How can we boost the impact of publications? Try better writing

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Peer-reviewed articles are the currency of science. They create knowledge and enable discovery. Despite this fundamental role, peer-reviewed articles tend to be written in a dry, dense, and impersonal style that can be challenging to read and understand (1–4). There are many potential benefits for writing in a more accessible style, from promoting much-needed communication among disciplines to making science more accessible to a broader community (5, 6). But good writing takes time for both the author who writes it and the institutions that teach it. So, is there really any benefit to writing better? We believe there is, and we believe our preliminary research underscores that conclusion.

To address the impact of better, clearer writing, we analyzed 130 peer-reviewed articles for 11 measurable

Our preliminary results suggest that better-written journal articles garner a bigger, broader audience for authors' work. Image courtesy of Tullio Rossi (artist).

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Table 1. Measures of writing style

Component	Meaning	Method of measurement	References
Word count	Word count is the most apparent component of an abstract. Longer abstracts include more ideas, but this can come at the expense of clarity.	Number of words in the abstract.	7, 8, 11
Setting	Setting gives context by placing the research in a time or place.	If the abstract explicitly mentioned a time or place, the abstract scored 1. Otherwise, it scored 0.	7
Narrator	Narrator refers to authors who refer to themselves in the first person.	If the authors used the words "we" or "I," the abstract scored 1. Otherwise, it scored 0.	1, 3, 7
Conjunctions	Conjunctions provide links between different ideas.	We counted the number of conjunctions that denoted cause and effect, contrast, or ordering.	1, 7
Signposts	Signposts provide a clear structure or order for ideas.	We counted the number of times a sentence or idea was introduced by using a number or an adverb denoting order (e.g., firstly, finally).	12, 13
Punctuation marks	Punctuation marks link ideas in nuanced ways, enabling the author to direct the reader's attention.	We counted the number of colons, semicolons, and dashes that appeared between words.	1
Consistent language	Consistent language reduces complexity by using consistent terminology.	We counted the number of times a word or phrase in a sentence was the same as a word or phrase in the sentence immediately before but only where the meaning was the same.	1, 7, 12
Parallel phrasing	Parallel phrasing reduces complexity by using a consistent sentence structure.	We counted the number of times that the subject of a sentence was the same as the subject immediately before it.	1
Hedging	Hedging uses qualifiers (e.g., largely, has the potential to, may) to dampen the confidence of statements.	We counted the number of adverbs, prepositional phrases, and auxiliary verbs that were used to hedge.	1, 3, 12
Acronyms	Acronyms shorten phrases to save space, but they also reduce the clarity of the phrase's meaning.	We counted the number of times acronyms were used. We did not count acronyms that were not defined in the text because some acronyms appear in day-to-day language (e.g., DNA).	1, 11, 13
Noun chunks	Noun chunks are strings of multiple consecutive nouns. Noun chunks connect objects or ideas in ambiguous ways.	We counted the number of chunks of three or more nouns (e.g., biodiversity conservation concern; distance education practice).	1, 12, 13

We analyzed each abstract for 11 measurable components. The components represented the principles of clarity, creativity, and narrative structure and were derived from psychology, English, and science communication.

components of writing style so that each component could be scored with minimal subjectivity (Table 1). These 11 components broadly reflect the principles of clarity, creativity, and narrative structure and are considered either common ailments of academic writing, such as the overuse of acronyms and noun chunks, or common remedies to improve academic writing, such as signposting (1, 3, 7, 8).

As a proxy for reviewing complete articles, we analyzed the abstracts, which reflect the overall writing style of entire articles (9). The abstracts were published in 2012 or 2013 and represented three timely topics with varying levels of influence (defined as the number of citations) in their respective disciplines. To capture variety within scientific publishing, we selected articles across three disciplines—environmental science, social science, and medical science. We then selected a specific topic representing each discipline: biodiversity loss, social media in education, and childhood obesity. These selections enabled us to analyze language and influence without the confounding factors associated with the article topic; different topics will attract different levels of attention regardless of how the articles are written.

We obtained abstracts from Scopus by stratifying search results by citations and randomly sampling from within citation groups. The 130 abstracts we selected included 48 abstracts for environmental science, 41 for social science, and 44 for medical science. As a measure of the articles' influence, we recorded the number of citations in Scopus on a set date (July 2018), and as a measure of the journals' influence, we recorded the 2017 Scopus CiteScore (impact factor). To test whether there is a benefit to writing better, we converted our 11 components into a single quantifiable index we call the writing index (see *SI Text*).

