Using Readability Statistics to Enhance the "Reading Ease" of Your Proposal or Manuscript

Often, a proposal or manuscript that describes innovative, truly praiseworthy science falls flat because the text is difficult to read. Too many long sentences and paragraphs filled with technical jargon can prompt even the most dedicated reviewer to decide to take some coffee – or a quick nap. If a reviewer has to read and re-read a page of text several times for full understanding, it is likely that your proposal will receive a low score, or your manuscript will be rejected.

The best scientific writers know that a proposal or a manuscript must tell a compelling story, and in language that entices one to get to the next part of the story. Professional grant proposal writers will advise novices to put in "white space" – empty space between paragraphs and around figures – to cut down on eyestrain from reading very dense text. But page limits may make that almost impossible, since you need to relate a complete story about your proposed project on those six or twelve pages.

Another technique to make your story move along in logical fashion, without reading like a series of lists or a cake recipe, is to vary your sentence and paragraph length. If all of the sentences in a paragraph are the same length, this produces a hypnotic, singsong effect that is a sure cure for insomnia. Long paragraphs composed of long sentences are often hard to decipher, and you find yourself reading the same paragraph for the third time just to understand the point.

How can one accomplish this without leaving out the important science?

The famous Cornell writing professor William Strunk, Jr. said it best in his classic *The Elements of Style*:[1] "Omit needless words." For example, you can easily cull out repeated expressions like "as well as" and substitute the shorter "and" – or rewrite to obviate the need for "as well as" altogether. Practicing just this one guideline will make your proposal narrative or manuscript succinct and easier to read, because every word will contribute to the story. Consider:

Original: "We conducted the first round of experiments with a vehicle-only control, as well as doing them with equal populations of male and female mice." (25 words, one sentence)

Revised: "We first ran a set of experiments versus a vehicle-only control. We also controlled for gender difference." (18 words, two sentences of unequal length)

It's easy to get the feel of varying sentence length and omitting language that doesn't advance your narrative on such a small sample, but harder to do for an entire manuscript or research strategy. That's where a readability statistics analysis tool comes in.

Microsoft Word has a readability tool embedded in its proofing code. Once set up in Word, an automatic calculation of Flesch Reading Ease and the Flesch-Kincaid Grade Level is done when you check spelling. They are named for Rudolf Flesch (author of *Why Johnny Can't Read*, 1955) and Peter Kincaid.[2,3]

As measurements of readability, Flesch Reading Ease and Flesch-Kincaid Grade Level both use the same data, average sentence length and average word length, but these are weighted differently for the two tests. Without going into calculation details,[3] they are inverse to each other – text with a high Flesch Reading Ease score will have a low Flesch-Kincaid Grade Level score and vice versa. A general sense of ordering of these scores for common publications can be appreciated by considering that *Time* magazine has a readability index of about 52, while the defunct *Reader's Digest* scores about 65,[3] and therefore *Reader's Digest* text will generally have a lower grade level compared to *Time*.

These measurements are sometimes not very useful for scientific writing, because we must use polysyllabic words throughout much of our writing, and often need to express an ordering of some parameter for many groups of test subjects, resulting in relatively long sentences. Therefore, often the Flesch Reading Ease for the proposals and manuscripts that you write will be in the low single digits, making it seem like your content is very hard to read. But this is all relative, and remember that your audience of readers will have an education and experience similar to yours.

Setting up MS Word to calculate and display readability statistics:

For PC users:

- Click “File”
- Select “Options”
- Select “Proofing”
- On the options under “When correcting spelling and grammar in Word” check the “Show readability statistics” box
- Click “OK”
- Upon return to document, run the Spelling & Grammar check.

For Mac users:

- Click “Word”
- Select “Preferences”
- Select “Spelling & Grammar”
- On the options under “Grammar” check the “Show readability statistics” box
- Click the red “exit” dot
- Upon return to document, run the Spelling & Grammar check.

Since these measurements are relative, you can use a “before and after editing” approach to compare readability statistics before and after a revision is made. Select a section of your text for spell checking – at least 100 words is advised – or you can simply spell check the entire document.

A sample readability statistics result, after completing spell check:

Consider the “original” vs. “revised” example from page 1:

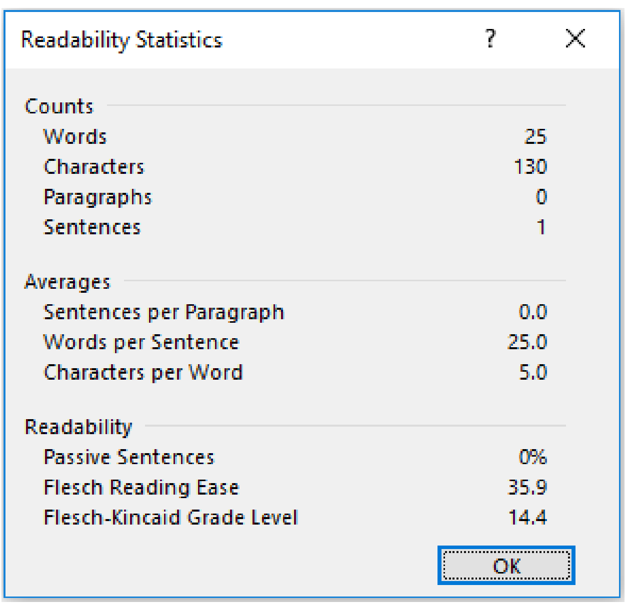

Fig. 1 “We conducted the first round of experiments with a vehicle-only control, as well as doing them with equal populations of male and female mice.”

