microseconds. Dull writing and text-heavy layouts cause them to skip away. As a rule, good web writing:

- is short, sharp and snappy
- is fresh and newsy
- has the main point at the top
- uses dot points and crisp delivery of facts
- has informative headings
- has an open, attractive layout
- contains reputable information sources
- links to places the reader can find out more
- is more concise than scientific and print media writing
- has one idea per paragraph
- is illustrated with attractive thumbnail images.

Much is written about website design, but as a rule a clean, uncluttered layout with plenty of white space works better for science than one jam-packed with small items, boxes, ads and gizmos. It looks more authoritative and less amateurish. It conveys information more efficiently. It is less difficult to maintain and keep in good order.

The essence of the internet is that it is a public highway. One of the worst crimes habitually performed on it is to create a website that invites the public in – and then closes the door in their face. This poor outcome is achieved by:

- making information hard to access and contacts hard to find
- hiding phone numbers and email addresses
- concealing the identity of staff, providing poor searchability; making the site look stale by failing to refresh its content
- using clunky online forms
- having poor navigation and searchability

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- putting firewalls and password protection everywhere
- using poor, uninformative writing
- generally making visitors feel they are unwelcome.

With those caveats, the internet is one of the most important outlets for good science writing and open science – and one that by 2010 reached over two billion people all around the world.

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