Our analysis suggests that influential articles (those earning 100–1000 cites) had more positive writing

components and were thus written more with the reader in mind. For instance, highly cited articles were short; used first-person narration; placed findings in context by providing a setting (e.g., "in the world's oceans" or "over the past 20 years"); linked ideas by using conjunctions (e.g., "therefore" or "conversely"), punctuation marks (e.g., semicolons and dashes), and consistent terminology; and avoided excessive acronyms and awkward noun chunks (Table 1). However, we also observed that less-influential articles (those earning fewer than 100 cites) spanned the entire breadth of the writing index. This observation suggests that less-cited articles not only contain positive components of writing but also tend to contain a greater proportion of negative components, such as noun chunks and acronyms. Crucially, articles that received higher citations were not defined by one component or a fixed set of components but rather by a varying combination of components (i.e., more citable writing could be achieved by using some of the 11 components but not all). This diversity suggests that there is no single formula for writing better.

But is there a benefit to writing better? Our model suggests that increases in clarity, narrative structure, and creativity could translate to a boost in citations (Fig. 1). Interestingly, an increase in citations was related to journal influence so that researchers publishing in broader journals had a greater increase in citations (impact factor 12, 74%) compared with researchers publishing in local or specific journals (impact factor 3, 26%). This suggests that the traditional style of scientific writing appears to restrain citations, but clarity, creativity, and narrative could remove this restraint and maximize citations.

Our results suggest that writing more with the reader mind produces more citations, regardless of career stage or where you aim to publish. Of course, there are important caveats. Article content and the context in which it was written can determine how influential an article is, regardless of writing style. Furthermore, condensing writing to a set of quantifiable components does not encapsulate everything that is good or bad about writing, a challenge that is difficult, if not impossible, to overcome entirely.

Yet our analysis is a first step toward understanding the benefit of writing with the reader in mind and gives some initial clues regarding what good writing in science can achieve. Although more citations do not necessarily translate to greater research impact, more citations do suggest a broader readership and may assist with greater knowledge transfer among peers and disciplines, greater research translation to industry, and greater uptake of research by the media, educators, and the broader community.

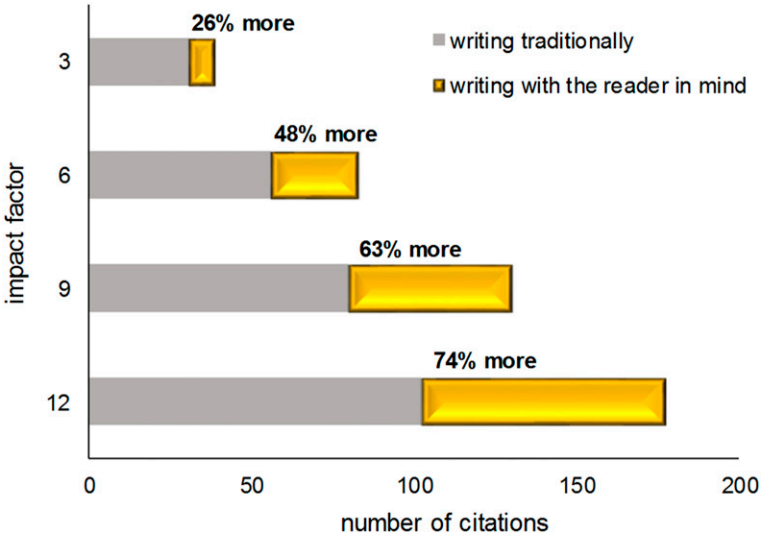

Fig. 1. Writing with the reader in mind can boost the citation rate of scientific articles. Based on our data, this boost occurs wherever you publish. But the higher the impact factor, the greater benefit you will receive. Bars show the number of citations each article has accumulated, on average, over a 6-year period. The grey bars represent articles written in the traditional style, and the gold bars represent articles written more with the reader in mind.

Science research is resource-hungry, and we should be making the most of the resources we use by writing better. Writing is underappreciated in science. Indeed, creativity and narrative structure, which were reflected in our 11 writing components, are seldom taught as part of science training. Imagine the results if we amplified writing quality beyond what we see today; imagine if writing were not just taught throughout a researcher's career but also taught with a focus on reader enjoyment (10). Imagine then the impact that science research could have.

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