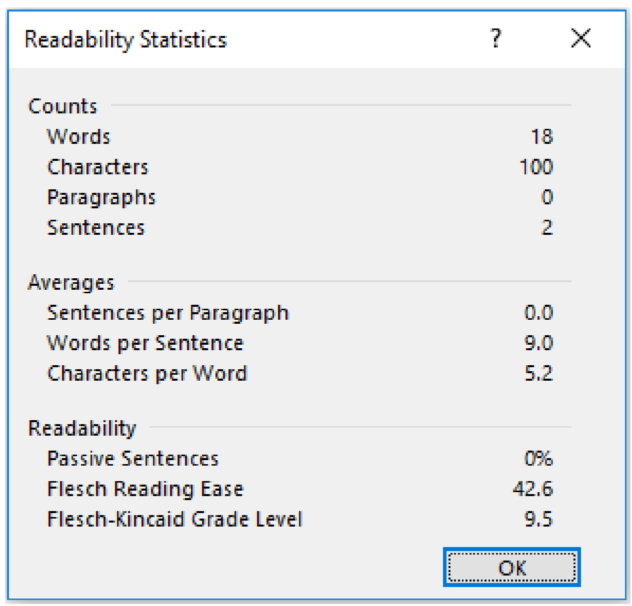

Fig. 2 “We first ran a set of experiments versus a vehicle-only control. We also controlled for gender difference.”

The content in the boxes is the actual way that the data appear after the text is spell-checked, given that the user has set up the PC or Mac spell checking function as described above. In revising the original long sentence into two shorter sentences, the Flesch Reading Ease increased from 35.9 to

42.6, and the corresponding Flesch-Kincaid Grade Level decreased from 14.4 to 9.5. In writing for peer-reviewed journals or for funding sponsors, the first text might be preferred – this example is just meant to demonstrate how to use editing to increase readability, in a comparative way before and after revisions are made.

Here's another example from an abstract published[4] by the writer of this training document:

Original text, with readability statistics:
Ultra-High-Molecular-Weight-Polyethylene (UHMWPE) is the material of choice for one of the articulating surfaces in many total joint replacements, notably hip and knee prostheses. The various methods used by the orthopaedic biomaterials industry to sterilize and anneal UHMWPE components, and the resulting oxidation and crosslinking, affect the mechanical wear resistance properties in ways still unknown at the microscopic and molecular levels. Transmission electron microscopy and chemical pyrolysis were used to quantify crosslinking induced by gamma irradiation and annealing in air. Changes in lamellar stacking and the amount of crosslinking suggest two types of crosslinking: relatively unstable crosslinks in the amorphous region initially resulting from gamma irradiation which are later replaced by more thermally stable crosslinks resulting from rearrangements at the annealing temperature. Lamellar mobility, the ability of crystalline lamellae to flow in the material, is enhanced during the transition from one type of bond to the other, and this appears to optimize near eight hours of annealing time. Results from decomposition and percent crystallinity measurements provide further support for this theory.
(Flesch Reading Ease 3.4, Flesch-Kincaid Grade Level 19.8)

After editing:
Ultra-High-Molecular-Weight-Polyethylene (UHMWPE) is the material of choice for one of the articulating surfaces in many total joint replacements, notably hip and knee prostheses. The various methods used by the orthopaedic biomaterials industry to sterilize and anneal UHMWPE components affect the mechanical wear resistance properties in ways still unknown at the microscopic and molecular levels. Oxidation and crosslinking resulting from annealing also play a role. Transmission electron microscopy and chemical pyrolysis were used to quantify crosslinking induced by gamma irradiation and annealing in air. Changes in lamellar stacking and the amount of crosslinking suggest that there are two types of crosslinking, which occur sequentially. First, relatively unstable crosslinks form in the amorphous region, initially resulting from gamma irradiation. These are later replaced by more thermally stable crosslinks resulting from rearrangements at the annealing temperature. Lamellar mobility [omit definition of "lamellar mobility"] is enhanced during the transition from one type of bond to the other, and this appears to optimize near eight hours of annealing time. Results from decomposition and percent crystallinity measurements provide further support for this theory.
(Flesch Reading Ease 15.2, Flesch-Kincaid Grade Level 15.8) Note: statistics checked before adding the explanatory phrase "omit definition of "lamellar mobility"" in brackets.

Note revisions, set off in red. The first revision broke up the long second sentence into two sentences, then the long sentence beginning with "Changes in lamellar stacking…" was revised into three shorter sentences. Finally the defining phrase "the ability to of crystalline lamellae to flow in the material" that defines "lamellar mobility" was omitted. The readability of the abstract improved so that its Flesch-Kincaid Grade Level shows that it is more accessible to an undergraduate reader, and the scientific content was not compromised beyond the omission of a technical definition, which can be fully explained in the article text.

Of course, we will usually not write at the undergraduate level for a peer-reviewed journal audience, but the changes in this example illustrate how one might use readability statistics to judge if a proposed revision will greatly enhance (or not) the ease of reading – and reviewing – one's proposals or manuscripts. Remember, if a proposal or manuscript reviewer feels "lost in the weeds" after only one or two pages of reading – you have probably lost that reviewer for a favorable score on your submission.

REFERENCES:

1. Strunk, W. and White, E.B. *The Elements of Style*. 4th ed. Upper Saddle River: Pearson; 2000. doi:10.1037/h0057532
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3. Wikipedia: the free encyclopedia [Internet]. Flesch–Kincaid readability tests. Available from https://en.wikipedia.org/wiki/Flesch-Kincaid_readability_tests
4. Viano A, Spence K, Shanks, M, Scott, M, Redfearn R, Carlson C, Holm T, Ray, A. Structural and chemical changes in ultra-high-molecular-weight polyethylene due to gamma radiation-induced crosslinking and annealing in air. Biomed Mater Eng. 2007 17(5):257-68.